SPORT AND PHYSICAL ACTIVITY PARTICIPATION AND SEDENTARY BEHAVIOUR AMONG ADOLESCENTS: EXPLORING THE TRANSITION FROM COMPULSORY EDUCATION

CHRISTOPHER STEPHEN OWENS

A thesis submitted to
the University of Gloucestershire
in accordance with the requirements of the degree of
Doctor of Philosophy
in the Faculty of Applied Sciences

May 2012

ABSTRACT

The move out of compulsory education is a key transition period in adolescents' lives. The aim of the present study was to investigate physical activity and sedentary behaviour (using 'screen time' as the proxy measure) among adolescents during the transition from completing compulsory education to entering further education, training or (un)employment. A prospective population-based longitudinal design was adopted, using a large cohort of adolescents in Gloucestershire. A questionnaire was administered to participants at two time points (baseline and follow-up). At baseline, 2204 Year 11 pupils (aged 14 to 17 years) and at follow-up, 886 participants from the baseline sample (aged 15 to 17 years) completed the questionnaire.

For all statistical analyses performed, two sets of analysis were conducted. Analysis one included the final sample of participants (n = 663) who had an associated output area (OA) code to include in statistical analyses and analysis two included the final sample of participants (n = 834) who did not have an associated OA code included in statistical analyses. Since the overall findings for each analysis were similar, only findings from analysis one are presented. For physical activity, there was a significant change in the number of participants meeting guidelines at baseline but not meeting guidelines at follow-up. For screen time status, there was no significant change between baseline and follow-up. Binary logistic regression (BLR) revealed that for gender, in comparison to males, females were 52.4% less likely to meet guidelines for physical activity at follow-up. Meanwhile, BLR revealed that there were no significant associations with screen time status at follow-up. Further BLR for the decline in physical activity through the transition, revealed that for gender, in comparison to males, females were 42.4% less likely to move from meeting guidelines at baseline to not meeting guidelines at follow-up (i.e., physical activity decline was associated with being male).

The findings of the present study have demonstrated: i) a decline in physical activity through the transition; ii) the high proportion of adolescents not meeting guidelines for screen time at either baseline or follow-up; and iii) associations between gender and physical activity during this transitional period. There is a need for future research to longitudinally examine adolescents' physical activity and sedentary behaviour during this transitional period.

DECLARATION

I declare that the work in this thesis was carried out in accordance with the regulations of the University of Gloucestershire and is original except where indicated by specific reference in the text. No part of the thesis has been submitted as part of any other academic award. The thesis has not been presented to any other education institution in the United Kingdom or overseas.

Any views expressed in the thesis are those of the author and in no way represent those of the University.

Signed: [redacted] Date: 3rd May 2012

ACKNOWLEDGEMENTS

Firstly, I would like to thank Prof. David James (University of Gloucestershire), Dr. Christopher Gidlow (Staffordshire University) and Mollie Gilchrist (Coventry University) for all their statistical support and advice regarding data analysis during the process of the present study. Your advice kept me focused on the task in hand when some important decisions had to be made. Particular thanks go to Dr. Christopher Gidlow for his technical support with postcode analysis – thanks Chris. Secondly, I am indebted to the co-operation and support from the schools and pupils within each school in Gloucestershire that I collected baseline and follow-up data from. Without these schools allowing me to visit and collect data, the completion of the present study could never have been achieved. I am very grateful to all headteachers, deputy headteachers, heads of Year 11 and pupils at each of the 24 schools that I worked with. I owe a great deal to all these establishments and individuals.

Thirdly, I cannot stress enough how grateful I am to my three supervisors: Dr. Diane Crone, Prof. David James and Dr. Mark De Ste Croix. Their constant support, guidance and above all, encouragement, enabled me to get completion, particularly in the period after my viva. I particularly owe a great deal to Dr. Diane Crone, who has always been there to support me and has given me the opportunity to pursue my research interests and my career in academia - thanks for having faith in me Di. I am also very grateful to John Stevens at Active Gloucestershire for providing me with financial support through the scholarship I was awarded. A big thanks to the University of Gloucestershire for also providing joint funding for my scholarship. A special thanks also go to Angela James at Gloucestershire County Council for her help with pointing me in the right direction regarding making contact with the schools during the data collection process. Thanks also to Prof. Jane Coad at Coventry University for her encouragement and support during the period after my viva. Finally, I am forever indebted to my girlfriend Kate. Thanks for supporting me through the last five years and for always being there during the difficult times. I certainly would not have got to completion without your constant understanding, support and encouragement.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

CHAPTER 1: INTRODUCTION

1.1 Introduction

There is widespread concern about the low levels of physical activity and high rates of sedentary behaviour in adolescents (Department of Health, 2004; Smith et al., 2004; Guthold et al., 2010). Lifestyle choices such as physical activity appear to be established as people proceed through adolescence, thus the amount of physical activity undertaken by adolescents in their teenage years is pertinent to such lifestyle choices in adulthood (Hallal et al., 2006a). Additionally, adequate participation in physical activity during childhood and adolescence may play a significant role in the prevention of chronic disease later in life (Twisk et al., 2002a; Smith et al., 2004). Increasing time spent in physical activity and decreasing time spent in sedentary behaviours is therefore a public health priority (Nelson et al., 2005). In recognition of these health benefits, physical activity (including taking part in sport) recommendations for children and adolescents have been developed in many countries worldwide including England[1] (Department of Health, 2004). These recommendations typically include a recommendation to undertake a minimum number of daily minutes (e.g., 60 minutes) of moderate to vigorous physical activity (MVPA) (Marshall and Welk, 2008). On the other hand, in relation to recommendations for sedentary behaviour, some countries have advised limiting sedentary time but do not attempt to provide a quantification of this[1] (The Sedentary Behaviour and Obesity Expert Working Group, 2010a). However, a number of countries have introduced specific sedentary behaviour recommendations for young people (e.g., Australia – Department of Health and Ageing, 2005; Canada - Tremblay et al., 2011). These recommend limits to screen based behaviours, most commonly recommending less than two hours a day of screen time (Television (TV) viewing, video use, computer use) for those aged five to 18 years (Koh, 2010; Salmon et al., 2011).

[1] New physical activity guidelines for children and young people (aged five to 18 years) have recently been published (in July 2011) in a U.K.-wide Chief Medical Officers' report (including a recommendation for sedentary behaviour – i.e., minimising the amount of time spent being sedentary (sitting) for extended periods). The implications of these guidelines are reflected in Section 8.6 on 'Implications of findings for future research and practice' in Chapter 8.

1.2 Physical activity and sedentary behaviour among adolescents

There is a wealth of evidence confirming the declining levels of physical activity through the period of adolescence (Raitakari et al., 1994; Caspersen et al., 2000; Kimm et al., 2000; McMurray et al., 2003; Thompson et al., 2003; Oehlschlaeger et al., 2004; Nelson et al., 2005; Eiðsdóttir et al., 2008). It has also been shown that physical activity levels continue to decline as adolescents transition into adulthood (Gordon-Larsen et al., 2000). In England, concern about the health of young people is associated with declining levels of participation in physical activity (Smith et al., 2004). Furthermore, the large proportion of young people in England who are not meeting the recommended guidelines indicates the importance of increasing young people's physical activity (Biddle et al., 2011a). In response to this concern, the United Kingdom (U.K.) Government has attempted to reverse the purported decline in young people's physical activity participation as recognised in official sport policies (e.g., Department for Culture, Media and Sport, 2000; Department for Culture, Media and Sport Strategy Unit, 2002).

In contrast to the wealth of physical activity research, the research into sedentary behaviour levels of adolescents is in its infancy (Gorely et al., 2009c). Most research into sedentary behaviour among adolescents has focused on highly visible and prevalent sedentary behaviours such as TV viewing and other screen-based media (referred to as 'screen time') (Henning Brodersen et al., 2007). The evidence to date indicates trends of increasing sedentary behaviour among youth (Salmon et al., 2011). For instance, in relation to the prevalence of children and youth not meeting screen based (screen time) recommendations, studies have shown large variability with reports of 34% (Marshall et al., 2006) to as high as 93% to 94% (Commonwealth Scientific Industrial Research Organisation, 2008). According to displacement hypotheses, sedentary behaviours such as watching TV, using computers and playing video games may reduce the time devoted to physically active pursuits and are possibly a reason for declining physical activity levels among adolescents (Tammelin et al., 2007). However, it is possible to meet physical activity recommendations and still engage in high amounts of sedentary behaviour (Pate et al., 2008; Salmon et al., 2011). Other research suggests that the declining levels of physical activity among adolescents are due to the transition that occurs when leaving school. Zick et al. (2007) suggested that this is because high school and college physical education classes often emphasise team sports which may be challenging to organise and participate in once individuals leave school.

U.K. studies investigating physical activity and sedentary behaviour among adolescents over a longitudinal period are lacking (Henning Brodersen et al., 2007). It is important that this is recognised because future research could possibly identify factors associated with the reduction in physical activity participation and an increase in sedentary behaviour among adolescents in the U.K. There has only been one longitudinal study conducted into physical activity and sedentary behaviour among a large cohort of English adolescents (Henning Brodersen et al., 2007). In this particular study, adolescents were tracked over five years between the ages of 11 to 12 years until 15 to 16 years in relation to developmental trends in physical activity and sedentary behaviour (i.e., screen time) in relation to gender, ethnicity and socioeconomic status. They concluded that there were marked reductions in physical activity and increases in sedentary behaviour between the ages of 11 to 12 years and 15 to 16 years over this five year period.

The study conducted by Henning Brodersen et al. (2007) is welcomed but they did not track their cohort beyond the school setting. Further, Leslie et al. (2001) have suggested that there has been no documented research into the patterns of physical activity around the time of finishing school and either entering the workforce or starting tertiary studies. Anderssen et al. (2005) proposed that this is because tracking physical activity during adolescence can be challenging because of cohort effects (exclusive influences on the cohort under study) and time trends (general population changes). Consequently, this research, through adopting a prospective population-based longitudinal design, aimed to address these challenges and the dearth of research in this area by investigating physical activity and sedentary behaviour (screen time) among a large cohort of adolescents during the transition from completing compulsory education in Year 11 and entering further education, employment, training or unemployment across one large English county consisting of rural and urban areas. The objectives of the study were:

1. To investigate whether there is a change in physical activity after completing compulsory education versus physical activity in Year 11.

2. To investigate the key associations for physical activity after completing compulsory education.
3. To investigate whether there is a change in screen time status after completing compulsory education versus screen time status in Year 11.
4. To investigate the key associations for screen time status after completing compulsory education.

1.3 Context for the research

The present study was undertaken and supported through a unique collaboration, involving a partnership between the University of Gloucestershire and Active Gloucestershire. Gloucestershire County Council also supported the present study in an advisory capacity. Active Gloucestershire are one of 49 County Sports Partnerships in England. The aim of Active Gloucestershire and all other County Sports Partnerships is to bring together local authorities, national governing bodies of sport, schools and school sport partnerships, Primary Care Trusts and other agencies involved with increasing participation in sport and physical activity. Active Gloucestershire are co-ordinated by the County Sports Partnership Network (Sport England, 2010).

At the commencement of this three year study, the topic of interest had not been decided upon but Active Gloucestershire and their Chief Executive Officer had stressed that they needed to acquire information on the sport and physical activity participation behaviours of young people in Gloucestershire. After extensive discussion between the research project team and Active Gloucestershire officials, it was decided that the focus of the present study should be on the sport and physical activity participation and sedentary behaviour of adolescents as they completed their General Certificate of Secondary Education (GCSE) examinations and the period afterwards. Due to the partnership between the University of Gloucestershire and Active Gloucestershire, the researcher was able to make strong links with the five school sport partnerships that cover the county of Gloucestershire. This enabled the researcher to establish a working relationship with School Sports Co-ordinators and Partnership Development Managers connected with each School Sport Partnership.

1.4 Research questions and thesis perspective

Due to the information required by Active Gloucestershire and the gap that exists in the evidence base concerning adolescents in the U.K. in this particular age group, four primary research questions were addressed and were directly related to the objectives of the study:

Research Question 1

Is there a change in physical activity in the transition between Year 11 and the period post compulsory education completion?

Research Question 2

How is physical activity post compulsory education completion associated with a range of independent variables?

Research Question 3

Is there a change in screen time status in the transition between Year 11 and the period post compulsory education completion?

Research Question 4

How is screen time status post compulsory education completion associated with a range of independent variables?

By determining if there was a 'change' in physical activity and screen time status during this critical transitional period, it would be possible to identify whether recommendations for physical activity and screen time are being met at either time point, and whether a decline, increase or no change in physical activity and screen time takes place in this life-changing phase (Research Question 1 and Research Question 3). Meanwhile, Research Question 2 and Research Question 4 were concerned with investigating factors associated with physical activity and sedentary behaviour (screen-viewing behaviours as 'screen time' was measured) after completing compulsory education when in further education, employment, training or unemployment. Investigating possible factors associated with each behaviour (correlates) would aid in targeting specific factors (e.g., gender) associated with the likelihood of meeting or not meeting guidelines for physical activity after completing compulsory education (Research Question 2) and meeting or not meeting screen time recommendations after completing compulsory education (Research Question 4). The most noteworthy aspects of this research that illustrate why the present study will make a significant contribution to knowledge are four-fold.

Firstly, the important transition period during an adolescent's life, in which the present study measures these key lifestyle behaviours over a longitudinal period, is under researched. Secondly, no other study in the U.K. has ever measured these behaviours during this transitional period over a longitudinal period of time, let alone longitudinally with such a 'difficult to follow-up' cohort. Thirdly, measuring both physical activity and sedentary behaviour at the same time is unusual in a longitudinal study but, as can be seen later in the literature review, there is a lack of studies measuring sedentary behaviour longitudinally nationally and internationally. Finally, some of the particular factors that were investigated in the present study (e.g., educational attainment, rural/urban area of residence, state/private school type) have either never been measured or have only been measured in a few studies in relation to physical activity and sedentary behaviour separately.

1.5 Thesis structure

Due to the lack of research in the U.K. into physical activity and sedentary behaviour among adolescents during the period between completing compulsory education and entering further education, employment, training or unemployment, it was necessary to conduct a detailed and extensive review of existing international literature from both a physical activity and sedentary behaviour perspective as applied to adolescents. Therefore, a large proportion of this thesis is comprised of four chapters (Chapter 2 to Chapter 5) which cover the literature in this particular area of research. A breakdown of each chapter for the entire thesis follows.

- Chapter 2 provided an explanation of the definitions used throughout the literature review and wider thesis. Terms such as adolescent, physical activity, exercise, sport and sedentary behaviour were then detailed. This chapter then contextualised physical activity and sedentary behaviour during adolescence and health outcomes such as cardiovascular disease, metabolic syndrome, overweight and obesity, type II diabetes, skeletal health (osteoporosis/bone health) and psychological well-being (mental health). The theoretical framework for this thesis was then explained.

- Chapter 3 detailed the measurement of adolescents' physical activity and sedentary behaviour with a main focus on self-report questionnaires. Sections then followed on adolescent physical activity and sedentary behaviour recommendations. Policy that surrounds both behaviours was then discussed.

- Chapter 4 reviewed the evidence that surrounds adolescents' physical activity and sedentary behaviour. Self-report studies adopting a cross-sectional and longitudinal design were looked at separately for each behaviour with summary tables included for cross-sectional self-report studies and longitudinal self-report studies respectively.

- Chapter 5 focused on the factors associated with physical activity and sedentary behaviour (screen viewing behaviours) among adolescents. Systematic reviews on correlates for each behaviour were discussed. These were followed by a focus on selected factors of interest to the present study in relation to physical activity and screen viewing behaviours. An attempt was made at this point in the chapter to demonstrate some specific studies which have investigated the association between these particular factors and adolescents' physical activity and screen viewing behaviour. The chapter was concluded with a focus on the rationale for the study with a particular emphasis on the transition out of compulsory education.

- Chapter 6 provided detail on the methods used and what procedures were followed from the planning phase through to completion of data analysis. As the present study was longitudinal, a detailed account of how participants were recruited at baseline and then followed up later was explained. The data analysis undertaken and ethical considerations were also detailed.

- Chapter 7 reported the findings in relation to the four research questions and further additional statistical analyses undertaken.

- Chapter 8 discussed the findings for all research questions and further statistical analyses, and interpreted the findings in comparison to previous literature. Limitations of the study were also detailed, in addition to the implications of the findings for future research and practice. Conclusions were then summarised including the main findings and the primary implications.

1.6 Summary

This introductory chapter has provided the background to the area of physical activity and sedentary behaviour among adolescents in general and, in particular, in U.K. adolescents. The lack of research in the U.K. has been highlighted, especially research during the transition out of compulsory education, and the resulting objectives and research questions that form the basis for the present study were detailed. The present study has been put into context regarding the collaboration between the University of Gloucestershire and Active Gloucestershire. Finally, the structure of the thesis has been explained. Chapter 2 follows and is the first chapter of the literature review regarding key definitions, adolescents' physical activity and sedentary behaviour and health outcomes and the theoretical framework for this thesis.

LITERATURE REVIEW

CHAPTER 2: DEFINITIONS, HEALTH OUTCOMES AND THEORETICAL FRAMEWORK

This chapter is divided into three main sections. Firstly, definitions of terms that are important to the study are provided (i.e., adolescent, sport, physical activity, sedentary behaviour). Secondly, the link between physical activity and sedentary behaviour during adolescence and health outcomes is discussed. Thirdly, the theoretical framework for this thesis is detailed.

2.1 Definitions

2.1.1 Adolescent

It is important to define the terminology that is used throughout this literature review and thesis. Firstly, as the present study focused on a population of 'adolescents', an attempt is made to define this particular group. There is a great deal of debate surrounding the definition of an adolescent and it was only at the beginning of the twentieth century that psychologists first identified that adolescence was a new phase in the lifecourse (Hall, 1904). Pate et al. (1994) suggested that the term adolescent is operationally defined as including persons in the 11 to 21 years age range. However, the term 'young people' also includes adolescents and is typically defined as those under 18 years of age (Biddle et al., 2004a). This definition is supported by Cavill et al. who defined young people as 'people aged 5-18 years' (2001: p14). Stratton and Watson (2009) referred to adolescents in a recent review as those individuals aged 12 to 18 years.

Clearly, from these various definitions, the age parameters within which 'adolescence' lies (i.e., the age limits) are not clearly defined but Clarke (2010) suggested that it is generally assumed that it is a developmental stage, beginning with puberty and ending in the middle to late teenage years when physical growth is almost complete. Asmussen et al. (2007) proposed that there are three distinct phases of adolescence. Firstly, 'pre-adolescence' comprising those aged nine to 13 years starting with the onset of puberty and marked by a rapid growth spurt. Secondly, 'middle adolescence' includes those aged 14 to 16 years when the need for independence becomes more apparent and friends and peers come to have an increasing influence. Finally, 'late adolescence' includes those aged 17 to 19 years. This is the period when teenagers begin to disengage from their families accompanied by a gradual shift towards economic and emotional independence. Taking these definitions, for the purposes of the present study, participants were within the 'middle adolescence' phase during Year 11 and within the 'late adolescence' phase after completing compulsory education.

2.1.2 Physical activity, exercise and sport

There is also much debate regarding the definition of physical activity. Arguably, the most popular definition, because it is so frequently referenced, is the one proposed by Caspersen et al. who stated that physical activity is 'any bodily movement produced by skeletal muscles that results in energy expenditure' (1986: p127). Consequently, physical activity is a broad construct that includes almost all kinds of movement (Pate et al., 1994). Criticisms have also been targeted at this definition of physical activity suggesting that it is too broad and does not highlight the energy expenditure needed to improve health (Marshall and Welk, 2008). This has resulted in a range of experts and organisations, and in particular, the American College of Sports Medicine, defining physical activity as bodily movement that causes a substantial increase in energy expenditure (Marshall and Welk, 2008).

Exercise is a subset of physical activity that is defined by Caspersen et al. as 'planned, structured, and repetitive bodily movement done to improve or maintain one or more components of physical fitness' (1985: p128). Sport is an important term used throughout this literature review and is defined by the Department of Health (2004: p81) as:

> *...a subset of physical activity, which involves structured competitive situations governed by rules. However, in mainland Europe, and increasingly within the UK, sport is often used in a wider context to include all exercise and leisure physical activity.*

Sport is an important component of physical activity among a population such as adolescents because at this stage during the lifecourse, physical activity becomes more structured and organised; these are characteristics typically associated with sport (Department of Health, 2011). Sport is also associated more with vigorous intensity physical activities than moderate intensity physical activity such as brisk walking and cycling (Department of Health, 2011). As a consequence of the importance of sport within the wider context of physical activity, a broader question of 'sport and physical activity' was the main focus of this thesis. The inclusion of sport within the question in the present study on physical activity was therefore more likely to capture a wider spectrum of adolescents' overall physical activity. Overall, through using the term 'physical activity' in the present study, the aim was to include all forms of physical activity and sport.

2.1.3 Sedentary behaviour

Sedentary behaviour is a complex term to define and has subsequently been defined in various ways. Historically, among researchers, there has been a belief that sedentary behaviour is simply a lack of physical activity, absence of physical activity or inactivity (The Sedentary Behaviour and Obesity Expert Working Group, 2010a; Ullrich-French et al., 2010). However, this is misleading. For example, many studies refer to 'sedentary' participants as those not meeting a criterion (e.g., recommended) level of physical activity (Biddle, 2007; The Sedentary Behaviour and Obesity Expert Working Group, 2010a). Furthermore, as suggested by Marshall and Welk (2008), although in studies the distinction is often ignored, it is important to be aware that young people being 'insufficiently active' is different from being 'sedentary'. As a consequence of this distinction, Marshall and Welk (2008) proposed that the term 'sedentary behaviour' be used rather than 'physical inactivity'. This is echoed by other researchers who believe that sedentary behaviour should not be defined as failure to attain recommended levels of physical activity (Pate et al., 2011). Although physical inactivity is an increasingly common term, a more appropriate term for the concept of physical inactivity is sedentary behaviour because physical inactivity assumes 'activity absence' only (Biddle et al., 2004a; Marshall and Welk, 2008). However, the term 'sedentary behaviour' reflects the fact that a diverse range of behaviours can be considered as 'inactive' (Marshall and Welk, 2008). Overall, 'physical inactivity' was not of interest in the present study because it is more commonly used to describe those not meeting physical activity guidelines (i.e., they are physically inactive). Therefore, the preferred term in the present study was 'sedentary behaviour'.

Sedentary behaviour (from the Latin *sedere* – 'to sit') is defined by Owen et al. as the 'term now used to characterise those behaviours for which energy expenditure is low, including prolonged sitting time in transit, at work, at home and in leisure time' (2009: p82). In addition, Biddle et al. suggested that sedentary behaviour can be conceptualised as '...a distinct class of behaviours characterised by low energy expenditure' (2004a: p30). It has also been suggested that sedentary behaviour should reflect more than the mere absence of physical activity alone (i.e., not physically active) but specific behaviours of very low to low intensity and having an appropriate multiple of the resting metabolic rate value less than 2.0 (i.e., sitting or lying down) but more than 0.9 (sleeping) (Ainsworth et al., 2000). More recently, in 2008, suggestions were made by other researchers that sedentary behaviour refers to activities that do not increase energy expenditure substantially above the resting level (1.0 to 1.5 metabolic equivalents (METs)) and include activities such as sleeping, sitting, lying down, watching TV and other forms of screen-based entertainment (Pate et al., 2008). In addition, Pate et al. (2008) classified light activity as within the region of 1.6 to 2.9 METs.

Researchers of sedentary behaviour do now not accept the notion that sedentary behaviour is simply a lack of physical activity and are now targeting specific individual behaviours where sitting or lying is the dominant mode of posture and energy expenditure is low (The Sedentary Behaviour and Obesity Expert Working Group, 2010a). These specific key individual behaviours include screen time (including TV and computer use), motorised transport, time spent sitting doing reading, homework, talking (sedentary socialising) or listening to music (Marshall and Welk, 2008; Biddle et al., 2009a). Sedentary behaviours are also multi-faceted and include these behaviours at work or school, at home, during transport and in leisure time (The Sedentary Behaviour and Obesity Expert Working Group, 2010a).

Figure 2.1 below, assists in clarifying the ambiguity in defining sedentary behaviour. This figure relates to different behaviours that vary in energy expenditure. Sedentary behaviours typically include those that involve sitting. The distinction between sitting or lying and standing regarding being 'sedentary' is confirmed by Yates et al. (2011) who proposed that when an individual is sitting or lying, the majority of the human body's largest muscle groups are under relaxation thus any non-exercise activity that involves sitting or lying can be considered 'sedentary'. Conversely, when in the mode of standing (even if still), a large proportion of the body's muscles are under tension thus any standing activity can be considered non-sedentary.

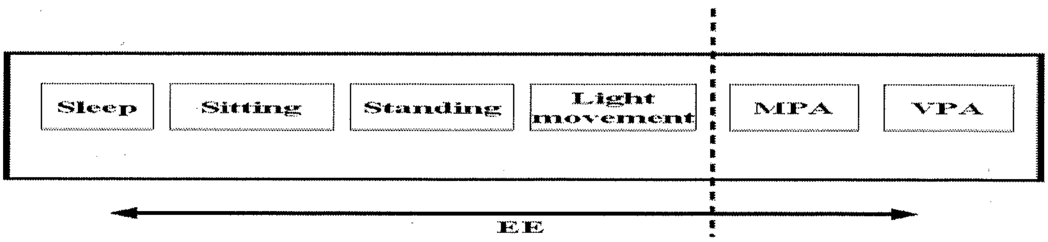

Figure 2.1 Sedentary behaviour (represented by 'sitting') differentiated from other behaviours. Behaviours to the right of the dotted line are those featured in physical activity guidelines documents (figure adapted by Mark Tremblay, University of Ottawa, Canada and taken from the Sedentary Behaviour and Obesity Expert Working Group, 2010a)

Key: EE: energy expenditure; MPA: moderate intensity physical activity; VPA: vigorous intensity physical activity

Therefore, taking the approach that sedentary behaviour is to be defined in terms of the time spent in (a) low energy (sitting) tasks and (b) specific sedentary behaviours, measurement must reflect this. For the purposes of this research, the definition of sedentary behaviour adopted was that sedentary behaviour is where the individual behaviour of sitting or lying is the dominant mode of posture and energy expenditure is very low (i.e., not the absence of physical activity) (The Sedentary Behaviour and Obesity Expert Working Group, 2010a). In addition, screen time was the specific sedentary behaviour measured as a proxy measure of sedentary behaviour and was referred to as 'screen time status' for the purposes of answering the research questions proposed. Screen time is arguably the most dominant or major source of sedentary behaviour in adolescents (Mark et al., 2006; Iannotti et al., 2009). Screen time (including TV use, video games use and computer use) over a specified time frame was measured via a self-report instrument in the present study. Consequently, screen time was targeted to represent sedentary behaviour in the present study (Ullrich-French et al., 2010). Overall, throughout this thesis, distinctions were made between the definition of sedentary behaviour adopted in previous research reports and the measurement of sedentary behaviour used in the present study (i.e., screen time). Where other studies used different definitions of sedentary behaviour and/or indicators/measures of sedentary behaviour (e.g., TV viewing only, motorised transport, homework), this was highlighted and distinguished from screen time, throughout this thesis. In this situation, potential implications for the findings of these particular studies were made.

2.2 Physical activity and sedentary behaviour during adolescence and health outcomes

Adolescence is a critical period in the study of physical activity behaviour and sedentary behaviour (Duncan et al., 2007). From a physical activity perspective, participation in regular physical activity is associated with a decrease in all-cause mortality across the life span (Lollgen et al., 2009). However, many studies have shown that physical activity continues to decline both during adolescence and in the transition to adulthood (Caspersen et al., 2000; Van Mechelen et al., 2000; Kemper et al., 2001; Telama et al., 2005). On the other hand, from a sedentary behaviour perspective, reallocations of time spent in sedentary behaviours in favour of more physically active behaviours have been shown to have significant positive health implications (Epstein and Roemmich, 2001). It is therefore concerning that increasing evidence is showing that adolescents spend too much time in sedentary behaviours (Van Sluijs et al., 2010). Consequently, attempts at increasing physical activity and decreasing sedentary behaviours among adolescents is an important public health priority (Nelson et al., 2005).

Adolescence is also a period when independence is established, and dietary and activity patterns may be adopted that are followed for many years (Berkey et al., 2000). The adoptions made then have a great influence on adult fatness and chronic disease incidence, many decades later (Berkey et al., 2000). Many of the behaviours that influence carcinogenesis or lead to other chronic diseases are learned in youth and adolescence with some having suggested that, once learned, they become adult behaviours (Croft et al., 1986; Kedler et al., 1994; Raitakari et al., 1995). Therefore, as an adolescent, completing compulsory education at either aged 16 or 18 years is one of the major transitions in life at which point learned health behaviours (such as physical activity and sedentary behaviour) are carried on into early adulthood. This major transition period of an adolescent's life entails lifestyle changes such as financial or residential independence from parents/guardian, labour force entry, advanced schooling, marriage and/or parenthood (Hogan and Astone, 1986). Resource and social role changes are also involved, including a decrease in parental influence, an increase in peer/other influences and changes in financial and physical resources (Hogan and Astone, 1986). All of these may then be related to changes in chronic disease risk behaviours. Additionally, lifestyle behaviours related to affiliation needs (e.g., sexual practices, alcohol consumption) may occur during this important transitional period (Cullen et al., 1999). Adolescence, therefore, represents a critical period during which young people develop greater autonomy in decision-making and adopt new behaviours, some of which may affect their health (Silbereisen, 2001).

As eluded to earlier, there are rising concerns about the declining levels of physical activity among young people (Coleman et al., 2008). The 'couch-potato' culture has been described as becoming the defining characteristic of contemporary youth lifestyles particularly in the U.K. (Department of Health, 2003; Royal College of Physicians et al., 2004; Smith and Green, 2005). This is concerning because it is recognised that regular physical activity can improve health and aid in the prevention of disease (Biddle et al., 2004b). However, the higher prevalence of diseases in young people today (e.g., obesity, cardiovascular diseases, mental health problems) are assumed to be, in the opinion of experts, due to increasingly sedentary lifestyles and reduced physical activity (Cavill et al., 2001; Lobstein et al., 2004; Wareham et al., 2005).

The literature on the relationship between physical activity and health outcomes in adults has been documented and is well established (Hardman, 2001; Bouchard et al., 2007). However, for adolescents, the relationship between physical activity and health is relatively weak (Tittlbach et al., 2011). This is due to many reasons including: (1) it is more difficult to demonstrate because of a lack of accuracy in the assessment of physical activity; (2) a lack of sensitivity in health risk markers; (3) effect sizes of the association between physical activity and health parameters are small; and (4) studies often only compare physically active and inactive participants without assessing how the amount of physical activity was associated with certain health parameters (Fox and Riddoch, 2000; Molnar and Livingstone, 2000; Biddle et al., 2004b; Strong et al., 2005; Tittlbach et al., 2011). Conversely, the literature on the relationship between sedentary behaviours and health outcomes (for adolescents and adults) is even less well developed than that for physical activity, and researchers have called for more studies on health outcomes for these age groups (Biddle, 2007). In addition, little is known about the adverse health outcomes caused by prolonged sitting and other ubiquitous sedentary behaviours, especially in young people (Chinapaw et al., 2011). Biddle et al. have recently re-emphasised this lack of evidence by stating that 'it is not until more recent times that researchers have started to systematically address whether sedentary behaviour.....have deleterious health consequences' (2010: p346). There is also a need for further exploration to see whether it is truly (prolonged) sedentary behaviour that is associated with poor health or whether it is a lack of MVPA or both (Biddle, 2007). From a sedentary behaviour perspective, the literature that exists has mainly investigated the relationship with overweight and obesity (The Sedentary Behaviour and Obesity Expert Working Group, 2010a). Overall, support is now emerging for exploring the independent health links of specific sedentary and physical activity behaviours in early adolescence (Keeton and Kennedy, 2009; Steele et al., 2009).

2.2.1 Cardiovascular disease

It is known that the development of cardiovascular disease begins in childhood and adolescence (McGill et al., 2000). Studies such as the Bogalusa Heart Study provided evidence for this development in childhood and have shown that cardiovascular disease risk factors track from childhood into adulthood (Nicklas et al., 2002). Researchers such as Biddle et al. (2004b) therefore suggested that it is logical to attempt to limit the development of cardiovascular disease as early as possible in children and adolescents who exhibit cardiovascular disease risk factors such as elevated cholesterol and blood pressure. This is exemplified in a study by Boreham et al. (2004) who highlighted that adolescents have been shown to exhibit many of the potentially modifiable cardiovascular disease risk factors that have been identified in adults. For instance, of the 1015 adolescents aged 12 years and 15 years who participated in the first phase of the Northern Ireland Young Hearts Project (Boreham et al., 1993), 18% to 34% were considered to have excess body fat, 24%

to 29% had low physical activity levels and 26% to 34% had poor cardiorespiratory fitness. In addition, mean total fat intakes were higher than desirable.

Although there is evidence through randomised controlled trials with adults showing that physical activity has a beneficial influence on lipids/lipoproteins and blood pressure, the evidence with adolescents is much less robust, particularly in longitudinal studies (Biddle et al. 2004b). There have also been numerous studies undertaken which have investigated the influence of physical activity and physical fitness in adolescence on cardiovascular disease risk factors later in life such as the Amsterdam Growth and Health Longitudinal Study (Twisk et al., 2002b), the Muscatine Study (Janz et al., 2002), the Northern Ireland Young Hearts Project (Boreham et al., 2002), the Danish Youth and Sports Study (Hasselstrom et al., 2002) and the Leuven Longitudinal Study on Lifestyle, Fitness and Health (Lefevre et al., 2002). The overall consensus from these studies suggested that high physical fitness during adolescence and young adulthood is related to a 'healthy' cardiovascular disease risk profile later in life, but that physical activity levels do not influence cardiovascular disease risk in later life (Twisk et al., 2002a). In contrast, the European Youth Heart Study (Andersen et al., 2006) concluded that children and adolescents in the lowest three quintiles for physical activity had a higher cardiovascular disease risk factor score than those in quintile five (i.e., the most active quintile). Therefore, implying that physical activity levels do influence cardiovascular disease risk later in life. Evidence is also emerging for sedentary behaviour as a risk factor for cardiovascular disease in adolescents. For example, Pardee et al. (2007) reported that obese children and adolescents had an increased risk of hypertension from higher levels of TV viewing. Another study (Hancox et al., 2004) concluded that mean hours of TV viewing per weekday from ages five to 15 years was positively associated with cardiovascular disease risk at age 26 years indicated by elevated total cholesterol concentration, smoking and poor fitness levels. Recent evidence has also emerged showing that sedentary behaviour is associated with markers of cardiovascular disease risk in adolescents (Martinez-Gomez et al., 2010).

2.2.2 *Metabolic syndrome*

Many of the studies which have researched metabolic syndrome view it as a clustering or constellation of risk factors in adults such as abdominal obesity, type II diabetes, hypertension and increased levels of inflammatory markers (Strong et al., 2005; Mountjoy et al., 2011). However, it is now estimated that metabolic syndrome characteristics exist in 3% to 14% of all youth and this figure is set to increase as obesity in youth increases (Weiss et al., 2004; Jolliffe and Janssen, 2007). Even so, few studies have evaluated the impact of physical activity on the metabolic syndrome in youth (Strong et al., 2005). The metabolic syndrome can also be thought of as a constellation of physiological and risk factors that occur to a greater degree than expected by chance (Wilson et al., 2005). The metabolic syndrome traits, as defined by the National Cholesterol Education Program Adult Treatment Panel III include the following: (1) increased waist circumference; (2) blood pressure elevation; (3) low high density lipoprotein cholesterol; (4) high triglycerides; and (5) hyperglycemia (The National Cholesterol Education Program Expert Panel, 2001). It has been demonstrated in some studies that the metabolic syndrome is associated with increased cardiovascular disease risk (Girman et al., 2004). Some large studies have also shown that young people who spend extensive periods of time sitting are more likely to have worse metabolic health (Ekelund et al., 2006; Ekelund et al., 2007; Mark and Janssen, 2008; Sardinha et al., 2008; Tremblay et al., 2010). In particular, Ekelund et al. (2006) observed a positive association of sedentary behaviour with markers of metabolic risk and adiposity in a large European cohort of adolescents. However, only a few studies have examined the association between screen time and metabolic risk factors in adolescents (Wells et al., 2008; Hardy et al., 2010). For instance, among Canadian adolescents, more daily screen time has been shown to be independently associated with an increased likelihood of having metabolic syndrome (Coon and Tucker, 2002).

2.2.3 *Overweight and obesity*

Obesity is an excess of body fat to a level of body fat that is harmful (Reilly, 2006). There is firm evidence that the prevalence of obesity is increasing among children and adolescents not just in the U.K. but also in many other countries around the world (Reilly and Dorosty, 1999; Bundred et al., 2001; Chinn and Rona, 2001; Strauss and Pollack, 2001; Baur, 2002; Lobstein et al., 2004; Speiser et al., 2005;

Stamatakis et al., 2005; Ogden et al., 2006; Wang and Lobstein, 2006). This increasing body of evidence is highlighted by Reilly who stated that 'an epidemic of obesity affected children and adolescents across the developed and developing world in recent years' (2006: p429). This is particularly concerning because obesity in youth is associated with a variety of conditions, including dyslipidaemia (Stensel et al., 2001) and an increased risk of type II diabetes mellitus (Sinha et al., 2002). Furthermore, childhood obesity is also a strong predictor of obesity in adulthood (Whitaker et al., 1997; Mountjoy et al., 2011). Efforts are therefore needed to prevent and manage obesity in youth and should be treated seriously (Biddle et al., 2004b). It has also been suggested that a critical period for weight gain may occur during the transition from high school to college or university (Levitsky et al., 2004). Among the Canadian population, the largest increases in obesity prevalence occurred among young people aged 12 to 17 years (Statistics Canada, 2005).

Some cross-sectional studies have been undertaken which have shown an inverse association between physical activity levels and body mass index in adolescents but the associations are in the majority weak (Ekelund et al., 2005; Ruiz et al., 2006; Sulemana et al., 2006). On the other hand, longitudinal research has shown that a reduction in physical activity during childhood and adolescence is related to increases in adiposity in adulthood (Kimm et al., 2005). Some studies have attempted to show the link between sedentary behaviour and obesity revealing that young people who spend extensive periods of time sitting are more likely to be overweight (Hancox et al., 2004; Marshall et al., 2004; Viner and Cole, 2005; Vicente-Rodriguez et al., 2008; Fairclough et al., 2009). Two of these studies (Hancox et al., 2004; Viner and Cole, 2005) have reported associations between TV viewing and obesity in addition to an increasing likelihood of overweight with the greater the TV viewing time. Increasing levels of sedentary behaviours such as TV viewing have been hypothesised as having some relationship to the increase in weight found amongst young people (Kalra and Newman, 2009). Longitudinal studies conducted investigating the impact of screen time and physical activity on weight problems and obesity in late adolescence and early adulthood indicated that reducing screen time during adolescence and increasing physical activity can assist in reducing obesity prevalence in late adolescence and early adulthood (Elgar et al., 2005; Boone et al., 2007). A recent systematic review of longitudinal prospective studies examining the relationship between sedentary behaviours and health outcomes in youth found that there was insufficient evidence for a longitudinal positive relationship between 'sedentary time' (i.e., mainly TV viewing) and body mass index and more specific indicators of fat mass (Chinapaw et al., 2011). Overall, the evidence that exists regarding overweight, obesity and sedentary behaviour has been summarised by The Sedentary Behaviour and Obesity Expert Working Group (2010) whose statements are three-fold. Firstly, that the association between sedentary screen time with overweight and obesity does not vary by age and gender. Secondly, that TV viewing at a young age is predictive of overweight as a young adult. Thirdly, odds ratios have shown that there is a greater risk of developing obesity in groups with higher amounts of sedentary behaviour.

2.2.4 Type II diabetes

There has been an increase in reported cases of type II diabetes in children and adolescents over recent years (Sinha et al., 2002). In fact, type II diabetes prevalence rates among children and adolescents have increased to the stage where there has been discussion of an 'epidemic' of diabetes among youth worldwide (Rosenbloom et al., 1999; Rocchini, 2002). It is also thought that the emergence of type II diabetes in children and adolescents is very likely related to the increased prevalence of childhood obesity (Rocchini, 2002). Estimations have been made which suggested that more than 27,000 European children have type II diabetes with more than 400,000 having impaired glucose levels (Lobstein and Jackson-Leach, 2006). Because the prevalence of childhood obesity within the European Union is expected to rise by more than one million cases per year, the number of insulin-resistant youth is also likely to increase (Jago et al., 2008). Physical activity is important in preventing insulin resistance because it burns calories, leading to a reduction in body weight and increased metabolic rate (Poehlman et al., 1988; Toth and Poehlman, 1995; Rippe and Hess, 1998). However, to date, there do not appear to have been any intervention trials undertaken which have assessed the effectiveness of physical activity in preventing type II diabetes in young people (Stensel et al., 2008). There do not seem to be any studies in relation to the effectiveness of sedentary behaviour in preventing type II diabetes either.

2.2.5 *Skeletal health (osteoporosis / bone health)*

Bone is a dynamic tissue in which there is variation between individuals depending on age, sex, genetics and lifestyle (Mountjoy et al., 2011). The prevalence of osteoporosis is forecasted to increase in future years due to its association with ageing and because people are now living longer (Biddle et al., 2004b). Although mainly under genetic control, peak/enhanced bone mass, structure and strength is determined by a range of environmental influences such as diet and physical activity (Ralston, 1997; Daly and Petit, 2007; Macdonald et al., 2009). Therefore, physical activity is important during the period of childhood and adolescence due to the outcomes of maximising bone development and increasing the probability of preventing osteoporosis in later life (Biddle et al., 2004b). Although the onset and manifestation of bone disease and osteoporosis occurs primarily in the elderly, it is now well known that the foundations and origins of imbalances in bone metabolism that eventually lead to overt disease are established in youth (Chestnut, 1989; Matkovic, 1992; Khan et al., 1998). In addition, it has also been suggested that one of the primary ways of preventing osteoporosis is to affect modifying factors (e.g., physical activity) that influence bone density so that peak bone mass is achieved during the first twenty years of life (Matkovic, 1992; Anderssen and Metz, 1993; Johnston and Slemenda, 1995). However, despite this, although animal studies have shown that bone strength benefits persist into old age, human studies have indicated little evidence that the 'enhanced bone bank' persists into old age due to the difficulties in conducting longitudinal studies (Mountjoy et al., 2011).

2.2.6 *Psychological well-being (mental health)*

There is increasing evidence of continuity between mental disorders in adolescence and early adulthood (Pine et al., 1998; Lewinsohn et al., 1999; Fergusson and Woodward, 2002; Kim-Cohen et al., 2003). In fact, rates of psychological ill-health in adolescents are increasing and identifying modifiable risk factors for adolescent psychological health becomes increasingly important, given the persistence of adolescent psychological health into adulthood (Clark et al., 2007). It has been suggested that increasing rates of psychological ill health could be linked to increasing rates of health-risk behaviours such as smoking, alcohol and drug use (Bonomo and Proimos, 2005). Despite the predominant focus upon individual health-risk behaviours, it is known that health-risk behaviours co-occur in adolescence (Jackson et al., 2002; Bonomo and Proimos, 2005; Viner et al., 2006). Adolescent physical health also contributes to the aetiology of psychological health with cross-sectional support for associations between physical activity levels, general health and psychological health (Steptoe and Butler, 1996; Sawyer et al., 2001; Kirkcaldy et al., 2002; Tomson et al., 2003; Fulkerson et al., 2004). During the development period of adolescence, when physical activity levels decrease, especially for girls, depressive symptoms begin or increase (Allison et al., 2001). Overall, there has been a dearth of studies that have concentrated on the effect of physical activity on mental health in adolescents and where studies have been undertaken, these have mainly focused on depression, anxiety and self concept or self esteem (Stensel et al., 2008). This is reflected in review level evidence with young people which has shown small to moderate beneficial effects for reduced depression and anxiety from physical activity thus the evidence base is weak (Mountjoy et al., 2011). In relation to sedentary behaviour, there is little evidence relating to specific sedentary behaviours (Stensel et al., 2008). However, studies have shown that exposure to large amounts of TV can result in poorer cognitive development, short term memory and academic achievement (Hancox et al., 2005; Christakis, 2009). Furthermore, one longitudinal study has shown that TV viewing was associated with increased odds of depression after a seven year follow-up period between adolescence and young adulthood (Primack et al., 2009).

2.3 Theoretical framework for this thesis

The theoretical framework for this thesis was framed, primarily, within the social determinants of health. Several factors have been identified as determinants of an active lifestyle (Azevedo et al., 2007). These include demographic, biological, emotional and cultural variables, social attributes and environmental factors (Trost et al., 2002a). From a public health perspective, the magnitude of insufficient physical activity and sedentary behaviours in youth populations and the consequent effect on health is a growing concern (Department of Health, 2004). Therefore, establishing key factors associated with adolescents' physical activity and sedentary behaviour (also referred to as the study of 'correlates' or 'determinants') is an important endeavour.

To put the language used in this thesis into context regarding factors associated with physical activity and sedentary behaviour, the term 'correlates' was used to reflect factors that are associated with adolescents' physical activity and sedentary behaviour (mostly in relation to cross-sectional studies but also in relation to longitudinal studies). Sometimes, in the literature, the term 'determinants' is also used but correlates has now become a more standard term because many correlates may not be true determinants (National Institute for Health and Clinical Excellence (NICE) Public Health Collaborating Centre, 2007). In other words, data may show associations but may not be able to conclude on causality. Therefore, correlates are defined by researchers such as Buckworth and Dishman as 'reproducible associations that are potentially causal' (2002: p191). Determinants are most appropriately defined as causal factors thus it is recommended that the term 'determinant' be used with greater precision and not be used to describe correlates of physical activity (Bauman et al., 2002).

Some literature has used the term 'determinant' in the context of findings that demonstrate reproducible associations or predictive relationships (correlates) instead of the more appropriate use of the term as a cause-and-effect relationship (Dishman and Sallis, 1994; Biddle et al., 2004b). More specifically, the relationship between the outcome of interest (dependent variable) and a study factor (independent variable) is more likely to be causal when variation in physical activity (i.e., a 'change' in the dependent variable) has been produced by changes in the level or intensity of external influences (i.e., independent contributory variables) such as exposure to an intervention (Bauman et al., 2002). In order to assess the evidence for a causal relationship between the outcome of interest and a study factor, criteria have been developed (Rothman and Greenland, 2001). Firstly, the greatest scientific weight is given to experimental evidence, where a randomised controlled trial design is used. This is followed by evidence from interventions that use quasi-experimental designs and then evidence emanating from observational studies such as cohort (panel) designs (e.g., a prospective population-based longitudinal study such as the present study). Finally, the weakest designs for casual evidence are cross-sectional analytic studies (typically surveys) that 'generate hypotheses' and provide measures of association, rather than defining 'causal' factors (Bauman et al., 2002). Consequently, in this thesis, although the term 'determinants' was used where appropriate (e.g., regarding factors associated with adolescents' physical activity and sedentary behaviour in systematic reviews of prospective studies), the term 'correlates' was mainly used.

Health is known to be shaped by multiple factors such as personal lifestyle and the social, cultural and physical environment within which a person exists (Murphy et al., 2009). Furthermore, the health of individuals and populations is influenced (positively and negatively) by a wide range of inter-related factors (also referred to as 'determinants of health') (Cavill et al., 2006). As can be seen in Figure 2.2, a multi-layered model based on the 'determinants of health' (referred to as the 'social determinants of health model' in this thesis) best illustrates the interaction of these multiple factors (Dahlgren and Whitehead, 1991). This model, formulated by Dahlgren and Whitehead (1991), is interchangeably referred to as the 'Rainbow Model', 'social determinants of health model' or 'main determinants of health model' in the literature and represents factors that determine health status through an inter-related nature (Earle and O'Donnell, 2007; Murphy et al., 2009; Sengupta, 2009; Bambra et al., 2010). The centre of the model features non-modifiable (fixed determinants) factors such as age, gender and genetics. Moving out from the centre of the model are layers of influence that are potentially modifiable (variable determinants) by manipulation of either the environment or individual behaviour. The inner most layer represents individual lifestyle factors such as physical activity, sedentary behaviour or dietary behaviour which have the potential to promote or damage health. Elements of the social environment include family structure and social networks (i.e., the 'social and community networks' layer). The next layer focuses on living and working conditions including education, housing, employment and access to healthcare (Earle and O'Donnell, 2007). The final outer layer highlights broader socioeconomic, cultural and environmental forces such as social forces and structures and can include physical environmental conditions that have been linked to health (Murphy et al., 2009). Most importantly for the present study, this model recognises the importance of the broader social, cultural and environmental determinants of health, and their inter-relationship with lifestyle choices of individuals.

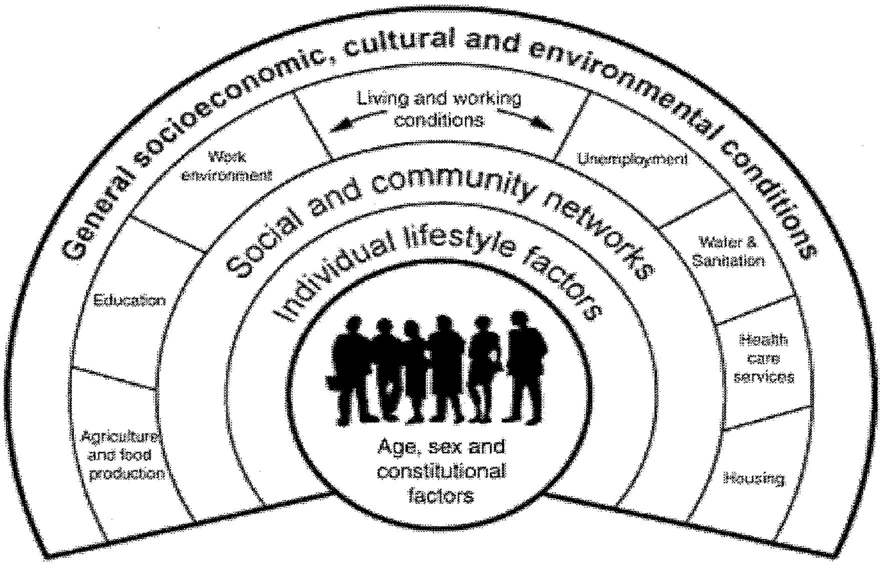

Figure 2.2 The social determinants of health as illustrated by Dahlgren and Whitehead (1991)

In conjunction with the social determinants of health model, the theoretical framework for this thesis was also framed within the context of the 'behavioural epidemiology' framework (Sallis and Owen, 1999; Sallis et al., 2000a). This framework can be applied specifically to adolescents' physical activity and sedentary behaviour research and specifies five main research phases in a rationally ordered sequence (Marshall and Welk, 2008; Marshall and Ramirez, 2011), as follows (adapted from Sallis and Owen, 1999):

- Phase one – Establish the links between physical activity / sedentary behaviour and health
- Phase two - Develop methods for accurately assessing physical activity and sedentary behaviour
- Phase three - Identify factors that are associated cross-sectionally and longitudinally with physical activity and sedentary behaviour
- Phase four - Evaluate interventions designed to increase physical activity and reduce sedentary behaviour
- Phase five – Translate physical activity and sedentary behaviour research into practice

Each phase of research is intended to build on previous phases thus provides a useful 'road map' for how to best prioritise and sequence efforts in physical activity and sedentary behaviour research (Marshall and Welk, 2008; Marshall and Ramirez, 2011). Firstly, phase one involves establishing if there are links between each of these behaviours and health. This chapter (Chapter 2) was linked to phase one through the inclusion of demonstrating the link between physical activity or sedentary behaviour and health among adolescents. Phase two requires development of valid, reliable and accurate measures of physical activity and sedentary behaviour. Chapter 3 was relevant to phase two as it focused on the measurement of physical activity and sedentary behaviour among adolescents. This phase also includes assessing the behaviour in question (i.e., the prevalence and trends and descriptive epidemiology of physical activity or sedentary behaviour) (Sallis and Owen, 1999; Biddle and Mutrie, 2008). Chapter 4 covered this dimension of phase two through the review of self-report studies investigating physical activity and sedentary behaviour among adolescents included. This phase is an important research priority because accurate assessment tools help in understanding the determinants or correlates of physical activity and sedentary behaviour (phase three).

For the purposes of the present study, phase three was concentrated on because this is where the social determinants of health model (which influenced the choice of variables (factors) as explained below) can be ideally situated and is where these two frameworks link together. This is because phase three is concerned with identifying factors associated with physical activity and sedentary behaviour (also referred to as the study of 'determinants' or 'correlates') cross-sectionally and longitudinally. In addition, phase three can also involve identifying the descriptive epidemiology of physical activity and sedentary behaviour (screen time in the present study) (Marshall and Welk, 2008; Marshall and Ramirez, 2011). Therefore, a combination of the social determinants of health model and these two components in phase three encompass the focus of the whole thesis which was indicted by the four research questions shown previously in Chapter 1. Chapter 5 included a review of the factors associated with physical activity and sedentary behaviour among adolescents and was therefore linked directly to phase three. Phase three is a particularly important phase because before interventions can be planned, the key variables that are correlated with the behaviour (i.e., physical activity or sedentary behaviour) need to be identified (Biddle et al., 2011a). The rationale for this is because a behaviour such as physical activity or sedentary behaviour is not changed by the intervention but by a change in some personal, social or environmental variable (i.e., a change in a 'correlate') (NICE Public Health Collaborating Centre, 2007). Having established the likely correlates of physical activity or sedentary behaviour, these might be used as moderators or mediators in physical activity/sedentary behaviour change interventions (Biddle et al., 2011a). Phase four therefore seeks to evaluate interventions designed to promote physical activity and reduce sedentary behaviour by demonstrating that they are effective in controlled trials (Marshall and Ramirez, 2011). In the final phase (phase five), the aim is to translate findings from research into practice thus translating interventions shown to be effective in phase four for use in diverse settings such as schools and worksites (Marshall and Ramirez, 2011).

With respect to the variables (also referred to as 'factors'/ 'independent variables' throughout this thesis) included in the present study, the choice of these particular variables were influenced primarily by the layers of the social determinants of health model which effectively sits within phase three of the behavioural epidemiology framework as the focus of this phase is on investigating the factors associated with physical activity and sedentary behaviour. More specifically, the first outer layer of the model (i.e., individual lifestyle factors) contains the two main dependent variables of the present study (physical activity and screen time status) as they are both individual lifestyle factors which are modifiable and linked to all other layers of the model. For instance, the social determinants of health model suggests there is the potential for an inter-relationship (i.e., a possible association) with both of these behaviours and independent variables (factors) of interest in the present study that are related to other layers of the social determinants of health model. Firstly, gender and ethnicity which are contained within the core centre of the model (i.e., age, sex and constitutional (hereditary) factors centre). Secondly, educational attainment and socioeconomic status which are related to the living and working conditions layer. Thirdly, school type and area of residence which are located in the general socioeconomic, cultural and environmental conditions outer layer. Furthermore, a range of other variables could be considered that are related to each of these layers of the model. For example, variables such as social support and active parents which would be related to the social and community networks layer of the model.

Another way of conceptualising the social determinants of health model is to view it as possessing three different levels, which in turn may have an influence on both physical activity and sedentary behaviour. Cavill et al. (2006) proposed that the three levels are: (1) intrapersonal; (2) socio-cultural (also typically referred to as 'interpersonal'); and (3) physical-environmental. Collectively, these three particular levels are more commonly referred to as the 'ecological framework/model' (Sallis and Owen, 2002). Individuals' health behaviours (e.g., physical activity and sedentary behaviour) are therefore influenced by intrapersonal, socio-cultural (interpersonal) and physical-environmental factors and these factors (variables) are likely to interact (Sallis and Owen, 2002). Research into the factors associated with physical activity and sedentary behaviour advocates the use of an ecological framework to identify a broad range of intrapersonal, interpersonal and physical environmental influences (Gorely et al., 2004). Systematic reviews of correlates and determinants of adolescents' physical activity and sedentary behaviours typically categorise these three broad influences under the headings of: (1) demographic and biological factors; (2) psychological factors; (3) behavioural factors; (4) social-cultural factors; and (5) environmental factors (Sallis et al., 2000b; Gorely et al., 2004; Biddle et al., 2005; Van der Horst et al., 2007; Pate et al., 2011; Uijtdewilligen et al., 2011).

At the intrapersonal level, the ecological framework/model suggests that behaviour is influenced by demographic and biological (e.g., gender, age, ethnicity, education, social class) and psychological, cognitive and emotional factors (e.g., personal confidence, behavioural attributes and skills). Therefore, the factors of interest in the present study such as gender, ethnicity, socioeconomic status and educational attainment could be aligned to this level (as they are all 'demographic' factors). From the socio-cultural (interpersonal) level, this model suggests that behaviour is influenced by factors including social support from peers and family and normative beliefs. Finally, at the physical-environmental level, this model suggests that behaviour is influenced by factors such as climate, seasonal factors and aspects of urban design such as residential density. Consequently, factors such as urban/rural area of residence and school type (public versus private) could potentially be aligned to this level (as they are both 'environmental' factors). Conceptualising the model in these three layers aids in understanding how these specific demographic and environmental factors suggested could potentially interact with both physical activity and sedentary behaviour. In research that investigates factors associated with adolescents' physical activity, correlates at all of these levels have been identified (Sallis et al., 2000b; Van der Horst et al., 2007; Biddle et al., 2011a). However, research investigating factors associated with adolescents' sedentary behaviour is more limited, although evidence is developing that has suggested this model would be useful for understanding these behaviours (Gordon-Larsen et al., 2000; Gorely et al., 2004; Henning Brodersen et al., 2005; Van der Horst et al., 2007; Pate et al., 2011; Uijtdewilligen et al., 2011).

2.4 Summary

This chapter has highlighted the difficulty in conceptualising the meaning of physical activity and sport, and sedentary behaviour. The definitions used for each behaviour have been made clear in that sedentary behaviour is the preferred term used and is defined as the individual behaviour of sitting or lying down with screen time being adopted as the proxy measure of sedentary behaviour. In addition, physical activity and sport have been defined and an explanation provided for including sport within the broader definition of 'physical activity'. The theoretical framework for this thesis has been appropriately framed, primarily, within the social determinants of health (i.e., the Dahlgren and Whitehead (1991)) model and the behavioural epidemiology framework (with a primary focus on phase three for answering the four research questions). The relationship of this thesis to the ecological framework/model has also been demonstrated regarding the variables (factors) chosen (demographic and environmental) in the present study which have been aligned to the social determinants of health model and the ecological framework/model appropriately. Chapter 3 independently details the measurement of physical activity and sedentary behaviour among adolescents, in addition to independently demonstrating the recommendations (guidelines) and policy that surround physical activity and sedentary behaviour among adolescents.

CHAPTER 3: MEASUREMENT OF PHYSICAL ACTIVITY AND SEDENTARY BEHAVIOUR AMONG ADOLESCENTS, RECOMMENDATIONS AND POLICY

This chapter is divided into five main sections. The first two sections of the chapter discuss the measurement of physical activity among adolescents and then an account of adolescent physical activity recommendations is provided. The next two sections discuss the measurement of sedentary behaviour among adolescents and then an account of adolescent sedentary behaviour recommendations is provided. The remainder of the chapter includes an explanation of the policy surrounding physical activity and sedentary behaviour among adolescents.

3.1 Measurement of physical activity among adolescents

As demonstrated throughout this thesis, physical activity is an important behaviour related to a number of health outcomes in adolescents (Hallal et al., 2006a). Accurate assessment of physical activity levels is vital, not only to understand the association between physical activity and health, but also to monitor secular trends in behaviour and to evaluate the effectiveness of interventions (Ward et al., 2005). Furthermore, accurate and reliable assessment of physical activity is also essential for any study where physical activity is either an outcome measure or intervention (Rowlands and Easton, 2007). In addition, accurate and reliable assessment of physical activity is important in order to: (1) establish the prevalence at a population level of persons who are inactive or physically active at a level sufficient to meet recommendations; (2) understand patterns of physical activity by gender, age, geography, socioeconomic status and other demographic categories of interest; and (3) to track physical activity trends over time (Dollman et al., 2009; Pratt and Fulton, 2009).

The measurement of physical activity has typically been categorised into objective and subjective measures. Objective measures include heart rate monitoring, direct observation, doubly labelled water, accelerometry and pedometry whereas subjective measures include use of self-report methods such as questionnaires, activity logs and diaries (Trost, 2007; Dollman et al., 2009). Three objectives measures in particular; doubly labelled water; indirect calorimetry; and direct observation are also referred to as 'criterion measures' (i.e., gold standard measures) because they are the most valid and reliable measures of physical activity (Marshall and Welk, 2008).

Regarding the assessment of physical activity in adolescents, Kohl et al. (2000) provided a useful review and synthesis of six categories of assessment. These were self-report, electrical or mechanical monitoring, direct observation, indirect calorimetry, doubly labelled water and direct calorimetry. These six categories of assessment can be practically reduced to criterion measures, motion sensors and heart rate monitors and self-report.

Indirect calorimetry and doubly labelled water are seen as the main criterion measures of energy expenditure (Marshall and Welk, 2008). Indirect calorimetry encompasses measuring oxygen consumption as a proxy of energy expenditure but the major limitation of this technique it restricts a participant to an unnatural laboratory setting (Marshall and Welk, 2008). The technique of doubly labelled water represents an unobtrusive and non-invasive means to measure total energy expenditure in free-living adolescents (Trost, 2007). Despite being viewed as a potential gold standard for estimating physical activity-related energy expenditure, a major limitation of this technique is its excessive cost (Trost, 2007).

The other criterion measure is direct observation, which involves observing a child at home or school for extended periods of time and recording into either a laptop computer or coding form, an instantaneous rating of the child's activity (Trost, 2007). In this case, physical activity will have been rated based on estimated intensity on a momentary time-sampling basis at time intervals ranging from five seconds to one minute (Kohl et al., 2000; Trost, 2007). The advantages of observational measurement are that it carries 'face validity', high reliability and fidelity (ability to record data regarding the specific modes of activity), in addition to the possibility of recording the physical and social environment in which the activity occurred (Pate, 1993). Direct observation methods are not practical for large population studies of physical activity because of a relatively high cost per observation but even so they can be useful for smaller scale studies, especially with young children in confined environments (Kohl et al., 2000). Direct observation can be reactive (i.e., affect the behaviour being measured – The Hawthorne effect) and can be difficult to implement in a large geographic area (Trost, 2007). However, the technique can be used successfully in studies in which participants are confined to a defined space such as the playground (Kohl et al., 2000).

Motion sensors consist of pedometers and accelerometers. Motion sensors, in particular, accelerometers and pedometers are generally worn at the hip and record movement as 'counts' of activity or as estimated caloric expenditure (Pate, 1993). Accelerometers are the most common method used to measure used to assess free-living physical activity by measuring the acceleration of body segments or limbs during movement (Marshall and Welk, 2008; Ekelund et al., 2011). There are a wide range of accelerometers available which facilitate objective assessment of physical activity intensity and duration among children (McClain and Tudor-Locke, 2009). The benefits of using accelerometry include the provision of highly detailed information on physical activity observed over relatively long periods, in addition to the fact that they are useful in children of all ages (Trost et al., 1998; Fairweather et al., 1999; Louie et al., 1999; Rowlands et al., 1999; Trost et al., 2000; Rowlands et al., 2009). It is also suggested that accelerometers are one of the most effective ways to produce objective information (frequency, duration, intensity) on the physical activity levels of children (Rowlands, 2007; Stone et al., 2009). A main limitation of accelerometers is that they are not able to account for the increased energy cost associated with walking up stairs or an incline (Trost, 2007). Secondly, pedometers are of varying type but usually provide some measure of a number of steps taken during a given period of time (Kohl et al., 2000). They offer a simple and low cost estimate of total volume of physical activity which is outputted as the number of steps taken (McClain and Tudor-Locke, 2010). However, pedometers have the same basic limitation as accelerometers because they are insensitive to some forms of movement (Trost, 2007). More specifically, this is because step counts are inversely proportional to leg (stride) length (Marshall and Welk, 2008).

The final objective measure (i.e., heart rate monitoring) is relatively inexpensive and is an attractive approach because of the useful estimates of physical activity provided because heart rate is well known to be linearly related to power output (i.e., intensity of physical activity) during performance of activity with ergometric devices (Pate, 1993; Trost, 2007). Heart rate monitors are worn around the chest and record the participant's heart rate during the period of observation (Kohl et al., 2000). Despite heart rate monitors providing an indicator of activity that reflects the true physiological stress on the body, individual differences in heart rate response to activity present a form of error (Marshall and Welk, 2008). Overall, few studies worldwide have collected objective physical activity data in large samples of children and there is a lack of population-based objective data describing levels and patterns of children's activity (Riddoch et al., 2007).

Self-report measures consist mainly of self-administered questionnaires (recalls), interviewer-administered questionnaires (recalls), proxy-administered questionnaires completed by parents (often used with a young population) and diaries (Trost, 2007). Furthermore, self-report measures can be split into two categories: recall-based measures (i.e., obtain actual information about an individual's activity on a specific day or series of days) and general measures (i.e., tend to emphasise typical activity behaviour) (Marshall and Welk, 2008). The main benefit of self-report measures in comparison to objectives such as heart rate monitoring and accelerometers is that they provide information on about the type of physical activity behaviour or in what context and where the activity was performed (e.g., active transport, sports, school) (Chinapaw et al., 2010). Self-reports are the most commonly employed procedures to measure physical activity (Kohl et al., 2000). These instruments have been designed to elicit information on physical activity participation during a recall period varying from one day to one week or 'a usual week' (i.e., a retrospective recall of behaviour) (Chinapaw et al., 2010). Self-report instruments for physical activity assessment have been used in three general areas of investigation: epidemiologic, behaviour change and correlational studies (Baranowski, 1988). Typically, self-report methods are easy to administer, relatively inexpensive and acceptable to study participants (Montoye et al., 1996). Furthermore, several sources of physical activity information can be obtained from an interview, questionnaire or log (Kohl et al., 2000). Also, self-report methods such as questionnaires are often validated against criterion (objective) methods with the most commonly used method being accelerometers because of its ability to detect amount, frequency and duration of movement and its predictive relationship with heart rate and energy expenditure in the laboratory (Melanson, 1995; Basset et al., 2000; Freedson and Miller, 2000; Slootmaker et al., 2009).

Although there are numerous advantages of using self-report measures to measure physical activity, there are some disadvantages that a researcher needs to be aware of. Firstly, there is the issue of social desirability which may lead to adolescents overestimating their physical activity (Warnecke et al., 1997; Galuska and Fulton, 2009). Conversely, some researchers have found that children and adolescents underestimate physical activity of moderate intensity (Riddoch et al., 2004; Telford et al., 2004). Although the use of self-report is practical among large groups, there is also the potential for self-report bias, errors in recall and gaining an accurate picture of habitual activity (Biddle et al., 2004b). In particular, errors in recall (recall bias) can occur because recalling physical activity is a highly cognitive task and youth are less likely to make accurate self-report assessments than adults (Chinapaw et al., 2010). This is mostly due to developmental differences (e.g., in the ability to think abstractly and undertake detailed recall) (Sallis, 1991; Going et al., 1999). For the purposes of the present study, the main focus was on a key self-report instrument (i.e., a questionnaire) as this was the measurement approach used. Consequently, the following section focuses on self-report (questionnaires) regarding physical activity among adolescents.

3.1.1 Self-report (Questionnaires)

Self-report techniques, in particular questionnaires are currently the most widely used and simplest method for the assessment of physical activity in epidemiological research among youth (Marshall and Welk, 2008; Ekelund et al., 2011). There are many advantages to using a questionnaire to measure physical activity participation. Firstly, they have the ability to collect data from a large number of people at low cost with low participant burden (Sallis and Saelens, 2000; Dugdill and Stratton, 2007). Secondly, recalling also does not alter the behaviour under study, in addition to being able to assess all the dimensions of physical activity so patterns of behaviour can be examined (Sallis and Saelens, 2000). Thirdly, where the main interest of a study is to estimate the change in the total amount of daily or weekly physical activity, questionnaires are a commonly used method to enable this (Trost, 2007; Salmon et al., 2007). Fourthly, questionnaires can be used across a range of ages with measures able to adapt to fit the needs of a particular population or research question (Sallis and Saelens, 2000). Finally, self-report methods such as questionnaires are an ideal option for measuring physical activity among adolescents for the following reasons: self-report allows physical activity to be described quite broadly; due to the likelihood of need to obtain a relatively large sample size; and the ability to assess compliance with guidelines (Dollman et al., 2009). Overall, self-report tools such as questionnaires have become accepted as the only feasible method of assessing physical activity in large-scale population surveys due to available resources (Shephard, 2003; Chinapaw et al., 2010). Booth (2000: p114) further summarised this acceptance with the following statement:

> *Although there are many different direct and indirect methods of assessing physical activity participation, the only feasible method of measurement for use in large scale population surveys in developed and developing countries is self report.*

Selection of a suitable physical activity questionnaire is not only based on the specific purpose of the study (e.g., discrimination, evaluation, prediction), but also the type of information sought and outcome of interest, characteristics of the population (e.g., age, gender, ethnicity) and size of the sample being studied, in addition to the respondent burden associated with acquiring the data as well as reliability, validity and responsiveness (i.e., fidelity – ability to detect changes) (Dollman et al., 2009; Chinapaw et al., 2010). It is important that a researcher contemplating using a questionnaire among a population group such as adolescents is aware that self-report is greatly influenced by the ability to comprehend (i.e., understand) a question and to recall physical activity patterns retrospectively and hence, the most reliable tools tend to be three day or seven day recall (i.e., physical activity participation over past three or seven days) (Dugdill and Stratton, 2007; Ekelund et al., 2011). These tools are therefore recommended as they have adequate reliability and validity in large populations among both children and adults (Welk, 2002). Dugdill and Stratton (2007) also identify that population self-report of sport and physical activity has been inconsistent across the U.K. This is suggested because various tools have been used to gather data and all use slightly different measurement parameters and methods, consequently making trend analysis difficult (e.g., Health Survey for England, 2003; Active People Survey, 2006).

There are numerous self-report questionnaires that measure adolescents' physical activity participation. A useful and comprehensive selection of physical activity questionnaires have been published in a special edition of *Medicine and Science in Sports and Exercise* (Pereira et al., 1997) and a useful systematic review of measurement properties for physical activity questionnaires for youth (including adolescents) has been recently published (Chinapaw et al., 2010). Additionally, Biddle et al. (2011b) have undertaken a review of existing self-report instruments assessing physical activity in young people. This review culminated in a short list of measures that may be suitable for population surveillance of self-reported physical activity among young people. A selection of physical activity questionnaires extracted from these reviews designed for use with adolescents specifically is detailed below.

Physical Activity Questionnaire for Adolescents (PAQ-A)

The PAQ-A (Kowalski et al., 1997b) seeks information on participation in vigorous intensity activities over the last seven days drawn from a limited checklist (Booth et al., 2002a). Other items asked in the questionnaire include participation in vigorous intensity activities during specific times of the day (lunch) or week (weekends). However, no information is sought on duration of participation, moderate intensity activities, nonorganised activities or seasonal differences (Booth et al., 2002a). Kowalski et al. (1997b) moderately related the PAQ-A to an activity rating ($r = 0.73$), the Leisure Time Exercise Questionnaire ($r = 0.57$), a Caltrac motion sensor ($r = 0.33$) and the seven-day physical activity recall interview ($r = 0.59$). Their results supported the convergent validity of the PAQ-A as a measure of general physical activity level for high school students. Furthermore, the PAQ-A generally had the highest correlations with other measures. On the other hand, Lachat et al. (2008) compared the validity of the short form of the International Physical Activity Questionnaire (IPAQ) and a locally adapted version of the PAQ-A for use in school attending adolescents in rural and urban areas in Vietnam. Criterion validity was assessed by comparison with seven days continuous accelerometer jogging. They concluded that reliability of both questionnaires was poor for both the IPAQ and the PAQ-A (ICC = 0.40). Further, criterion validity of both questionnaires was acceptable and similar for the IPAQ and the PAQ-A but a significantly lower validity was observed in rural areas. In addition, both forms poorly estimated time spent on light, moderate and vigorous physical activity. However, despite these limitations, the PAQ-A has been identified as potentially suitable for use in population surveillance of youth physical activity (Biddle et al., 2011b).

Modifiable Activity Questionnaire for Adolescents

The Modifiable Activity Questionnaire for Adolescents was adapted from the original Modifiable Activity Questionnaire (Kriska et al., 1988; Lee et al., 1990). This questionnaire assesses past year participation in leisure time and competitive activities. In addition, this questionnaire also includes four multiple choice questions that assess the days of 'hard exercise' and 'easy exercise' over the past 14 days, hours of screen time (i.e., watching TV and videos, playing computer or video games) per day during a normal week and competitive athletic participation over the past 12 months. These four questions were adapted from the Youth Risk Behavior Survey by the U.S. Centers for Disease Control (Aaron et al., 1993). Reliability and validity studies have shown that this questionnaire has yielded reproducible and valid estimates of past year physical activity in adolescents (Aaron et al., 1993; Aaron et al., 1995b; Simon et al., 2004). For example, in Aaron et al.'s (1995b) study, the criterion measure used was a 'past week' physical activity questionnaire administered four times throughout a one year period (three months apart). The average of the four past week recalls of activity was used as the 'gold-standard' against which the Modifiable Activity Questionnaire for Adolescents was compared to evaluate validity. In addition, construct validity of the questionnaire was also undertaken through being compared against objective measures including body mass index and a battery of fitness tests. Although there was no association between the past year activity questionnaire results and objective measures, there was a significant association between the physical activity questionnaire and time to complete a one mile run in females. Further, the results of this study provided evidence that the questionnaire yields a reasonable estimate of past year physical activity with Spearman correlations between the questionnaire and the average of the seven day recalls ranging from 0.55 to 0.83 for the different measures of physical activity and a good one month test-retest reproducibility (intraclass correlation of 0.66). One distinct advantage from a comparability of findings perspective is that this questionnaire has been used in several studies among adolescent populations (Kolbe, 1990; Kriska et al., 1990; Kriska and Bennett, 1992; Aaron et al., 1995a; Aaron et al., 2002; Simon et al., 2004; Klein-Platat et al., 2005; Platat et al., 2006).

Adolescent Physical Activity Recall Questionnaire (A-PARQ)

The A-PARQ (Booth et al., 2002a) contains two main components: participation in organised sports, games and other activities; and participation in nonorganised physical activities. Booth et al. (2002a) undertook a study of the A-PARQ's reliability and validity. The reliability study involved the questionnaire being administered to the same group of students on two occasions (two weeks apart). On the other hand, the validity study involved a field measure of aerobic fitness (the multistage fitness test) being administered to the students who had completed the questionnaire thus facilitating utility of the self-report instrument. Booth et al. (2002a) concluded that the A-PARQ has acceptable to good test-retest reliability and validity and that the reliability and validity characteristics of the A-PARQ appear to be at least comparable with other instruments. However, the validity reported in this study is indirect and it has been suggested that the A-PARQ requires more reliability and validity testing before generalising to other ages can be made (Biddle et al., 2011b).

The Physical Activity Questionnaire for Older Children (PAQ-C)

The PAQ-C (Crocker et al., 1997) is a self-administered seven-day recall questionnaire intended to assess habitual MVPA in older children for a specific season (fall, winter and spring). The purpose of the PAQ-C was to provide a general indication of children's physical activity levels for use in the six year Saskatchewan Pediatric Bone Mineral Accrual Study. The questionnaire was administered three times per year (autumn, winter, spring) in the school system to a large number of students (in excess of 250) for six years. In a study undertaken by Crocker et al. (1997), the questionnaire was used in three separate studies and it was concluded that the PAQ-C demonstrated acceptable internal consistency. Kowalski et al. (1997a) conducted two studies which investigated the validity of the PAQ-C. The first study examined convergent and construct validity of the PAQ-C using numerous criterion measures including an activity rating, week summation of 24 hour moderate to vigorous activity recalls, a teacher's rating of physical activity and perceptions of athletic competence. The PAQ-C was moderately related to all these criterion measures. In the second study, convergent and construct validity of the PAQ-C were again examined but in relation to the criterion measures of an activity rating, the Leisure Time Exercise Questionnaire, a Caltrac motion sensor, a seven-day physical activity recall interview and a step test of fitness. Once again, the PAQ-C was moderately related to all criterion measures. Both studies supported the validity of the PAQ-C as a method of assessing older children's general physical activity levels.

Self-Report Habit Index (SRHI)

The SRHI is a self-report instrument to measure habit strength, consisting of 12 items, based on habitual features such as history of repetition, difficulty of controlling the behaviour, lack of awareness, efficiency and the identity element (Kremers and Brug, 2008). The SRHI has been shown to have high internal reliability with respect to a large variety of behaviours, particularly TV viewing and active transport (Verplanken and Orbell, 2003). The most common use of the SRHI has been among undergraduate students within university and high school settings (Kremers and Brug, 2008). In relation to the use of the SRHI with an adolescent population, Kremers and Brug (2008) recently conducted a study with the questionnaire to measure physical activity behaviours among children and adolescents. Their aim was to investigate reliability and validity of the SRHI regarding physical activity (study one) and sedentary behaviour (study two). For study one (physical activity), convergent validity of the SRHI was examined by correlating the index with estimates of past behaviour frequency. In relation to study two (sedentary behaviour), construct validity of the SRHI was investigated by relating the SRHI scores with attitude and intention scores. They found that internal reliabilities of the SRHI proved to be high in both studies. Additionally, the SRHI correlated significantly with behavioural frequency measures and cognitive associates of these behaviours.

World Health Organization Health Behaviour in Schoolchildren (WHO HBSC) Survey Questionnaire

The WHO HBSC survey questionnaire (King et al., 1996) records the responder's physical activity level in sports and exercise by asking the adolescent to report the frequency and total amount of time spent exercising vigorously outside school hours. Two extensive studies in Norway have used the WHO HBSC physical activity questionnaire; The Young-HUNT Study (adolescents aged 13 to 19 years) and in the Health Behaviour in Schoolchildren Study (King et al., 1996; Holmen et al., 2002). Rangul et al. (2008) undertook a study into the reliability and validity of the physical activity questions from the WHO HBSC survey questionnaire with adolescents aged 13 to 18 years. Reliability was assessed by administering the WHO HBSC questionnaire twice to the same adolescents (eight to 12 days apart). Validity was assessed by comparing answers from the questionnaire with the criterion measures of a cardiorespiratory fitness test and seven days activity monitoring with ActiReg (measures physical activity level and total energy expenditure). It was concluded that the WHO HBSC questionnaire had substantial reliability and was acceptable as an instrument for estimating cardiorespiratory fitness, especially among girls. However, validity was low for the questionnaire when compared to total energy expenditure and physical activity level in adolescents.

International Physical Activity Questionnaire (IPAQ, short version)

The IPAQ self administered short version was designed for use among young and middle-aged adults, aged 15 to 69 years (Rangul et al., 2008). The questionnaire inquires about activity during the last week. The questions focus on four activity types: 'vigorous activity' periods for at least 10 minutes; 'moderate activity' periods for at least 10 minutes; 'walking' periods for at least 10 minutes; and times spent 'sitting' at weekdays. Rangul et al. (2008) investigated the reliability and validity of the IPAQ short version with adolescents aged 13 to 18 years. Reliability and validity of the IPAQ was assessed using the same methods and criterion measures as those used for the WHO HBSC questionnaire in the previous paragraph. It was found that the test-retest reliability of the IPAQ was lower than that of the WHO HBCS questionnaire. Validity was also low for the IPAQ when measured against total energy expenditure and physical activity level.

3.2 Adolescent physical activity recommendations

There is a great deal of debate surrounding the recommended levels of physical activity for young people (Stratton and Watson, 2009). Strategies adopted with the aim of combating trends in increasing levels of overweight and obesity and decreasing levels of fitness include increasing physical activity and reducing sedentary behaviour (Olds et al., 2007). As a consequence, a number of professional and government bodies around the world have issued recommendations for physical activity for young people (e.g., U.S. - U.S. Department of Health and Human Services and U.S. Department of Agriculture, 2005; U.K. - Department of Health, 2004; Australia - Department of Health and Ageing, 2005b). These guidelines typically specify a minimum number of daily minutes of MVPA. However, current recommendations on physical activity differ between countries (The Sedentary Behaviour and Obesity Expert Working Group, 2010a).

Before detailing the recommendations set out by different countries, it is essential to briefly explain the debate that has existed for many years regarding moderate versus vigorous intensity physical activity in relation to physical activity participation. The importance of intensity can be dated back to the 1950s when Jeremy Morris published a series of papers. Morris's research identified the higher rates of cardiovascular events in occupationally sedentary bus drivers and mail sorters as opposed to more active bus conductors and postal delivery workers (Morris et al., 1953a, 1953b). Following on from this research, subsequent epidemiological studies identified the independent relationship between low levels of energy expenditure and adverse health outcomes (Taylor et al., 1962; Brunner et al., 1974; Paffenbarger and Hale, 1975). The focus in these early epidemiological studies was on the health consequences of inactivity. Then, from the 1960s, the focus in epidemiological work in the field changed to activity. Most research studies in this period recommended aerobic fitness training through vigorous exercise at least three times a week for more than 20 minutes (American College of Sports Medicine, 1978).

By the 1990s, epidemiological evidence showed that moderate intensity activity could, through its effect on population-attributable risk of inactivity, have a greater impact on population health than vigorous intensity activity (Bauman, 1988). This is reinforced by the 1996 U.S. Surgeon General's report, in addition to consistent subsequent epidemiological evidence which led public health policy makers around the world to adopt the 'moderate physical activity' message (Brown et al., 2009). Brown et al. (2009) stressed that the concept of accumulating physical activity with short bouts of activity (for health related benefits) in diverse settings across the day (for example, in transport, occupations, gardening, housework and active play with children). This has gained increasing prominence through what has become known as the 'active living' or 'healthy lifestyle' approach (Dunn and Blair, 2002).

Currently, from a U.K. perspective, guidelines for physical activity differ between the four home countries. When first reviewing the physical activity guidelines from England, Scotland, Wales and Northern Ireland respectively, there is a large amount of similarity but when looking more closely, there are some ambiguities. For example, in England and Northern Ireland, the same recommended guideline is used for children and young people. More specifically, it is stated within the Department of Health's White Paper 'At least five a week' that 'For children and young people, a total of at least 60 minutes of at least moderate intensity physical activity each day is needed' (2004: piii). This moderate intensity refers to movements that make an individual breathe harder and require at least as much effort as brisk walking, including taking part in sport (Bar-Or and Rowland, 2004). This target comes from recommendations for young people and physical activity, proposed by Cavill et al. (2001) in their Consensus Statement. Cavill et al. (2001) recommended that an average of one hour per day of physical activity is the preferred recommendation because although the majority of young people are currently meeting the criterion of 30 minutes of moderate physical activity per day on most days of the week, childhood overweight and obesity is increasing in the U.K. Further, to confirm, Cavill et al. suggested the recommendation that 'All young people should participate in physical activity of at least moderate intensity for one hour per day' (2001: p18).

The ambiguity between the guideline issued by England (and Northern Ireland) and those of the other two home countries can be seen when inspecting the recommended guideline from Scotland which proposed that at least 60 minutes of moderate activity on most days of the week should be undertaken by children and young people (Scottish Executive, 2003). Similarly, Wales have set out a recommended guideline of 60 minutes of moderate intensity physical activity on at least five days of the week (Welsh Assembly Government, 2006). Overall, although each home country of the U.K. is consistent regarding children and young people undertaking 60 minutes a day of moderate intensity physical activity, they differ in terms of the number of days (i.e., each day of the week (England and Northern Ireland), most days of the week (Scotland) and at least five days a week (Wales)). However, in the majority of literature, the recommended guideline put forward in the Department of Health's (2004) White Paper is typically referred to as the 'U.K. recommended physical activity guidelines'. Therefore, for the purposes of the present study, this specific recommended guideline was referred to as the 'U.K. (English) recommended guidelines for physical activity'.

The recommended guidelines in the U.K. are reinforced in the U.S. through the 2008 Physical Activity Guidelines for Americans (U.S. Department of Health and Human Services). The U.S. Department for Health and Human Services state that 'Children and adolescents should do 60 minutes (one hour) or more of physical activity daily' (2008: pvii). This recommendation is further evidenced by a panel from the U.S. Centers for Disease Control and Prevention, as well as the 2006 U.S. Dietary Guidelines, which stated that adolescents need to accumulate at least 60 minutes of moderate physical activity most, if not all, days of the week (Strong et al., 2005; U.S. Department of Agriculture, 2005). However, the U.S. also recommended that young people participate in vigorous intensity activity at least three days per week in order to cause more improvement in cardiorespiratory fitness (U.S. Department of Health and Human Services, 2008). Canada's guidelines included MVPA recommending that young people should aim to increase their physical activity by 90 minutes a day (over five months), 30 minutes of which should be vigorous (Health Canada and the Canadian Society for Exercise Physiology, 2002a, 2002b). However, Janssen (2007) undertook a review of Canadian guidelines and suggested retaining the vigorous intensity but also suggested a possible minimum target of 60 minutes physical activity a day (British Heart Foundation, 2009a). From an Australian perspective, the Australian Government's Department of Health and Ageing recommended that children aged five to 18 years old get a minimum of 60 minutes per day of MVPA (Department of Health and Ageing, 2005a). The European Union and its members states also recommended a minimum of 60 minutes daily moderate intensity physical activity for children and young people (EU Working Group "Sport and Health", 2008).

From the recommendations reviewed from different countries, it appears the 60 minute recommendation for moderate intensity physical activity is now widely accepted by the scientific community (Marshall and Welk, 2008). However, evidence-based physical activity guidelines for adolescents is still a public health challenge (Hallal et al., 2006b). From a U.K. perspective, recent developments in the area of physical activity recommendations have been highlighted by the Chief

Medical Officer's 2009 Annual Report on 'the State of Public Health' (Department of Health), which proposed the following actions: that '...recommendations on minimum physical activity requirements should be consistent across the United Kingdom' (2010a: p29); and 'New recommendations on the minimum physical activity requirements should be built immediately into public health programmes' (2010a: p29). Due to the release of the 2008 Physical Activity Guidelines for Americans (U.S. Department of Health and Human Services, 2008), a collaboration has recently been undertaken in the U.K. between the home country Governments in England, Scotland, Wales and Northern Ireland, and the British Heart Foundation National Collaborating Centre with the aim to undertake a review of the current physical activity guidelines in the U.K. (British Heart Foundation, 2009b). This collaboration involved the establishment of a Physical Activity Guidelines Editorial Group who are imminently due to publish the final set of new (updated) recommended guidelines for use within the four home countries in the U.K. (as a whole) for children and young people which will be reflected in a U.K.-wide Chief Medical Officers' report (British Heart Foundation, 2010).

3.3 Measurement of sedentary behaviour among adolescents

If taking the definition that sedentary behaviour is defined in relation to time spent in: (1) low energy (sitting) tasks and (2) specific sedentary behaviours, measurement choice must reflect this (The Sedentary Behaviour and Obesity Expert Working Group, 2010a). Consequently, there are two broad categories of measuring sedentary behaviour. Firstly, total time spent in sedentary behaviours can be measured through objective monitoring devices (e.g., accelerometers and inclinometers). For example, studies have been undertaken which have measured sedentary behaviour by using accelerometers to create a series of cut points for movement counts that best discriminate between sedentary behaviour and physical activity (Reilly et al., 2003). Although this method calculates the amount of movement that occurs while sedentary, it does not allow an assessment of what young people are actually doing (Marshall and Welk, 2008). Secondly, what people are actually doing in terms of different sedentary behaviours can be measured through using various self-report assessment methods (e.g., questionnaires, ecological momentary assessment / time use diaries) (The Sedentary Behaviour and Obesity Expert Working Group, 2010a). Self-reported sedentary behaviour instruments can ask respondents to report the frequency and duration of time spent in different sedentary behaviours (e.g., TV viewing, computer game playing) over a specified period of time (Hardy et al., 2007b). On the other hand, the main criterion of sedentary behaviours which are screen-based is direct observation. However, this measure is impractical because it is expensive, imposes a high burden on the researcher and may cause participants to change their behaviour (due to knowing they are being observed) (Marshall and Welk, 2008).

More specifically, a novel self-report tool that is increasing among adolescents when monitoring both sedentary behaviour (and physical activity) is ecological momentary assessment. Ecological momentary assessment is essentially a pencil and paper self-report diary of 'free-time'. Studies adopting this method of collection among adolescent populations have recently been used in studies of adolescents' sedentary behaviour (Gorely et al., 2007a, 2007b; Gorely et al., 2009a, 2009b, 2009c; Biddle et al., 2009b; Hamar et al., 2010). Ecological momentary assessment involves participants recording what they are doing at an exact point in time and importantly reduces sources of bias, notoriously present within other self-report measures such as estimation bias (Baranowski, 1985; Smyth and Stone, 2003). In addition, ecological momentary assessment also has the potential to capture a wider range of behaviours as participants 'free-record' what they are doing (Gorely et al., 2007b). Ecological momentary assessment is particularly suitable for assessing sedentary behaviour in young people because they are less likely to provide reliable estimates of intermittent, unstructured, low intensity behaviour through recall (Welk et al., 2000). Further, this method generates data about the temporal patterns of behaviour and the context in which it occurs (Dunton et al., 2005). However, there are limitations to the use of this method. Firstly, there is the difficulty in recruiting participants and the implications for generating large sample sizes in large scale longitudinal research. This is partly due to the higher burden placed on participants in comparison to other retrospective recalls such as questionnaires (Gorely et al., 2007b; Gorely et al., 2009b). Secondly, adolescents who have low literacy may not be able to understand diary instructions or comply with the recording schedule (Dunton et al., 2005).

Considering the definition of sedentary behaviour adopted in the present study and the focus on screen time as the proxy measure of sedentary behaviour, the following section focuses on the subjective measure of self-report questionnaires that measure screen-based media (e.g., TV viewing, computer/Internet use, playing video games) as this was the measurement approach used in the present study.

3.3.1 Self-report (Questionnaires)

Measurement of sedentary behaviour primarily utilises self or proxy report surveys or log books to capture specific sedentary behaviours such as TV viewing, electronic game use, reading and computer use (Hinkley et al., 2010). The utilisation of self-reported behaviour enables respondents to report the frequency and duration of time spent in different sedentary behaviours (e.g., TV viewing and computer use) over a defined period of time (e.g., last seven days) or in general (e.g., 'typical' weekday) (Sallis et al., 1993; Marshall and Welk, 2008). In addition, self-report methods (e.g., questionnaires) have the advantage of capturing the type (e.g., TV viewing) and context (e.g., home) of sedentary behaviours thus potentially indentifying key targets for designing efficacious interventions aimed at reducing inactivity (Affuso et al., 2011). Where the focus of assessment is screen-based media (i.e., screen time), researchers should collect data during weekdays and weekend days because of the known differences across these periods (Vandewater et al., 2006). Questions in self-report surveys typically refer to the 'time spent sitting' or the time engaged in specific behaviours (Marshall and Welk, 2008). In comparison to self-report measures of physical activity, there are similar limitations to be aware of when using self-report measures of sedentary behaviours. Firstly, response bias can occur whereby respondents intentionally provide incorrect answers due to responding in a socially acceptable manner (Jago et al., 2007). Secondly, there is the issue of social desirability resulting misreporting of activity behaviours in males and females (Klesges et al., 2004). On the other hand, there are advantages to using self-report measures including questionnaires such as having a low financial burden and being easy to administer or use (Affuso et al., 2011).

There are concerns that young people are more sedentary than previous generations (Hill et al., 2003). As a result, the development of valid and reliable self-report measures of sedentary behaviour is important for public health research (Hardy et al., 2007b). However, to date, there is a dearth of published data available which supports the validity and reliability of self-report measures of sedentary behaviour, whether they are based on specific activities (e.g., TV viewing) or groups of activities (e.g., screen-based media) (Marshall and Welk, 2008). This is due to three key issues. Firstly, conceptualisation of sedentary behaviour has not resulted in agreement about what (e.g., screen time) should be measured and therefore criterion validity studies have not been conducted. Secondly, the behaviour has not been associated with health outcomes in the same way that physical activity has thus gradients between the behaviour and health are not known. This is mainly due to the lack of evidence demonstrating an association between sedentary behaviour and long-term health outcomes (Ullrich-French et al., 2010). In fact, the majority of research on sedentary behaviour has mainly targeted the association of screen time with weight-related health indicators of body mass index, body fatness, waist circumference and overweight status (Marshall et al., 2004; Patrick et al., 2004; Leatherdale and Wong, 2008; Rey-Lopez et al., 2008; Hume et al., 2009). Thirdly, self-report methods vary widely, resulting in limited opportunity to compare findings across studies. Therefore, it is recognised that the measurement of TV viewing time, screen time and other sedentary behaviours is difficult and requires further work (Biddle, 2007). Consequently, sedentary behaviour measurement is currently a developing area and no one measure of sedentary behaviour is the 'preferred' or 'gold standard' measure.

The majority of sedentary behaviour measures are subjective and there are few resources available to guide researchers (Marshall and Welk, 2008). Although some instruments measure time spent in a number of sedentary behaviours (e.g., TV viewing, computer use), questions that focus on measuring these sedentary behaviours appear to be included mainly within physical activity questionnaires or broader 'health survey' questionnaires (Gordon-Larsen et al., 2004; Henning Brodersen et al., 2007; Scully et al., 2007; Ullrich-French et al., 2010). However, there is one dedicated self-report questionnaire that measures time spent in a comprehensive range of sedentary behaviours among young people; the Adolescent Sedentary Activity Questionnaire (ASAQ) (Hardy et al., 2007b). The ASAQ assesses the time spent in a comprehensive range of sedentary activities, among school-aged children, outside of school hours. A test-retest reliability study undertaken by Hardy et al. (2007b) for the ASAQ included 250 adolescents aged 11 to 15 years in Australia who completed the ASAQ under the same conditions on two occasions (two weeks apart). The findings revealed that the ASAQ has good to excellent reliability and can be considered as a potentially useful measure of a comprehensive range of sedentary behaviours among young people. In addition, there was little difference in the reliability across age groups indicating that the ASAQ is not age dependent. However, there were limitations with using this questionnaire including reliability being lower for social activities, travel and, except among high school girls, on weekends. This could be due to poor reliability of reporting or the behaviour assessed not being very stable over time. Also, behaviours could have been reported very accurately on both occasions but there could have been poor agreement because the behaviour was different on the two occasions.

As a consequence of the limited existence of specific self-report sedentary behaviour questionnaires designed for young people, this has implications for the comparability of findings. This is because when comparing the results of studies in relation to some form of outcome measure (e.g., proportion of adolescents meeting the recommended level for screen time viewing), it is difficult to make direct comparisons because of the differences in the question(s) asked and the instrument utilised. Therefore, the assessment and measurement of sedentary behaviour when using self-report methods requires further work (The Sedentary Behaviour and Obesity Expert Working Group, 2010a). Further, due to the continued trend of a lack of measures of a comprehensive range of sedentary behaviours, the focus is likely to remain on proxy measures of sedentary behaviour (e.g., screen time). These proxy measures are most likely to be agreed upon through identifying the most prevalent sedentary pursuits in the population in question (e.g., TV viewing, screen time). For instance, screen time as a proxy measure of sedentary behaviour is the most commonly measured aspect of total sedentary time (Olds et al., 2010). This is due to a number of reasons including the following: (1) being relatively discrete, easily identified and cheap to measure; (2) it is seen largely as discretionary time (a time buffer) which exhibits considerable elasticity to competing demands; and (3) is known to be associated with excessive adiposity in children. More specifically, the proportion of total sedentary behaviour time likely to be accounted for by screen time has been reported. In a recent study by Olds et al. (2010) among Australian adolescents aged nine to 16 years, 'screen sedentary time' accounted for 40% of total sedentary time. This study therefore provided support for the likely association between total screen time and total sedentary behaviour time.

3.4 Adolescent sedentary behaviour recommendations

There are very few published reports which present specific guidelines for the amount of sedentary behaviour that is recommended for young people (Marshall and Welk, 2008). However, guidelines that do exist typically specify a maximum number of daily minutes of exposure to TV, computer and video games (i.e., screen time). The majority of the current sedentary behaviour recommendations from zero to 18 years target limits to screen-based behaviours ranging from no screen time for those aged less than two years, to less than one hour a day for those aged two to five years and less than two hours a day for those aged five to 18 years (Salmon et al., 2011). The most regularly used and adopted recommendation is from the American Academy of Pediatrics (2001a) which focused mainly on TV viewing or general categories such as media usage (Marshall and Welk, 2008). In accordance with the guidelines from the American Academy of Pediatrics (2001a), the recommendation that they put forward is for a maximum 'total media time' (entertainment media) to no more than one to two hours of quality programming per day. More specifically, the Committee on Public Education (America Academy of Pediatrics, 2001a, 2001b) recommended engaging in two hours or less per day of TV and video viewing and computer/video game use (i.e., screen time) (Gordon-Larsen et al., 2004). Previous to this recommendation, the American Academy of Pediatrics (1986) recommended that the boundaries for prevalence estimates for TV viewing were set at less than two hours per day for 'low users' and more than four hours per day for 'high users'. For the past 20 years, the American Academy of Pediatrics has expressed its concerns about the amount of time children and adolescents spend viewing TV and the content of what they view (American Academy of Pediatrics, 1984). According to Marshall et al. (2006), almost a third of young people in developed countries watch more than four hours of TV per day.

At present only two countries (Australia and Canada) have published guidelines about the amount of time young people should spend engaged in sedentary behaviour (Marshall and Welk, 2008). The Australian Government (Department of Health and

Ageing) recommended that 'Children and young people should not spend more than 2 hours a day using electronic media for entertainment (e.g., computer games, Internet, TV), particularly during daylight hours' (2005a: paragraph 1). In contrast, Health Canada (Health Canada and the Canadian Society for Exercise Physiology, 2002a, 2002b) published guidelines for reducing the time young people spend being sedentary. What they advised is that physically inactive children decrease the time they spend watching TV, playing computer games and surfing the Internet by at least 30 minutes per day. In addition, they recommended that, over several months, children and youth should decrease by at least 90 minutes per day the amount of time spent on non-active pursuits such as watching videos and sitting at a computer (Marshall and Welk, 2008). These particular recommendations acknowledge that physical activity and sedentary behaviour are not two sides of the same coin and each carries independent health risks (Dietz and Gortmaker, 1985; Owen et al., 2000; Marshall et al., 2002). Furthermore, high levels of physical activity and sedentary behaviour are able to coexist within the lifestyle of a young person (Marshall and Welk, 2008). However, recently, the Canadian Society for Exercise Physiology have developed the Canadian Sedentary Behaviour Guidelines for Youth (aged 12 to 17 years) (Tremblay et al., 2011). The final recommendations stated that for health benefits, youth (aged 12 to 17 years) should minimise the time that they spend being sedentary each day, which may be achieved by: (1) limiting recreational screen time to no more than two hours per day; and (2) limiting sedentary (motorised) transport, extended sitting time and time spent indoors throughout the day.

Overall, relatively few countries have quantified recommendations for sedentary behaviour and although many countries have recommendations to limit sedentary time (e.g., Denmark – National Board of Health, 2003; National Heart Foundation of New Zealand, 2004) they do not quantify these (The Sedentary Behaviour and Obesity Expert Working Group, 2010a). A recent review on 'International Guidelines on Sedentary Behaviour' by The Sedentary Behaviour and Obesity Expert Working Group in the U.K. (2010: p44) stated the following concerning the lack of justification for any time limit on sedentary behaviour:

It is interesting that little or no justification given in the vast majority recommendation documents for any limit. The main argument appears to be that it is desirable for children to reduce sedentary time, so that any recommended level should be lower than current estimates of time spent in sedentary pursuits and screen time. Some evidence is presented of the dose-response relationship between sedentary time and obesity, but this does not in itself justify a threshold level for a recommendation. It appears that most recommendations are made based more on common sense than evidence.

Additionally, Rey-López et al. (2008) recently produced a useful review of published studies about sedentary behaviour among children and adolescents in relation to the association with TV viewing, video games and computer use, and overweight/obesity risk. In reviewing a large number of studies from around the world they concluded that with regard to environmental factors, there was sufficient evidence to recommend setting a limit to the time spent watching TV, especially by young children. Concerns about the sedentary behaviour of young people has also been detailed in a report 'Couch kids: the nation's future...' (British Heart Foundation, 2009a). An emphasis is placed in this report on how young people are spending increasing amounts of time being sedentary and the implications this has for their health, irrespective of the amount of physical activity they participate in.

The lack of a definitive or universal sedentary behaviour recommendation is reflected in the lack of consistency across studies measuring sedentary behaviour and the cut-off points used for categorising an adolescent as 'sedentary'. For instance, Hallal et al. (2006b) undertook a study into the effects of early social, anthropometric and behavioural variables on physical activity in adolescents and defined a sedentary lifestyle as less than 300 minutes of physical activity per week. Conversely, Samdal et al. (2006) used a cut-off point for TV watching set at four hours a day or more in their study of trends in vigorous physical activity and TV watching of adolescents from 1986 to 2002 in seven European countries. Their justification for using this cut-off point was because this amount of TV viewing has been linked with an increased risk of obesity for young people in studies (Andersen et al., 1998; Crespo et al., 2001). The comparison is made between these two studies because each study is measuring a different behaviour (i.e., physical activity, TV viewing) but still classifying an adolescent as 'sedentary' and consequently have used different definitions and cut-off points. Overall, the cut-offs used for defining sedentary behaviour currently differ between studies and this possibly needs to be standardised (The Sedentary Behaviour and Obesity Expert Working Group, 2010a). From a U.K. perspective, there are currently no guidelines for sedentary behaviour. However, the recommendations to be put forward in the final report produced by the Sedentary Behaviour and Obesity Expert Working Group and the establishment of the Physical Activity Guidelines Editorial Group will result in a guideline being published imminently in relation to sedentary behaviour among young people four use within all four countries of the U.K. (as a whole). This particular guideline will be included within a U.K.-wide Chief Medical Officers' report (British Heart Foundation, 2010).

3.5 Policy surrounding physical activity and sedentary behaviour among adolescents

With reference to policy nationally, there have been many policy papers published with the aim of increasing participation in physical activity among young people/adolescents. However, sedentary behaviour, perhaps for the reasons already explained, such as a lack of consensus on how to define it, lack of consensus in terms of a guideline and how it is measured, has not received the same level of attention.

From a 'sport' perspective, starting in 1985, the British Sports Council initiated a media-marketing campaign designed to 'sell' sport participation to young people, especially 14 to 18 year old working-class youth who had quit or never participated in organised sport programmes (Coakley and White, 1992). Following on, in 1992, the Health of the Nation White Paper (Department of Health, 1992) was the Government's strategy for the health of the population of England. This White Paper emphasised the need to establish active lifestyles at a young age. Further, it acknowledged the importance of maintaining a healthy lifestyle, such as a balanced diet and exercise in adulthood, stressing the importance of these lifestyle habits being established in childhood.

Given the scale of the problem of obesity, more recently, the Government's Foresight report was published in 2007 and took a cross-government 'systems' approach to the issues of obesity, setting out a number of key challenges (Government Office for Science and U.K. Government's Foresight Programme, 2007). Of these challenges, the most notable one was the need to view obesity as a complex system that required complex multi-level solutions (The Sedentary Behaviour and Obesity Expert Working Group, 2010a). As a consequence of this report, the Government published 'Healthy Weight, Healthy Lives: One Year on' (Cross-Government Obesity Unit, 2009: p31) which focused on the promotion of physical activity across the lifecourse and also made a commitment to addressing sedentary behaviour when it stated that:

> *We will, therefore, set up an expert working group on sedentary behaviour, screen time and obesity to consider the latest evidence on the health risks of sedentary behaviour and advise of the implications for messages to families in this area by December 2009.*

True to this statement, the Sedentary Behaviour and Obesity Expert Working Group was set up and a 'Working Paper' on 'Sedentary Behaviour and Obesity: Review of the Current Scientific Evidence' has been developed which has the ultimate aim to develop recommendations on limiting time spent being sedentary (The Sedentary Behaviour and Obesity Expert Working Group, 2010a). This expert group is considering the evidence for the development of specific recommendations on limiting time spent being sedentary, which will sit alongside recommendations on physical activity (from the Physical Activity Guidelines Editorial Group) (Department of Health, 2010a). The report produced (i.e., a U.K.-wide Chief Medical Officers' report) as a result of the findings of this expert group was due for publication in July 2011 and will be the first publication that will focus on both physical activity and sedentary behaviour across the lifecourse. This report, when published, will supersede the Chief Medical Officer's report 'At least five a week' (Department of Health, 2004) from which the physical activity recommendations for young people were taken for the present study.

Another pertinent recent policy paper was 'Be Active, Be Healthy' (Department of Health, 2009) which established a framework for the delivery of physical activity aligned with sport for the period leading up to the London 2012 Olympic Games and Paralympic Games. This policy paper highlighted that due to activity levels falling dramatically after the age of 16 years, there would be a partnership formed between the Department of Health, the Fitness Industry Association and local authorities who would pilot 'Fit for the Future', an incentive scheme to offer 5,000 16 to 22 year olds subsidised gym memberships linked to frequency of use. Further, the Change4Life campaign was launched in 2009 and aimed to get the population more active through the '60 Active Minutes campaign' encouraging children to do at least 60 minutes of physical activity per day and through the 'Up and About campaign' which aimed to decrease the amount of time children spend in sedentary activities (Department of Health, 2010b).

The most recent policy document to be published was the Public Health White Paper 'Healthy Lives, Healthy People' (Department of Health, 2010c) which pledged to promote physical activity during adolescence through making schools become active promoters through health (e.g., through the Personal, Social and Health Education framework) and support families to make informed choices about their levels of physical activity (through updated guidelines on physical activity). Other recent guidance has also been published on promoting physical activity for children and young people from the National Institute for Health and Clinical Excellence (NICE, 2009). NICE provided recommendations relating to all children and young people up to the age of 18 years, including those with a medical condition or disability. This guidance document complemented and supported, but did not replace NICE guidance on obesity, physical activity, physical activity and the environment, depression among children and young people, and social and emotional wellbeing in schools. The recommendations from NICE (2009: p6) stated that:

> *The recommendations refer to opportunities for moderate to vigorous-intensity physical activity. Children and young people should undertake a range of activities at this level for at least 60 minutes over the course of a day.*

The importance of tackling the drop off in physical activity levels of adolescents was reinforced by Sport England's Strategy 2008-2011 (Sport England, 2008), which stressed that Sport England is committed to delivering a reduction in post-16 drop-off in at least five sports by 25% by 2012-2013. They suggested that one of the three key challenges facing community sport is 'tackling drop-off'. Thousands of people drop-out of playing sport each year and there is a particular problem at the age of 16 years, where 250,000 drop-out of sport each year (Sport England, 2006).

The lack of physical activity among some children in England has become a source of concern (Quick, 2008). In 1994, it was estimated that 46% of children in Years 2 to 11 (children between the ages of six and 16 years) participated in at least two hours of physical education in school each week (Quick, 2008). By 1999, this had fallen to just 33% (MORI/Sport England, 2002). In recent years, the Government has responded to this growing problem by putting in place a number of different initiatives. These included the School Fruit Programme (introduced in 2004), increased funding for school meals, investment in community sport via Sport England and the 'Five a Day' campaign. Due to this problem of declining physical activity levels, a joint Department for Education and Skills / Department for Culture, Media and Sport Public Service Agreement Target (Quick, 2008: p193) was set with the target to:

> *Enhance the take-up of sporting opportunities by 5 to 16 year olds so that the percentage of school children in England who spend a minimum of two hours each week on high quality PE and school sport within and beyond the curriculum increases from 25% in 2002 to 75% by 2006 and to 85% by 2008, and to at least 75% in each School Sport Partnership by 2008.*

Following on, by 2010, the ambition was to offer all children at least four hours of sport a week made up of at least two hours of physical education and school sport and an additional two to three hours beyond the school day delivered by a range of school, community and club providers (Quick, 2008). Additionally, the new Public Service Agreement Target 22 indicator aimed to deliver a successful Olympic and Paralympic Games with the notion of a 'sustainable legacy', attracting more children and young people to take part in high quality physical education and sport through the creation of a world class system for physical education and sport (The NHS Information Centre, 2010). The delivery for this was to be through the five hour offer that will enable every young person aged five to 16 years to have access to five hours of physical education and sport each week. In the context of the present study, those aged 16 to 19 years will have access to three hours of physical education and sport each week (The NHS Information Centre, 2010).

In conclusion, there appears to be well developed policy on sport and physical activity among adolescents. This is evidenced by the numerous White Papers and policy documents published. This is contrast to the lack of policy on sedentary behaviour among adolescents for the reasons explained such as a lack of consensus on a definition, cut-off points, measurement and recommendations. Despite this, sedentary behaviour is beginning to be introduced into policy documents such as the imminent publication of the U.K.-wide Chief Medical Officers' report. However, what does emerge within the policy presented is the issue of declining levels of physical activity and increasing levels of sedentary behaviour among the adolescent population, in particular the drop off levels in physical activity after completing compulsory education at age 16 years.

3.6 Summary

After reviewing the various techniques that are utilised for the measurement of physical activity and sedentary behaviour among adolescents, self-report questionnaires are the most common method used, particularly among large populations for the reasons already explained. The questions that are used to measure each behaviour also seem to be included within the same questionnaire due to a lack of independent sedentary behaviour questionnaires. In relation to physical activity, questions that assess adolescents' compliance with recommendations for physical activity, self-report questionnaires typically enable this and many studies can be compared on this basis. Furthermore, although there are differences between countries on physical activity guidelines for adolescents, there is a consensus that 60 minutes a day of at least moderate intensity is required. In addition, screen time is the most frequent proxy measure of sedentary behaviour within studies among adolescents. This is mainly because of the large proportion of total sedentary time accounted for by screen time among adolescents. Screen time is therefore a good proxy measure of sedentary behaviour to use when investigating adolescents' sedentary behaviour. In relation to recommendations for sedentary behaviour among adolescents, although there is no universal recommendation that has been agreed upon, screen time guidelines are typically used across studies (i.e., less than two hours per day) and this suggests that use of this recommendation in future studies allows comparability although the issues of cut-offs and measurement tools used should not be dismissed. From a policy perspective, there is a domination of policy focusing on physical activity rather than sedentary behaviour among adolescents. However, policies that focus on adolescents' sedentary behaviour are gathering momentum. There is also a theme that emerges from the policies in that physical activity 'drops off' after age 16 years in the U.K. (i.e., at the completion of compulsory education) thus warranting further investigation in future research. Policies that focus on adolescents' sedentary behaviour are gathering momentum. Chapter 4 focuses in detail on physical activity and sedentary behaviour among adolescents by reviewing the evidence from cross-sectional and longitudinal studies.

CHAPTER 4: REVIEW OF EVIDENCE INVESTIGATING PHYSICAL ACTIVITY AND SEDENTARY BEHAVIOUR AMONG ADOLESCENTS

This chapter is divided into two main sections; physical activity, and sedentary behaviour, among adolescents. Initially, for both the physical activity and sedentary behaviour sections combined, details of the systematic approach to reviewing the literature undertaken is provided with a description of the search strategy employed, and the inclusion and exclusion criteria utilised. A synthesis of the findings (including methodological issues) is then provided for each behaviour separately.

4.1 Search strategy employed

A systematic approach to reviewing the literature was undertaken which involved a three-staged search being undertaken. The first search involved locating literature in the area of physical activity among adolescents. The second search involved identifying literature in the area of sedentary behaviour among adolescents. The third search encompassed locating literature in the dual area of both physical activity and sedentary behaviour among adolescents.

The first search was built around four groups of keywords: physical activity, study type, data collection method and sample type. Key terms for physical activity were used in combination with key terms for study type, data collection and sample type to identify potentially relevant studies. Key terms for physical activity included: 'physical activity', 'sport participation', 'exercise' and 'sport'. Key terms for study type included: 'longitudinal', 'cross-sectional', 'cohort', 'prospective' and 'population-based'. Key terms for data collection method included: 'self-report', 'questionnaire' and 'survey'. Key terms for sample type included: 'adolescent(s)', 'adolescence', 'youth', 'young people', 'compulsory education completion', 'year 11' and 'sixth form'.

The second search was built around four groups of keywords: sedentary behaviour, study type, data collection method and sample type. Key terms for sedentary behaviours were used in combination with key terms for study type, data collection and sample type to identify potentially relevant studies Key terms for sedentary behaviours included: ‘sedentary behaviour’, ‘television viewing’, ‘screen-based media’, ‘screen time’, ‘screen viewing’, ‘computer’, ‘video games’ and ‘internet’. Key terms for study type included: ‘longitudinal’, ‘cross-sectional’, ‘cohort’, ‘prospective’ and ‘population-based’. Key terms for data collection method included: ‘self-report’, ‘questionnaire’ and ‘survey’. Key terms for sample type included: ‘adolescent(s)’, ‘adolescence’, ‘youth’, ‘young people’, ‘compulsory education completion’, ‘year 11’ and ‘sixth form’.

The third search was built around four groups of keywords: physical activity and sedentary behaviour, study type, data collection method and sample type. Key terms for physical activity and sedentary behaviour were used in combination with key terms for study type, data collection and sample type to identify potentially relevant studies Key terms for physical activity and sedentary behaviour included: ‘physical activity and sedentary behaviour’, ‘physical activity and screen time’, ‘physical activity and television viewing’, ‘physical activity and screen based media’, ‘sport participation and sedentary behaviour’, ‘sport participation and screen time’, ‘sport participation and television viewing’ and ‘sport participation and screen based media’. Key terms for study type included: ‘longitudinal’, ‘cross-sectional’, ‘cohort’, ‘prospective’ and ‘population-based’. Key terms for data collection method included: ‘self-report’, ‘questionnaire’ and ‘survey’. Key terms for sample type included: ‘adolescent(s)’, ‘adolescence’, ‘youth’, ‘young people’, ‘compulsory education completion’, ‘year 11’ and ‘sixth form’.

For all three searches, the following electronic databases were searched using the key terms: Academic Search Complete, PubMed, PsychINFO, Web of Science, Science Direct, SPORTDiscus and Zetoc. Potentially relevant articles were selected by screening their title, abstract and the full article. Where an abstract was not available, the whole article was retrieved and screened in order to determine if it met the inclusion criteria. All relevant studies included had to meet specific inclusion and exclusion criteria.

4.2 Inclusion and exclusion criteria

For inclusion, studies were required to:

(1) include adolescents in the age range of 15 to 18 years (or at least have included one of the specific ages (e.g., 16 years) in this age range);
(2) be longitudinal or cross-sectional studies;
(3) have measured physical activity / sedentary behaviour (screen time, TV viewing or other sedentary behaviours) via a self-report method(s); and
(4) be published in peer-reviewed journals in the English language (or have been translated into English).

For exclusion, studies were excluded if:
(1) participants were adults at baseline (i.e., greater than 18 years);
(2) other data collection methods such as objective measures (e.g., accelerometers) had been used to measure physical activity or sedentary behaviour; and/or
(3) published in a foreign language.

4.3 Physical activity among adolescents

Physical inactivity (i.e., not meeting a criterion of physical activity) is recognised as a major public health concern (Allison et al., 2007; Bauer et al., 2008). Consequently, increasing physical activity among adolescents to a level that meets health-related physical activity guidelines is a major public health challenge (Allison et al., 2007). The interest that has evolved in adolescent physical activity is primarily a consequence of public health considerations since it is believed that physical activity in the future adult population might be improved by encouraging improved habits of leisure time physical activity among children and youths (Anderssen et al., 2006). Furthermore, better targeted, more effective physical activity promotion in school aims to instil positive health behaviours early on and maintain them into adolescence (Gidlow et al., 2008b). If successful, this could have important public health consequences in terms of reducing the risks of physical inactivity and associated morbidities into adulthood (Gidlow et al., 2008b).

Many studies measuring physical activity during adolescence have shown a decline in physical activity with increasing age (Sallis, 1993; Allison and Adlaf, 1997; Caspersen et al., 2000; Kimm et al., 2000; Sallis, 2000; Silva and Malina, 2000; Telama and Yang, 2000; Van Mechelen et al., 2000; Kimm et al., 2002; Trost et al., 2002b; McMurray et al., 2003; Thompson et al., 2003; Oehlschlaeger et al., 2004;

Nelson et al., 2005; Eiðsdóttir et al., 2008). However, the results are mixed concerning the age period of the decline due to differences between studies regarding the age period studied. As a consequence, this is a methodological issue making direct comparisons between studies difficult (Allison et al., 2007). For instance, among U.S. adolescents, physical activity has been shown to decline steeply from ages 15 to 18 years (Caspersen et al., 2000). Among Canadian adolescents, the decline has been reported to be from age 14 to 16 years (Allison and Adlaf, 1997). For Finnish youth, the age period of greatest decline is 12 to 15 years or 15 to 18 years (Telama and Yang, 2000) and for Dutch adolescents 13 to 16 years (Van Mechelen et al., 2000). Furthermore, Sallis (2000) published a symposium paper which investigated whether there are critical periods and the quantification of gender differences in the decline of physical activity. After studying data from cross-sectional and prospective studies, Sallis (2000) indicated that the decline is steepest between the ages of 13 and 18 years and that boys are more active than girls. Sallis (2000) also suggested that decline during adulthood occurs at a much slower rate than during adolescence.

Physical activity in late adolescence is more a matter of choice than it is at a younger age when school curricula influence activity levels (Dovey et al., 1998). Additionally, involvement in sports and other physical activities may be difficult to arrange without the organisational support and the practical encouragement provided by schools, and consequently, the pressure to spend more time in work or education may diminish the priority given to physical activities (Dovey et al., 1998). Despite frequent assumptions in both the academic and popular media that young people today are less active than in previous generations, there is actually insufficient direct data at both the behavioural (i.e., participation rates) and physiological (i.e., aerobic fitness) level to argue convincingly in favour of this assumption (Sallis et al., 1992; Cavill et al., 2001). Additionally, from an England and Wales perspective, Green et al. (2005b) suggested that there is a significant minority of young people doing relatively little or absolutely nothing and that there has been a marked decline in the drop-out rate during late adolescence and that young people are much more likely to continue participating in sport and physical activities after completing their full-time education (Roberts, 1996). This notion is further supported by Smith et al. (2004: p61) who proposed:

> *...to suggest that young people have reduced their levels of daily physical activity in recent years is at best a gross oversimplification and, at worst, betrays the fact that there is a dearth of available evidence to support such a bold claim.*

Monitoring physical activity among youth is important for a number of reasons, as proposed by Hardy et al. (2008). Firstly, they suggest that information on longitudinal (long-term) trends will help predict future health outcomes (e.g., overweight and obesity) associated with changes in physical activity and assist with determining the most appropriate allocation of health promotion resources (e.g., improved access to physical activity facilities). Secondly, surveys that provide information on factors associated with physical activity, such as gender, seasonality and socioeconomic status are particularly useful to intervention and health promotion planning.

4.4 Study differences in adolescents' physical activity classification

In terms of methodological differences between studies, regardless of whether they are cross-sectional or longitudinal studies in the area of adolescents' physical activity, a significant factor appears to emerge. This is the variation between studies regarding the classification of 'sufficient' physical activity for an adolescent. As stated in the previous chapter in Section 3.2, there appears to be a consensus from a worldwide perspective that the '60 minutes a day moderate intensity physical activity' message is being used by the scientific community although recommendations put forward by different countries are varied. Both longitudinal and cross-sectional studies highlight that physical activity compliance varies widely depending on the categorisations used by researchers.

From the cross-sectional and longitudinal studies reviewed, studies such as Butcher et al. (2008) have defined compliance with physical activity guidelines as 60 minutes of MVPA on more than five days per week. Similarly, Roman et al. (2008) and Samdal et al. (2006) used the criterion of 60 minutes of moderate intensity physical activity daily as meeting recommendations. Likewise, Scully et al. (2007) classified an adolescent as meeting recommended guidelines if they reported participating in seven days of MVPA. In addition, Lake et al. (2009) classified an adolescent as 'active' if they were physically active for at least one hour a day over five to seven days. Li et al. (2007) also assessed compliance with physical activity guidelines with adolescents in their study by measuring against the criterion of 60 minutes a day of MVPA. Other researchers such as Tammelin et al. (2007) have attempted to assess compliance with the recommended guidelines for physical activity but rather than calculate this from asking one question, they used a more comprehensive set of measures. More specifically, to give an 'overall picture' of the proportion of adolescents that were meeting guidelines, they summed together all forms of physical activity that had been reported (i.e., MVPA, light physical activity and commuting physical activity) by adolescents.

Conversely, other longitudinal and cross-sectional studies have used classifications of physical activity which vary considerably from the recommended guideline. For instance, Allison et al. (2007) used the categorisation of three days or more doing at least 20 minutes of vigorous physical activity. Likewise, Lubans et al. (2007) used a similar categorisation but instead adopted five or more sessions of 20 minutes or longer of MVPA. Azevedo et al. (2007) used a cut-off value of 150 minutes per week (determining an individual as adequately active or not) through the construction of a physical activity score which involved the weekly time spent in moderate activities plus twice the weekly time spent in vigorous activities. In contrast, Bastos et al. (2008) assigned a cut-off point of 300 minutes per week of MVPA thus adolescents below this cut-off point were classified as undertaking 'insufficient physical activity'.

At the other extreme, Peiró-Velert et al. (2008) used Cale's Four by One Day Physical Activity Questionnaire which measured adolescents' physical activity and energy expended through categorising energy expenditure into four physical activity groups (i.e., 'very active', 'inactive', 'moderately active' and 'active'). In this study, reported activities were used to calculate average daily expenditure (activity scores). Firstly, a MET value was attached to each group of activities reported by participants (i.e., 1 MET for 'sleeping', 1.5 METs for 'very light activities', 2.5 METs for 'light activities', 4 METs for 'moderate activities', 6 METs for 'hard activities' and 10 METs for 'very hard activities'). Secondly, in order to then calculate the specific daily energy expenditure (activity scores), the numbers of hours spent in each activity intensity were multiplied by the average MET value for that intensity thus resulting in a physical activity index for each participant in $kcal^{-1}.kg^{-1}.day^{-1}$. Finally, based on each participant's estimated energy expenditure, participants were classified into one of four activity categories: active (40 $kcal^{-1}.kg^{-1}.day^{-1}$ or more); moderately active (37-39.99 $kcal^{-1}.kg^{-1}.day^{-1}$); inactive (33-36.99 $kcal^{-1}.kg^{-1}.day^{-1}$); and very inactive (less than 33 $kcal^{-1}.kg^{-1}.day^{-1}$). Similarly, Utter et al. (2003) asked three questions on physical activity to assess the number of hours per week spent in strenuous, moderate and mild activities and all were assigned a MET value of 9, 5 and 3 respectively. MET values were then used to approximate energy expenditure for the different levels of physical activity. Similar to other studies previously referred to, energy expenditures were calculated as the number of hours multiplied by the MET value for that activity and summed across the three levels of exercise intensity resulting in a 'active energy' energy expenditure figure per kilogram per week. MET values have also been used to assess physical activity levels in other studies such as Gordon-Larsen et al. (2004). In response to a question asking participants to record the number of times they had participated in a range of specified activities in the previous week, a calculation was undertaken for frequency (number of sessions) of specified activities per week by MET value (where 1 MET was defined as the energy expenditure associated with quiet sitting). Information was then elicited on participation in MVPA, classified as 5 to 8 METs in the previous week using the criterion of five or more weekly sessions of MVPA to denote participants as 'achieving favourable activity patterns'.

Some studies have not specified a cut-off point for defining an adolescent as 'active'. For example, Eiðsdóttir et al. (2008) only vigorous physical activity of adolescents was measured (i.e., how often participants 'physically tested' themselves). Vigorous intensity physical activity was classified as participation in physical activity that made one breather hard or sweat, four or more times a week. Additionally, 'inactivity' was classified as participation in physical activity that made one breathe hard or sweat less than once per week. Likewise from a vigorous physical activity perspective, Henning Brodersen et al. (2007) assessed only vigorous physical activity by asking adolescents how many of the past seven days they had carried out vigorous exercise that made them sweat and breathe hard.

Other studies have also produced an 'overall' physical activity score. In a study by Thibault et al. (2010), adolescents were asked to report separately, how many hours they spent every week in different types of physical activities. These answers were summed to create a total cumulative weekly time spent on physical activity. In addition, some studies have computed a combination of self-reported questions on physical activity into a sum index of physical activity (e.g., Juan et al., 2010). There also studies that have measured physical activity among adolescents through assessing the time spent (hours per week) during a previous 12 month period in separate individual and team activities (e.g., Kahn et al., 2008). Activities in this study were defined as moderate (less than 6 METs) or vigorous (6 or more METs). A total physical activity score (in hours per week) was then created through the summing of moderate plus vigorous physical activity. However, recall accuracy is a limitation with this method due to the long recall period. Furthermore, studies such as Mota et al. (2006) assessed physical activity by asking five questions covering organised sport, nonorganised sport, sport or physical activity of at least 20 minutes, physical activity that gets you out of breath or sweating and competitive sport. From the answers to these questions, a number of points were summed and 'physical activity index' was obtained. Four different categories were created according to the total sum of the points ('sedentary' (0 to 5 points), 'low active' (6 to 10 points), 'moderately active' (11 to 15 points) and 'vigorously active' (16 to 20 points)). Due to youth guidelines stressing engagement in MVPA, two further groups were created; an active group (comprising 'moderately active' and 'vigorously active') and a less active group (comprising 'sedentary' and 'low active'). Finally, Brown and Trost (2003) utilised a method in which frequency of participation in 'vigorous' and 'less vigorous' was used to derive a baseline activity score by weighting frequency of vigorous exercise by five and less-vigorous exercise by three. A score of 15 (which is equivalent to vigorous exercise three times a week or less vigorous exercise five times a week) was used as the threshold for categorising participants as 'active' or 'inactive'.

The differences between studies regarding the determination of physical activity categorisation and the cut-off point for an 'active' category makes comparisons difficult. For example, although two studies may reach a similar conclusion (for e.g., that physical activity levels decline (in a longitudinal study) or that there is a difference (in a cross-sectional study) between 16 to 17 years), they may have used different methods and classifications to determine physical activity levels. Hypothetically speaking, one study might have classified physical activity according to compliance with a recommended guideline (e.g., 60 minutes on each day of the week) whereas the other study may have utilised some form of 'overall' physical activity score (e.g., physical activity index). Although, as explained in the previous chapter, the 60 minute moderate intensity message appears to be accepted worldwide, this is not reflected in research undertaken in different countries around the world. This is highlighted as this chapter progresses.

4.5 Evidence from cross-sectional and longitudinal studies – physical activity among adolescents

Most studies of physical activity among adolescents are cross-sectional (Hallal et al., 2006b). Despite the importance of physical activity in adolescence, studies show consistently that participation in physical activity declines during adolescence (Sagatun et al., 2008). This decline has been reported in both cross-sectional (Trost et al., 2002b; Riddoch et al., 2004; Allison et al., 2007) and longitudinal studies (Telama et al., 1997; Kimm et al., 2000; Telama and Yang, 2000; Van Mechelen et al., 2000; Aarnio et al., 2002; Kimm et al., 2002; McMurray et al., 2003; Anderssen et al., 2005; Nelson et al., 2006; Kristensen et al., 2008). These declines have been demonstrated in studies using self-reported measures (Telama et al., 1997; Telama and Yang, 2000; Aarnio et al., 2002; Kimm et al., 2002; Anderssen et al., 2005; Nelson et al., 2006; Allison et al., 2007) and objective measures (Trost et al., 2002b; Riddoch et al., 2004; Kristensen et al., 2008) of physical activity.

Despite the dominance of cross-sectional studies of adolescents' physical activity, longitudinal studies are becoming increasingly popular when investigating physical activity levels of adolescents (Gordon-Larsen et al., 2004; Nelson et al., 2006; Henning Brodersen et al., 2007) with the main benefit being that they enable possible determinants of physical activity behaviour to be identified through exploring the factors associated with changes in the behaviour of interest (Hallal et al., 2006b). However, in comparison to cross-sectional studies, there are still relatively few longitudinal studies on physical activity conducted during adolescence (Dovey et al., 1998; Duncan et al., 2007). All cross-sectional and longitudinal studies identified in the sections that follow are detailed in Table 4.1 (cross-sectional) and Table 4.2 (longitudinal).

4.5.1 Cross-sectional self-report data – Decline in adolescents' physical activity

Cross-sectional studies investigating adolescents' physical activity have demonstrated a mixture of findings. Firstly, some studies have shown that physical activity is not only low in the adolescent population but that it declines as adolescence progresses. Studies which support this include Allison et al. (2007) who examined the physical activity levels among a large number of adolescents in the U.S. (2001 Youth Risk Behavior Survey) and Canada (2001 Ontario Student Drug Use Survey). Two outcomes were examined; past seven day participation in vigorous physical activity (number of days) and past seven day participation in vigorous physical activity (three or more days). Participants aged between 14 and 18 years reported the number of the last seven days they did exercise or had participated in sports activities for at least 20 minutes that made them sweat and breathe hard (including both school and non-school activities). It was found that in both samples, for both males and females, there was a dominant and steady decline in physical activity between 14 and 18 years. More specifically, there was a significant decline between 16 and 17 years. In this case, the number of physical activity days was 0.47 days higher among 16 year olds compared to 17 year olds. The large sample size (U.S.: n = 13,503; Canada: n = 1322) was a main strength in this study and the use of two different countries which allowed for comparisons. However, the use of a cross-sectional design did not facilitate an observation of changes over time in physical activity. Another study that has demonstrated a decline in physical activity during adolescence is Thibault et al. (2010). Thibault et al. (2010) determined the prevalence by age and gender of physical activity among French adolescents aged 11 to 18 years. Participants reported the number of weekly hours they did 'exercise' or 'sports' by reporting separately how many hours they spent every week in different types of physical activities at school during physical education (lessons), at sports clubs and during their free time. Answers were then summed to create a total cumulative weekly time spent on physical activity. They found that physical activity decreased with increasing age and mean weekly time of cumulative physical activity was higher for boys than girls. Physical activity was also significantly higher for participants from the higher socioeconomic status based on the professional occupation of the father.

4.5.2 Cross-sectional self-report data – Age period of decline in adolescents' physical activity

There are also cross-sectional studies which have indicted the age period during adolescence at which a possible decline in physical activity occurs. For instance, Michaud et al. (1999) gathered data on the physical fitness and physical/sports activity of children and adolescents in Switzerland aged nine to 19 years. Physical/sports activity was measured by two components ('habitual physical activity' and 'moderate to vigorous activities') assessed through participants reporting: (1) the number and types of sports episodes engaged in during the previous seven days; (2) the average daily time spent in activities inducing sweating; and (3) to questions assessing habitual leisure activities. The most pertinent finding was that participation in physical and sport activities was lower after age 15 years than before, in addition to being lower among females compared with males. This is important to highlight because a decline at this age point indicated a decline in informal sports activity possibly due to the progression from 16 years of age in terms of adolescents having a time schedule which is heavily loaded by professional learning tasks, in addition to other social activities like going out and spending time with friends. This study highlighted the importance of this transitional stage of 15 years of age for adolescents' physical activity. Strengths of this study were the use of a variety of questions taken from different surveys thus providing a good assessment of the adolescent's involvement in physical activity and sport. However, similarly to the previous studies mentioned, the study's cross-sectional design does not allow an observation of declining levels among the same cohort. This particular finding is supported by the findings of Lubans et al. (2007) who measured the amount of time spent in physical activity among adolescents in England aged 11 to 12 years and 15 to 16 years. Participants reported the number of times per week they engaged in MVPA for 20 minutes or longer. They concluded that 31.9% of participants reported involvement in at least five sessions of MVPA in the previous week. Furthermore, they found that those participants aged 11 to 12 years were more active (in relation to the number of sessions per week of MVPA of 20 minutes or longer) than those aged 15 to 16 years.

4.5.3 Cross-sectional self-report data – Increase in adolescents' physical activity

Studies have also shown that physical activity increases during adolescence from a cross-sectional viewpoint. Seabra et al. (2007) studied sport participation among Portuguese school youth aged 10 to 18 years. Sports participation was estimated with the Baecke questionnaire via two indicators: (1) a binary variable regarding participation in sports: "Do you play sport? – yes or no?"; and (2) a sport score (based on questions covering: (1) which sport do you play most frequently; (2) how many hours a week; (3) how many months a year; and (4) the same questions relating to a second sport). The construction of the sport score (using different categories for each question) are specified in Table 4.1. They found that males had a greater prevalence of sport participation than females at all ages. Although there was variation among age groups, the trend for females suggested a decline in sports participation with age. For males, there was a relatively stable prevalence of sport participation across age. Also, mean sport scores increased in both sexes from 10 to 18 years. Seabra et al. (2007) concluded that sports participation is an important component of physical activity among Portuguese youth and has a relatively stable prevalence between 10 to 18 years. This finding is insightful and indicates the potential importance of sport within an overall measure of adolescents' physical activity but there was a domination of sport and no inclusion of physical activity. Even so, the large sample size (n = 12,568) is a significant strength of this study.

Eiðsdóttir et al. (2008) also demonstrated an increase in physical activity through examining cross-sectional trends in physical activity and participation in sports clubs among Icelandic adolescents aged 14 and 15 years across four different cohorts in 1992, 1997, 2000 and 2006. Participants reported their level of participation in physical activity (vigorous activity) ('how often you physically test yourself so that you wind yourself (i.e., meaning 'out of breath') significantly or sweat') and participation in a sports club ('how often you participate (practice or compete) in sports with a club or a team'). Findings revealed that there was a 6% increase in the rate of vigorous physical activity (defined as 'physical activity that made breathing hard or sweating, four or more times a week') and a 15% increase in active sports club participation (defined as 'participation in a sports club or with a team four or more times per week') among 14 and 15 year old Icelandic adolescents from 1992 to

2006. Regarding gender differences, more boys consistently reported meeting the criterion for vigorous physical activity although girls displayed a larger proportional increase during the study period. The sample size in this study is to be commended (n = 27,426), particularly in a country where little data has been collected before on adolescent physical activity. However, there are weaknesses that need to be highlighted such as the lack of a measure of physical activity that defined a number of minutes of physical activity in the questions asked of participants. This makes is difficult to relate the findings to recommendations.

4.5.4 Summary

In this section, it is evident that opposing findings have emerged in cross-sectional studies reflecting either a decline or an increase (albeit limited evidence) in physical activity as adolescence progresses. Further, some cross-sectional studies (i.e., Michaud et al., 1999; Lubans et al., 2007) have indicated the age period during adolescence at which physical activity declines. Opposing findings among these studies are possibly due to the differences in methodological design. Although they all have used self-report methods to assess physical activity, each study differed in terms of the question(s) answered by adolescents and the classification of the behaviour (e.g., 'active' or 'not'). Also, the recall period is different among studies with some basing their measure of physical activity on the previous seven days, with others basing it on longer periods of recall (e.g., a month).

4.5.5 Cross-sectional self-report data – adolescents' compliance with physical activity guidelines

Following on from cross-sectional studies demonstrating a decline or increase in physical activity and the age period of a decline in physical activity, there is also evidence from cross-sectional studies highlighting the proportions of adolescents who are achieving recommended guidelines for physical activity (i.e., compliance with guidelines). Recent publications have estimated that based on cross-sectional reported physical activity, 30% to 40% of young people currently meet health-related physical activity recommended guidelines (Sisson and Katzmarzyk, 2008; Li et al., 2010). However, as demonstrated in the studies that follow, this percentage varies between studies.

A range of studies have found moderate compliance prevalence rates such as Butcher et al. (2008) in the U.S. Butcher et al. (2008) assessed the rates and correlates of 14 to 17 year old adolescents' compliance with national U.S. guidelines for physical activity (i.e., 60 minutes of MVPA at least five days per week). Participants were asked about their own MVPA using two items. The definition of physical activity that was given was 'any activity that increases your heart rate and makes you get out of breath some of the time' and examples provided included both moderate and vigorous physical activities. Participants were also asked to add physical activity for all purposes throughout the day except for activity during physical education classes because low activity levels during most physical education classes were expected to lead to over reporting. The first item involved participants reporting how many of the past seven days they were physically active for a total of at least 60 minutes per day. Meanwhile, the second item was similar to the first item but asked about physical activity during a 'typical or usual week'. They concluded that for males and females combined, 47.9% complied with the physical activity guidelines. Furthermore, approximately 40% of the females and 57% of the males complied with the national physical activity guidelines. This study's main strengths were the large sample size (n = 6125) thus suggesting the rates of physical activity were representative among U.S. urban teens. In addition, the use of a previously validated physical activity measure provided rigour.

Similar rates of moderate compliance have also been reported by Roman et al. (2008) who analysed the prevalence of compliance with the most recent recommendations on physical activity and sports (60 minutes of moderate intensity physical activity daily) within a population of Spanish adolescents aged six to 18 years. Roman et al. (2008) used physical activity questions adapted from the World Health Organisation physical activity CINDI questionnaire (World Health Orgnaisation, 1991) and the MARATHOM leisure time physical activity questionnaire (Elosua et al., 1994). The accumulation of at least 60 minutes of physical of at least moderate intensity daily was calculated by the sum of time spent practicing sports during leisure time daily, plus the minutes walked a day and the number of hours spent practicing sports at school (with activities classified as moderate (5 to 8 METs) or vigorous (more than 8 METs)). Results showed that only 47.5% of participants aged from six to 18 years reported at least 60 minutes of physical activity daily. In relation to participants aged 14 to 18 years, 48.8% complied with the physical activity recommendation with more males (60.6%) than females (38.0%) complying with this recommendation. Overall, compliance increased with age in males but not in females. The main strength of this study was its use of the international physical activity recommendation (seven days multiplied by 60 minutes), making its findings comparable with others.

On the other hand, some studies have reported slightly higher rates of compliance with recommended guidelines. For example, Li et al. (2007) assessed physical activity levels among Chinese adolescents aged 11 to 17 years. Participants recorded the time spent on organised and nonorganised physical activities in an average week in spring and autumn semesters. Reported activities were then given a MET score with light activities defined as less than 4 METs, moderate activity ranging from 4 to 6 METs and vigorous activity more than 6 METs. The proportion of participants meeting and not meeting the recommended guidelines were then calculated for the 1994 adolescent physical activity recommendation (i.e., where 'active' is defined as having more than 150 minutes a week of moderate activity or 60 minutes a week vigorous activity) and the 2001 international recommendations for youth (i.e., 60 minutes a day of MVPA). For the 1994 recommendation, 84% of participants were active whereas the 2001 recommendation was not met by 44% (i.e., 56% did meet the recommendation) of the participants overall (37% of boys and 53% of girls). Conversely, Tammelin et al. (2007) reported lower levels than Li et al. (2007) when comparing to the 2001 international recommendation for youth. Tammelin et al. (2007) aimed to determine the prevalence of young Finns currently meeting international guidelines for physical activity (physical activity of at least moderate intensity for at least one hour a day). Participants aged 15 to 16 years reported how many hours a week altogether they spent in (a) brisk (referring to MVPA) and (b) light physical activity outside school hours. In addition, participants reported how often they participated in brisk physical activity outside school hours at least 20 minutes at a time (referring to MVPA). Participants were also required to report on commuting physical activity to and from school. A 'level of leisure time physical activity' outside of school hours score was calculated using the information collected. It was found that 59% of the boys and 50% of the girls reported 60 minutes or more of total physical activity per day (when all forms i.e., light physical activity, MVPA and commuting physical activity were considered). However, Only 23% of boys and 10% of girls reported 60 minutes of MVPA per day. Strengths of this study included the breadth of different types of physical activity that were captured among participants. This aided in seeking to understand and develop a comprehensive account of physical activity behaviour among the participants studied. Conversely, a limitation of the study was that physical activity at school was not assessed which may have led to underestimation of the number of sufficiently active participants at this critical period of adolescence between 15 to 16 years old.

On the other hand, low compliance with recommended guidelines for adolescents' physical activity has been reported by Scully et al. (2007). Australian participants aged 12 to 17 years reported how many days in the past week that had included any vigorous or moderate physical activity for a total of at least one hour. Responses to this question were then dichotomised into seven days (recommended minimum compliance level) or not. Findings showed that only 14% of participants reported engaging in at least 60 minutes of MVPA each day in the previous week (i.e., seven days x 60 minutes). Further, this proportion was lowest among 16 to 17 year old females (7%) and males were more likely than females to meet the physical activity recommendation. This study was the first to measure Australian teenagers' compliance with physical activity guidelines, did not use parent proxy measures of physical activity and included a large sample size (n = 18,486); all main strengths of the research. However, a relatively simple question on physical activity was asked without giving examples of physical activities that would be classed as MVPA and the low values of those meeting guidelines is likely to be due to the strict criteria for 'meeting guidelines'.

Slightly higher compliance rates to those reported by Scully et al. (2007) (although still low) have been found by Bastos et al. (2008) who investigated levels of physical activity among Brazilian adolescents between the ages of 10 to 19 years. A standardised and pretested questionnaire was applied to participants in their homes by face-to-face interviews. The physical activity questionnaire addressed transportation to and from school or work and leisure time physical activities, which included seven questions on transport-related physical activity and a box with a list of leisure time activities. Only activities lasting longer than 10 consecutive minutes or more were considered. After calculations were made for a score (in minutes per week) and then using the cut-off point of 300 minutes per week recommended for adolescents, 69.8% of the participants were not sufficiently active with prevalence for boys (56.5%) and girls (82.1%). In comparison to the previous study (Scully et al., 2007), this cut-off point is more forgiving thus is a possible reason for the higher compliance rate. Following on, another study which used a similar and more 'forgiving' classification is Lake et al. (2009) who reported that 31 of 73 16 to 20 year olds in full-time education in the North-east of England were active for a total of at least one hour a day over five to seven days. Further, 28 of the 73 participants were active for a total of at least one hour a day over three to four days. This study is welcomed due to the consistency of utilising the U.K. recommended guidelines for physical activity. However, 73 participants is a very small sample of participants, particularly when self-report is the method of collecting data. If more participants had been recruited, the findings may have been more representative.

Some studies have also reported compliance with the U.K. recommended guidelines for physical activity but in these studies compliance with these guidelines was not the main focus. For example, Gorely et al. (2009c) using data from Project STIL (Sedentary Teenagers and Inactive Lifestyles) and using a time-use diary (ecological momentary assessment), examined the leisure time physical activity among adolescent boys aged between 12.7 years and 16.7 years in the U.K. Participants completed a self-report diary of 'free-time' outside of school hours (not including behaviours during school time). Every 15 minutes for three weekdays outside of school hours and one weekend day, participants recorded their behaviour, location and social context they were engaged in. To estimate the time spent in each behaviour category, the number of times a behaviour was recorded each day was multiplied by 15. For weekdays, the mean time per behaviour was then calculated and used within the analysis. In order to ensure that behaviours that would contribute either a duration or intensity that was consistent with the U.K. physical activity guidelines, separate behaviour categories were classified as 'sedentary' (e.g., watching TV, paid work). It was concluded that only 19% of boys reported doing sports and exercise for more than one hour on weekdays which increased to 37.5% at weekends. In addition, 60% of boys participated in up to one hour of active travel on weekdays. At the weekend, active travel participation decreased and 68.3% reported no active travel and only 25.1% reported up to one hour. In relation to compliance with the U.K. recommended guidelines for physical activity (i.e., at least 60 minutes of at least moderate intensity physical activity each day), Gorely et al. (2009c) concluded that, overall, 63% of participants met the recommendation of 60 minutes each day for weekdays and 50% of participants for weekends (classified as including 'sports and exercise' and 'active travel').

Two other studies using the same methodology as Gorely et al. (2009c) have also been undertaken as part of Project STIL (Gorely et al., 2007a – adolescent girls aged 12.5 to 17.6 years in the U.K.; Biddle et al., 2009b – adolescents aged 12.6 to 16.7 years in Scotland). These two studies also include reference to participants' compliance with the U.K. physical activity guidelines but do not provide exact proportions of participants meeting or not meeting the guidelines. However, the consensus in Gorely et al. (2007a) was that few girls met the guidelines with an average of 44 minutes leisure time physical activity (classified as including 'sports and exercise' and 'active travel') on weekdays and 53 minutes on weekends. Biddle et al. (2009b) found that, on average, adolescent girls achieved 55 minutes and adolescent boys achieved 62 minutes of leisure time physical activity (classified as including 'sports and exercise' and 'active travel') on weekdays. On weekend days, adolescent girls achieved 47 minutes and adolescent boys achieved 91 minutes. Biddle et al. (2009b) concluded by suggesting that participants were 'active' but it is not clear whether this in relation to the U.K. physical activity guidelines. These particular studies did not measure school-based physical activity and therefore it is likely that these figures are an underestimate. However, a limitation of these studies is that the physical activity estimates did not include an intensity component thus any physical activity reported was included. As a consequence, some of the physical activity reported may have not met the moderate intensity threshold associated with the U.K. physical activity guidelines.

4.5.6 Summary

In this section, a number of cross-sectional studies have been discussed which have reported compliance with physical activity guidelines for adolescents. It is clear that among studies measuring against the same recommendations that the method of calculating compliance with recommendation is different for each study thus making comparisons difficult. However, studies in this section have all attempted to be consistent with the recommended guidelines although some studies appear to classify 'meeting guidelines' as at least five days of MVPA, 'meeting guidelines' as MVPA on each day of the week and others as 'meeting guidelines' as an average amounting to 60 minutes over five days (i.e., a sum of 300 minutes). A limitation of all these studies though is their cross-sectional design which does not allow observation of possible changes in physical activity in terms of meeting recommendations to be monitored over a period of time. Interestingly, from the literature reviewed, there did not appear to be any longitudinal studies undertaken which have measured adolescents' compliance with recommendations over a period of time.

Table 4.1
Summary of cross-sectional self-report studies investigating adolescents' physical activity

Author(s) and date	Country	Sample characteristics (age range, gender and sample size)	Self-report tool(s) used	Question(s) asked and/or classification system (or calculation system) used	Main finding(s)
Decline in adolescents' physical activity					
Allison et al. (2007)	U.S. and Canada	14 to 18 years (male and female) derived from the U.S. (n=13,503) and Canada (n=1322)	2001 Youth Risk Behavior Survey and 2001 Ontario Student Drug Use Survey	'On how many of the last 7 days did you exercise or participate in sports activities for at least 20 minutes that made you sweat and breathe hard? Please include activities such as basketball, jogging, fast dancing, swimming laps, tennis, fast bicycling or similar aerobic activities (include both school and non-school activities)'. Responses indicated the number of days between 0 and 7. Two outcomes: (1) past 7 day participation in vigorous physical activity (number of days); and (2) past 7 day participation in vigorous physical activity (3+ days).	Physical activity declined by 0.16 days with each increase (in years) in age. First and only significant decline between 16 and 17 years. Number of physical activity days was 0.47 days higher among 16 years olds compared to 17 year olds. 3+ physical days – significant decline between 16 and 17 year olds. Both males and females - dominant and steady decline in physical activity between ages 14 and 18 years.
Thibault et al. (2010)	France	11 to18 years (male and female) (n=2385)	99-item self-report questionnaire	Physical activity determined from the number of weekly hours reported doing 'exercise or sports'. Participants reported separately how many they spent every	Physical activity declined with increasing age - weekly time of cumulative physical activity (including sports clubs, free-time

				week in different types of physical activities (at school during physical education lessons, at sports clubs and during free time). Answers summed to create a total cumulative weekly time spent on physical activity.	activity and school-based physical education) decreased from nine hours for children aged 11 years to six hours for participants aged 18 years. Mean weekly time of cumulative physical activity was higher for boys than girls (8.9 hours +/- 4.8 hours versus 6.3 hours +/- 4 hours and was higher for participants from a higher socioeconomic status based on the professional occupation of the father (8.25 hours +/- 4.9, 7.6 +/- 4.5 hours and 7.25 +/- 4.5 hours from the highest to the lowest socioeconomic status.
Age period of decline in adolescents' physical activity					
Michaud et al. (1999)	Switzerland	9 to 19 years (male and female) (n=3540)	Questionnaire (not specifically stated)	Two components of 'habitual physical activity' and 'moderate to vigorous activities' assessed through the following: (1) one-page diary listing the number and types of sports episodes engaged in during the last 7 days (measuring type of sports practised and the number of episodes of sports over one week); and (2) average daily time spent in activities including sweating (measuring MVPA). Categorisations used for MVPA were: (1) less than 30 minutes; (2) about 30 minutes; (3) about 1 hour; (4) about 2 hours; and (5) about 3 hours or more.	Two to three times more boys than girls engaged in heavy activities for about three hours or more (e.g., in late adolescents, 10.9% of boys compared to 3.1% of girls reported spending 'about three hours or more' in activities that induced sweating during the last seven days). Participation in physical and sports activities lower after age 15 years than before and also lower among girls than among boys (e.g., in relation to 'about 3 hours

					or more' of MVPA – children: girls (8.4%) versus boys (19.2%); early adolescents: girls (5.8%) versus boys (14.6%); and late adolescents: girls (3.1%) versus boys (10.9%). Total number of episodes of sports activity (frequency of sports activity – informal and formal) peaked at ages 12 to 14 years and thereafter decreased steadily among boys and girls.
Lubans et al. (2007)	U.K. (England)	11to 12 years (male and female) (n=207) and 15 to 16 years (male and female) (n=195)	MVPA measured using an item modified from the Health Behaviour in School-aged Children study	Reported the number of times a week engaged in MVPA for 20 minutes or longer (with the definition of MVPA given as: 'activity that makes you breathe heavily and increases your heart rate'). The number of sessions of MVPA (i.e., 20 minutes or longer) were reported with no cut-off point assigned.	31.9% of participants reported involvement in at last five sessions of MVPA in the previous week. Adolescents aged 11 to 12 years were more active (4.8 sessions per week) than those aged 15 to 16 years (4.2 sessions per week).
Increase in adolescents' physical activity					
Seabra et al. (2007)	Portugal	10 to 18 years (male and female) (n=12,568)	The Baecke Questionnaire	Sport participation comprised of two indicators: (1) binary variable regarding participation in sports: 'Do you play sport? – yes/no?'; and (2) sport score based on a number of items. These included the following: (1) 'Which sport do you play most frequently?' (2) 'How many hours a week?' (3) 'How many months a year?'	Males are significantly more active in sport than females at all ages with the sport score increasing systematically with age from 10 years to 18 years in both sexes. Prevalence of sports participation was greater in males than females.

				Intensity of sport participation was estimated where energy expenditure divided into three categories: (1) low (0.76 Mjoules); (2) medium (1.26 Mjoules); and (3) high (1.76 Mjoules). Amount of time per week in sport participation divided into five categories: (1) less than 1 hour; (2) 1 to 2 hours; (3) 2 to 3 hours; (4) 3 to 4 hours; and (5) more than 4 hours. Yearly proportion of sport participation divided into five monthly fractions: (1) less than 1 month; (2) 1 to 3 months; (3) 4 to 6 months; (4) 7 to 9 months; and (5) more than 9 months. Sport score = Sum of (intensity x time x proportion).	Females decline in sports participation with age. Males had a relatively stable prevalence of sport participation across age.
Eiðsdóttir et al. (2008)	Iceland	14 and 15 years (male and female) (n= 27,426 across four nationally representative population-based cohorts of 14 and 15 year olds)	Physical activity questions from a national survey in Iceland ('Youth in Iceland')	Two questions which asked about participation in physical activity, vigorous activity and participation in a sports club: (1) vigorous physical activity question was 'How often do you physically test yourself so you wind yourself significantly or sweat?'; and (2) participation in sports clubs question was: 'How often do you participate (practice or compete) in sports with a club or a team?'. Responses for each question varied slightly from year to year but all useable responses were able to be collapsed and recoded into the	6% increase in the rate of vigorous physical activity and a 15% increase in active sports club participation among 14 and 15 year old Icelandic adolescents from 1992 to 2006. Greater increase in the number of inactive participants – after an initial decrease from approximately 16% in 1992 to 13% in 1997, the percentage of inactive participants steadily

				following categories: 'Never or less than once a week', 'once a week', '2 to 3 times a week'; '4 times a week or more'. 'Vigorous activity' was defined as participation in physical activity that made one wind significantly (i.e., breathe hard) or sweat, four times or more per week and 'inactivity' as participation in physical activity that made one wind significantly or sweat less than one time per week. 'Active participation' was defined as participation in a sports club or with a team four times or more per week and 'non participation' as less than one time per week.	increased by a total of 10% to 23% in 2006. Although more boys consistently reported meeting the vigorous physical activity criterion, girls displayed a larger proportional increase during the study period. Both boys and girls saw a decrease in inactivity from 1992 to 1997 (2.9% and 1.9% respectively) before beginning a steady increase from 1997 to 2006 (11.25 for boys and 7.8% for girls). Percentage of participants actively involved in sports clubs rose steadily from 17.2% in 1992 to 31.7% in 2006 (a 14.5% increase). Percentage of boys engaged in active participation with a sports club was consistently higher than that for girls (8.7% on average).
Adolescents' compliance with physical activity guidelines					
Butcher et al. (2008)	U.S.	14 to17 years (male and female) (n=6125)	Telephone survey	Participants asked about their own MVPA using two items. Definition of physical activity given was 'any activity that increases your heart rate and makes you get out of breath some of the time' and examples given of moderate and vigorous	47.9% (males and females combined) complied with the physical activity guideline (i.e., 60 minutes of MVPA at least five days per week).

				physical activities. First item was: (1) 'Over the past 7 days, on how many days were you physically active for a total of at least 60 minutes per day?'. The response options ranged from 0 to 7 days. Second item was: (2) Similar to the first item but asked about physical activity during a 'typical or usual week'. The response options ranged from 0 to 7 days. Five to seven days was categorised as compliant with the guidelines; zero to four days was categorised as non compliant.	40% of females and 57% of males complied with the physical activity guidelines. Females - compliance declined significantly with age.
Roman et al. (2008)	Spain	6 to 18 years (male and female) (n=1723)	Physical activity questions used from two validated questionnaires (World Health Organisation physical activity CINDI questionnaire and MARATHOM leisure time physical activity questionnaire)	Questions about the type and frequency of usually practised organised sports (and recreational activities such as dancing or trekking) at school and after school (months a year, days per week or month and total hours a day), type of physical activity practised during leisure time, number of hours walking a day, total number of stairs climbed a day and usual practise of competitive sports. Categorisation of 'an accumulation of at least 60 minutes of physical activity of at least moderate intensity daily' = Sum of the time spent practicing sports during leisure time daily, plus the minutes walked a day and the number of hours spent	48.8% of 14 to 18 year olds reported at least 60 minutes of physical activity daily. 47.5% of all participants reported at least 60 minutes of physical activity daily. 60.6% of boys aged 14 to 18 years reported at least 60 minutes of physical activity daily. 38.0% of girls aged 14 to 18 years reported at least 60 minutes of physical activity daily. Compliance with

				practicing sports at school.	recommendations (i.e., 60 minutes of moderate intensity physical activity daily) increased with age in males but not in females.
Li et al. (2007)	China	11to17 years (male and female) (n=1804)	Adolescents Physical Activity Recall Questionnaire	Participants recorded time spent in organised and nonorganised physical activities in an average week in spring and autumn semesters (each activity assigned a MET value: light physical activities = less than four METs; moderate activity = four to six METs; and vigorous activity = more than six METs). Categorisation using the Physical Activity Guidelines for Adolescents in 1994 (i.e., more than 150 minutes a week or moderate activity or 60 minutes a week vigorous activity) and 2001 international recommendations for youth (i.e., 60 minutes a day MVPA).	Based on Physical Activity Guidelines for Adolescents in 1994 – 84% of all participants active with significantly more boys (89%) were physically active than girls (79%). Based on the 2001 international recommendations for youth – 44% of all participants were inactive with 37% of boys and 53% of girls were inactive.
Tammelin et al. (2007)	Finland	15 to 16 years (male and female) (n=6928) Members of the northern Finland birth cohort 1986	Questionnaire mailed (not specifically stated)	Physical activity outside school hours evaluated separately for MVPA and light physical activity by asking the following question: 'How many hours a week altogether do you participate in (a) brisk (i.e., MVPA) and (b) light physical activity outside school hours?'. Response options were: Not at all; about 0.5; about 1; 2 to 3; about 4 to 6; and 7 hours. Frequency of participation on MVPA was	59% of boys and 50% of girls reported 60 minutes or more of total physical activity per day. Only 23% of boys and 10% of girls reported 60 minutes of MVPA per day (seven hours a week). Approximately 20% of participants reported participating in MVPA for less than one hour a

				asked by the following question: 'How often do you participate in brisk physical activity outside school hours at least 20 minutes at a time?'. Response options were: never; once a month or less; 2 to 3 times a month; once a week; twice a week; 3 times a week; 4 to 6 times a week; and daily. Commuting physical activity was evaluated by asking about participants daily time spent in physically active commutes to and from school. Response options were: not at all; less than 20 minutes; 20 to 39 minutes; 40 to 59 minutes; and at least 60 minutes a day. Overall level of leisure time physical activity outside school hours was estimated using the information on MVPA, light physical activity and commuting physical activity with the categories of: inactive; somewhat active; moderately active; active; and very active. Categories were created for MVPA with seven hours a week as compliance with the recommended international guideline.	week (with no marked differences between the genders) with 11% of boys and 9% of girls were classified as 'inactive'.
Scully et al. (2007)	Australia	12 to 17 years (male and female) (n=18,486)	2005 Australian Secondary Students Alcohol and Drug Survey	Participants asked 'How many days in the past week have you done any vigorous or moderate physical activity for at least one hour (this could be made up of different activities during the day such as cycling or walking to and from school, playing sport	14% of participants reported engaging in at least 60 minutes of MVPA each day in the previous week (proportion lowest among 16 to 17 year old females – 7%).

				at lunchtime or after school, doing an exercise class, doing housework etc.). Responses ranged from 1 day to 7 days. Categorisation was determined by dichotomising responses into seven days (recommended minimum level) or not.	Males more likely than females to meet the physical activity recommendation. Physical activity declined with age, particularly among females. Younger participants were more likely than those 16 to 17 years to meet the recommendation.
Bastos et al. (2008)	Brazil	10 to 19 years (male and female) (n=857)	Standardised and pretested questionnaire completed via face to face interview	Transportation to and from school or work and leisure time physical activities evaluated - seven questions on transport-related physical activity and a box with a list of leisure time activities. Only activities practised for 10 consecutive minutes or more were considered. Transportation and leisure time physical activity were summed together and insufficient physical activity was defined as less than 300 minutes per week of MVPA.	69.8% of the participants were not sufficiently active (i.e., using a cut-off point of 300 minutes per week) (boys = 56.5%; girls = 82.1%). 52% of participants reported any kind of leisure time physical activity in the week before the interview. Using the cut-off recommended for adults (i.e., 150 minutes per week), 54.6% of participants were classified as insufficiently active.
Lake et al. (2009)	U.K. (England)	16 to 20 years (male and female) (n=73)	U.K. version of the Youth Neighbourhood Environment Walkability Survey	Participants responded to a question asking how many days a week they were active for a total of at least one hour. Categorisation (most active category) made of five to seven days of at least one hour a day of physical activity.	Most participants were active for a total of at least one hour a day on three to four (n = 28) or five to seven (n = 31) days a week.

Gorely et al. (2009c)	U.K. (England, Northern Ireland, Scotland and Wales)	12.7 to 16.7 years (male) (n=561) Part of Project STIL (Sedentary Teenagers and Inactive Lifestyles)	Ecological momentary assessment diary	Participants completed the diary for four days (three weekdays and one weekend day, both during the school term), randomly assigned by weekday and weekend day. At 15 minute intervals, participants self-reported their main behaviour in response to a single item: 'What are you doing now?'. Behaviours coded into 23 mutually exclusive categories (from a focus group undertaken about how English youth spend their free time). To estimate the time spent in each behaviour category, number of times a behaviour was recorded each day was multiplied by 15. For weekdays, mean time per behaviour calculated (minutes per day). Leisure time physical activity categorised as 'sports and exercise' and 'active travel'.	Average – boys achieved 54 minutes of leisure time physical activity on weekdays (63% meeting the U.K. recommendation of 60 minutes of moderate intensity physical activity each day). Average – boys achieved 81.1 minutes on weekend days (50% meeting the recommendation of 60 minutes of moderate intensity physical activity each day at weekends).
Gorely et al. (2007a)	U.K. (England, Northern Ireland, Scotland and Wales)	12.5 to 17.6 years (female) (n=923) Part of Project STIL (Sedentary Teenagers and Inactive Lifestyles)	Ecological momentary assessment diary	Same as above for completion of the diary (i.e., Gorely et al., 2009c). Behaviours coded into 23 mutually exclusive categories (from a focus group undertaken about how English youth spend their free time). Estimate of time spent in each behaviour category is the same as above (i.e., Gorely et al., 2007a). Leisure time physical activity categorised as 'sports and exercise' and 'active travel'.	Average – girls achieved 44 minutes of leisure time physical activity on weekdays. Average – girls achieved 53 minutes of leisure time physical activity on weekend days. Overall, few girls met the U.K. recommendation of 60 minutes of moderate intensity physical activity each day.

Biddle et al. (2009b)	U.K. (Scotland)	12.6 to 16.7 years (male and female) (n=991) Part of Project STIL (Sedentary Teenagers and Inactive Lifestyles)	Ecological momentary assessment diary	Same as above for completion of the diary (i.e., Gorely et al., 2007c). Behaviours coded into 18 mutually exclusive categories representing volitional leisure time activities. Estimate of time spent in each behaviour category is the same as above (i.e., Gorely et al., 2007c). Leisure time physical activity categorised as 'sports and exercise' and 'active travel'.	Average – boys achieved 62 minutes of leisure time physical activity on weekdays. Average – boys achieved 91 minutes of leisure time physical activity on weekend days. Average – girls achieved 55 minutes of leisure time physical activity on weekdays. Average – girls achieved 47 minutes of leisure time physical activity on weekend days. Overall, data suggests adolescents are 'active'.

4.5.7 Longitudinal self-report data trends – Decline in adolescents' physical activity

Longitudinal studies investigating adolescents' physical activity have also demonstrated a mixture of findings. Firstly, the focus is on studies that have found a decline in physical activity during adolescence. For instance, in the U.S., Kahn et al. (2008) assessed adolescents' physical activity over a three year period (covering ages 10 to 18 years). The investigators developed a youth-specific physical activity measure that assessed the time spent during the past year in 18 separate individual and team activities (outside of school gym or physical education class). Items assessed how many hours per week participants participated in each of these activities during each season of the past year. Activities were defined as moderate (MET of less than 6) or vigorous (MET of 6 or more). The midpoint in each response category was taken to compute the number of hours per week of physical activity for each participant during the past year and then a calculation was undertaken to formulate the number of hours per week of moderate physical activity, vigorous physical activity and moderate plus vigorous physical activity. It was reported that physical activity increased until early adolescence and after 13 years of age, it declined. Furthermore, there was a lower physical activity level in boys than girls in late adolescence. This was partly due to a steeper decline in physical activity in boys compared to girls, especially between the ages of 15 and 18 years. Strengths of this study were its longitudinal design thus enabling changes in physical activity over a three year period to be monitored and the large sample size examined (n = 12,812). Even so, the calculation of physical levels was problematic considering that a 'midpoint' value was used. Taking a midpoint value may have lead to some participants' participation in physical activity being either overestimated or underestimated. Similar to Kahn et al.'s (2008) study, other researchers have noted that the decline in physical activity appeared to be steepest between the ages of 13 and 18 years (Pratt et al., 1999; Sallis, 2000; Van Mechelen et al., 2000).

Similarly, Sagatun et al. (2008) also confirmed a decline in physical activity among adolescents from age 15 to 18 years in their longitudinal population-based study of participants who were studied at age 15 years (baseline) and again at age 18 years (follow-up) in Norway. Weekly hours of physical activity in leisure time were assessed by participants reporting how many hours per week they spent in physical activity that made them sweat and/or out of breath outside of school. Change in physical activity was defined as the difference in hours of physical activity per week between baseline and follow-up. Results showed that boys were more physically active than girls at both 15 and 18 years. There was also a decline found in mean hours per week of physical activity from age 15 to 18 years. Methodologically, by asking such a crude question to measure physical activity does not capture all of the physical activities that adolescents possibly undertake to promote health. However, by this study measuring the 'change in' physical activity over this particular transitional phase is a major strength as very few studies have achieved this.

Further declines in physical activity from age 15 to 18 years have also been reported by Dovey et al. (1998) in New Zealand who studied whether, between ages 15 and 18 years, there were changes in the time spent in physical activity and in preferred sports. Participants were asked to recall, for each month of the previous year, the sports and similar physical activities in which they had participated, the number of times they had been involved in each activity and the amount of participation time on each occasion. Activities included those undertaken as part of school programmes, competitive sports and leisure time activities undertaken for exercise or recreation. Participation time was categorised as less than one hour a week, one to four hours a week and more than four hours a week (in accordance with recommendation for adults at the time of data collection of 20 minutes three times a week). Total participation time at age 18 years was 63% of that reported at age 15 years (i.e., there was a decline). Dovey et al. (1998) point out that more than half the 15 year olds who spent at least four hours a week in physical activity had reduced their participation time to below this level at age 18 years. Dovey et al. (1998) also stressed that four hours a week is not extreme and this finding should cause some concern among health promoters. Furthermore, boys at age 15 years spent a mean of 11.7 hours a week in physical activity compared with 7.5 hours a week for girls. At age 18 years, boys reported a mean of 7.8 hours a week in physical activity compared with 4.3 hours a week for girls. The main strength of this study was its longitudinal design which identified that the change in physical activity from mid to late adolescence was clearly an ageing effect (i.e., similar ageing effects are likely to be found among other groups of teenagers as they grow through adolescence).

Limitations of this study, however, included a biased sample towards the advantaged socioeconomically.

Additional evidence of the decline during this critical age period during adolescence regarding physical activity has been reported by Aarnio et al. (2002) who conducted a longitudinal study by measuring the stability of leisure time physical activity during adolescence among Finnish youth from ages 16 to 18 years. In this study, a questionnaire was sent to the same Finnish cohort on their 16th and 17th birthdays and six months after their 18th birthday. In all three questionnaires completed by the participants, two questions were answered concerning physical activity in an identical form. The first question measured the frequency of leisure time physical activity. The second question asked for the adolescent's own perception of his or her physical fitness. The stability of physical activity and self-reported fitness were categorised by classifying those participants who answered in all three questionnaires that their frequency of physical activity was four to five times per week or more formed the 'persistent exerciser' group. Results showed that only 19.1% of boys and 11.2% of girls were persistent exercisers (i.e., very active on all three years) and 15.6% of girls were persistently fit (i.e., very good self-reported fitness on all three years). Considering this study was conducted over a longitudinal period, it had a high response rate thus low attrition and although twins were included in the study, twin ship was not considered (i.e., participants were analysed individually). However, this study did not specify the duration of physical activity (e.g., minutes or hours) undertaken by participants in relation to the number of times physical activity was participated in (e.g., a month, per week, per day).

Supporting evidence to the previous studies demonstrating a decline in physical activity between ages 15 and 18 years include a U.S. study by Nelson et al. (2006). This study involved following a large cohort of participants longitudinally through various stages of the adolescent transition to young adulthood (i.e., from 11 years through to 23 years). The objective of this particular study was to evaluate five year longitudinal trends in MVPA in a large, diverse cohort of participants. Longitudinal changes from early to mid adolescence and mid to late adolescence were observed. Participants responded to two survey items individually assessing moderate and vigorous activity in relation to how many hours participants spent in a usual week doing a range of stated activities. Nelson et al.'s (2006) findings indicated longitudinal changes in MVPA from early to mid adolescence and mid to late adolescence. In particular, they found substantial longitudinal changes in MVPA among girls. Among girls, MVPA decreased from 5.9 to 4.9 hours a week from early to mid adolescence and from 5.1 to 3.5 hours a week from mid to late adolescence. Strengths of this study included the ability to capture robust trends in activity-related behaviour that occur over a substantial period of time (five years) during the key adolescent periods studied. On the other hand, a main limitation concerns the surveying of a greater number of participants in the older cohort than the younger cohort thus yielding additional statistical power to detect significant associations during the transition from mid to late adolescence compared with those from early to mid-adolescence.

A further study which measured physical activity among U.S. adolescents aged 12 to 17 years over a four year period found that there was an overall decline in physical activity through adolescence (Duncan et al., 2007). Duncan et al. (2007) measured physical activity through multiple sources including three survey items. The first two survey items were based on questions from the Youth Risk Behavior Survey which required participants to report the following: (1) how many of the past seven days they did exercise or took part in hard physical activities that made them sweat and breathe hard for at least 20 minutes without stopping; and (2) In a typical week, how many days they took part in any regular physical activity long enough to work up a sweat (heart beats rapidly). The third survey item asked participants to report, compared to others the same age and sex as them, how much physical activity they got. A combination of the data collected from the survey items and from the pedometer readings showed there was a significant decline in physical activity from ages 12 to 17 years, with both boys and girls becoming significantly less physically active from ages 12 to 17 years. This study had strengths including the use of multiple self-report items to gain a relatively comprehensive measure of physical activity. Conversely, a main limitation is the use of the 20 minute recommendation which is not consistent with recommended guidelines for young people, in addition to the small sample size (n = 371).

Declines in physical activity have also been shown by Bélanger et al. (2009) who studied the patterns of participation in 29 different physical activities during secondary school in Canada. Consequently, from 1999 to 2005, participants initially aged 12 to 13 years completed a seven day physical activity recall every three months during the 10 month school year during each of the five years of secondary school. The number of physical activity sessions per week was obtained from a seven day physical activity recall, adapted from the Weekly Activity Checklist, which reflected activities engaged in by participants. This involved participants thinking about the physical activities they had undertaken in the last week from Monday to Sunday outside their regular school gym class. They then had to indicate, for each activity what they did for five minutes or more at a time, the day(s) on which they did that activity. A list of 29 activities was provided. The 29 activities were categorised in relation to format (i.e., team activity, individual activity) and intensity (i.e., based on energy cost: light intensity less than 4 METs; moderate intensity 4 to 7 METs; vigorous intensity more than 7 METs). Participants had to have taken part in three or more activity sessions of a specific intensity during the past week to reflect 'regular participation' for that activity to be included in a specific intensity category. They found that the probability of sustaining participation in individual physical activity declined (albeit only slightly) over time for both boys and girls. In relation to team activities, participation declined rapidly in both genders. Finally, declines over time in the probability of sustaining vigorous-intensity activities were steeper than declines in light or moderate intensity activities in both genders. Clear strengths of this study included the measurement of a broad range of activities that related to intensity and the format of physical activity. However, it is disappointing that this study did not collect data after completing secondary school to measure changes after completing education.

Henning Brodersen et al. (2007) have undertaken one of the few longitudinal studies in the U.K. The objective of their study was to assess developmental trends in physical activity among a cohort of adolescents. The study lasted for five years and followed a cohort of participants in England aged 11 to 12 years at baseline in 1999. Henning Brodersen et al. (2007) assessed vigorous physical activity by asking participants to report how many of the past seven days they had carried out vigorous exercise that made them sweat and breathe hard. Results confirmed that boys consistently reported more physical activity than girls over the five year period. However, there was a fall in the mean number of days of vigorous physical activity per week in boys and girls. Therefore, conclusions were that there were marked reductions in physical activity between ages 11 to 12 years and 15 to 16 years, with a larger decline in girls than in boys. Although this study is welcomed due to the dearth of U.K. research with adolescents over a longitudinal period, it did not follow the cohort beyond the educational setting at age 16 years. Additionally, the question used to assess physical activity was simple and did not specify the duration or type of activity undertaken.

Similarly, Aaron et al. (2002) investigated the pattern of change in the number of physical activities, the time spent on specific activities and the stability of participation and non-participation in specific activities during adolescence among U.S. adolescents aged 12 to 15 years at baseline over a four year period. Participants reported all activities they participated in at least 10 times during the last year. They also reported frequency and duration of participation in each activity during the past year. An estimate of the average number of hours spent on each activity was calculated and the hours from all activities summed to derive an overall leisure time physical activity estimate (hours per week) averaged over the past year. Additionally, stability of participation in different types of activities was analysed. They concluded that physical activity declined during the four years period by 26%. This decline was due to a decrease in the number of reported activities. Although this study could be viewed as providing a measure of leisure time physical activity over a year period, it is debatable concerning how accurate adolescents' recall of the past year is considering that even over a shorter period (e.g., a month) subject recall is notoriously a problem.

4.5.8 Longitudinal self-report data trends – Decline in adolescent females' physical activity

A series of studies have been undertaken in the U.S. which provide insight into the declines in physical activity over a longitudinal period among adolescent females. Kimm et al. (2000) assessed longitudinal changes in physical activity in a large biethnic (Black and White) cohort of young girls in the U.S. from childhood to adolescence (nine to 10 years to 18 to 19 years) followed from ages nine to 10 years to 18 to 19 years in the U.S. Two self-report methods were used including a three day activity diary and a habitual activity patterns questionnaire. Concentrating specifically on the habitual activity patterns questionnaire, this questionnaire assessed the type and frequency of participation outside of school in sports, physical activities and classes/lessons during the past year. Participants reported all these activity categories for the school year and the summer months, in addition to the weekly frequency for each activity listed. A summary weekly activity score was calculated by multiplying the MET value for each recorded activity by the frequency and by the fraction of the year each activity was performed. The final score was the sum of the weekly score for all activity categories for the previous year. Kimm et al. (2000) concluded that there was an 83% decline in habitual physical activity during the study period from ages nine to 10 years until 18 to 19 years. Following on from this study, Kimm et al. (2002) examined the same sample of Black and White girls and further confirmed this 83% decline in habitual physical activity but also commented that although the decline began at the outset of adolescence (nine to 10 years), its rate accelerated so that by the age of 18 and 19 years, the majority of the girls engaged in virtually no habitual physical activity other than those performed during school. Clearly, there were strengths to both of these studies such as the multidimensional information on physical activity collected (i.e., level of daily physical activity and habitual activity) and because the habitual activity information included both the school year and summer months, potential differences in seasonal variation were more likely to be accounted for. However, the habitual activity patterns questionnaire did not take into account the duration of the activities performed and activities such as non recreational walking were not included in this questionnaire.

Further declines in female adolescents' physical activity have also been shown by Pate et al. (2007). U.S. female adolescents aged average 13.6 years at baseline were followed up at three time points over a four year period and at each point completed the 3-Day Physical Activity Recall. Females reported their predominant activity and its intensity level in each 30 minute time block on the previous three days. They found that vigorous physical activity standard levels (i.e., reporting an average of two or more 30 minute blocks of MVPA per day and/or one or more 30 minute blocks of vigorous physical activity per day) declined from 45.4% in 8th grade (at baseline) to 34.1% in 12th grade (final follow-up). They also found that the probability of participating in several forms of vigorous physical activity in 12th grade was strongly associated with participation in those activities in 8th grade. Consequently, they suggested that early-in-life participation in sports and other forms of physical activity is important to the maintenance of physical activity during adolescence in girls. Clearly, a main strength of this study included the three time points in which the same measurement instrument was administered (i.e., enabling changes to be monitored). However, non inclusion of males in this study did not allow for gender differences in physical activity to be examined.

Similar findings regarding a decline in female adolescents' physical activity were also found in Pfeiffer et al.'s (2006) study which determined the odds of engaging in future MVPA and vigorous physical activity in U.S. adolescent female sport participants. Using a longitudinal design over a four year period, data was collected at three time points from participants aged an average of 13.6 years at baseline (8th grade) up to 12th grade, when approximately aged 17 years. The 3-Day Physical Activity Recall was used and all data from this instrument was converted into MET scores. Participants reported their predominant activity in 30 minute time blocks. Each 30 minute block of each day was assigned a MET intensity and the number of blocks were then summed for activities that were assigned an intensity of 3 METs or greater (i.e., MVPA) and for activities that were assigned an intensity of 6 METs or greater (i.e., vigorous physical activity). Two or more blocks of MVPA per day or one or more blocks of vigorous physical activity per day averaged across the three days. It was found that girls spent similar percentages of time engaging in physical activity (both MVPA and vigorous physical activity) in 8th and 9th grades with values lower in 12th grade (i.e., a decline). Further, it was found that for MVPA, ninth grade sport participants were more likely to be active in 12th grade and eighth and ninth grade sport participants were more likely to be active in the 12th grade than nonparticipants. For vigorous physical activity, sport participants had higher odds of being active at all future time points. A strength of this study included the demonstrated link between sport participation and physical activity across four years but there is a weakness in this study in that specific information on participation in formal physical activity programmes or lessons was not collected.

4.5.9 Longitudinal self-report data trends – Increase in adolescents' physical activity

The focus of this chapter is now on longitudinal studies that have demonstrated an increase in physical activity during adolescence. Laakso et al. (2008) undertook a longitudinal study among young people in Finland over a 30 year period (1977 to 2007), investigating trends in leisure time physical activity. Data was obtained from the Finnish Adolescent Health and Lifestyle Study with girls and boys aged 12, 14, 16 and 18 years over this 30 year period. In this survey, nationwide samples were drawn every second year since 1977. Participants were the same age at every measurement (12.6, 14.6, 16.6 and 18.6 years). Participation in leisure time physical activity was measured by asking participants how often they had participated in sport or recreational physical activity during their leisure time. A combined frequency of leisure time physical activity variable was created resulting in four categories: inactive, occasionally active, active and very active. The main finding was that participation in organised youth sport increased in both genders. Additionally, in both genders, participation in unorganised leisure time physical activity decreased from 1977 to 1985, increasing thereafter until 2007. Also, there was an increase from 2003 to 2007 that was significant in organised sport but not in unorganised leisure time physical activity. In conclusion, there was a longitudinal upward trend in Finnish adolescents' leisure time physical activity and in organised sport in particular. The 30 year period is a key strength of the study, in addition to the use of the same questionnaire over this period. However, the measurement of physical activity was centred on only a few simple questions that are related solely to only leisure time physical activities and sports.

Also, Aires et al. (2010) undertook a three year longitudinal analysis of changes in fitness and physical activity among Portuguese adolescents aged 11 to 19 years. A 'Physical Activity Index' was created by asking five questions that covered whether participants: (1) took part in organised sport outside school; (2) took part in nonorganised sport outside of school; (3) how many times per week they took part in sport or physical activity for at least 20 minutes outside of school; (4) how many hours they usually took part in physical activity so much that they got out of breath or sweated outside of school; and (5) if they took part in competitive sport. Changes in physical activity index were positively and independently associated with changes in fitness. Participants classified as highly fit at baseline (determined as those who had physical fitness scores (a composite Z score made up of three Z scores from three physical fitness test) higher than the first tertile) were those who showed positive changes in physical activity index over three years. Changes in physical activity index were the best predictor for changes in fitness in each year and over the three years of evaluation in youth. The three year period of this study which allowed for repeated measures and measurement of changes in physical activity over time was a key strength of the study design. On the other hand, all questions asked relating to physical activity were outside of school and none were related to inside school thus total physical activity could have been underestimated.

4.5.10 Longitudinal self-report data trends – Physical activity from adolescence to adulthood

There have also been longitudinal studies undertaken which have measured physical activity from adolescence into adulthood. Although adulthood is not a population that is focused upon in this study it is included in this part of the review because studies which include adulthood (in longitudinal studies) highlight the pattern with physical activity during adolescence. The majority of these studies have demonstrated a decline in physical activity from the period of adolescence to adulthood. For example, Kjønniksen et al. (2008) undertook a 10 year longitudinal study of adolescents aged 13 years at baseline collection and 23 years at final follow-up collection. Kjønniksen et al. (2008) examined change and stability in global and specific types of leisure time physical activity during adolescence and young adulthood. Participants reported global leisure time physical activity by responding to a question adapted from the Health Behaviour in School-aged Children survey. This asked how often participants (in their leisure time) did sports or exercise until they out of breath or sweating resulting in three categories (i.e., low activity group, moderate activity group and a high activity group). Two questions were also answered by adolescents in relation to outdoor recreational activity; (1) how often they usually did outdoor activity in the summer and (2) how often they usually did outdoor activity in the winter. The main aim was therefore to show how participation in leisure time physical activity changes over this 10 year period. Their findings identified that the transition from adolescence to adulthood is a period of general decline in physical activity, but with the decline levelling off in adulthood. The decline was also greater among females as opposed to males. The comprehensive nature of the self-report measures of physical activity used was a key strength in this study. This study, did however, suffer from a possible selection bias in the sample with a higher rate of males dropping out of the study whereas females dropping out of the study had a higher baseline vigorous physical activity thus the findings are less representative for females with a high level of physical activity in early adolescence.

Similarly, declines in physical activity from adolescence to adulthood have been found by Telama and Yang (2000) who undertook a study based on the Cardiovascular Risk in Young Finns study. Their aim in this study was to analyse age-related decline of physical activity among young Finnish people. This study was longitudinal and involved a sample that was selected representing Finnish children and adolescents at the ages of nine, 12, 15 and 18 years. The same participants were then followed up in 1983, 1986, 1989 and 1992. In 1992, they were aged 18, 21, 24 and 27 years. Consequently, the data covers ages from nine to 27 years. Questions on frequency and intensity of leisure time physical activity (how often engaged in physical activity during leisure time for at least half an hour each time), participation in sport club training, participation in sport competitions and habitual ways of spending leisure time were answered by participants and a 'Physical Activity Index' was computed. Results identified that there was a marked decline in the frequency of physical activity after age 12 years. This decline was steeper among males than females, and among males this decline continued up to age 27 years. After the age of 18, females engaged in physical activity more frequently than males. Major strengths of this study were the age coverage of this longitudinal period from nine to 27 years and the regular follow-ups that were undertaken at key transitional points.

Further longitudinal studies showing a decline in physical activity from adolescence into adulthood include Van Mechelen et al. (2000) who studied the habitual physical activity behaviour of young Dutch male and female participants between the ages of 13 and 27 years, using data from the Amsterdam Longitudinal Growth and Health Study. A semi-structured interview was used to collect data on physical activity and covered the following areas of habitual physical activity (an intensity of 4 or more METs): (1) organised sports activities; (2) nonorganised sports and other leisure time activities; (3) transportation in relation to school, work etc.; and (4) work-related activities. An average of the total weekly physical activity time was then calculated. Further calculations were then made in order to produce a weighted weekly physical activity score. Results showed that for females, habitual physical activity time during the adolescent period of aged 13 to 16 years declined by 3%, followed by a 5% increase between ages 16 and 21 years. For males, when looking at the same age periods, the following pattern was seen: first a 20% decrease then a 5% increase. Consequently, the most marked decrease was among males during the adolescent period from aged 13 to 16 years. A significant strength of this study was the follow-up of the same participants over a long period of time although it must be recognised that the method of interviewer administered three month recall was limited in comparison to other studies across the same age range.

Further evidence supporting the decline in physical activity from adolescence to adulthood has also been examined in relation to the measurement of meeting recommended guidelines for physical activity. For example, Gordon-Larsen et al. (2004) investigated trends in achieving five or more sessions of MVPA per week across the transition from adolescence to young adulthood. Gordon-Larsen et al. (2004) were particularly interested in the incidence, maintenance and reversal of achieving five or fewer weekly sessions of MVPA per week in adolescence and adulthood across time. During adolescence (Wave I with an age range of 11 to 21 years) participants reported their participation in MVPA (5 to 8 METs activities such as skating, cycling, exercise and active sports) in the previous week. The question asked of participants was based on 'how many times did you...in the past week' followed by activities including basketball and softball. MET values were then created based on the frequency of sessions of specified activities per week. During young adulthood (Wave III with an age range of 18 to 26 years), participants reported the frequency of the activities from the Wave I questionnaire, in addition to other additional questions specifically aimed at young adults. A scaled sum of MVPA was created to avoid over inflation of young adult physical activity levels due to the additional questions at Wave III. Classification categories were then created; (1) achieving or (2) not achieving five or more weekly sessions of MVPA. Results showed that there was a dramatic decrease in the percentage of participants who achieved five or more sessions of MVPA per week and continued to achieve this amount as adults. Further, it was shown that the majority of males, and particularly females, did not achieve this amount of physical activity in either period. Compared to Black and Hispanic females, White females displayed unhealthy shifts in physical activity (i.e., from achieving the recommended amount of physical activity to not achieving this as young adults). The longitudinal period over which this data was collected was a main strength as this allowed changes over time to be assessed although the different measures used at Wave I and Wave III (although justified) to measure physical activity may call into question the issue of consistency across measurements points (i.e., a comparability issue). The size of the sample examined was also a major strength (n = 13,030).

Finally, longitudinal studies have also been undertaken into the association of physical activity during adolescence with physical activity during adulthood. A study that highlights the importance of undertaking physical activity during adolescence and its influence on physical activity in adulthood is a study undertaken by Tammelin et al. (2003) in Finland. Evaluations were carried out in 1980 and 1997-1998, at ages 14 and 31 years. At both ages, questionnaires were mailed to all participants whose addresses were known. However, different questions were asked at 14 years and 31 years. Physical activity at age 14 years was assessed through participants reporting how often they participated in sports after school hours, in addition to providing the main types of sports they practiced, which comprised of 20 coded groups. Physical activity at age 31 years was measured by asking participants how often they participated in light (no sweating or breathlessness) and brisk (i.e., some sweating and breathlessness) physical activities, with the duration of one bout of activity considered separately for light and brisk activities. They concluded that participation in sports at least once a week in adolescent females and twice a week in adolescent males was associated with high levels of physical activity later in life.

Additionally, Telama et al. (2005) conducted a 21 year tracking study in order to investigate how physical activity tracks from childhood and adolescence to adulthood in several age cohorts. This was in order to determine how well adult physical activity can be predicted by persistent physical activity in childhood and adolescence. The study was started in 1980, when cohorts of randomly sampled boys and girls aged three, six, nine, 12, 15 and 18 years. Measurements were repeated in

1983, 1986, 1989, 1992 and 2001. In 2001, 1563 of the original cohort were aged 24, 27, 30, 33, 36 and 39 years. Physical activity and participation in sports of the adolescents aged nine to 18 years (between 1980 and 1989) was undertaken by asking questions on: (1) frequency and intensity of leisure time physical activity; (2) participation in sport club training; (3) participation in competitive sport events; (4) common activity during leisure time; (5) school physical education grades; and (6) type of school commute. An index of physical activity was then calculated. However, in 2001, the physical activity questionnaire included questions on frequency of physical activity, intensity of physical activity, frequency of vigorous physical activity, average duration of a physical activity session and participation in organised physical activity. Consistent with the previous questionnaire, an index of physical activity was calculated. They concluded that a high level of physical activity at ages nine to 18 years significantly predicted a high level of adult physical activity. A total of 21 years as an observation period was a strength of the study in addition to the use of six age cohorts thus allowing for tracking to be studied across different life periods. Even so, there was a limitation across the duration of the time period as the measure used at each time point was not consistently the same although it is understandable that this was undertaken because the physical activities undertaken by children and adults are different.

4.5.11 Summary

In this section of the review of literature, concentration has been on longitudinal studies into physical activity among adolescents. The most striking aspect is that the majority of the literature is showing a decline in physical activity between the age of 15 years to 18 years. The majority of studies also indicate that the decline is greater for females as opposed to males. However, from a U.K. perspective there do not appear to be any longitudinal studies which have investigated physical activity during the age period between 15 to 16 years and 16 to 17 years (i.e., within the declining age period evidenced by numerous studies); a clear gap in the evidence base. There is limited literature regarding an increase in physical activity, a decrease in physical activity from adolescence to adulthood and an association between physical activity during adolescence and adulthood. However, studies appear to be increasing which are targeting the decline in adolescent females' physical activity. Although the majority of the longitudinal literature is centred on the decrease in physical activity, there are many differences between the studies in terms of the gradient of the decline. This is possibly due to methodological differences between studies including: longitudinal duration period; age period studied; measures used to assess physical activity levels (i.e., different types of questions with some referring to physical activity and/or sport); calculation of physical activity and categorisations; and sample size. Differences between studies showing an increase in physical activity, a decrease between adolescence and adulthood, and associations between adolescence and adulthood physical activity are also possibly due to these methodological differences.

Table 4.2
Summary of longitudinal self-report studies investigating adolescents' physical activity

Author(s) and date	Country (and study duration where applicable)	Sample characteristics (age range, gender and sample size)	Self-report tool(s) used	Question(s) asked and/or classification system (or calculation system) used	Main finding(s)
Decline in adolescents' physical activity					
Kahn et al. (2008)	U.S. (three years)	10 to 16 years at baseline and 12 to 18 years at follow-up (male and female) (n=12,812) Part of the Growing Up Today Study	'Investigator' developed youth-specific physical activity measure questionnaire	Assessed the time spent during the past year in 18 separate individual and team activities (outside of school gym or physical education class) with activities defined as moderate (MET value less than 6) or vigorous (MET value of 6 or more). Mid-point used in each response category to compute the number of hours per week of physical activity for each participant during the past year. Following this, the number of hours per week were of: (1) moderate intensity physical activity; (2) vigorous physical activity; and (3) moderate plus vigorous physical activity were computed.	Physical activity increased until early adolescence and after age 13 years it declined. In boys and girls, physical activity levels decreased after about 13 years of age. In late adolescence, boys reported less physical activity than girls (boys showed a steeper decline in physical activity than girls between the ages of 15 and 18 years). By age 18 the level of physical activity was higher in girls than boys.
Sagatun et al. (2008)	Norway (three years)	15 to 16 years at baseline and 18 to 19 years at follow-up (male and female) (n=2489)	Questionnaire (not specifically stated)	Participants asked how many hours per week they spent in physical activity 'to an extent that makes you sweat and/or out of breath' (with the options – 0 hours; 1 to 2 hours; 3 to 4 hours; 5 to 7 hours; 8 to 10 hours; or 11 hours or more per week). Change in physical activity – difference in the hours of physical activity per week between	Boys more physically active than girls at both 15 and 18 years. Physical activity levels declined (mean hours per week) in all groups from age 15 to 18 years.

				baseline and follow-up (mid-point of each response option to the question utilised in ranked ordinal variable as a continuous variable). Stability in physical activity from baseline to follow-up – dichotomised hours per week spent doing physical activity as either: (1) zero to two hours: versus (2) three hours or more.	
Dovey et al. (1998)	New Zealand (four years)	15 years at baseline and 18 years at follow-up (male and female) (n=775)	Minnesota Leisure Time Physical Activity Questionnaire	Participants asked to recall, for each month of the previous year, the sports and similar physical activities participated in, number of times involved in each activity and the amount of participation time on each occasion ((1) activities included those undertaken as part of school programmes, competitive sports and leisure time activities undertaken for exercise or recreation and (2) participation time included time involved in physical training for an activity). Proportions of participants reporting participation times of less than one hour a week, one to four hours a week and more than four hours a week compared at age 15 years and 18 years.	Total participation at age 18 was 63.5% less than at age 15 years. At both 15 years (11.7 hours versus 7.5 hours) and 18 years (7.8 hours versus 4.3 hours), boys spent significantly more time in physical activity than girls. 37% reduction in total time spent in physical activity from age 15 years to 18 years. Overall mean time per week spent in physical activity at age 15 years was 9.7 hours compared to 6.1 hours at age 18 years. Proportion of participants participating in more than four hours of physical activities a week declined in boys from 84.5% to 65.5% and in girls from 68.5% to 36.8%.
Aarnio et al. (2002)	Finland (three years)	16 to 18 years (male and female)	Questionnaire – not specifically	Two questions asked concerning physical activity: (1) frequency of leisure time physical activity (with the options – not at all or less than once a	Fifth of boys and every tenth girl were persistent exercisers (i.e., very active on all three years) – only 19.1% of boys

		(n=2934)	stated	month; 1 to 2 times a month; about once a week; 2 to 3 times a week; 4 to 5 times a week; and every day); and (2) subject's own perception of their physical fitness (with the options – very good; fairly good; satisfactory; rather poor; and very poor). Participants who answered at all three time points that their frequency of physical activity was '4 to 5 times per week' or more formed the 'persistent exerciser' group.	and 11.2% of girls were persistent exercisers over the three measurement occasions. Boys who participated in physical activity daily at age 16, 46.7% did so also at age 18 years. Girls who participated in physical activity daily at age 16 years, 46.3% did so also at age 18 years.
Nelson et al. (2006)	U.S. (five years)	11 to 23 years (male and female) (n=2516) Part of the Project EAT-I (Eating Among Teens) and Project EAT-II (a follow-up study)	Questions from the Godin Leisure-Time Exercise Questionnaire and Planet Health surveys	Two survey items (as indicated) individually assessed moderate and vigorous activity asking the following: 'In a usual week, how many hours do you spend doing the following activities...'. Vigorous activity was described as strenuous, during which the heart beats rapidly. Moderate activity was described as not exhausting. More than 10 examples of specific activities were given after each question with possible response options ranging from 0 hours to 6 hours or more per week. Hours per week of MVPA were reported.	Substantial longitudinal decreases in MVPA across the adolescent period. MVPA among girls dramatically declined from 5.9 to 4.9 hours a week from early to mid adolescence and from 5.1 to 3.5 hours a week during mid to late adolescence. Boys showed a more delayed decline in physical activity – MVPA did not decline from early to mid adolescence but did decline significantly from mid to late adolescence (6.5 hours to 5.1 hours a week).
Duncan et al. (2007)	U.S. (four years)	12 to 17 years (male and female) (n=371)	Two items based on questions from the Youth Risk Behavior Survey	Three survey items used with youth being asked: (1) 'On how many of the past 7 days did you exercise or take part in hard physical activities that made you sweat and breathe hard for at least 20 min without stopping (such as basketball, jogging, swimming laps, fast bicycling or similar aerobic	Significant decline in physical activity from ages 12 to 17 years. Boys and girls became significantly less physically active from ages 12 to 17 years.

				activities)?'; and (2) 'In a typical week, how many days do you take part in any regular physical activity long enough to work up a sweat (heart beats rapidly)?' For items 1 and 2, responses ranged from 0 to 7 days. The third survey item asked: 'Compared to others the same age and sex, how much physical activity do you get?' with 1 = much less than others and 5 = much more than others	
Bélanger et al. (2009)	Canada (five years)	12 to 13 years at baseline (male and female) (n=1276)	Questionnaire adapted from the 'Weekly Activity Checklist'	Number of physical activity sessions per week obtained from a 7-day physical activity recall. Data collected at each survey cycle by asking the question: 'Think about the physical activities that you did last week from Monday to Sunday outside your regular school gym class. For each activity that you did for 5 minutes or more at one time, mark an 'X' to show the day(s) on which you did that activity. This question was followed by a list of 29 activities. Each of the 29 different types of physical activities were categorised according to format (i.e., a team activity or an individual activity) and intensity (i.e., based on energy cost; light intensity = less than 4 METs; moderate intensity = 4 to 7 METs; and vigorous intensity = more than 7 METs). Participants had to have taken part in three or more activity sessions of a specific intensity during the past week (to reflect regular participation) for that activity to be included in a specific intensity	Probability of sustaining participation in individual physical activities declined only slightly over time for both boys and girls. Participation in team activities declined rapidly across both genders. Prevalence of participation in most activities declined over the five years. Within two years of baseline, majority of participants discontinued participation in most activities in which they had reported participation at baseline. Decline over time in vigorous intensity activities were steeper than declines in light or moderate intensity activities for both genders (90%, 73% and 40% of girls and 77%, 86% and 60% or boys

				category.	initially involved in activities of light, moderate and vigorous intensity sustained participation in activities of the same intensity at the end of follow-up).
Henning Brodersen et al. (2007)	U.K. (England) (five years)	11 to 12 years at baseline and 15 to 16 years at follow-up (male and female) (n=5863)	Questionnaire – not specifically stated	Vigorous physical activity assessed by asking participants on how many of the past 7 days they had carried out vigorous exercise that made them sweat and breathe hard. Responses coded from 0 (no days) to 7 (every day). Days per week of vigorous physical activity was the dependent variable.	Fall in the mean number of days of vigorous physical activity per week in boys (-1.06 days) and girls (-1.82 days) over the course of the study. Boys (0.99 days per week) reported more physical activity than girls over the five year period. The decline in physical activity was greater in girls (46% reduction) than boys (23%).
Aaron et al. (2002)	U.S. (four years)	12 to 15 years at baseline (male and female) (n=782) Part of the Adolescent Injury Control Study	Modifiable Activity Questionnaire for Adolescents	Questionnaire administered during the spring of each year. A menu of 26 common recreational and leisure time activities required participants to indicate all activities they had participated in at least 10 times during the past year. The frequency and duration of participation in each activity during the past year was collected. An estimate of the average number of hours spent on each activity was calculated. The hours from all activities were summed to derive an overall leisure time physical activity estimate (hours per week) averaged over the past year.	Total physical activity (hours per week) for entire sample declined by 26% during the four year period. Physical activity decreased by 43% in male participants and by 26% in female participants (although at each year, male participants were significantly more active than female participants). The mean number of reported activities declined by 56% from 7.05 in year 1 to 3.08 in year four.
Decline in adolescent females' physical activity					
Kimm et al.	U.S. (10	9 to 10 years at	Three day	The 'Habitual Activity Questionnaire' involved	Level of girls' daily activity declined by

(2000)	years)	baseline and 18 to 19 years at follow-up (female) (n=2379) Part of the National Heart, Lung and Blood Institute Growth and Health Study	diary and Habitual Activity Questionnaire	participants listing all activities (frequency and duration) undertaken within the categories of: outside of school in sports, physical activities and classes/lessons during the past year (for school year and summer months). Participants also estimated the weekly frequency for each activity listed. Summary weekly activity score calculated by multiplying the MET value for each recorded activity by the frequency (times per week) and by the fraction of the year each activity was performed. The final Habitual Activity Questionnaire score (MET times per week) was the sum of the weekly score for all activity categories (i.e., school sports, summer sports, classes/lessons) for the previous year.	35% from nine to 10 years to 18 to 19 years Level of girls' habitual activity declined by 83% from nine to 10 years to 18 to19 years
Kimm et al. (2002)	U.S. (10 years)	9 to 10 years at baseline and 18 to 19 years at follow-up (female) (n=2379) Part of the National Heart, Lung and Blood Institute Growth and Health Study	Questionnaire - Habitual Activity Questionnaire	Same as above for all (i.e., Kimm et al., 2000).	Rate in the decline of physical activity accelerated by 18 to 19 years. Black girls had a decline in physical activity twice that of White girls.
Pate et al.	U.S. (four	13 to 17 years	3-Day Physical	Participants completed a grid for each day	Vigorous physical activity standard

(2007)	years)	(female) (n=398)	Activity Recall	recalled. The grid was divided into 30 minute time blocks, beginning at 7am and ending at 12 midnight. Participants reported their predominant activity in each of the 30 minute blocks. From a list of 55 activities provided, participants entered the number of an activity and if the activity was performed at a light, moderate, hard or very hard intensity. Data for each day was reduced to the number of 30 minute blocks for which the reported activity was rated at an intensity of 3 or more METs (MVPA) and 6 or more METs (vigorous physical activity). Girls were classified as meeting physical activity standards if they reported an average of two or more 30 minute blocks of MVPA per day and/or one or more 30 minute blocks of vigorous physical activity per day.	levels declined from 45.4% in 8th grade (13 years) to 34.1% in 12th grade (17 years). Probability of participating in several forms of vigorous physical activity in 12th grade was strongly associated with participation in those activities in 8th grade.
Pfeiffer et al. (2006)	U.S. (four years)	13 to 17 years (female) (n=429)	3-Day Physical Activity Recall	Same as above (i.e., Pate et al., 2007) (note: girls not meeting the criteria for physical activity standards were categorised as inactive).	Girls showed similar percentages if time engaged in MVPA and vigorous physical activity in 8th and 9th grades but less time in 12th grade. For MVPA – 9th grade sport participants were more likely to be active in 12th grade. For vigorous physical activity – sport participants had higher odds of being active at all future time points.
Increase in adolescents' physical activity					
Laakso et al.	Finland (30	12, 14, 16 and	Finnish	Participation in leisure time physical activity	Participation in organised youth sport

(2008)	years)	18 years (male and female) (n=2832 to 8390: nationwide samples drawn every second year since 1977) Part of the Finnish Adolescent Health and Lifestyle Study	Adolescent Health and Lifestyle Survey	measured by the question: 'How often do you participate in sport or recreational physical activity during your leisure time?', with four additional response alternatives: (1) in a school sport club (outside PE lessons); (2) in a sport club outside school; (3) in some other club or association; and (4) informally alone or with your friends. Each item was scored on a seven point scale (of frequency) ranging from 1 (not at all) to 7 (about every day). A combined variable for leisure time physical activity frequency (informal or unorganised leisure time physical activity) was created by recoding into four categories: (1) less than once a week; (2) once a week; (3) 2 to 3 times a week; and (4) more than 3 times a week. Three items on organised leisure time physical activity were combined and recoded using the same scale. Two variables were cross-tabulated to obtain the combined frequency of leisure time physical activity variable resulting in four categories: (1) inactive; (2) occasionally active; (3) active; and (4) very active.	increased in both genders but more among girls than boys. For both genders, participation in unorganised leisure time physical activity decreased from 1977 to 1985 but then increasing until 2007. Increase from 2003 to 2007 in organised sport but not in unorganised leisure time physical activity.
Aires et al. (2010)	Portugal (three years)	11 to 19 years (male and female) (n=345)	Questionnaire – not specifically stated	Physical Activity Index created by a combination/sum of the points indicated by the following five questions: (1) Do you take part in organised sport outside school? (2) Do you take part in nonorganised sport outside school?	Changes in physical activity index positively associated with changes in fitness Participants highly fit at baseline were those who showed positive changes in physical activity index over the three

				(3) How many times per week do you take part in sport or physical activity for at least 20 minutes outside school? (4) How many hours per week do you usually take part in physical activity so much that you get out of breath or sweat outside school? (5) Do you take part in competitive sport?	years
Physical activity from adolescence to adulthood					
Kjønniksen et al. (2008)	Norway (10 years)	13 years at baseline and 23 years at final follow-up (male and female) (n=630) Part of the Norwegian Longitudinal Health Behaviour Study	Global leisure-time physical activity questionnaire	Global leisure time physical activity was assessed by asking the question: 'In your leisure time, how often do you do sports or exercise until you are out of breathe or sweat?'. Response options were: every day; 4 to 6 times per week; 2 to 3 times per week; once per week; 1 to 3 times per month; less than once per month; and never. Baseline status was divided into three groups: (1) low activity group (individuals with less than weekly activity); (2) moderate activity group (those being active 1 to 3 times per week); and (3) high activity group (those being active 4 times or more weekly). Two questions also asked on outdoor recreational activity: (1) 'How often do you usually do outdoor activity in summer?' and (2) 'How often do you usually do outdoor activity in the winter?'.	Average decline in global leisure time physical activity and recreational activity for both males and females. Period of adolescence to adulthood, there was a decline in physical activity. The decline was greater for males than females.
Telama and Yang (2000)	Finland (nine years)	9, 12, 15 and 18 years at baseline and 18, 21, 24 and 27 years at final follow-up	Questionnaire – not specifically stated	Physical activity measured by questions on the frequency and intensity of leisure time physical activity, participation in sport club training, participation in sport competitions and the participants' habitual ways of spending their leisure time.	Physical activity declined markedly from age 12 to 27 years. In younger age groups, the boys were more active than girls but the decline of activity was steeper among male than

		(male and female) (n=939) Part of the Cardiovascular Risk in Young Finns Study		A sum index of physical activity calculated from these five variables.	female participants. After the age of 18 years, female participants participated in physical activity more frequently than male participants.
Van Mechelen et al. (2000)	Holland (15 years)	13 years at baseline and 14, 15, 16, 21 and 27 years at follow-up (male and female) (n=181) Part of the Amsterdam Longitudinal Growth and Health Study	Structured interview	Habitual physical activity assessed by covering the following areas (4 or more METs): (1) organised sports activities; (2) nonorganised sports and other leisure time activities; (3) transportation in relation to school, work etc.; and (4) work-related activities. Average total weekly physical activity time (minutes per week) was calculated. Scored activities subdivided into three different levels of intensity according to relative energy expenditure: moderate (4 to 7 METs), vigorous (7 to 10 METs) and very vigorous physical activity (10 or more METs). Overall measure of the amount of physical activity (time and intensity) = total amount of physical activity above 4 METs by multiplying the average weekly time (minutes) spent per level of intensity of habitual physical activity by a fixed value for the relative energy expenditure. A weekly physical activity score was then created by summing the three calculated values (moderate + vigorous + very vigorous physical activity).	Over the 15 year period, a gradual decline in physical activity both in male and female participants. Females – from 13 to 16 years, habitual physical activity declined by 3%. 5% increase between 16 to 21 years. Males – from 13 to 16 years, habitual physical activity declined by 20%. 5% increase between 16 and 21 years. Decline in physical activity with age was greater for males than females. Greatest decline in physical activity took place during the adolescent period.
Gordon -Larsen et al.	U.S. (six to seven	Wave 1: 11 to 21 years and	Add Health Questionnaires	Information sought on participation in MVPA (five to eight METs). Physical activity questions	Longitudinal shifts in achieving five or more sessions of MVPA per week from

(2004)	years)	Wave 3: 18 to 26 years (male and female) (n=13,030) Part of the National Longitudinal Study of Adolescent Health (Add Health)		were worded in the following way: 'During the past week, how many times did you,' followed by activities such as walking, basketball etc. Calculation of frequency multiplied by MET value was then undertaken. Wave III - frequency of the activities from the Wave I questionnaire, plus additional questions for young adults. A scaled sum of MVPA was created. Participants classified as achieving or not achieving five or more weekly sessions of MVPA.	adolescence to young adulthood - majority of males and females did not achieve this amount of physical activity in either period. Ethnicity differences with White females showing unhealthy shifts as opposed to Black and Hispanic females.
Tammelin et al. (2003)	Finland (17 years)	14 years at baseline and 31 years at follow-up (male and female) (n=7794) Northern Finland 1966 birth cohort	Questionnaire – not specifically stated	At age 14 years, participants asked how often they participated in sports after school hours and the main types of sports they practiced. The types of sports were coded into 20 groups. At age 31 years, participants asked how often they participated in light and brisk physical activities with response alternatives including: daily, four to six times a week, two to three times a week, once a week, two to three times a month and once a month or less often. Participants were then classified into four groups (very active – exercised briskly four times a week or more often; active – exercised briskly two to three times a week, at least 20 minutes at a time; moderately active – exercised briskly once a week, or more often than once a week but less than 20 minutes at a time, or participated in light physical activity at least four times a week; and inactive – brisk physical activity less often than four times a week).	Participation in sport at least once a week in adolescent females and twice a week in adolescent males was associated with higher levels of physical activity later in life. Frequent participation in sports after school hours in adolescence was associated with a high level of physical activity in adulthood.
Telama et al.	Finland (21	3, 6, 9, 12, 15	Questionnaire	Baseline - physical activity and participation in	High level of physical activity at ages

(2005)	years)	and 18 years at baseline and 24, 27, 30, 33, 36 and 39 years at final follow-up (male and female) (n=1563) Part of the Cardiovascular Risk in Young Finns Study	– not specifically stated	sports of participants nine to 18 years was measured by asking questions concerning the frequency and intensity of leisure time physical activity, participation in sport club training, participation in competitive sport events, common activity during leisure time, school physical education grades and type of school commute. Answers to all questions were coded from 1 to 3: 1) representing inactivity or very low activity; 2) moderately intensive or frequent activity; and 3) frequent or vigorous activity. Following coding, a sum index of physical activity was calculated. Follow-up – questions asked on frequency of physical activity, intensity of physical activity, frequency of vigorous physical activity, hours spent on vigorous physical activity, average duration of a physical activity session and participation in organised physical activity. A sum index of physical activity was calculated the same as previous.	nine to 18 years, significantly predicted a high level of adult physical activity.

4.6 Sedentary behaviour among adolescents

There is a growing concern around the world regarding sedentarism among adolescents (Oehlschlaeger et al., 2004). Consequently, sedentary behaviour has become a major focal area in obesity research, interventions and policies (Boone et al., 2007). Building upon the conceptualisation and definition of sedentary behaviour provided earlier in Section 2.1.3, truly speaking, sedentary behaviour generally encompasses sitting (Olds et al., 2010) or clear 'inactivity' but as Biddle pointed out 'the key issue is that it is not one behavior' (2007: p502). For example, key sedentary behaviours include screen time (TV viewing, videogames and computer use), motorised transport and sitting to read, talk, do homework or listening to music (The Sedentary Behaviour and Obesity Expert Working Group, 2010a).

Typically, sedentary behaviour is often assessed with reference only to TV viewing or TV viewing alongside other technologically-based sedentary behaviours, such as computer use (Biddle, 2007). More specifically, TV viewing is the most commonly studied indicator because it represents the single largest share of sedentary behaviour (Gorely et al., 2004). It has been reported that TV viewing is in fact the dominant 'screen behaviour', comprising approximately 70% of all screen time for children and adolescents (Olds et al., 2006; Biddle et al., 2009b). Evidence has been reported which shows that TV viewing took up 40% of the time spent in the five most prevalent sedentary behaviours during the week and 37% of the time at weekends (Gorely et al., 2007a). Although this is still a substantial amount of time, it does suggest that TV viewing alone does not capture the range and diversity of sedentary behaviours. Consequently, a recent study has examined if TV viewing is a suitable marker of sedentary behaviour in adolescents (Biddle et al., 2009a). This study aimed to test whether TV viewing was a marker of a broader pattern of sedentary behaviour. Findings indicated that high levels of TV viewing were associated with less time in other key sedentary behaviours (e.g., computer use in boys and motorised transport in girls). Although the authors acknowledged that TV viewing is the most prevalent sedentary behaviour, it was suggested that it is not a good marker of sedentary behaviour in young people. In support of Biddle et al.'s (2009a) study, Olds et al. (2010) recently found that non screen sedentary time (e.g., time sitting in school/college/class, riding in cars, eating, socialising, reading and studying) constituted 60% of total sedentary time with screen sedentary time (of which TV viewing was only one behaviour) occupying only 40% of total sedentary time among Australian adolescents. Furthermore, they reported TV viewing time constituted about 70% of total screen time.

Sedentary behaviours, such as TV viewing and computer games, may influence energy balance through displacement of physical activity, increased energy intake or reduced metabolic rate (Boone et al., 2007). A displacement hypothesis exists, which suggests that sedentary pursuits, such as TV viewing, will displace more active pursuits (Biddle et al., 2004b). While there are potential benefits from watching some TV programmes, videos or DVDs, such as relaxation, enjoyment or education, there are serious concerns that time spent in front of a TV, particularly during daylight hours, displaces more cognitively and physically challenging pursuits (Huston et al., 1999). According to Biddle et al. (2004b), however, the evidence that physical activity among children and adolescents is displaced by time spent in front of a TV is equivocal. Even so, there is consistent evidence in studies from around the world that time spent in front of a TV is associated with a number of negative outcomes amongst adolescents, including overweight and obesity (although not clinically significant), poor dietary habits and social problems such as school level of achievement (Gortmaker et al., 1996; Jeffery and French, 1998; Marshall et al., 2004; Strasburger, 2004).

In relation to screen time, this has been reported to represent more than half the time spent in sedentary behaviours (Norman et al., 2005). Consequently, screen time is regarded as the most common sedentary activity among young people (Hardy et al., 2006; Gorely et al., 2009c). From the perspective of researchers aiming to design interventions, measuring screen time is attractive for several reasons. Firstly, it is relatively discrete, easily identified and is affordable to measure (Olds et al., 2010; Affuso et al., 2011). This is in contrast to measures of physical activity such as accelerometers and doubly labelled water which are expensive data collection methods requiring costly instruments. The cost-effectiveness of measuring screen time results in this proxy measure of sedentary behaviour being a clear target for surveying, monitoring and parental regulation (Olds et al., 2010). Secondly, due to screen time being largely seen as discretionary time it is essentially a 'time buffer' which can be flexible in relation to competing demands thus making it a good target for behavioural interventions (Olds et al., 2010). In addition, the use of screen time in self-report recall (e.g., questionnaires) also has the benefit of capturing the type (e.g., TV viewing, computer use) and context (e.g., school, home) of screen time behaviours (Affuso et al., 2011).

Due to the popularity of screen time, it has often been adopted as a proxy measure of sedentary behaviour among youth (Cui et al., 2011). As a proxy measure of overall sedentary behaviour, screen time is an ideal measure to use because the underlying assumption in behavioural epidemiology is that screen time is a good surrogate for overall sedentary behaviour. This is due to two main reasons including: (1) the assumption that screen time quantitatively dominates sedentary behaviour (Gordon-Larsen et al., 2000; Gorely et al., 2007b; Sisson et al., 2009); and (2) patterns of screen time in relation to sociodemographic and health-related characteristics are similar to patterns of overall sedentary behaviour (DeMattia et al., 2007; Iannotti et al., 2009).

4.7 Study differences in sedentary behaviour definitions and classifications

Following reviewing the literature in the area of sedentary behaviour, the majority of studies do not clearly state from the outset what their definition of sedentary behaviour is. In some studies, it is clear that their definition is consistent with the definition adopted in the present study (i.e., sedentary behaviour is where the individual behaviour of sitting or lying is the dominant mode of posture and energy expenditure is very low (i.e., not the absence of physical activity)). However, in some research there seems to be an assumption that the reader understands what sedentary behaviour is or that sedentary behaviour is simply a lack of physical activity in which a physical activity criterion is not met by an adolescent (Oehlschlaeger et al., 2004).

The majority of studies concentrate on specific sedentary behaviours such as TV viewing or 'total' screen time specifically. Consequently, many studies have classified both of these sedentary behaviours according to the recommendations from the American Academy of Pediatrics (2001a) of screen time (TV and computer), being limited to no more than two hours per day (for screen time: Gordon-Larsen et al., 2004; Mark et al., 2006; Scully et al., 2007; Hardy et al., 2010; Ullrich-French et al., 2010; and for TV viewing: Sanchez et al., 2007; Tammelin et al., 2007). Some researchers believe this recommendation is unclear in terms of whether it is referring to only TV viewing or other screen time and how such a figure (of two hours) was arrived at (The Sedentary Behaviour and Obesity Expert Working Group, 2010a; Biddle et al., 2011c). This is most likely to be the reason why studies measuring either TV viewing or all screen time as a representation of sedentary behaviour are utilising the same recommendation. However, all research in the area of sedentary behaviour is currently in a position in which estimates of the prevalence of total or discrete sedentary behaviours is difficult to evaluate (The Sedentary Behaviour and Obesity Expert Working Group, 2010a).

Other studies have attempted to provide a measurement of 'overall sedentary time'. For example, Norman et al. (2005) investigated a range of sedentary behaviours among U.S. adolescents aged 11 to 15 years. Participants reported time spent in leisure time sedentary behaviours including TV viewing (including videos), playing computer or video games, sitting and listening to music on the radio, audiotapes or CDs and sitting and talking on the telephone (for most recent 'non-school day' and 'school day'). An index of sedentary behaviour was created by summing the four items for non-school days and they dichotomised sedentary time into 240 minutes or less and more than 240 minutes. Their reasoning for this cut-off point was because the Healthy People 2010 and American Academy of Pediatrics recommend less than two hours per day of TV viewing per day. Consequently, four hours per day would be a logical extension when considering several types of sedentary behaviour are being measured and that other studies have suggested that TV viewing may account for up to 40% of the most prevalent sedentary behaviours (Gorely et al., 2004).

More recently, Olds et al. (2010) attempted to demonstrate the magnitude and composition of screen sedentary time and non screen sedentary time in order to provide a 'total sedentary time' among Australian adolescents aged nine to 16 years. Using the Multimedia Activity Recall for Children and Adolescents (MARCA) (Ridley et al., 2006), participants recalled everything that they did on the previous day from waking up to going to bed. This was in the form of 'time-slices' as small as five minutes, using a segmented day format in which participants chose from a list of 250 activities grouped together under seven rubics (inactivity, transport, sport and play, school, self-care, chores and other). The MARCA was administered on two occasions and on each occasion, participants recalled their activities over the previous two days (i.e., four days were sampled in total). One school day one non-school day were sampled. Total sedentary time was calculated through summing together screen sedentary time (calculated as the number of minutes the adolescent reported watching TV, playing videogames or using a computer) and non screen sedentary time (calculated as the number of minutes the adolescent reported being involved in activities when seated or lying down expected to elicit less than 3 METs, with the exception of sleep). Overall, it was found that participants spent a total of 575 +/- 101 minutes a day in sedentary activities in total. Of this total sedentary time, screen sedentary time accounted for 40% and non screen sedentary time accounted for 60%.

Historically, sedentary behaviour has been measured as the absence of physical activity. There are still studies that have been undertaken relatively recently which have defined sedentarism as the absence of physical activity. For instance, Oehlschlaeger et al. (2004) determined the prevalence of sedentarism by asking Brazilian adolescents aged 15 to 18 years, questions on the practicing of physical activity at school and outside of school, the time in minutes spent in daily activity and the frequency in the number of times per week. Participants were considered to be 'sedentary' when they said they were not participating in any type of physical activity at school or outside of school or participated in physical activity for periods of less than 20 minutes a day and with frequencies of less than three times per week.

4.8 Evidence from cross-sectional and longitudinal studies – sedentary behaviour among adolescents

Studies investigating sedentary behaviour among adolescents are more common among those adopting a cross-sectional design. This is confirmed by the Sedentary Behaviour and Obesity Expert Working Group when referring to 'gaps in evidence' who stated: 'Better identification of changes in sedentary behaviour across time is needed' (2010a: p45). This would seem to indicate that more longitudinal studies into sedentary behaviour among adolescents are required. Historically, numerous large-scale surveys have attempted to assess the prevalence of physical inactivity or 'sedentariness' in a population by measuring against a criterion for physical activity (e.g., at work or in leisure or both) or energy expenditure thought necessary to obtain health benefits (Biddle et al., 2004a). Longitudinal studies have the distinct advantage over cross-sectional studies because they can identify likely trends in sedentary behaviour (The Sedentary Behaviour and Obesity Expert Working Group, 2010a). All cross-sectional and longitudinal studies identified in the sections that follow are detailed in Table 4.3 (cross-sectional) and Table 4.4 (longitudinal).

4.8.1 Cross-sectional self-report data – adolescents' sedentary behaviour

As stated previously, there are significantly more cross-sectional studies investigating sedentary behaviour than longitudinal studies. However, there are a range of different measures of sedentary behaviour that have been used among cross-sectional studies among adolescents. For instance, some studies have measured 'screen time' in which TV viewing and computer time are assessed together (Biddle et al., 2010). On the other hand, a large majority of studies have either independently measured TV viewing or measured TV viewing in combination with other sedentary behaviours thus TV viewing is the most commonly studied indicator of sedentary behaviour (Gorely et al., 2004). There are also other specific indicators of sedentary behaviour that have been measured in both isolation to and in addition to screen time or TV viewing such as reading, doing homework, motorised transport, sitting and talking, listening to music, talking on the telephone, sitting doing nothing and shopping/hanging out in town. Some studies have also attempted to measure total sedentary time in which a broad range of sedentary behaviours are measured although the majority of these have been studies using accelerometers (Biddle et al., 2010). Finally, some studies still determine 'sedentary behaviour' by measuring physical activity recommendations compliance as the criterion (Oehlschlaeger et al., 2004).

4.8.2 Screen time cross-sectional self-report studies among adolescents

Cross-sectional studies investigating screen time have measured it either directly as a proxy of sedentary behaviour among adolescents (usually referred to as 'total screen time') or have not referred to it directly as screen time. Instead, these studies tend to refer to 'TV/computer/video usage' for example. However, taking the definition of screen time to mean watching television, playing video games and using a computer

(Ullrich-French et al., 2010), studies measuring these components as a whole are detailed in this section.

The evidence that is available on screen time use among the adolescent population indicates a domination of literature toward the position that adolescents' screen time use is high and above the recommended levels thus percentages of those meeting the recommended guidelines are low. As previously mentioned in Section 4.7, many screen time studies have measured screen time in relation whether or not adolescents are meeting the recommendations from the American Academy of Pediatrics (2001a) of screen time (TV and computer) being limited to no more than two hours per day. Ullrich-French et al. (2010) used a cut-off point of less than two hours per day to classify non-school related screen time (in accordance with the recommendations from the Council on Sports Medicine and Fitness and Council on School Health (2006) and the American Academy of Pediatrics Committee on Nutrition (2003)). This involved U.S. adolescents aged 11 to 15 years reporting screen time use during average weekday hours (after school) using three separate items (two items from the Youth Risk Behaviour Survey (U.S. Centers for Disease Control and Prevention, 2008) and one item from the 1999 Youth Risk Behaviour Surveillance Systems). Firstly, time spent during a typical school day: (1) watching TV and (2) playing video or computer games not related to school work. Secondly, average school day hours watching TV or playing video games. They reported that only a small percentage (23.5%) of the sample met recommended levels of no more than two hours per day of non-school related screen time. This study's main strength was from the perspective of questionnaire measurement because they asked separate questions on TV and playing video or computer games thus increasing the opportunity for an adolescent to realistically recall each separate sedentary behaviour. However, school related screen time was not measured which means that the calculations undertaken of participants' screen time was possibly underestimated.

Similarly, Mark et al. (2006) used the same cut-off point for screen time with Canadian adolescents aged 10 to 16 years. Screen time was measured by participants reporting separately: (1) the number of hours a day they usually watched TV (including videos) in their free-time; and (2) the number of hours a day they usually use a computer (for playing games, emailing, chatting or surfing on the Internet) in their free time. For both questions, each was asked for both weekday and weekend use. A weighted mean was then calculated to determine the average amount of free time per day spent watching TV and using the computer. Total screen time was calculated as the sum of TV and computer hours. Following this calculation, TV, computer and total screen time were categorised into those who did and those who did not meet the American Academy of Pediatrics (2001a) recommended guideline of two hours or less per day. For total screen time (TV and computer), only 18% of girls and 14% of boys met the recommended level of no more than two hours per day of screen time. A main limitation of this study was that the researchers did not ask about video games that can be played directly on the TV (e.g., Nintendo) therefore screen time may have been underestimated by some adolescents. Conversely, considering that the majority of previous studies have been restricted to only measuring TV viewing, the measurement of TV and computer was a strength of this study.

Further supporting evidence of low percentages of adolescents meeting this recommended guideline is provided by Hardy et al. (2010) who measured screen time use among Australian adolescents with a mean age of 15.4 years. Participants reported the time they usually spent engaged in a range of sedentary behaviours including screen time, before and after school, separately for each day of the week and weekend day. Screen time included watching TV/DVDs/videos and using a computer for recreation. Mean screen time (hours per day) and the proportions of participants meeting the recommended guidelines of no more than two hours per day were calculated separately for the whole week, weekdays and weekend days. Using this same categorisation as the previous two studies, they found that the mean screen time for all participants was 3.1 hours per day with boys more likely to exceed screen time guidelines than girls. For example, for the whole week period (seven days), 89.7% of boys and 76.2% of girls exceeded the recommended guidelines of two hours per day. Methodological strengths of this study included the authors' acknowledgement that some adolescents multitask (i.e., using a computer at the same time as watching TV). In this situation, participants were able to estimate the time they spent on each activity separately. On the other hand, limitations of the study included the cross-sectional study design which did not allow for changes in screen time to be measured over a period of time and the small sample size studied (n = 496).

Following on, studies which measured screen time as a whole but have not referred to a combination of TV viewing and computer use as 'screen time' specifically include Scully et al. (2007) who reported a low percentage of Australian adolescents meeting recommended guidelines for screen time use. In this study, participants aged 12 to 17 years reported how many hours a day (on an average school day when not at school) they: did homework; watched TV/videos; and used the internet/played computer games (not including computer use for homework). The questions on TV viewing and computer use were then combined and were dichotomised in accordance with meeting the recommended guidelines of two hours per day or not. They concluded that only 29% of participants reported spending no more than two hours per day using electronic media for entertainment on an average school day. Major strengths of this study were the large sample size (n = 18,486), however, this study did not measure sedentary behaviour on a weekend suggesting that this measure is not reflective of screen time on an average day. On the other hand, Ussher et al. (2007) measured TV viewing, video use and computer use among adolescents in England and Wales aged 13 to 16 years. They reported that more boys (21.1%) than girls (16.4%) reported more than three hours a day of TV viewing/video/computer (i.e., 'screen time'). Weaknesses of this study included a lack of consideration to differentiating between weekday and weekend screen time use. The question asked in this study simply asked participants to indicate how many hours each day they spent doing these things (i.e., TV, video and computer games) altogether. On the positive front, this study at least did attempt to measure more than just TV viewing.

Finally, high levels of screen time use among adolescents have been reported but not in relation to recommended guidelines. For instance, Thibault et al. (2010) examined weekly screen time among French adolescents aged 11 to 18 years. Participants reported separately how many hours they spent watching TV, using a computer and playing video games on a usual school day and a usual weekend day. Usual weekly time of screen viewing was calculated and summed to create a total cumulative weekly time spent on screen viewing termed 'sedentary behaviour'. Results confirmed that participants had a high level of sedentary behaviour with a mean of 25 hours a week screen time. There was a significant difference in sedentary behaviour time for gender with boys spending more time in sedentary behaviour than girls. This difference was due to boys spending more time playing video games and using a computer than girls. Measurement of screen time on a weekday and a weekend day was a strength of this study, in addition to the large sample size (n= 2385). Although referred to earlier, Olds et al. (2010) also measured 'screen sedentary time' among Australian adolescents aged nine to 16 years without comparing to recommended guidelines for screen time. Screen sedentary time was measured as the number of minutes participants reported watching TV, playing video games or using a computer (i.e., screen time). Screen sedentary time was calculated as the average of school day and non-school day values. They reported that participants spent a mean of 230 minutes a day in screen sedentary time with boys accruing more time in screen sedentary time than girls. Although this study was one of the first studies to measure total sedentary time comprising of screen time and non-screen time, it did not relate the measurements of screen time to any guideline of compliance as former studies have done.

4.8.3 TV viewing and other types of sedentary behaviour cross-sectional self-report studies among adolescents

The majority of cross-sectional studies into sedentary behaviour among adolescents are with regard to TV viewing specifically. However, where TV viewing is measured, it is often measured in addition to other measures such as reading, talking on the telephone and motorised transport. Firstly, studies that have specifically measured TV viewing indicate a mixed picture for the TV viewing behaviour of adolescents. Sanchez et al. (2007) have provided support for lower levels of TV viewing among adolescents. They measured time spent watching TV on a recent non school day as a proxy measure of sedentary behaviour in relation to the proportion of U.S. adolescents aged 11 to 15 years who were meeting the recommended guideline of two hours per day TV viewing time (i.e., compliance with the Healthy 2010 TV viewing time guideline (U.S. Department of Health and Human Services, 2000)). Conclusions were that only 30% of participants exceeded the recommended guideline of two hours per day (i.e., 70% were participating in two hours or less per day of TV viewing). An obvious limitation of this study concerned the non inclusion of a 'recent school day' to give a more accurate account of TV viewing time. However, consistency with recommended guidelines allowed for the findings to be compared with other similar studies.

Similar rates to those reported by Sanchez et al. (2007) have been reported by Li et al. (2007). Chinese adolescents aged 11 to 17 years reported the time spent in sedentary activities for a weekday and weekend day for watching TV, playing games, working on the computer, doing homework and sedentary hobbies. Results showed that only 24% of participants watched TV for more than two hours per day. However, they did report that 79% of participants spent more than two hours a day doing homework and of these 79%, 35% spent more than four hours a day on homework. Other studies have reported figures of approximately 50% regarding adolescents that do not meet the TV viewing guideline of two hours per day (e.g., Tammelin et al., 2007). In this study, Finnish adolescents aged 15 to 16 years reported how many hours per day outside of school hours, on average, they spent TV viewing, reading books or magazines, playing or working on a computer/playing video games and other sedentary activities. Although 50% of participants watched TV for two hours a day or less, 25% of boys and 21% of girls reported watching TV for at least four hours a day. In addition, 24% of boys but only 3% of the girls used the computer or played video games for more than two hours a day.

Other studies such as Samdal et al. (2006) have been undertaken which have examined trends in leisure time TV viewing of adolescents (aged 11, 13 and 15 years) across several European countries. In this study, between 1985/1986 and 2001/2002, participants reported how many hours a day they usually watched TV. From a U.K. perspective, it was revealed that in Scotland and Wales, the proportion of participants watching four hours of TV daily changed little between 1985/1986 and 1997/1998. However, boys and girls in Wales reported higher levels of TV viewing across all four surveys than their counterparts in Scotland. This study reported useful findings particularly because a comparison was undertaken between countries.

Further cross-sectional literature also reflects the inclusion of TV viewing within a wide range of other measured sedentary behaviours. What appears to be the predominant outcome of these findings is that TV viewing is the most prevalent sedentary behaviour among adolescents. This is confirmed by studies including Biddle et al. (2009b) (also incorporating Gorely et al. (2007a) reporting prevalence data for U.K. girls and Gorely et al. (2009c) reporting prevalence data for U.K. boys). Across all three of these studies, data from Project STIL (Sedentary Teenagers and Inactive Lifestyles) were collected using a time-use diary and using the self-report ecological momentary assessment diary. In Biddle et al.'s (2009b) study, a total of 991 adolescents in Scotland ranging between 12.6 to 16.7 years completed the diary outside of school hours and requested participants to record the sedentary behaviours they engaged in each day. On the other hand, Gorely et al.'s (2007a) study included a total of 923 adolescent girls in the U.K. aged between 12.5 to 17.6 years and in Gorely et al.'s (2009c) study, a total of 561 adolescent boys aged between 12.7 to 16.7 years in the U.K. Participants completed the diary for four days across all three studies (three weekdays and one weekend day, both during the school term and randomly assigned).

Results identified across all three studies were similar in that participants watched, on average, just below two hours (Biddle et al., 2009b), one and three quarter hours (Gorely et al., 2007a) and two and a quarter hours (Gorely et al., 2009c) of TV on weekdays and just over two and a half hours (Biddle et al., 2009b), about two and a half hours (Gorely et al., 2007a) and about three and a half hours (Gorely et al., 2009c) on weekend days. From a prevalence rates perspective, these results indicated that TV viewing across all three studies was not excessive during the week with 54.2% of boys and 56.7% of girls (Biddle et al., 2009b), 62.1% (Gorely et al., 2007a) and 50.2% (Gorely et al., 2009c) (i.e., the majority) categorised as 'low users' of TV (two hours per day or less) and only 5.8% of boys and 6.1% of girls (Biddle et al., 2009b), 3.3% (Gorely et al., 2007a) and 8.9% (Gorely et al., 2009c) (i.e., the minority) categorised as watching more than four hours per day (twice the recommended guideline by the American Academy of Pediatrics, 2001a). Despite this, the percentage watching more than four hours of TV per day at weekends increased (i.e., 25.9% (boys) and 23.5% (girls) - Biddle et al., 2009b; 20.7% - Gorely et al., 2007a; 33.8% – Gorely et al., 2009c). However, the prevalence rates of participants were still relatively low for 'low users' of TV at weekends (i.e., 32.1%

(boys) and 45.6% (girls) – Biddle et al., 2009b; 42.6% - Gorely et al., 2007a; 25.5% - Gorely et al., 2009c).

All three studies similarly concluded that TV viewing accounts for a substantial amount of total sedentary time but highlighted that it is not the only sedentary activity. More specifically, Biddle et al. (2009b) reported that, after TV viewing, the four most time consuming weekday sedentary behaviours for: (1) girls were homework, motorised transport, sitting and talking and shopping/hanging out in town; and (2) boys were homework, playing computer/video games, motorised transport and behavioural hobbies (e.g., playing musical instruments). During the weekend, after TV viewing, Biddle et al. (2009b) found that the four most time consuming sedentary behaviours for: (1) girls were shopping/hanging out in town, sitting and talking, motorised transport and behavioural hobbies; and (2) boys were shopping/hanging out in town, playing computer/video games, behavioural hobbies and motorised transport. Similarly, Gorely et al. (2007a) in relation to adolescent girls found that, after TV viewing, the four most time consuming weekday sedentary behaviours were homework, motorised transport, sitting and talking and behavioural hobbies. On the other hand, at the weekend, after TV viewing, the four most time consuming sedentary behaviours were shopping/hanging out in town, sitting and talking, motorised transport and doing homework. Slightly different sedentary behaviours were reported in Gorely et al.'s (2009c) study with adolescent boys with the most time consuming weekday sedentary activities, after TV viewing, being homework, motorised transport, playing computer/video games and shopping/hanging out. In relation to the weekend, after TV viewing, the four most time consuming sedentary activities were shopping/hanging out in town, motorised transport, sitting and talking and playing computer/video games. Overall, the data presented in these three particular studies concluded that although TV viewing accounts for approximately 50% of all sedentary time, it is by no means the only such behaviour, yet has dominated the literature for the assessment of sedentary behaviour. These studies are welcomed for capturing a wide range of sedentary behaviours.

Additional supporting studies include Hamar at al. (2010). Using the same data collection tool as Biddle et al. (2009b) (i.e., a time-use diary), Hungarian adolescents aged 12.5 to 17.6 years completed the diary for four days (three weekdays and one weekend day) and self-reported (free responded) their behaviour at 15 minute intervals. It was found that TV viewing occupied the most leisure time on both weekdays and weekend days. After TV viewing, the four most time consuming weekday sedentary activities were homework, motorised transport, sitting and talking and playing computer/video games. At weekends, after TV viewing, the four most time consuming weekend sedentary activities were homework, sitting and talking, playing computer/video games and motorised transport. Importantly, they pointed out that the majority of participants (64%) watched less than two hours a day of TV on weekdays and only a small minority (3%) watched more than four hours. More TV was watched at the weekend with 39% watching less than two hours and 24% watched more than four hours. This study provided useful data on sedentary behavioural patterns and trends but due to capturing data in 15 minute time intervals, was not able to capture short or infrequent sedentary behaviours.

Additionally, Marshall et al. (2002) measured a wide range of different sedentary behaviours such as computer/internet use, playing video games, doing homework, reading (not for school), sitting and talking/listening to music, talking on the telephone and TV viewing. Participants included U.S. and U.K. (English) adolescents aged 11 to 15 years who completed a self-administered physical activity checklist in which participants recalled their sedentary behaviour over the previous seven days. Seven sedentary activities were listed and participants indicated which of the seven activities they had participated in the last seven days, the number of days they had participated and the total number of minutes each day. They concluded that the most prevalent sedentary behaviour was TV viewing with approximately one third of U.S. and U.K. youth reporting watching TV more than four hours a day (twice that recommended).

Finally, Utter et al. (2003) examined TV viewing/video use and computer use (in addition to reading and doing homework) in a sample of U.S. adolescents with a mean age of 14.9 years. The time spent in these three sedentary behaviours were assessed by three questions which asked participants to report how many hours they spent on an average weekday (and an average weekend day): (1) watching TV and videos; (2) reading and doing homework; and (3) using a computer (not for homework). For each of these sedentary behaviours, an hours per week variable was created by calculating a weighted sum of weekday and weekend use. The hours per day variable was then created by dividing the hours per week variable by seven. Most significantly, they concluded that boys spent significantly more time (2.8 hours per day) than girls (2.6 hours per day) with TV/videos. Further, it was found that boys and girls spent more time watching TV/videos than with computers or reading/doing homework. Although they had the capacity to measure overall screen time, they did not do this and reported findings for each of the individual behaviours. On the other hand, this study recruited a large sample size (n = 4746). Conversely, although referred to earlier, studies such as Li et al. (2007) have shown that TV viewing is not the predominant sedentary behaviour among adolescents. They measured the time spent in sedentary activities such as TV viewing, playing games, working on the computer, doing homework and other sedentary hobbies. Chinese adolescents aged 11 to 17 years spent an average of 3.4 hours a day doing homework and only 1.4 hours watching TV. As mentioned earlier, only 24% of participants watched TV for more than two hours per day.

Evidence is also increasing in relation to the modes of transport adopted by adolescents as an indicator of sedentary behaviour (sometimes referred to as 'motorised transport' or 'commuting'). Studies in this area indicate that the most common form of transport among adolescents is via passive modes of transport such as the car as opposed to active modes (e.g., walking or cycling). Mota et al. (2006) measured the prevalence of active and passive commuting among Portuguese adolescents whose average age was 14.6 years. Participants were asked whether they walked, bicycled, went by car or went by bus to and from school, as well as the duration in minutes of the journey. Focusing in on obese and non-obese participants in their sample, it was found that 76.3% of non-obese participants took passive forms of transport (bus, riding in a private vehicle) to school and only 23.8% took active forms of transport (walking, cycling) to school. The same classification (i.e., passive versus active) was used by Santos et al. (2005) who investigated commuting to and from school among the same population of participants as Mota et al. (2006). However, they investigated possible significant differences between commuting mode (passive, active) and whether participants were in an 'active' physical activity category or a 'nonactive' physical activity category. Findings revealed that there were no significant differences for commuting mode although approximately 75% of participants, regardless of whether they were in the active or non active group took passive forms of transport to and from school. Both studies attempted to measure a range of passive and active modes of transport among participants but only focused on travel to and from school. As a consequence, an 'overall' measure of active versus passive transport was not provided.

Although referred to earlier, Biddle et al. (2009b) also reported prevalence rates for motorised transport use among adolescents. In their study of Scottish adolescents aged 12.6 to 16.7 years, they found that only 17.9% of boys and 15.6% of girls reported no motorised transport use during the week, with a rise to 45.2% (boys) and 21.2% (girls) at weekends thus indicating a marked effect for school commuting among boys but not as much for girls. On the other hand, Gorely et al. (2007a), referred to earlier, have shown prevalence rates for motorised transport among U.K. adolescent girls aged 12.5 to 17.6 years (and Gorely et al. (2009c) for U.K. adolescent boys aged 12.7 to 16.7 years (also referred to earlier)). Gorely et al. (2007a) found that 57% of girls reported up to one hour of motorised travel on weekdays with 32% reporting more than one hour daily. From a weekend perspective, 41% or girls reported more than one hour of motorised travel each day with 30% of girls reporting none. Conversely, Gorely et al. (2009c) concluded that 74% of boys reported up to one hour of motorised travel on weekdays with 34.8% of boys reporting more than one hour of motorised travel each day. However, 41.7% of boys reported none. Similarly, Hamar et al. (2010) also referred to earlier, reported prevalence rates or motorised transport use among Hungarian adolescents aged 13.5 to 17.9 years. They concluded that 45% of participants reported up to one hour of motorised travel on weekdays and 32% more than one hour on a daily basis. At weekends, 20% of participants reported more than one hour of motorised travel each day while 64% reported none. Other work in this area includes Gorely et al. (2009b) who examined the relationship between distance to school and levels of sedentary behaviour in UK adolescents aged 12.5 to 17.6 years. They classified travel to school as motorised or active but found no differences in sedentary behaviour time by distance to school.

Studies have also examined a range of sedentary behaviours to produce a 'total sedentary behaviour time'. For example, Gorely et al. (2009a) reported sedentary behaviours including TV viewing, computer time (i.e., computer game playing and non homework computer use), sedentary socialising behaviours (hanging out, sitting and talking and phone) and total sedentary time among English adolescents aged 12.5 to 17.6 years. A self-report diary (based on the principles of ecological momentary assessment) was completed by all participants outside of school hours with the sedentary behaviours being measured via part two of the diary for four randomly assigned days (three weekdays and one weekend day) through participants self-reporting (free responding) their main behaviour at 15 minute intervals. Total sedentary behaviour time for weekdays and weekends was calculated by summing TV viewing, computer time and sedentary socialising behaviours. Gorely et al. (2009a) concluded that TV viewing and computer use (i.e., screen time) was significantly greater in boys than girls during the week and at weekends. Girls spent significantly more time in social sedentary behaviours than boys on weekdays and weekends. Meanwhile, weekday and weekend total sedentary time was significantly greater in boys than girls. Clear strengths of this study rest with the use of ecological momentary assessment which captured a range of sedentary behaviours although there were limitations such as the burdensome nature of the ecological momentary assessment instrument on participants in relation to the time required to complete it.

4.8.4 Summary

The range of cross-sectional studies discussed in this section have been divided into 'screen time' and 'TV viewing and other sedentary behaviours'. The studies measuring screen time among adolescents have shown that there is a low prevalence of adolescents meeting the recommended guidelines of two hours per day of screen time. However, it is difficult to make direct comparisons between studies due to differences in study design including the calculation and categorisation of screen time per day. The predominant sedentary behaviour among other cross-sectional studies with adolescents is TV viewing. Modes of transportation among adolescents as a representation of sedentary behaviour are also increasing among studies with adolescents. Similar to screen time, when comparing studies that have measured other sedentary behaviours other than screen time specifically, different methodologies adopted make direct comparisons difficult.

Table 4.3
Summary of cross-sectional self-report studies investigating adolescents' sedentary behaviour

Author(s) and date	Country	Sample characteristics (age range, gender and sample size)	Self-report tool(s) used	Question(s) asked and/or classification system (or calculation system) used	Main finding(s)
Screen time studies					
Ullrich-French et al. (2010)	U.S.	11 to 15 years (male and female) (n=153)	Two items from the Youth Risk Behaviour Survey and one item adapted from the 1999 Youth Risk Behavior Surveillance Systems	Participants self-reported screen time use during average weekday hours (after school) assessed using three items: (1) time spent during a typical school day watching TV; (2) time spent during a typical school day playing video or computer games not related to school work; and (3) average school day hours watching television or playing video games. Classification used of those who met the recommendation of two hours or less of non-school related screen time per day with those who exceeded this recommendation.	23.5% of sample met the recommended level.
Mark et al. (2006)	Canada	10 to 16 years (male and female) (n=6942)	Questionnaire – not specifically stated	Amount of time spent watching TV and using the computer using the question: 'About how many hours a day do you usually watch TV (including videos) in your free time?' and 'About how many hours a day do you usually a computer (for playing games, emailing, chatting or surfing on the internet) in your free	Total screen time (TV and computer) - 18% of girls and 14% of boys met the recommended guideline. TV – 41% of girls and 34% of boys met the recommended guideline. Leisure time computer use (not including

				time?'. Response options to each question were 'none at all', 'about half an hour a day', 'about 1 hour day', 'about 2 hours a day', 'about 3 hours a day', 'about 4 hours a day', 'about 5 hours a day', 'about 6 hours a day' and 'about 7 or more hours a day'. Questions asked for both weekday and weekend use. Weighted mean calculated to determine the average amount of free time per day spent watching TV and using the computer. Total screen time = TV hours + computer hours. For TV, computer and screen time, participants were categorised into those who did and did not meet the recommended guideline of two hours or less per day.	homework) – 72% of girls and 65% of boys met the recommended guideline.
Hardy et al. (2010)	Australia	15 to 16 years (male and female) (n=496)	Adolescent Sedentary Activity Questionnaire	Participants reported time usually spent engaged in a range of sedentary activities including screen time (before and after school)) separately for each day of the week and each weekend day. Mean screen time (hours per day) and proportion of participants meeting	Mean screen time for all participants was 3.1 hours per day (2.6 hours per day for weekdays and 4.4 hours per day for weekends). Boys more likely to exceed screen time guidelines than girls.

				national (Australian) screen time guidelines (less than two hours or two or more hours per day) calculated separately for the whole week, weekdays and weekend days.	For the whole week, 89.7% (boys) and 76.2% (girls) exceeded the recommended screen time guidelines.
Scully et al. (2007)	Australia	12 to 17 years (male and female) (n=18,486)	2005 Australian Secondary Students Alcohol and Drug Survey	Participants asked the question: 'On an average school day, about how many hours a day do you do the following when you are not at school: (i) homework; (ii) watching TV/videos; and (iii) using Internet/playing computer games (not including computer use for homework). Responses ranged from 'none' to 'five hours or more'. Responses were categorised as one hour or less or two or more hours (with the questions on TV and computer use assessed both individually and combined) and then dichotomised into two hours or less per day (recommended maximum) or not.	Only 29% of participants reported spending no more than two hours a day using electronic media for entertainment on an average school day. 65% of participants reported watching TV for no more than two hours per day on an average school day and 75% reported spending no more than two hours on a school day using the Internet or playing computer games. Females more likely than males to meet the sedentary behaviour guideline.
Ussher et al. (2007)	U.K. (England and Wales)	13 to 16 years (male and female) (n=2623)	Questionnaire – not specifically stated	Participants reported how many hours a day they used TV/ video/computer.	More boys (21.1%) than girls (16.4%) reported more than three hours a day using a TV/video/computer.
Thibault et al. (2010)	France	11 to 18 years (male and female) (n = 2385)	99-item self-report questionnaire	Participants reported separately how many hours they spent watching TV, using a computer and playing video games on a usual school day and a usual weekend day.	Mean of 25 +/- 15.1 hours a week on sedentary activity (watching TV, playing video games and using a computer). Boys (26.8 +/- 15.7 hours) spent more time

				Usual weekly time of screen viewing was calculated and summed to create a total cumulative weekly time spent on screen viewing (termed 'sedentary behaviour').	in screen time than girls (23.3 +/- 14.3 hours). Boys (12.5 +/- 10.7 hours) spent more time than girls (8.1 +/- 8.6 hours) playing video games and using a computer.
Olds et al. (2010)	Australia	9 to 16 years (male and female) (n=2200)	Multimedia Activity Recall for Children and Adolescents	Participants reported the number of minutes they watched TV, played video games or used a computer. This represented 'screen sedentary time' (i.e., screen time). Overall screen sedentary time was calculated as the average of school day and non-school day values.	A mean of 230 +/- 105 minutes a day of screen sedentary time was participated in. Screen sedentary time constituted 40% of total sedentary time. Boys spent more time in screen sedentary time than girls.
TV viewing and other types of sedentary behaviour studies					
Sanchez et al. (2007)	U.S.	11 to 15 years (male and female) (n=878)	Survey adapted from Robinson (1999)	Time spent watching TV was the proxy used for sedentary behaviour to measure compliance with the Health 2010 TV viewing time guideline. Time spent watching TV on a recent non school day was measured. Non school day TV time was measured to estimate self-selected behaviour during unstructured time (e.g., no school).	30% exceeded the recommended guideline of two hours daily of TV viewing time. More boys (70.5%) reported meeting the recommended guideline than girls (64.3%).
Samdal et al. (2006)	Austria, Finland, Hungary, Norway, Sweden, U.K.	Nationally representative samples of ages 11, 13 and 15 years (male and female)	Health Behaviour in School-aged Children study questionnaires	TV viewing was measured by the item 'How many hours a day do you usually watch TV?'. There were six response options: (1) not at all; (2) less than half an hour a	Percentage watching more than four hours of TV daily: **Scotland** 1986 (30% girls; 33% boys)

	(Scotland and Wales)	Part of the 'Health Behaviour in School-aged Children. A WHO Cross-national study'		day; (3) half an hour to 1 hour; (4) 2 to 3 hours; (5) 4 hours; and (6) more than 4 hours. Responses were dichotomised by us the cut-off point for TV watching being set at four hours or more a day.	1990 (28% girls; 33% boys) 1994 (35% girls; 33% boys) 1998 (27% girls; 29% boys) **Wales** 1986 (43% girls; 44% boys) 1990 (37% girls; 37% boys) 1994 (43% girls; 46% boys) 1998 (38% girls; 36% boys)
Li et al. (2007)	China	11 to 17 years (male and female) (n=1804)	Questionnaire (recorded on a form) – not specifically stated	Time spent in sedentary activities was recorded on a form in which weekday and weekend daily time for watching TV, playing games, working on the computer, doing homework and sedentary hobbies were listed.	24% watched TV for more than two hours per day. 79% spent more than two hours per day doing homework (of which 35% spent more than four hours a day doing homework). Average of 3.4 hours per day doing homework. Average of 1.4 hours per day watching TV. Girls spent significantly more time doing homework (3.3 hours a day) and less time playing video games (0.4 hours a day) compared with boys.
Tammelin et	Finland	15 to 16 years	Questionnaire	Participants responded to an open	50% watched TV for two hours a day or

al. (2007)		(male and female) (n=6928)	– not specifically stated	ended question by reporting how many hours per day, on average, they spent on the following sedentary activities outside school hours: (1) TV viewing; (2) reading books or magazines; (3) playing or working on a computer/playing video games; and (4) other sedentary activities. Categorisation was made in relation to the proportion of participants who were meeting the guidelines of two hours a day of TV viewing. The total time spent on all of these sedentary activities was also calculated.	less. 25% of boys and 21% of girls reported watching TV for at least four hours a day. 24% of boys and 3% of girls used the computer or played video games for more than two hours per day.
Biddle et al. (2009b)	U.K. (Scotland)	12.6 to 16.7 years (male and female) (n=991) Part of Project STIL (Sedentary Teenagers and Inactive Lifestyles)	Ecological momentary assessment diary	Participants completed the diary for four days (three weekdays and one weekend day, both during the school term), randomly assigned by weekday and weekend day. At 15 minute intervals, participants self-reported their main behaviour in response to a single item: 'What are you doing now?'. Behaviours coded into 18 mutually exclusive categories representing volitional leisure time activities. To estimate the time spent in each behaviour category, number of times a behaviour was recorded each day was multiplied by 15. For weekdays, mean time per behaviour calculated (minutes	Average – just below two hours of TV on weekdays and just over two and a half hours on weekend days. 54.2% of boys watched two hours or less of TV on a weekday (32.1% on weekends). 5.8% of boys watched more than four hours of TV on a weekday (25.9% on weekends). 56.7% of girls watched two hours or less of TV on a weekday (45.6% on weekends). 6.1% of girls watched more than four hours of TV on a weekday (23.5% on

				per day). Behaviour categories classified as 'sedentary' included: watching TV, doing homework, motorised transport, playing computer/video games, shopping/hanging out in town, sitting and talking, using a computer, behavioural hobbies, listening to music, paid work, reading, using the telephone, sitting doing nothing, cognitive hobbies and unstructured play.	weekends). Boys (weekday) - TV viewing was the most time consuming weekday sedentary activity followed by homework, playing computer/video games, motorised transport and behavioural hobbies. Boys (weekend) – TV viewing was the most time consuming weekend sedentary activity followed by shopping/hanging out in town, playing computer/video games, behavioural hobbies and motorised transport. Girls (weekday) – TV viewing was the most time consuming weekday sedentary activity followed by homework, motorised transport, sitting and talking and shopping/hanging out in town. Girls (weekend) – TV viewing was the most time consuming weekend sedentary activity followed by shopping/hanging out in town, sitting and talking, motorised transport and behavioural hobbies. 17.9% of boys and 15.6% of girls reported no motorised transport use in the week but increase to 45.2% (boys) and 21.2% (girls) at the weekend. 17.9% of boys (15.6% of girls) reported no motorised transport use during the week, rising to 45.2% (21.2% of girls) at

					weekends. 71.3% of boys (70.3% of girls) travelled on motorised transport during the week for up to one hour (26.2% of boys and 40% of girls reporting 30 to 60 minutes). 49.3% of boys (69.6%) travelling by motorised transport for at least 30 minutes at the weekend.
Gorely et al. (2007a)	U.K. (England, Northern Ireland, Scotland and Wales)	12.5 to 17.6 years (female) (n=923) Part of Project STIL (Sedentary Teenagers and Inactive Lifestyles)	Ecological momentary assessment diary	Same as above for completion of the diary (i.e., Biddle et al., 2009b). Behaviours coded into 23 mutually exclusive categories (from a focus group undertaken about how English youth spend their free time). Estimate of time spent in each behaviour category is the same as above. Behaviour categories classified as 'sedentary' – same as above.	Average – approximately one and three quarter hours of TV on weekdays and about two and a half hours on weekend days. 62.1% of girls watched two hours or less of TV on a weekday (42.6% on weekends). 3.3% of girls watched more than four hours of TV on a weekday (20.7% on weekends). Girls (weekday) - TV viewing was the most time consuming weekday sedentary activity followed by homework, motorised transport, sitting and talking and behavioural hobbies. Girls (weekend) – TV viewing was the most time consuming weekend sedentary activity followed by shopping/hanging out in town, sitting and talking, motorised transport and doing homework.

					57% of girls reported up to one hour of motorised travel on weekdays and 32% reported more than one hour daily. 41% of girls reported more than one hour of motorised travel each day at the weekend but 30% of girls reported none.
Gorely et al. (2009c)	U.K. (England, Northern Ireland, Scotland and Wales)	12.7 to 16.7 years (male) (n=561) Part of Project STIL (Sedentary Teenagers and Inactive Lifestyles)	Ecological momentary assessment diary	Same as above for all (i.e., Gorely et al., 2007a).	Average – approximately two and a quarter hours of TV on weekdays and about three and a quarter hours on weekend days. 50.2% of boys watched two hours or less of TV on a weekday (25.5% on weekends). 8.9% of boys watched more than four hours of TV on a weekday (33.8% on weekends). Boys (weekday) - TV viewing was the most time consuming weekday sedentary activity followed by homework, motorised transport, playing computer/video games sitting and shopping/hanging out. Boys (weekend) – TV viewing was the most time consuming weekend sedentary activity followed by shopping/hanging out in town, motorised transport, sitting and talking and playing computer/video games. 74% of boys reported up to one hour of

					motorised travel on weekdays. 34.8% of boys reported more than one hour of motorised travel each day at the weekend but 41.7% of girls reported none.
Hamar et al. (2010)	Hungary	13.5 to 17.9 years (male and female) (n=301) Cross-cultural extension to Project STIL (Sedentary Teenagers and Inactive Lifestyles)	Ecological momentary assessment diary	Same as above for completion of the diary (i.e., Biddle et al., 2009b) (note: participants also responded to two closed response items for each time period concerning their location and social context). Behaviours coded into 23 mutually exclusive categories of leisure time behaviour. To estimate the time spent in each behaviour category, the interval-level data were aggregated for each individual (separately by weekday and weekend day) by multiplying the daily frequency of the event by 15. The weekday data were then aggregated further to produce a mean, in minutes per day, across weekdays. No further aggregation for weekend was necessary. Behaviours classified as sedentary included: TV viewing, doing homework, motorised transport, sitting and talking, behavioural hobbies, shopping/hanging out in town, listening to music and using a computer.	TV viewing occupied the greatest proportion of leisure time on a weekend day and a weekday. TV viewing was the most leisure time followed by homework, motorised transport, sitting and talking and playing computer/video games (weekday); and homework, sitting and talking, playing computer/video games and motorised transport (weekend) . 64% watched less than two hours per day on weekdays and 3% watched more than four hours per day. 39% watched less than two hours per day and 24% watched more than four hours per day at the weekend. 45% reported up to one hour of motorised travel on a weekday and 32% more than one hour on a daily basis decreasing to 20% at the weekend. 76% did up to one hour of active travel on weekdays and 17% reported no weekday active travel.

					64% reported no motorised travel at the weekend.
Marshall et al. (2002)	U.S. and U.K. (England)	11 to 15 years (male and female) (n=2494: of which n=1750 in the U.S. and n=744 in the U.K.)	Modified form of the Self-Administered Physical Activity Checklist	Sedentary behaviours were polychotomised with cut points based on the distribution of each variable as well as levels that would easily translate into recommendations for public health. Time spent on the computer/internet, playing video games, doing homework, reading (not for school), sitting and talking/listening to music and talking on the telephone were classified into four categories: (1) none (0 hours per week); (2) low (0.1 to 2.9 hours a week); (3) moderate (3 to 6.9 hours a week); and (4) high (7+ hours a week). TV use was classified into five categories: (1) none (0 hours per week); (2) low (0.1 to 6.9 hours per week); (3) moderate (7 to 13.9 hours a week); (4) high (14 to 27.9 hours a week); and (5) very high (28+ hours a week).	Most prevalent sedentary behaviour was TV viewing. One third of U.S. and U.K. youth reported watching TV more than four hours a day.
Utter et al. (2003)	U.S.	12 to 18 years (male and female) (n=4746) Part of Project EAT (Eating Among Teens)	Questionnaire – not specifically stated	Three sedentary behaviours assessed by the two questions: (1) 'In your free time on an average weekday (Monday – Friday), how many hours do you spend...a. watching TV and videos, b. reading and doing homework and c. using a computer (not	Boys spent significantly more time (2.8 hours per day) than girls (2.6 hours per day) watching TV/videos and computers. Girls spent significantly more time than boys reading and doing homework. Both boys and girls spent more time

				for homework)?' (2) 'On an average weekend day (Saturday or Sunday), how many hours do you spend...a. watching TV and videos, b. reading and doing homework and c. using a computer (not for homework)?'. Response categories for each of these questions were 0 hours through to more than 5 hours. For each sedentary behaviour (TV/videos, using a computer and reading/doing homework), an hours-per-week variable was created by calculating a weighted sum of weekday and weekend use. The hours-per-day variable was created by dividing the hours-per-week variable by seven. Each of the three sedentary was also divided into a three-category variable: high use, average use and low use. Cut-off points for the categories were made at the nearest whole hour-per-day at the 33^{rd} and 66^{th} percentiles of the distribution for each behaviour. TV/videos: high use = four of more hours per day; average use = between one and four hours per day; low use = one hour or less per day.	watching TV than with computers or reading/doing homework.

				Using a computer: high use = more than two hours per day; average use = half an hour to two hours per day; low use = less than half an hour per day. Reading/homework: high level = more than three hours per day; average level = one to three hours per day; low level = less than one hour per day.	
Mota et al. (2006)	Portugal	12 to 18 years (male and female) (n=450)	Questionnaire – not specifically stated	Participants were asked whether they walked, bicycled, went by car or went by bus to and from school, as well as the duration (in minutes) of the journey. Based on answers, participants categorised as active (e.g., walking, bicycling) or passive (e.g., bus, riding in a private vehicle) commuters.	76.3% of those non-obese took passive forms of transport to school and 23.8% took active forms of transport.
Santos et al. (2005)	Portugal	Same as above (i.e., Mota et al., 2006).	Questionnaire – not specifically stated	Commuting to and from school was assessed by asking participants if they walked, bicycled, went by car or went by bus to and from school and the duration (in minutes) of the trip. Based on answers, participants categorised as active (e.g., walking, bicycling) or passive (e.g., bus, riding in a private vehicle) commuters.	75% took passive forms of transport to and from school.
Gorely et al. (2009a)	U.K. (England)	13 to 16 years (mean age of 14.8 years)	Ecological momentary assessment	Same as above for completion of the diary (i.e., Biddle et al., 2009b) (note: participants also responded to two	TV viewing and computer use was significantly greater in boys than girls during weekdays (TV: 127 versus 102

		(male and female) (n=1171) Part of Project STIL (Sedentary Teenagers and Inactive Lifestyles)	diary	closed response items [where are you? - location] and [who's with you? – who]. Behaviours coded into 23 mutually exclusive categories of leisure time behaviour. To estimate the time spent in each behaviour category, the interval-level data were aggregated for each individual (separately by weekday and weekend day) by multiplying the daily frequency of the event by 15. Sedentary behaviours examined were: TV viewing, computer time (computer game playing + non-homework computer use), sedentary socialising behaviours (hanging out + sitting and talking + phone) and total sedentary time.	minutes a day; computer: 42 versus 15 minutes a day) and at the weekend (TV: 198 versus 154 minutes a day; computer: 84 versus 22 minutes a day). Girls spent significantly more time in social sedentary behaviours than boys on weekdays (61 versus 38 minutes a day) and weekends (161 versus 99 minutes a day). Total sedentary time (weekday and weekend) was significantly greater in boys than girls (weekdays: 207 versus 178 minutes a day; weekends: 381 versus 337 minutes a day).
Gorely et al. (2009b)	U.K. (England, Northern Ireland, Scotland and Wales)	12.5 to 17.6 years (male and female) (n=1385) Part of Project STIL (Sedentary Teenagers and Inactive Lifestyles)	Ecological momentary assessment diary	Same as above for completion of the diary (i.e., Gorely et al., 2009a) (note: first part of the diary included a question asking participants how far their home as from school with the options: less than 1 mile; 1 to 2 miles; 2 to 3 miles; 3 to 5 miles; or more than 5 miles). Same as above for the number of behaviours coded. TV viewing, using a computer and playing computer or video games = 'technology-based sedentary	Distance from home to school was not related to time spent in sedentary behaviour for boys or girls, except in boys living two to three miles from school.

				behaviours'. Sitting and talking, shopping/hanging out and using the telephone = 'social sedentary behaviours'. Total sedentary behaviour = technology-based sedentary behaviours + social sedentary behaviours.	

4.8.5 Longitudinal self-report data – adolescents' sedentary behaviour

In comparison to cross-sectional studies on sedentary behaviour, longitudinal studies are in the minority. Little is known about how sedentary behaviours such as leisure time computer use change with age and time thus studies over a longitudinal, prospective period are required (Roberts et al., 2006). Similarly to cross-sectional studies, the majority of the longitudinal evidence published has been around screen time and TV viewing to date.

4.8.6 Screen time longitudinal self-report studies among adolescents

Longitudinal studies undertaken into screen time as a proxy for sedentary behaviour reveals a mixed trend during the period of adolescence. For example, a study that has shown an increase in sedentary behaviour (screen time) during the period of adolescence between 11 to 12 years and 15 to 16 years is Henning Brodersen et al. (2007). The objective of their five year study was to assess developmental trends in sedentary behaviour (screen time) in English adolescents in relation to gender, ethnicity and socioeconomic status. Sedentary behaviour (screen time) was measured by asking participants how many hours they watched TV, or played computer or video games on school days and weekends with responses added to generate an estimate of total hours of sedentary behaviour (screen time). They found that there were marked increases in screen time between ages 11 to 12 years and 15 to 16 years, with an average increase of 2.52 hours per week in boys and 2.81 hours per week in girls. Regarding ethnicity, Black participants of both sexes reported higher levels of screen time than their White peers. This difference averaged 2.76 hours in boys and 5.4 hours in girls although this difference did not vary over the five years of the study. Screen time was also greater in participants from lower socioeconomic status neighbourhoods, with the difference between the higher and lower socioeconomic status groups averaging 2.29 hours per week in boys and 4.09 hours per week in girls. Similarly, this difference did not change over the five years of the study. Although this study is welcomed, it did not follow the cohort beyond the educational setting at age 16 years.

Conversely, other longitudinal studies have established no change in screen time among an adolescent population. Aires et al. (2010) undertook a three year longitudinal analysis of changes in fitness, physical activity, fatness and screen time among Portuguese adolescents aged 11 to 19 years. Participants reported how many hours and minutes they usually watched TV or used a computer for work and for leisure during the day preceding (weekdays) and during the weekend. Hours were then converted to minutes and summed to obtain a screen time score. Results revealed that participants spent more time watching TV than using a computer over the three year period, although there were no statistically significant changes with regard to screen time over the three year period.

Other studies have measured the components of screen time (i.e., TV viewing/videos and computer use) over a longitudinal period but have reported the findings for each sedentary behaviour separately and in the process have reported differences in behaviour trends. Nelson et al. (2006) undertook a longitudinal study incorporating Project EAT-I (Eating Among Teens) and Project EAT-II (a follow-up study). This study involved following a large cohort of U.S. adolescents longitudinally through various stages of the adolescent transition (11 to 15 years; 15 to 18 years) to young adulthood (18 to 23 years). Project EAT-I and Project EAT-II allowed Nelson et al. (2006) the unique opportunity to examine important health behaviour trends that occurred concurrently as a result of age and time. The objective of this particular study was to evaluate these five year longitudinal and long-term trends in TV viewing and leisure time computer use in a large, diverse cohort of adolescents. Participants reported their average hours per weekday and weekend day for their usual time spent in watching TV and videos and using a computer (not for homework).

Firstly, longitudinal changes from early to mid adolescence (junior to high school; mean age 12.8 years) and mid to late adolescence (high school to post high school; mean age 17.2 years) were observed. Findings indicated that for girls who were making the transition from early (11 to 15 years) to mid adolescence (15 to 18 years), TV/video viewing time decreased significantly by 2.2 hours a week. Leisure time computer use showed a non significant trend towards increasing. However, computer use significantly increased among older girls when transitioning from mid (15 to 18 years) to late adolescence (18 to 23 years). From a male perspective, leisure time computer use increased substantially from both early (11 to 15 years) to mid adolescence (15 to 18 years) (from 11.4 to 15.2 hours per week) and mid (15 to

18 years) to late adolescence (18 to 23 years) (from 10.4 to 14.2 hours per week). In contrast, TV viewing did not show any longitudinal changes among boys of either age group. Secondly, trends revealed the magnitude of the longitudinal changes referred to previously with changes in mid adolescence (15 to 18 years) over a five year period. During mid adolescence, there were striking increases in computer use (mid adolescent boys engaged in 10.4 hours a week in 1999 as opposed to 15.2 hours a week in 2004). This represented a 50% increase in this sedentary behaviour. Mid adolescent girls also engaged in 2.3 more hours of computer use in 2004, as opposed to 1999.

In conclusion, Nelson et al. (2006) indicate that participants experienced unfavourable shifts through dramatic longitudinal and long-term increases in sedentary behaviours attributable specifically to computer use. Limitations of the study included the surveying of a greater number of participants in the older cohort (n = 1710) than the younger cohort (n = 806) thus yielding additional statistical power to detect significant associations during the transition from mid to late adolescence compared with those from early to mid-adolescence. Strengths on the other hand included the ability to capture robust trends in activity-related behaviour that occur over a substantial period of time (five years) during the key adolescent periods studied.

Another study which showed the high levels of screen time among adolescents is Gordon-Larsen et al. (2004) who investigated trends in achieving 14 hours or less of screen time per week across the critical and understudied period of the transition from adolescence to young adulthood based on data from the National Longitudinal Study of Adolescent Health in the U.S. A large sample size of participants were included in the final analysis sample (n = 13,030) who completed a questionnaire at Wave I (1994-1995) and Wave III (2001). TV viewing, video viewing and computer/video game use was recorded as hours over the past week. They concluded that approximately 25% of participants failed to achieve favourable sedentary behaviour patterns (i.e., participated in more than 14 hours of screen time per week) and continued to engage in this amount of sedentary behaviour as adults. Further, of those achieving 14 hours or less of weekly screen time as adolescents, few continued to achieve these favourable amounts of screen time (37%) as adults. Further, even more failed to maintain this favourable amount of screen time (17.3%) into adulthood. Even so, significantly more males achieved 14 hours or less of screen time per week at both periods. Strengths of this study included the adoption of a 14 hour cut-off point as this is consistent with the recommended guidelines of two hours a day for 'screen time' from the American Academy of Pediatrics (2001a).

4.8.7 TV viewing and other types of sedentary behaviour longitudinal self-report studies among adolescents

Studies are lacking considerably which report longitudinal data on sedentary behaviours other than screen time. The only identified study is Kimm et al. (2006) who studied Black and White adolescent girls who were surveyed for three consecutive years from ages 16 or 17 years. Potential barriers to activity participation were surveyed initially and it was found that approximately half of participants were screened as 'sedentary' (determined as those girls who only took part in physical activities one to two times per week or one time or less per week) which increased with age. As this study was looking solely at barriers to activity participation, it is pertinent to make reference to the TV viewing, videos and computer use of those participants who cited 'no' to the barrier 'I don't have time' regarding physical activity participation. Sedentary activities were measured by participants reporting average daily minutes spent specifically in sitting, reading, talking on the telephone, watching TV and listening to music. Activity menu items assisted with this reporting and were given to participants at ages 16 or 17 years and also at 18 or 19 years. A separate estimate of time spent watching TV, videos or computer games was then obtained. Those who said 'no' reported significantly greater hours per week watching TV than those who said 'yes' for all three years. The definition of 'sedentary' in this study was a limitation because of the reference to a criterion of physical activity rather than 'sitting'. Conversely, strengths included the longitudinal design adopted enabling changes over time in 'sedentary' to be monitored, in addition to a large sample size (n = 2379).

4.8.8 Summary

As demonstrated in this section, the majority of longitudinal studies among adolescents have been centred on screen time use. In some studies, although they have measured screen time they do not refer specifically to the behaviour as screen time. As shown, studies highlight a variety of differences in screen time behaviours with increases in screen time, no change in screen time during the adolescent period and high levels of screen time (i.e., in excess of the recommended guidelines for screen time) and other sedentary behaviours being reported. Again, similarly to the reasons for differences in the results of physical activity among adolescents, methodological differences between studies is partly responsible for the outcomes of screen time changes being different (i.e., questions asked to capture screen time and the calculations used to determine cut-off points). Furthermore, there is also a dearth of longitudinal literature on screen time use among adolescents. In particular, there do not appear to have been any longitudinal studies of screen time conducted in the U.K. among adolescents aged between 15 to 16 years and 16 to 17 years. Longitudinal studies measuring TV viewing and other sedentary behaviours among adolescents are minimal with only one study identified in this section. Overall, longitudinal research is lacking measuring screen time among adolescents and other sedentary behaviours.

Table 4.4

Summary of longitudinal self-report studies investigating adolescents' sedentary behaviour

Author(s) and date	Country (and study duration where applicable)	Sample characteristics (age range, gender and sample size)	Self-report tool(s) used	Question(s) asked and/or classification system)or calculation system) used	Main finding(s)
Screen time studies					
Henning Brodersen et al. (2007)	U.K. (England) (five years)	11 to 12 years at baseline and 15 to 16 years at follow-up (male and female) (n=5863)	Questionnaire – not specifically stated	Participants asked how many hours they watched TV, or played computer or video games on school days and weekends. Responses were added to generate an estimate an estimate of total hours of sedentary behaviour (i.e., screen time). The dependent variable was hours per week of sedentary behaviour (i.e., screen time).	Marked increases in sedentary behaviour (screen time) between 11 to 12 years and 15 to 16 years (average for boys = 2.52 hours per week; girls = 2.81 hours per week). Black participants (boys and girls) had higher levels of sedentary behaviour (screen time) than White participants (boys and girls) – difference averaged 2.76 hours (boys) and 5.4 hours (girls) but difference did not vary over the five years. Levels of sedentary behaviour (screen time) greater in lower socioeconomic status participants – difference between higher and lower socioeconomic groups averaging 2.29 hours per week (boys) and 4.09 hours per week (girls) but difference did not change over the five years.
Aires et al. (2010)	Portugal (three years)	11 to 19 years (male and	Questionnaire – not	Participants were asked how many hours and minutes they usually watched	More time watching TV than using a computer over the three year period.

		female) (n=345)	specifically stated	TV or used a computer for work and for leisure during the day preceding the examination (weekdays) and during the weekend. Hours were converted to minutes and summed to obtain a screen time score.	No statistically significant differences in screen time over the three year period.
Nelson et al. (2006)	U.S. (five years)	11 to 23 years (male and female) (n=2516) Part of the Project EAT-I (Eating Among Teens) and Project EAT-II (a follow-up study)	Questions from the Planet Health survey	Survey items adapted from Planet Health Survey assessing usual time spent in: (1) 'watching TV and videos' and (2) 'using a computer (not for homework)'. Participants reported average hours per weekday spent engaging in these behaviours, as well as average hours per weekend day (Saturday or Sunday). Possible categorical responses ranged from 0 to 5 or more hours per day.	Early to mid-adolescence (mean = 12.8 years) to mid to late adolescence (mean age = 17.2 years). Girls - TV/video viewing decreased 2.2 hours a week and leisure time computer use increased (non significant). Girls - Computer use significantly increased among older girls during the transition from mid to late adolescence. Boys – Leisure time computer use increased substantially (11.4 hours to 15.2 hours a week). Boys - TV viewing did not show any longitudinal changes.
Gordon Larsen et al. (2004)	U.S. (six to seven years)	Wave 1: 11 to 21 years and Wave 3: 18 to 26 years (male and female) (n=13,030)	Add Health Questionnaires	TV viewing, video viewing and computer/video game use were recorded as hours over the past week. Participants were classified as achieving 14 hours or less or more than 14 hours of weekly screen time.	Just under 25% of adolescent participants failed to achieve more than 14 hours of screen time per week and continued this into adulthood. Of the 75% that achieved 14 hours or less of screen time per week as

		Part of the National Longitudinal Study of Adolescent Health (Add Health)			adolescents, few continued this as adults (37%). More males achieved 14 hours or less of screen time per week at both periods.
TV viewing and other types of sedentary behaviour studies					
Kimm et al. (2006)	U.S. (three years)	9 to 10 years at baseline (when enrolled onto the study) – 16 to 17 years at baseline for this particular study and 18 to 19 years at follow-up (female) (n=2379) Part of the National Heart, Lung and Blood Institute Growth and Health Study	3-day Activity Diary and Habitual Activity Questionnaire	To identify girls who were 'sedentary', the following screening question was asked: 'In general, how often do you do physical activities like dancing, exercising or sports?'. Participants who answered 'sometimes' (1 to 2 times per week) or 'rarely' (1 time or less per week) were categorised as 'sedentary'. Average daily minutes spent specifically in sedentary activities (e.g., sitting, reading, talking on the phone, watching TV and listening to music) were estimated from activity menu items (via the 3-day Activity Diary). A separate estimate of time spent watching TV, videos or computer games (hours a week) was obtained from the Habitual Activity Questionnaire.	Approximately 50% of the cohort were screened as 'sedentary' with a trend toward an increasing proportion with age. When time spent watching TV, videos or computer was compared among those citing 'yes' or 'no' to 'I don't have time' (i.e., cited barrier to physical activity), those who said 'no' reported significantly greater hours per week watching TV than those who said 'yes' for all three years.

4.9 Summary

Overall, from the evidence base reviewed of studies investigating adolescents' physical activity and sedentary behaviour, there are clear gaps in the evidence base. Firstly, there are no identified longitudinal studies that have measured adolescents' compliance with meeting physical activity recommendations. Secondly, there are no U.K. longitudinal studies to date which have studied adolescents' physical activity between the ages of 15 to 18 years (i.e., the steepest period of decline during adolescence in the majority of the studies identified). Thirdly, there do not appear to be any longitudinal studies that have measured adolescents' compliance with screen time recommendations. Finally, there are no U.K. longitudinal studies to date that have investigated adolescents' screen time. Consequently, due to these gaps in the evidence base, the present study investigated these areas. The next chapter details the factors associated with physical activity and sedentary behaviour among adolescents, in addition to providing a rationale for the present study.

CHAPTER 5: FACTORS ASSOCIATED WITH PHYSICAL ACTIVITY AND SEDENTARY BEHAVIOUR AMONG ADOLESCENTS

This chapter is divided into two sections; factors associated with physical activity, and factors associated with sedentary behaviour (screen viewing behaviours), among adolescents. Initially, details of the systematic approach to reviewing the literature undertaken is provided. This is followed by sections on 'systematic reviews on correlates of adolescents' physical activity' and 'systematic reviews on correlates of adolescents' sedentary behaviours'. As a consequence of these reviews for each behaviour, sections then focus on the specific factors investigated in the present study for each behaviour. The chapter is concluded with a section that provides the rationale for the present study.

5.1 Search strategy employed

Similar to Chapter 4, a systematic approach to reviewing the literature was undertaken which included a two-staged search being undertaken. However, before this two-staged search could be undertaken, a primary search was undertaken which identified relevant published systematic review papers on correlates (including determinants) of adolescents' physical activity and adolescents' sedentary behaviour (screen viewing behaviours) using the following databases: Academic Search Complete, PubMed, PsychINFO, Web of Science, Science Direct, SPORTDiscus and Zetoc. Search terms included: 'physical activity', 'sport participation', 'exercise', 'sport', 'sedentary behaviour', 'television viewing', 'screen-based media', 'screen time', 'screen viewing', 'computer', 'video games', 'internet', 'adolescent(s)', 'adolescence', 'youth', 'young people', 'correlates', 'determinants', 'factors', 'associated with' and 'review'. An analysis of these identified systematic reviews by the researcher then took place with the aim of identifying the key factors (variables) that were worthy of investigating in relation to adolescents' physical activity and adolescents' sedentary behaviour (screen viewing behaviours). This review identified numerous factors that were potentially of interest to the present study. Due to limitations of the data collected via the questionnaire used and the final sample size of participants (see Chapter 6), the researcher decided to focus on a number of demographic and environmental factors identified across these reviews. The identified demographic factors were: gender, ethnicity, socioeconomic status and educational attainment. The identified environmental factors were school type (state/mainstream versus private/independent) and area of residence (urban/rural). Following identification of these demographic and environmental factors, the two searches were undertaken in order to identify appropriate studies that empirically examined these specific factors in relation to: (1) adolescents' physical activity; and (2) adolescents' sedentary behaviour (i.e., screen viewing behaviours as 'screen time' was the measure of sedentary behaviour used in the present study). This included screening the titles and abstracts of papers identified through a key words search (for the first search and second search) performed on the following databases: Academic Search Complete, PubMed, PsychINFO, Web of Science, Science Direct, SPORTDiscus and Zetoc. Where an abstract was not available or did not provide sufficient information, the whole article was retrieved and screened in order to determine if it met the inclusion criteria.

The first search was built around six groups of keywords: physical activity, demographic factors, environmental factors, study type, data collection method and sample type. Key terms for physical activity included: 'physical activity', 'sport participation', 'exercise' and 'sport'. Key terms for demographic factors included: 'gender', 'males', 'females', 'boys', 'girls', 'ethnicity', 'socioeconomic status', 'socioeconomic position', 'social class' and 'educational attainment'. Key terms for environmental factors included: 'area of residence', 'urban', 'rural', 'residential location', 'school type', 'private', 'independent', 'public', 'state' and 'mainstream'. Key terms for study type included: 'longitudinal', 'cross-sectional', 'cohort', 'prospective' and 'population-based'. Key terms for data collection method included: 'self-report', 'questionnaire' and 'survey'. Key terms for sample type included: 'adolescent(s)', 'adolescence', 'youth', 'young people', 'compulsory education completion', 'year 11' and 'sixth form'.

The second search was built around six groups of keywords: sedentary behaviour, demographic factors, environmental factors, study type, data collection method and sample type. Key terms for sedentary behaviour included: 'sedentary behaviour', 'television viewing', 'screen-based media', 'screen time', 'screen viewing', 'computer', 'video games' and 'internet'. Key terms for demographic factors included: 'gender', 'male', 'female', 'boys', 'girls', 'ethnicity', 'socioeconomic status', 'socioeconomic position', 'social class' and 'educational attainment'. Key terms for environmental factors included: 'area of residence', 'urban', 'rural', 'residential location', 'school type', 'private', 'independent', 'public', 'state' and 'mainstream'. Key terms for study type included: 'longitudinal', 'cross-sectional', 'cohort', 'prospective' and 'population-based'. Key terms for data collection method included: 'self-report', 'questionnaire' and 'survey'. Key terms for sample type included: 'adolescent(s)', 'adolescence', 'youth', 'young people', 'compulsory education completion', 'year 11' and 'sixth form'.

The final selection of studies measuring these specific factors (variables) in relation to adolescents' physical activity and adolescents' sedentary behaviour (screen viewing behaviours) had to meet specific inclusion and exclusion criteria.

5.2 Inclusion and exclusion criteria

For inclusion, studies were required to:

(1) include adolescents in the age range of 15 to 18 years (or at least have included one of the specific ages (e.g., 16 years) in this age range);

(2) be longitudinal or cross-sectional studies;

(3) have measured physical activity and/or sedentary behaviour (screen viewing behaviours including 'screen time') via a self-report method(s);

(4) be published in peer-reviewed journals in the English language (or have been translated into English);

(5) the outcome/dependent variable should be a measure of overall physical activity or specific type of physical activity (e.g., sport participation) / or a measure of overall screen-based viewing (e.g., screen time, TV viewing); and

(6) the variables had to have been tested for their association with the outcome/dependent variable.

For exclusion, studies were excluded if:

(1) participants were adults at baseline (i.e., greater than 18 years);

(2) other data collection methods such as objective measures (e.g., accelerometers) had solely been used to measure physical activity or screen-based viewing; and/or

(3) published in a foreign language.

5.3 Factors associated with physical activity and sedentary behaviour among adolescents

One of the main purposes of the present study was to investigate the factors associated with adolescents' physical activity and sedentary behaviour (i.e., screen time). Studies examining correlates of each of these behaviours have gathered momentum over recent years. However, in contrast to studies examining correlates of adolescents' physical activity, there are far fewer studies examining correlates of sedentary behaviour (NICE Public Health Collaborating Centre, 2007). As a consequence, research into the correlates of sedentary behaviour is an emerging field (Hinkley et al., 2010). Research into possible correlates of physical activity and sedentary behaviour among adolescents is important for a number of reasons. Firstly, the correlates of the behaviour concerned in the present study (i.e., physical activity and screen time) may also be correlates of health outcomes that the behaviour is associated with (e.g., CVD) but far less is known in relation to sedentary behaviour than physical activity (Biddle et al., 2011b; Proper et al., 2011). Secondly, the correlates may also vary according to the way the behaviour has been measured (e.g., self-reported as opposed to objective measures). For instance, demonstrating strong associations between variables is plagued by the variability in measurement tools and a lack of accurate measures of a behaviour thus increasing the likelihood of measurement error (Gorely et al., 2004; NICE Public Health Collaborating Centre, 2007). Thirdly, the correlates may vary depending on whether one is interested in the behaviour (cross-sectional) or a change over time in the behaviour (longitudinal) because correlates may change with time (Dumith et al., 2010). The following section discusses the findings of various systematic reviews into the correlates (including determinants) of adolescents' physical activity and sedentary behaviour.

5.4 Systematic reviews on correlates of adolescents' physical activity

To date, with regard to correlates of adolescents' physical activity specifically, there have been a number of significant reviews undertaken. To begin with, Sallis et al.'s (2000b) review comprehensively evaluated published studies of correlates of youth physical activity between the period of 1970 and 1998. Among the adolescent population (aged 13 to 18 years), a total of 54 studies of potential correlates of physical activity were identified, of which 69% used unvalidated self-reports, 28% were empirically supported self-reports and 4% were objective measures. The majority of the studies identified (n = 83%) utilised a cross-sectional design. At the conclusion of the review, nine demographic and biological factors (variables) were identified, five of which were studied three or more times (i.e., age, ethnicity, sex (male), body mass index/skinfolds and socioeconomic status). A total of 35 psychological variables were reported in studies, with only 17 studied three or more times. These 17 included: perceived benefits (grouped together); barriers; self-efficacy; body image; attitudes; knowledge; enjoyment of physical activity; talking loudly; external locus of control; self esteem; self motivation; enjoying exercise; perceived stress; achievement orientation; perceived competence; intention to be active; and depression. Regarding behavioural variables, 30 were identified but only 13 were reported three or more times which included: sensation seeking; previous physical activity; participation in community sports; cigarette smoking; alcohol use; healthy diet; sedentary time; and sedentary behaviour after school and on weekends. Social variables were also assessed and 23 variables were identified, 10 of which were reported in three or more studies. Social variables included parent physical activity levels, measures of parental support, direct help from parents, support from 'significant others', sibling physical activity, peer modelling of physical activity, perceived support from peers, subjective norms, perceived attitude of 'significant others' and teacher or coach support or modelling. The final group of variables assessed was the 'physical environment' category. Seven variables were identified, but only three had three or more comparisons including opportunities to exercise, equipment/supplies available and sports media influence.

Within the group of 'demographic and biological' factors, the most consistent findings included: boys were more active than girls; a negative association between age and physical activity; and ethnicity was consistently related with non-Hispanic Whites being more active than other ethnic groups. On the other hand, adolescent body weight and adiposity were indeterminate (i.e., nature of the association was unclear with a variable that has been frequently studied with considerable lack of consistency in the findings) and there was no association between socioeconomic status and youth physical activity. In the group of 'psychological' factors, the only positive associations with physical activity were achievement orientation, perceived competence and intention to be active. Further, the only psychological variable negatively correlated with adolescents' physical activity was depression.

Indeterminate associations were found for perceived benefits, self-efficacy, body image, attitudes, knowledge and enjoyment of physical education. No associations were found for talking loudly, external locus of control, self-esteem, self-motivation, enjoying exercise and perceived stress. In the 'behavioural' variable group, consistent positive associations were found for sensation seeking, previous physical activity and participation in community sports. Indeterminate associations were found for smoking and no association was found with physical activity for alcohol use, healthy diet and sedentary time. Conversely, sedentary behaviour after school and on weekends was consistently and inversely related to adolescents' physical activity. Furthermore, in the 'social' variable category, although parental physical activity levels were reported most frequently, there was no association with this variable. Other non associations included peer modelling of physical activity and teacher, or coach support or modelling. Measures of parental support, direct help from parents, support from 'significant others' and sibling physical activity were consistently associated with physical activity. Indeterminate associations were found for perceived support from others, subjective norms, or perceived attitudes of significant others. Finally, in the 'physical environment' category, consistently positive associations were found for opportunities to exercise but the other variables (equipment/supplies available and sports media influence) were not associated with adolescents' physical activity.

Sallis et al.'s (2000b) review was then built upon by a descriptive review undertaken by Davison and Lawson (2006). With a focus on only the physical environmental correlates of adolescents' (and children's) physical activity, Davison and Lawson (2006) identified a total of 33 articles for review published between 1990 and 2006. Although adolescents were included in this review, the authors did not distinguish between a 'child' and an 'adolescent' thus the age range included was three to 18 years. Findings from the studies were synthesised using three a priori categories of environmental attributes including: (1) recreational infrastructure (e.g., availability of parks/playgrounds, equipment in the home); (2) transport infrastructure (e.g., traffic speed/density, presence of sidewalks); and (3) local conditions (e.g., safety, crime, weather). Firstly, for recreational infrastructure, the majority of studies (n = 19 of a total of 21) used a cross-sectional design. A mixture of measures of physical activity were used in these studies (objective measure (accelerometer or heart rate monitoring) of physical activity: n = five; direct observation: n = four; self-report measure: n = 13; and objective and self-report measures: n = one). No association was found between home equipment and children's physical activity in four out of six studies. Additionally, a positive association was found between the proximity of parks and playgrounds to the home and children's physical activity in three of five studies. A negative association between distance to school and children's physical activity was reported in three of three studies. Secondly, for transport infrastructure, all studies identified (n = nine) utilised a cross-sectional design with two studies using an objective measure and seven studies used a self-report instrument. There was a positive association between the presence and condition of sidewalks and children's physical activity in three out of four studies, in addition to a positive association between access to destinations and children's physical activity in three out of four studies. Thirdly, for local conditions, the vast majority of studies (n = 17 out of a total of 18) used a cross-sectional design with four studies using an objective measure of physical activity (accelerometer), one using direct observation and 15 studies using a self-report measure. There was no association between perceived safety and children's physical activity in seven of nine studies. Three studies of three showed a negative association between crime or area deprivation and children's physical activity in two out of five studies. A significant association was reported between the weather and children's physical activity in only two out of five studies thus the evidence is inconsistent. Finally, only two studies examined urban/rural location and mixed findings were reported thus urban/rural location is inconclusive.

Another systematic review of correlates of physical activity among adolescents (Ferreira et al., 2006) also built upon the review by Sallis et al. (2000b). Although they solely concentrated on environmental correlates of adolescents' physical activity, Ferreira et al. (2006) identified 84 studies that presented an empirical association between physical activity and at least one environmental correlate among adolescents aged 13 to 18 years. All studies were published between 1980 and 2004 and the vast majority of studies adopted a cross-sectional design with the vast majority relying on adolescent/parental self-reports of physical activity. A range of potential environmental correlates of adolescents' physical activity were found at the following levels: the home level, the school level, the neighbourhood level, and the city/municipality and region/country level. At the home level, positive associations were found between physical activity and general support from significant others, in addition to mother's educational level and family income. No associations were found for: availability and accessibility of exercise equipment; single parent family; household size; number of children in the family; modelling of physical activity from parents, siblings and friends; parental socioeconomic status; and parental style. Conversely, occupational status of the household's head was an undetermined (i.e., a variable that has been frequently studied but with considerable lack of consistence) correlate of adolescents' physical activity.

Regarding potential correlates at the school level, only one positive association was found (i.e., type of school attended (high versus vocational school)). No associations were found between adolescents' physical activity and role modelling and support from teachers and for provision of instruction on physical activity or sport-related health benefits and special physical education programmes and/or school sports. It was undetermined regarding an association between problems with classmates and adolescents' physical activity. In relation to school type (i.e., public versus private school) only one study was identified thus the overall association summary code assigned was 'not applicable'. On the other hand, at the neighbourhood level, an inverse relationship was found for crime incidence whereas no association was found for availability and accessibility of physical activity equipment or facilities, in addition to neighbourhood safety estimates. Finally, at the city/municipality and region/country level, Ferriera et al. (2006) found that few studies had investigated differences in physical activity levels of adolescents between residence location. No association was found with residence in rural versus urban region. Further non associations were found for exposure to or interest in sports media. Seasonal effects on adolescents' physical activity were undetermined.

Following on from Sallis et al.'s (2000b) review, Van der Horst et al. (2007) elaborated further and described biological, demographic, psychological, behavioural, social and physical environmental correlates of physical activity. All studies identified were published between 1999 and January 2005. Among the adolescent population (aged 13 to 18 years), 40 studies were identified with the vast majority using a cross-sectional design and self-report measures of physical activity. Of the 40 studies focused on, a total of 24 studies examined demographic and biological variables as correlates of adolescents' physical activity including gender, age, ethnicity, socioeconomic status, parental education and BMI or skinfolds. Conversely, a total of 28 studies examined 10 psychological correlates of adolescents' physical activity including attitude, self-efficacy, intention, barriers to physical activity, perceived benefits of physical activity, sport competence, goal orientation, self-perception, fun/enjoyment and depression. Regarding the behavioural variables category, smoking, watching TV/sedentariness and physical education/school sports activity were examined for associations. A total of 13 studies investigated social variables as correlates of adolescents' physical activity. Social variables included: parental activity/modelling; family influences; and peer influences/friend support. In relation to (physical) environmental variables, only availability or proximity to sports facilities was examined with five studies indentified.

Within 'demographic and biological' variables, the main findings were that: there was a positive association for gender (male) and parental education with physical activity; there was no association between socioeconomic status or body mass index and physical activity; and the evidence was inconclusive (i.e., when exactly 50% of the associations were in a positive or inverse direction or if there was considerable lack of consistency in the findings demonstrating both positive and inverse associations) for age and ethnicity. On the other hand, within the 'psychological' correlates category, positive associations with physical activity were found for attitude, self-efficacy and goal orientation or motivation. Perceived benefits, self-perception, fun/enjoyment and depression had no association with adolescents' physical activity. Further, associations were inconclusive (i.e., when exactly 50% of the associations were in a positive or inverse (negative) direction, or if there was considerable lack of consistency in the findings (showing both positive and inverse associations)) for intention, perceived barriers and sport competence with adolescents' physical activity. In the 'behavioural' variables category, there was a positive association between physical education/school sports and physical activity. However, there was no association between watching TV/sedentariness and physical activity. Associations were inconclusive between smoking and physical activity. Additionally, in the 'social' variables category, positive associations were found between family influences and friend support and physical activity. Conversely, no association was found between parental activity was reported. Finally, in relation to (physical) 'environmental' variables, no association was found for availability of facilities and adolescents' physical activity.

Another systematic review has been conducted by Biddle et al. (2005) who undertook a review into the correlates of participation (demographic and biological, psychological, behavioural, social and cultural and physical environmental) in physical activity in adolescent girls aged 10 to 18 years. Studies published between 1999 and 2004 were identified which had a quantitative research design. A total of 50 published papers were reviewed with the majority being cross-sectional (n = 41) and assessed through self-report measures (n = 40). Variables had to have been investigated for their association with girls' physical activity in at least three studies to be included and were then classified as being related or not related to physical activity, in addition to the direction (positive, negative, indeterminate) and strength of association (none, small, moderate or large) being noted.

Within the 'demographic and biological' variables category, for gender, 22 studies out of 24 studies (92%) identified that girls were less active than boys (small to moderate negative association). The other two studies showed no difference. In relation to age, seven of 11 studies (64%) showed a small to moderate age-related trend of lower physical activity for older youth (i.e., a negative association). Ethnicity (i.e., White) was positively associated (small strength of association) with higher levels of physical activity for girls in six of the seven studies (86%) and increased body mass index was found to be negatively related (small strength of association) to physical in six out of eight studies (75%). Regarding socioeconomic status, higher family income was positively associated with higher physical activity for girls in three studies (100%) and higher parental education was positively associated with girls' physical activity in three of the four studies (75%) (moderate strength of association for both variables). On the other hand, within the 'psychological' variables category, a positive relationship with girls' physical activity was found for perceived competence with a small effect in four of five studies. Positive relationships (all with small to moderate strengths of association) were also found for self-efficacy (10 of 10 studies), enjoyment (seven of eight studies), perceived body attractiveness (three of three studies), physical self-worth (three of three studies) and appearance importance/concerns (three of four studies). Conversely, negative associations with girls' physical activity were found for perceived barriers (small to moderate strength of association) in three of three studies (100%) with lack of time showing a negative association (small strength of association) in four of four studies (100%).

Within the category of 'behavioural' variables, smoking was related to lower levels of physical activity (i.e., a negative association with a moderate strength of association) in three of four studies. Further, TV and video viewing/internet use had an indeterminate (i.e., nature of the association was unclear a variable that has been frequently studied with considerable lack of consistency in the findings) relationship with physical activity in six studies. More specifically, the effects were mixed with studies showing zero, small, moderate and large effects. The only positive association in this category was for girls' involvement in organised competitive sports (100% of studies) with showed a moderate to large strength of association. The 'social and cultural' variables category showed two indeterminate correlates of girls' physical activity; peer involvement and mother's physical activity. However, there were positive associations found for family support (seven of eight studies) and father's physical activity in three of five studies. Finally, although 18 environmental variables were located, within the 'physical environmental' variables category, no correlates could be reported because each of the 18 variables were only studied once or twice.

Three reviews have also been specifically conducted into the parental correlates of physical activity in adolescents (Gustafson and Rhodes, 2006; Pugliese and Tinsley, 2007; Edwardson and Gorely, 2010). Firstly, Gustafson and Rhodes's (2006) review built on the brief commentary on correlates of parent and child physical activity provided by Sallis et al. (2000b). Children (aged three to 12 years) and adolescents (specifically defined as aged 13 to 18 years) were the focus of the review. A total of 34 studies published between 1985 and 2003 were identified with the majority using a cross-sectional design (n = 29 out of 34 studies) and self-report measures of physical activity. Firstly, positive associations were reported for parental support and children's physical activity level (in 18 of 19 studies). Secondly, positive associations were found for a child having two active parents and children's physical activity level (in four out of five studies). Thirdly, positive associations were reported between socioeconomic status (using measures of parental employment and/or parental education) and children's physical activity level in six of six studies. Finally, positive relationships were also reported for mother's physical activity and daughter's physical activity, in addition to father's physical activity and son.

Secondly, Pugliese and Tinsley's (2007) review built on the review of Sallis et al. (2000b) by examining the empirical relations among parental socialisation behaviours and children's and adolescents' physical activity. In total, 96 studies were identified with 36 meeting the inclusion/exclusion criteria. Overall, 30 studies were included in the review with approximately 70% using self-report measures. Pugliese and Tinsley (2007) found that there was a small significant positive relation between parental behaviour and children's and adolescents' physical activity. Modelling demonstrated the weakest relation with regard to children's and adolescents' physical activity. In addition, encouragement and instrumental behaviours were significantly related to children's and adolescents' physical activity.

Thirdly, Edwardson and Gorely's (2010) review investigated how parental influence related to different types and intensities of physical activity across cross-sectional and longitudinal studies. Children aged six to 11 years and adolescents aged 12 to 18 years were differentiated between and a total of 96 studies were identified. Of these 96 studies, 60 were focused on adolescents with the majority of studies using a cross-sectional design (88.5%) and 86.5% of studies used self-report measures of physical activity. In relation to MVPA regarding parental influence, 11 cross-sectional and two longitudinal studies investigated the relationship between parental influence and MVPA. Cross-sectional studies showed that parental modelling, attitudes, transport and overall support had a positive relationship with MVPA. However, father modelling had an indeterminate relationship with MVPA. No associations were found with MVPA for mother modelling, parental physical activity, mother physical activity, father physical activity involvement, encouragement, fees paid, help from parents and the parents watching the child being active. In contrast, 34 cross-sectional studies and one longitudinal study examined the association between parental influence and overall physical activity. Positive associations were found for mother physical activity, father physical activity, overall support and attitudes in cross-sectional studies. Indeterminate associations were found for mother modelling, father modelling and encouragement and overall physical activity. The remaining variables (i.e., parental modelling, parental physical activity, involvement and help) had no association with overall physical activity in cross-sectional studies. Of the other types of physical activity examined (i.e., leisure-time physical activity, organised physical activity) and physical activity frequency, there was a positive relationship between transport and organised physical activity and an indeterminate relationship between father modelling and organised physical activity. Encouragement also showed a positive relationship with frequency of physical activity. Finally, there was an indeterminate relationship between mother physical activity and leisure time physical activity although father physical activity and transport demonstrated no association.

5.4.1 Synthesis of findings from systematic reviews on correlates of adolescents' physical activity

Overall, these eight reviews have identified a mixture of similar and different findings in relation to adolescents' physical activity. Three of the eight reviews (i.e., Sallis et al., 2000b; Biddle et al., 2005; Van der Horst et al., 2007) categorised and reported factors within the same categories (demographic and biological, psychological, behavioural, social (and cultural) and physical environmental). However, the review by Ferreira et al. (2006) reported only environmental correlates, Davison and Lawson (2006) reported only physical environmental correlates and the remaining reviews (Gustafson and Rhodes, 2006; Pugliese and Tinsley, 2007; Edwardson and Gorely, 2010) reported only parental correlates of adolescents' physical activity. Therefore, when making comparisons between reviews in relation to categories, relevant findings are reported where appropriate.

In relation to 'demographic and biological' factors, the reviews by Sallis et al. (2000b), Van der Horst et al. (2007) and Biddle et al. (2005) have all identified that for gender, boys are consistently more active than girls. There is also agreement from the reviews of Sallis et al. (2000b) and Biddle et al. (2005) that age has a negative association with adolescents' physical activity and for ethnicity, a positive association with non-Hispanic Whites being more active. However, the evidence provided in the review of Van der Horst et al. (2007) is inconclusive for both age and ethnicity and adolescents' physical activity. For socioeconomic status, no association was found with adolescents' physical activity in the reviews of Sallis et al. (2000b) and Van der Horst et al. (2007). Conversely, the reviews of Biddle et al. (2005) and Gustafson and Rhodes (2006) concluded that there was a positive association for socioeconomic status (in relation to higher family income, higher parental education and parental employment). Ferreira et al. (2006) also reported positive associations between proxy measures of socioeconomic status and adolescents' physical activity including mother's educational level and family income. Conversely, Ferreira et al. (2006) also showed that there was no association between parental socioeconomic status or occupational status of the household's head and adolescents' physical activity. For body mass index and adiposity, a mixture of findings were found across three of the reviews (Sallis et al., 2000b = indeterminate; Biddle et al. (2005) = negative association; and Van der Horst et al. (2007) = no association).

The reviews of Sallis et al. (2000b), Biddle et al. (2005) and Van der Horst et al. (2007) have also shown a mixture of findings for the 'psychological' factors. Only one of the psychological factors (i.e., achievement/goal orientation) was commonly associated with the review by Sallis et al. (2000b) and Van der Horst et al. (2007). Both reviews reported a positive association for this correlate of adolescents' physical activity. However, only one of the psychological factors (i.e., perceived competence) was reported with the same form of association (positive) in the reviews by Sallis et al. (2000b) and Biddle et al. (2005). Across the reviews of Sallis et al. (2000b) and Van der Horst et al. (2007), the correlates which are reported differently include: intention to be active (positive versus inconclusive), depression (negative versus no association), perceived benefits (indeterminate versus no association) and attitudes (indeterminate versus positive). Further, across the reviews of all three reviews (Sallis et al., 2000b; Biddle et al., 2005; Van der Horst et al., 2007) there are mixed associations reported for self-efficacy (indeterminate versus positive) and enjoyment (no association versus positive). The psychological correlate of perceived barriers was also reported differently (inconclusive versus negative) in the reviews by Van der Horst et al. (2007) and Biddle et al. (2005). Some factors are only reported in one particular review. For example, body image (indeterminate), knowledge (indeterminate), enjoyment of physical education (indeterminate), talking loudly (no association), external locus of control (no association), self-esteem (no association), self-motivation (no association) and perceived stress (no association) was only reported in Sallis et al.'s (2000b) review. Similarly, self perception (no association) and sport competence (indeterminate) were only reported in the review by Van der Horst et al. (2007). Finally, in the review by Biddle et al. (2005), perhaps because of the sole focus being on girls' physical activity, the factors of perceived body attractiveness (positive), physical self-worth (positive), appearance importance/concerns (positive) and lack of time (negative) were only reported in this review.

In relation to 'behavioural' factors, the reviews by Sallis et al. (2000b), Biddle et al. (2005) and Van der Horst et al. (2007), the actual factors reported were, in the majority, different. The only comparable correlates between the three reviews were smoking and sedentary behaviour. Smoking is reported by Sallis et al. (2000b) as indeterminate and was similarly reported by Van der Horst et al. (2007) as inconclusive. On the other hand, Biddle et al. (2005) reported a negative association between smoking and girls' physical activity. There was more similarity, however, between the three reviews with respect to sedentary behaviour (termed as 'sedentary time' and 'watching TV/sedentariness). Both Sallis et al. (2000b) and Van der Horst et al. (2007) reported no association and Biddle et al. (2005) reported that an association was indeterminate. The associations that are reported as positive such as: (1) sensation seeking, previous physical activity and participation in community sports were only reported by Sallis et al. (2000b); (2) physical education/school sports were only reported by Van der Horst et al. (2007); and (3) organised competitive sports were only reported in the review by Biddle et al. (2005). Finally, no associations were reported for alcohol use and healthy diet by Sallis et al. (2000b) only.

Before moving on to compare and contrast the reviews presented regarding 'social (and cultural)' factors, it is pertinent to make reference to the review of environmental correlates reported previously by Ferreira et al. (2006). Ferreria et al. (2006) included social and physical environmental factors in their review and consequently, these 'social environmental' factors are detailed in this section. Similarly, Gustafson and Rhodes's (2006) review reported parental correlates of adolescents' physical activity. Consistent findings between reviews in relation to 'social (and cultural)' factors included parental physical activity in which the reviews of Sallis et al. (2000b), Ferreira et al. (2006) and Van der Horst et al. (2007) reported no association with adolescents' physical activity. Similarly, Edwardson and Gorely (2010) reported no association between parental physical activity and MVPA and overall physical activity. However, Biddle et al. (2005) reported mother's and father's physical activity separately with an indeterminate association for mother's physical activity but a positive association for father's physical activity and girls' physical activity. Likewise, Gustafson and Rhodes (2006) concluded that there were positive associations for mother's physical activity and daughter's physical activity, father's physical activity and son's physical activity and a child having two active parents. Additionally, Edwardson and Gorely (2010) reported a positive association between both mother physical activity and father physical activity and overall physical activity. Conversely, they also found that there was no association for mother physical activity and father physical activity in relation to MVPA. There was, however, agreement across the majority of reviews of the positive association between parental support/family influences/friend support and adolescents' physical activity. Factors including peer modelling of physical activity, teacher/coach support and modelling were not associated with adolescents' physical activity according to the review of Sallis et al. (2000b) and Ferreira et al. (2006). Sallis et al. (2000b), Ferreira et al. (2006) and Edwardson and Gorely (2010) were also the only reviews to report that direct help from parents and support from significant others (overall support in Edwardson and Gorely's (2010) review) were positively associated, in addition to perceived support from others and subjective norms being indeterminately associated with adolescents' physical activity. Additionally, Ferriera et al.'s (2006) review was unique from the other views because it highlighted other 'social environmental' factors that needed to be examined. For example, a positive association was found for type of school and adolescents' physical activity.

Finally, within the 'physical environmental' factors category (also referred to as 'environmental' factors), fewer factors were reported than in any other category. No associations for availability of facilities were consistently reported in the reviews by Sallis et al. (2000b), Ferreira et al. (2006) and Van der Horst et al. (2007). On the other hand, in contrast to Sallis et al. (2000b) reporting a positive association between opportunities to exercise and adolescents' physical activity, Ferreira et al. (2006) found no association between adolescents' physical activity and access to community physical activity facilities. Residence location (i.e., urban or rural) was only reported in the reviews by Davison and Lawson (2006) (inconclusive) and Ferreira et al. (2006) (no association). School type (private versus public) was only reported in the review of Ferreira et al. (2006). The weather/seasonal effects were also only reported in the reviews by these authors with Davison and Lawson (2006) reporting that the evidence is inconsistent and Ferreira et al. (2006) similarly reporting an undetermined association. Sports media influences were not associated with adolescents' physical activity in Sallis et al. (2000b) or Ferreira et al. (2006). Other factors reported in this category were only disseminated in Davison and Lawson's (2006) review. Positive associations were reported for proximity of parks and playgrounds, access to destinations and presence and condition of sidewalks. Negative associations were reported for distance to school and crime/area deprivation, in addition to no associations reported for home equipment and perceived safety.

All eight reviews that have been presented in this chapter have also recently been included in a 'review of reviews' by Biddle et al. (2011a) who aimed to identify factors associated with children's and adolescents' physical activity. In this review of quantitative systematic reviews of non-intervention research relating to participation in physical activity by young people, nine systematic reviews were selected for in-depth analysis. The only review included in Biddle et al.'s (2011a) that was not included in this chapter was Hinkley et al. (2008) because their review focused only on a child population aged two to five years. From these reviews, Biddle et al. (2011a) brought the findings of all nine reviews together with a separate focus on the following: (1) demographic and biological correlates; (2) psychological correlates; (3) behavioural correlates; (4) social/cultural correlates; and (5) environmental correlates. Most notably, in relation demographic and biological correlates, it was concluded that gender differences in physical activity are highly reproducible (due to 'total physical activity' as opposed to specific types of physical activity), there is a deficit in the literature regarding ethnicity, and the evidence is unclear for socioeconomic status and adolescents' physical activity (due to issues such as measurement variability). Regarding psychological correlates, competence perceptions appears to be an important correlate although self-efficacy and enjoyment were not consistently associated with higher levels of physical activity across many of the reviews. In relation to behavioural correlates, previous physical activity, community sports participation, physical education and school sports appear to be associated with adolescents' physical activity in some reviews. Regarding smoking behaviour, this has shown both negative and inconsistent associations across reviews whilst the association with sedentary behaviour and adolescents' physical activity appears to be small. From a social/cultural correlates slant, parental support seems to be associated with adolescents' physical activity but the evidence is less clear regarding parental physical activity and adolescents' physical activity. Overall, parental influence appears to be important for adolescents' physical activity. From the perspective of environmental correlates, Biddle et al. (2011a) suggested that the relationship between physical activity and environmental factors in young people is still evolving and thus requires further study.

More recently, building on the reviews of Sallis et al. (2000b) and Van der Horst et al. (2007), Uijtdewilligen et al. (2011) conducted a systematic review which summarised and updated the existing literature on the determinants of physical activity and sedentary behaviour in young people, in addition to considering the methodological quality of the studies. This review is the first that has focused solely on prospective studies. Prospective studies were identified that had been published between April 2004 and November 2010 (i.e., following on from the end date in Van der Horst et al.'s (2007) review). Determinants from the 30 studies identified were classified as a 'child determinant' (aged four to 12 years) or an 'adolescent determinant' (aged 13 to 18 years or mean age more than 12 years). In relation to the present study, the findings relating to adolescent determinants only were included. The review identified 18 studies that investigated determinants of physical activity and/or sedentary behaviour in adolescents. Three articles identified determinants of both physical activity and sedentary behaviour. From all determinants of adolescents' physical activity identified, the main conclusions were: (1) moderate evidence for a significant positive relationship between age and physical activity (i.e., the older the participants, the higher their physical activity level); (2) moderate evidence for a significant positive relationship between planning and past physical activity in adolescents; and (3) moderate evidence for a significant negative relationship between ethnicity (African-American race) and physical activity. Furthermore, additional strong evidence was found for a positive association between being male and adolescents' physical activity. In contrast, from all sedentary behaviour determinants identified, it was concluded that there was insufficient evidence for adolescents and that prospective research with adolescents was scarce. It was also concluded that few prospective studies focused on environmental determinants of physical activity and sedentary behaviour.

5.5 Systematic reviews on correlates of adolescents' sedentary behaviours

In relation to systematic reviews of correlates of sedentary behaviour, there is a paucity of research examining the correlates of sedentary behaviours other than screen viewing behaviours (The Sedentary Behaviour and Obesity Working Group, 2010a). This paucity of research generally into correlates of sedentary behaviour is mainly due to studies of adolescents' sedentary behaviour (or 'inactivity') often being concentrated on 'activity absence' (i.e., not meeting a criterion of physical activity) (NICE Public Health Collaborating Centre, 2007). On the other hand, the majority of research into correlates being centred around screen viewing behaviours is because a major component of sedentary behaviour in youth is screen time (Must and Tybor, 2005). Therefore, systematic reviews into the correlates of screen-viewing among adolescents were focused upon here.

Overall, there are only three main systematic reviews of correlates of adolescents' sedentary behaviour that have been undertaken to date. One review in particular (Uijtdewilligen et al.'s (2011) determinants review of prospective studies) has been previously discussed so will not be referred to again in this section. Firstly, Gorely et al. (2004) undertook a review of correlates of screen viewing behaviours (TV/video viewing) among youth. Importantly, Gorely et al. (2004) did not examine correlates separately by developmental group (such as 'adolescent'), because of the limited evidence available. Therefore, children and youth aged two to 18 years were studied. The sole focus of the review was on TV/video viewing and therefore studies which included video/computer game playing were excluded. Overall, a total of 68 studies were identified and the measures of TV/video viewing used self-report in 66.4% of studies. In total, 70.2% of the studies were published after 1995 and 14.9% were published before 1990. The vast majority of studies (86%) used a cross-sectional design. Correlates were grouped according to demographic variables, health outcomes, psychological factors, behavioural attributes and skills, social and cultural factors and physical environment factors. Seven demographic variables were identified, of which six were studied three or more times (i.e., age, ethnicity (non-White), gender (female), socioeconomic status (parent education), socioeconomic status (other) and pubertal status). Nine health outcome variables were identified, of which six had been studied on three or more occasions (i.e., body weight, body fatness, blood pressure, metabolic indicators, bone mineral density and aerobic fitness). Three psychological factors had been studied on three or more occasions (i.e., cognitive functioning, self-perceptions and emotional support). Four social and cultural factors had been studied on three or more occasions (i.e., number of parents in house, being an only child, mother in employment and parents' TV viewing habits). Additionally, three physical environmental factors had been studied on three or more occasions (i.e., residential location, day of viewing and availability of TV sets).

Gorely et al. (2004) found that variables which were consistently positively associated with TV/video viewing were ethnicity (non-White), body weight, between meal snacking, parental TV habits, weekend and having a TV in one's bedroom. On the other hand, negative associations were found for parental income, parental education and number of parents in the house. No associations were found for gender, body fatness, cholesterol levels, aerobic fitness, strength, other indicators of fitness, self perceptions, emotional support, physical activity, other diet variables and being an only child. In relation to the physical environmental factor of residential location, it was concluded that the evidence remains equivocal as to whether young people in urban areas watch more or less TV than those in rural areas. Also, reference was also made to type of school in this review as an indicator of socioeconomic status (i.e., attending private school) but this showed no association with TV viewing. Gorely et al. (2004) importantly concluded in this review that few consistent modifiable correlates (i.e., those factors that can be changed) were found. Therefore, it was suggested that future research identifies modifiable correlates of TV viewing as they could aid in the development of more efficient interventions to reduce TV viewing.

Secondly, Van der Horst et al. (2007) examined the correlates of sedentary behaviour (e.g., TV watching, reading) in adolescents aged 13 to 18 years. In total, nine studies (the majority of them cross-sectional) published between 1999 and 2005 examined correlates of TV/video watching and computer games. Positive associations were found between gender (male), depression and body mass index and watching TV and video. An inverse association was found between ethnicity (Caucasian), socioeconomic status and parental education and watching TV and video. For all other variables studied (i.e., parent support, parent TV time, physical education/school sports and age), there was insufficient evidence to draw conclusions. Van der Horst et al. (2007) conclusions suggested that more information is required on the correlates of individual sedentary behaviours in order to facilitate the development of effective interventions to limit sedentary behaviours. In addition, Van der Horst et al. (2007) highlighted that more prospective studies are needed.

More recently, two publications have been disseminated which focus on factors associated with adolescents' sedentary behaviour. Firstly, The Sedentary Behaviour and Obesity Expert Working Group (2010a) undertook a small scale review of mediators and moderators of sedentary behaviour among young people (including adolescents). Due to the lack of research investigating correlates of sedentary behaviours other than screen viewing, their review focused on the correlates of screen viewing among adolescents. Their review concluded that the potential moderators (i.e., variables that predict behaviour but cannot be changed) of youth screen viewing for adolescents are age, gender, ethnicity, socioeconomic status and parental education and for young people in general, socioeconomic status, living in a single parent household, ethnicity and age are likely to moderate screen-viewing behaviours. Furthermore, they also concluded that the potential mediators (i.e., variables that predict behaviour and can be changed) of youth screen viewing for adolescents were body mass index (for higher levels of screen viewing). For young people in general, snacking, body weight, parental TV viewing and having a TV in the bedroom are potential mediators of screen viewing. However, the authors do highlight that these potential moderators and mediators of youth screen-viewing are likely to differ by participant age.

Secondly, Pate et al. (2011) undertook a review to determine specific factors that associate with sedentary behaviour in children (defined as aged two to 18 years therefore included adolescents within this definition category). Studies identified were published between 1990 and 2010 and factors identified were categorised as: demographic; biological; psychosocial; behavioural; and environmental. In relation to demographic variables, 13 studies investigated age with seven finding that older children spent more time in screen based sedentary behaviour. Race/ethnicity was investigated in 12 studies with most showing that non-White children spent more time in screen-based sedentary behaviour. For gender, the majority of studies used screen-based sedentary behaviour as the dependent variable and the results were mixed with some studies showing a positive association for females or males and others showing no association. Measures of socioeconomic status were consistently associated with screen-based sedentary behaviour. More specifically, children tended to spend more time in screen-based sedentary behaviours if they were from low socioeconomic status backgrounds (families with a lower income, lower level of parental education or lower level of parental employment). Regarding biological variables, 18 studies investigated the influence that a child's body mass index has on measures of sedentary behaviour with 50% of these studies finding no association and three studies examined the relationship between pubertal stage and measures of sedentary behaviour. Following on, with relation to psychosocial variables, 11 specific factors were identified in this review. However, each of these factors was only investigated in single studies thus making the data difficult to review. Notable evidence emerged for parents who limited screen time and enforced screen time rules had children who spent less time engaged in screen-based sedentary behaviours.

For behavioural variables, seven studies found no associations between children's physical activity levels and screen-based sedentary behaviour thus supporting the concept that sedentary behaviour is distinct from low levels of physical activity. Conversely, one particular study found that communication-based sedentary behaviour was negatively associated with physical activity levels. Four studies also showed that a child's screen-based sedentary behaviour was higher if his or her parent reported higher screen time and three studies found that children who ate meals whilst watching TV spent more time in screen-based sedentary behaviour. Finally, in relation to environmental variables it was reported that the household environment was important in terms of screen-based sedentary behaviour with the number of television and computers in a household associated with more screen-based sedentary behaviour. Also, children who had a TV in their bedroom spent more time in screen-based sedentary behaviour. Further, additional studies investigated the association between measures of sedentary behaviour and season, region (urban), school environment (public versus private) and community environment. Mixed associations were found for these environmental factors and screen-based sedentary behaviour. For example, two studies found a positive association between region (urban) and screen-based sedentary behaviour and two studies showed no association. For school type (public versus private), one study found a positive association with screen-based sedentary behaviour. Finally, for season, one study found a positive association (winter), a negative association (temperature) and no association and screen-based sedentary behaviour.

5.5.1 Synthesis of findings from systematic reviews on correlates of adolescents' sedentary behaviours

Overall, when bringing together the main systematic reviews of Gorely et al. (2004) and Van der Horst et al. (2007), in addition to the review of Pate et al. (2011) it is useful look at similar associations reported across both regarding adolescents' TV/video viewing (and screen-based sedentary behaviours). Positive associations reported across both studies are not the same across either review although body mass index was reported by Van der Horst et al. (2007) and body weight was reported by Gorely et al. (2004). However, caution should be applied here because Gorely et al. (2004) also reported no association for body fatness. However, Pate et al. (2011) reported no association between body mass index and screen-based sedentary behaviour. In relation to socioeconomic status, Van der Horst et al. (2007) reported a negative association with adolescents' TV/video viewing. Similarly, other indicators of socioeconomic status such as parental education is consistently reported as being negatively associated with adolescents' TV/video viewing in both reviews. Similarly, Pate et al. (2011) reported a negative association between socioeconomic status and screen-based sedentary behaviour. Age was included as a factor within two of the three reviews with Van der Horst et al. (2007) reporting the association as inconclusive but Pate et al. (2011) reported a positive association for older children and screen-based sedentary behaviour. Although ethnicity was reported as a positive association (non-White) by Van der Horst et al. (2007) and Pate et al. (2011), Gorely et al. (2004) reported ethnicity as a negative association (Caucasian). Interestingly, gender was reported differently across the three reviews. Van der Horst et al. (2007) report it is a positive association (male) whereas Gorely et al. (2004) found no association. Pate et al. (2011) support both of these other reviews because they concluded that studies have shown a mixed picture with studies reporting a positive association for females, positive association for males and no association with screen based sedentary behaviour. Parental TV habits are reported differently across two of the three reviews with Gorely et al. (2004) confirming a positive association with adolescents' TV/video viewing in contrast to Van der Horst et al. (2007) who claimed that there was insufficient evidence for an association between parent TV time and adolescents' TV/video viewing. However, Pate al. (2011) showed that a child's screen-based sedentary behaviour was higher if his or her parent reported higher screen time.

In relation to having a TV in one's bedroom, Gorely et al. (2004) and Pate et al. (2011) both reported a positive association with screen-based sedentary behaviour (Pate et al., 2011) and TV/video viewing (Gorely et al., 2004). In relation to environmental variables, Gorely et al. (2004) reported no association between type of school (private versus public school) whereas Pate et al. (2011) found a positive association (public) with screen-based sedentary behaviour but based on only one study. Also, an equivocal association for residential location (urban versus rural) and adolescents' TV/video viewing was reported by Gorely et al. (2004) in contrast to Pate et al. (2011) who found a positive association between region (urban) and screen-based sedentary behaviour in two studies but no association in two other studies. Additionally, physical activity was not associated with TV/video viewing (Gorely et al., 2004) or screen-based sedentary behaviours (Pate et al., 2011). The remaining correlates reported in each review are different and were unique to each respective review. For instance, Van der Horst et al. (2007) highlighted depression, parent support and physical education/school sports. On the other hand, unique correlates reported by Gorely et al. (2004) included between meal snacking, weekend, parental income, number of parents in the house, cholesterol levels, aerobic fitness, strength, other indicators of fitness, self-perceptions, emotional support, physical activity, other diet variables and being an only child. Additionally, Pate et al. (2011) reported on the factors of parents limiting screen time and enforcing screen time rules, communication-based sedentary behaviours, eating whilst watching TV, number of televisions and computers in a household, season and community environment.

5.6 Summary

Overall, the main eight reviews presented in the correlates of adolescents' physical activity section and the three main reviews critiqued in the correlates of adolescents' sedentary behaviours section have shown there is agreement about some particular correlates of adolescents' physical activity and sedentary behaviours but there is also limited agreement on other correlates. It is evident within the reviews undertaken that the main focus has been on studies examining correlates of the behaviour itself (i.e., adolescent's physical activity or sedentary behaviour) from a cross-sectional perspective rather than a change in the behaviour over a longitudinal period. Although cross-sectional studies which investigate correlates of physical activity and sedentary behaviour provide important information, it is not possible to identify the direction of association or the factors associated with changes in the outcome of interest (e.g., physical activity, screen time) and therefore longitudinal studies are preferable (Van der Horst et al., 2007).

It is therefore important that future research into correlates of adolescents' physical activity or sedentary behaviour strives to focus on correlates of change in physical activity levels or screen time. Longitudinal studies may also reveal different correlates to those shown by cross-sectional studies. Furthermore, although future research is required into changes in some personal, social or environmental variable (i.e., change in a correlate or a mediating variable) in order for a change in behaviour to occur (NICE Public Health Collaborating Centre, 2007), there is also a need for future research to identify key moderators of behaviour change (i.e., a factor or variable that cannot be changed (is fixed) but can vary in the strength of the relationship between a programme and outcome) (Biddle et al., 2011a). An example of a moderator is a factor such as age, gender or ethnicity for which an outcome may differ (NICE Public Health Collaborating Centre, 2007).

As highlighted earlier in the comparisons made between reviews on the correlates of adolescents' physical activity and adolescents' TV/video viewing and screen-based sedentary behaviours, there are a number of demographic and biological, psychological, behavioural, social/cultural and environmental factors that have been shown to be both consistently and inconsistently reported. Although the particular correlates indentified within the categories of biological, psychological, behavioural and social/cultural factors appear to be important for adolescents' physical activity and sedentary behaviours, the researcher decided to focus on a set of four particular demographic factors and two environmental factors in the present study as a result of reviewing the systematic reviews presented. The reasoning behind this decision was based mainly on the further investigation required highlighted by the previous reviews of correlates of adolescents' physical activity and sedentary behaviours undertaken and the practicalities of collecting more 'retrievable' data from the population of interest to the study (i.e., adolescents) as opposed to adults.

The four demographic factors that are focused on in the following sections are: gender; ethnicity, socioeconomic status; and educational attainment. Firstly, gender has been consistently shown to be associated with adolescents' physical activity (i.e., males being more active than females). However, gender has not been investigated in many studies as a possible correlate of adolescents' physical activity over a longitudinal period. This would therefore suggest that this factor requires future investigation. Additionally, gender is reported as being both associated and not associated with adolescents' TV/video viewing. Consequently, further research is required into gender as a possible correlate of screen time. Further, factors such as ethnicity and socioeconomic status as a possible correlate of adolescents' physical activity require further investigation because the evidence of an association is not consistent across the reviews presented. Although in relation to adolescents' TV/video viewing ethnicity is reported similarly across reviews (i.e., non-White viewing higher amounts of TV/video viewing), more studies are required which investigate this as a possible correlate of adolescents' screen time, particularly over a longitudinal period rather than from a cross-sectional perspective.

Similarly, although socioeconomic status is reported as being negatively associated with adolescents' TV/video viewing, the measures/indicators of socioeconomic status used are different. As a consequence, it would be worthwhile for future studies to investigate socioeconomic status via other measures as a possible correlate of adolescents' screen time. There is also another demographic factor (educational attainment) and an environmental factor (school type – private versus public) that is either non-existent or limited in the reviews of both adolescents' physical activity/ TV/ video viewing presented. This is surprising considering that adolescence is a period when individuals are in the school environment for a significant amount of time. As a consequence, these factors warranted further investigation as a possible correlate of both adolescents' physical activity and adolescents' screen time. After reviewing the literature in relation to school type (private versus public), some literature has specified 'school type' as a sociodemographic factor (Henning Brodersen et al., 2005), particularly where school type is treated as a proxy measure of socioeconomic status (Gorely et al., 2004). Conversely, reviews of correlates of adolescents' physical activity and sedentary behaviour have specified 'school type' as an environmental factor (Ferreira et al., 2006; Pate et al., 2011). Therefore, the present study treated school type as a stand-alone factor that is classified as an environmental factor. Finally, an environmental factor which appears to have been under researched as a possible correlate of adolescents' physical activity and adolescents' screen time is area of residence (i.e., urban versus rural). Numerous reviews of correlates of adolescents' physical activity and sedentary behaviour have specified area of residence (urban versus rural) as an environmental (i.e., 'physical environmental') factor (Gorely et al., 2004; Davison and Lawson, 2006; Ferreira et al., 2006; Pate et al., 2011). The present study therefore treated area of residence as an environmental factor. Overall, it remains to be seen whether these two environmental factors are associated with adolescents' physical activity and adolescents' screen time from both a cross-sectional and longitudinal perspective.

5.7 Gender and adolescents' physical activity

As identified in the systematic reviews of correlates of adolescents' physical activity, studies examining gender as a possible correlate of adolescents' physical activity have in the majority consistently shown that males are more active than females (Allison et al., 1999; Gordon-Larsen et al., 2000; Trost et al., 2003; Higgins et al., 2003; Molnar et al., 2004; Scully et al., 2007; Tammelin et al., 2007; Thibault et al., 2010). However, there is an issue with the magnitude of gender associated variation in physical activity levels due to variations of instruments used, particularly during adolescence. For example, in a longitudinal study of Dutch adolescents, total activity (determined as activities more than 4 METs, expressed as METs/week) declined, on average, from ages 13 through to 16 years with little absolute changes to age 21 years, and males were more active than females (Van Mechelen et al., 2000). However, depending on the type of activity performed by adolescents in this study, the differences between male and female vary. Males were more active than females in nonorganised sport but there was a major decline in activity in males from ages 13 to 16 years with a small decline in females, and a continued decline in both sexes to 21 years. Conversely, other 'non-sport' activities showed no consistent sex difference across adolescence into young adulthood, with stable levels from ages 13 to 16 years. Similar findings have been reported by Caspersen et al. (2000) in the U.S. who showed that longitudinally the percentage of males engaged in regular vigorous activity (defined as three or more days a week running, jogging, swimming) increased from ages 12 to 14 years and then declined through ages 19 to 21 years. Corresponding percentages of females declined linearly with age from 12 through to 20 years. The prevalence of regular sustained activity declined more in males (16%) than in females (10%).

Studies which further evidence that males are more active than female adolescents include Aaron et al. (1993) who undertook a prospective study which developed a physical activity questionnaire (the Modifiable Activity Questionnaire for Adolescents) and evaluated its appropriateness for measuring activity in a large biracial (Whites and non Whites) population-based cohort of U.S. adolescents. Adolescents aged 12 to 16 years were surveyed annually to assess past year leisure physical activity (defined as an estimate of the number of hours per week spent in each activity (each participated in at least 10 times), in addition to hours for all activities summed to produce an overall leisure time physical activity estimate). It was found that males were considerably more active than females on all measures of activity. Additionally, after adolescents reported the number of days of 'hard exercise' and 'easy exercise', males were 2.1 times more likely to be classified as being vigorously active (i.e., six or more days of hard exercise during the past two weeks). Further, Juan et al. (2010) cross-sectionally examined the association of selected individual and school factors with specific patterns of physical activity during adolescence. In this study, Spanish adolescents aged 12 to 17 years completed a self-report survey once during school hours. Five self-reported questions concerning the frequency and intensity of leisure time physical activity and participation in organised sports and sports competition were summed into an overall 'Physical Activity Index'. Categories were then created from the Physical Activity Index scores to represent vigorously active, moderately active, lightly active, insufficiently active and sedentary. Regarding gender, the odds of being considered moderately active and vigorously active were higher for boys than girls (i.e., boys were more active than girls). However, the two genders did not differ significantly in their odds of being classified as lightly active or as insufficiently active.

5.8 Gender and adolescents' screen viewing

Studies examining an association between gender and screen viewing among adolescents have in the majority shown a positive association between gender (male) and screen time (Gordon-Larsen et al., 1999, Gordon-Larsen et al., 2000; Lowry et al., 2002 (TV only); Marshall et al., 2006; Hardy et al., 2010; Olds et al., 2010). The majority of these studies, as indicated in the two systematic reviews of correlates of adolescents' TV/video viewing have used cross-sectional studies. However studies such as Hardy et al. (2007a) have used a longitudinal design albeit with only adolescent girls. Hardy et al. (2007a) conducted a study into the amount of time that Australian girls aged 12 to 15 years spent in a comprehensive range of sedentary behaviours and how these behaviours changed during early adolescence. The data for this study comes from the Girls' Healthy Development Study, which collected data for two and a half years on a range of variables associated with growth and development and modifiable behaviours among a cohort of adolescent school girls. Adopting a longitudinal design with a prospective cohort, five data collections were undertaken, six months apart, between 2000 and 2002. The most important finding to come out of this research was that watching TV, videos and playing video games (i.e., screen time) was the most popular sedentary pastime, which accounted for 33% of time spent in sedentariness, followed by homework and reading (25%). Sedentary behaviour also increased from 1.4 hours on week and weekend days to 3.3 hours on week and weekend days. In conclusion, among girls, the transition between early and mid-adolescence was accompanied by a significant increase in leisure time sedentary behaviour. There have also been studies which have shown no association between gender and adolescents' screen viewing behaviours (Henning Brodersen et al., 2007; Willoughby, 2008; Biddle et al., 2009c; Ceschini et al., 2009).

5.9 Ethnicity and adolescents' physical activity

Many studies appear to show that there is a positive association between being White (Caucasians) and increased physical activity among adolescents (Aaron et al., 1993; Gordon-Larsen et al., 2000 (females only); Booth et al., 2002b (females only); Henning Brodersen et al., 2007). For example, Butcher et al. (2008), in their cross-sectional U.S. study, compliance was defined as five to seven days of at least 60 minutes of physical activity. It was reported that for male adolescents aged between 14 and 17 years, ethnicity significantly predicted compliance. More specifically, male adolescents who were non-Hispanic White (versus non-Hispanic other or unknown race) were significantly more likely to comply. Similarly, Gordon-Larsen et al. (2004) longitudinally investigated trends in achieving five or more sessions of MVPA per week across the critical and understudied period of the transition from adolescence (age range of 11 to 21 years) to young adulthood in relation to ethnicity in the U.S. Results showed that Black females were more likely than their White counterparts to remain inactive (i.e., less than five or more sessions of MVPA) during adolescence and adulthood. There have also been studies which have concluded that there is no association between ethnicity and physical activity among adolescents (Sallis et al., 1999; Gordon-Larsen et al., 2000 (males only); Booth et al., 2002b (males only); Neumark-Sztainer et al., 2003 (girls only); Molnar et al., 2004).

5.10 Ethnicity and adolescents' screen viewing

Studies examining the association between ethnicity and screen viewing have shown that White adolescents participate in less screen time than non-White adolescents (i.e., non White adolescents participate in more screen time) (Gordon-Larsen et al., 1999; Gordon-Larsen et al., 2000; Henning Brodersen et al., 2007). From a cross-sectional perspective, studies such as Carlson et al (2010), although with a younger sample of adolescents (aged nine to 15 years in the U.S.), found that there was a positive association between Black ethnicity and the likelihood of exceeding recommended screen time limits of more than 120 minutes a day. Similarly but from a longitudinal perspective, Gordon-Larsen et al. (2004) adopted the desirable criterion of achieving 14 hours or less of screen time per week in their longitudinal study in the U.S. with adolescents in the age period of 11 to 21 years at baseline. Results identified that Black males were more likely than White males to have high (versus low) screen time hours during both adolescence and early adulthood. Further, Black males were also significantly more likely than White males to have low (versus high) screen time during adolescence only. Black females were also more likely than White females to have high (versus low) screen time during adolescence and early adulthood as well as during adolescence only. In addition, Whites were more likely to have unhealthful shifts in screen time during the period from adolescence to early adulthood. However, Gordon-Larsen et al. (2004) suggested that it must be kept in mind that a greater proportion of White adolescents engaged in favourable amounts of screen time (i.e., 14 hours or less a week) at baseline (during adolescence) than Blacks and Hispanics.

5.11 Socioeconomic status and adolescents' physical activity

The evidence is mixed regarding an association between socioeconomic status and adolescents' physical activity with some studies demonstrating a positive association (Gordon-Larsen et al., 2000; Kristjansdottir and Vilhjalmsson, 2001). However, other studies have reported no association (Booth et al., 2002b; Dunton et al., 2003 (females only); Higgins et al., 2003). Some studies which have shown that low socioeconomic status is associated with less physical activity include Lee and Cubbin (2002), Inchley et al. (2005) and Gorely et al. (2009a). Cross-sectional studies include Santos et al. (2004) who explored the relationship between Portuguese adolescents' choices regarding physical activity (organised and nonorganised) and their parents' socioeconomic status; an area of research that has not been well quantified. Adolescents aged between 13 and 20 years were given a questionnaire which assessed physical activity and was classified as organised or nonorganised. Findings revealed that participants from families of higher socioeconomic status chose significantly more organised activities. On the other hand, for those choosing nonorganised activities, only mothers' education was statistically significant. Participants who engaged in organised physical activity reported more moderate intensity physical activity whereas participants in nonorganised physical activities reported low-intensity activities. From a longitudinal perspective, Sagatun et al. (2008) investigated the relationship between physical activity and sociodemographic factors (i.e., socioeconomic status measures including father's income, mother's education, perceived family economy, parents marital status and residence in Oslo) among Norwegian adolescents at age 15 years and again at age 18 years. Physical activity level was measured by a question on weekly hours of physical activity outside of school. It was concluded that sociodemographic factors were only weakly related to physical activity level at age 15 and 18 years and the change in physical activity between these ages. Furthermore, Scully et al. (2007) examined the association between Australian adolescents' physical activity and socioeconomic status (i.e., in relation to postcode). Adolescents aged 12 to 17 years reported the number of days in the past week they had done any vigorous or moderate vigorous physical activity for a total of at least one hour. They concluded that the proportion of participants engaging in recommended physical activity levels (i.e., at least 60 minutes of MVPA each day in the previous week) was unrelated to socioeconomic status. Finally, similar findings have been reported by Henning Brodersen et al. (2007) among U.K. adolescents aged 11 to 12 years at baseline and 15 to 16 years at final follow-up. They reported no association between socioeconomic status (i.e., in relation to postcode) and physical activity, although girls from lower socioeconomic status were less active.

5.12 Socioeconomic status and adolescents' screen viewing

Socioeconomic status is in the majority consistently associated with screen viewing among adolescents (Uijtdewilligen et al., 2011). Some studies indicate that adolescents spend more time in screen time if they have a lower socioeconomic status (i.e., a negative association) (Gordon-Larsen et al., 2000; Willoughby, 2008 (computer/internet use only); Gorely et al., 2009a (TV viewing)). For example, Henning Brodersen et al. (2007) measured U.K. adolescents' self-reported time TV viewing and playing computer or video games (i.e., screen time). Results revealed that screen time levels were greater in participants from lower socioeconomic neighbourhoods. In contrast, focusing solely on TV viewing, Scully et al. (2007) measured TV viewing time among Australian adolescents aged 12 to 17 years. Participants reported how many hours on an average school day that they: (1) watched TV/videos; and (2) used the internet/played computer games (not for homework). They found that upper middle and high socioeconomic participants were more likely than the low socioeconomic group to watch two hours or less of TV on an average school day. Conversely, in comparison to low socioeconomic adolescents, upper middle and high socioeconomic participants were also more likely to spend two hours or less on a school day in front of a computer. However, in relation to screen time when the two measures were put together, the proportion of participants meeting the guideline did not differ significantly according to socioeconomic status. Despite a negative association being demonstrated in the majority of studies, other research has reported no association with screen viewing (Ceschini et al., 2009).

5.13 Educational attainment and adolescents' physical activity

From the review of literature undertaken for the purpose of this thesis, only one study was identified that specifically investigated the association between educational attainment and adolescents' physical activity. However, this longitudinal study by Zimmermann-Sloutskis et al. (2010) among Swiss adolescents aged 14 years at baseline and 24 years at final follow-up did not include education as a possible determinant. The reasoning for this was because of education having a strong correlation with age thus it was not possible to clarify the role of education as a potential confounder on the causal pathway between age and physical activity.

Adolescents' perceptions of higher academic rank or expectations has been shown to predict greater levels of physical activity and decreased amounts of sedentary lifestyle behaviours (Schmitz et al., 2002). A study conducted by Sigfúsdóttir et al. (2007) with Icelandic adolescents, aged 14 and 15 years, identified that body mass index, dietary behaviour and physical activity explained up to 24% of the variance in academic achievement when controlling for gender, parental education, family structure and school absenteeism. Moreover, the school setting is central to the lives of most adolescents and consequently is an institutional mediating structure providing young people with sentiments of obligation and commitment and a set of common goals (Seroczynski et al., 1997). Also, Kristjánsson et al. (2009) recently examined how health behaviour indicators, in the form of sedentary lifestyle, body mass index and physical activity, contributed to academic achievement, and whether these health behaviour indicators do so through increased school contentment. Among adolescents aged 14 and 15 years in Iceland, findings revealed that body mass index and sedentary lifestyle were negatively related to school contentment and academic achievement, but physical activity was positively related to school contentment and academic achievement. The main conclusion drawn from this study was that effort should be made to improve academic achievement and the general health status of youth.

5.14 Educational attainment and adolescents' screen-viewing

Similar to the dearth of studies investigating an association between educational attainment and adolescents' physical activity, studies examining associations between educational attainment and adolescents' screen viewing and more specifically, screen time, appear to be non-existent. The systematic reviews examined and the review of literature undertaken have not found any studies examining this factor as a possible correlate of adolescents' screen time. There have been limited studies which have measured parental education and children's TV viewing and these have focused on parental education level as a socioeconomic factor (Grund et al., 2001). As a consequence of this situation, studies are urgently required into the examination of this factor.

5.15 School type and adolescents' physical activity

Studies examining 'school type' (i.e., state or mainstream school versus independent or private school) as a possible correlate of adolescents' physical activity are minimal. School influences on adolescents' physical activity such as school type attended have been reported in the review of environmental correlates of physical activity in youth by Ferreria et al. (2006). However, this review only found one study that had measured the association between public versus private school and adolescents' physical activity, reporting an inverse association with adolescents' physical activity (Feldman et al., 2003). Another study also examined the association between school type and adolescents' physical activity but defined school type as including comprehensive or high school versus vocational school (Aarnio et al., 1997).

Three additional cross-sectional studies have also been identified from the literature search in relation to the association between physical activity and the type of school attended. Peiró-Velert et al. (2008) examined physical activity levels among Spanish adolescents aged 12 to 16 years in relation to type of school (private versus public). No significant differences in physical activity levels were found between participants from public schools and those from private schools. However, they did find that those participants from public schools showed the highest percentage in the 'active' category during weekends. Also, participants from private schools showed the highest percentage of the 'very inactive' category at weekends. Participants from private schools also displayed a higher percentage in the 'moderately active' category during weekends than public school participants. They concluded that the type of school may be important in determining activity patterns. Their results are also contrary to the literature which has shown that people of lower socioeconomic status spend less time on leisure time physical activity than those of higher socioeconomic status. In summary, Peiró-Velert et al. (2008) found that participants from Spanish public schools have on average, lower socioeconomic status than those attending private school who were more active than their private counterparts.

A further study which investigated the association between type of school (state versus private school) and adolescents' physical activity is Devís-Devís et al. (2010). In this cross-sectional study, Spanish adolescents aged 12 to 16 years reported the amount of physical activity participated in for three parts of the day (morning/afternoon/evening). Reported activities were then calculated in relation to average daily expenditure (MET values). METs values were then assigned to each group of activities and then classified into the following categories for physical activity (light intensity; moderate intensity; vigorous intensity). Findings from this study are in contrast to Peiró-Velert et al.'s (2008) findings because it was found that there was no association between type of school and participants' physical activity (of any intensity) for weekdays. However, it was found that, for weekends, participants from state schools reported a higher participation in either 'light' or 'vigorous' activities than participants attending private schools.

Another study that has investigated the type of school on physical activity levels is Juan et al. (2010), a study undertaken in Spain with adolescents aged 12 to 17 years. They concluded that the odds of engaging in vigorous physical activity were lower in participants attending public schools, compared to those in private school. The same tendency was evident across all physical activity categories. Juan et al. (2010) suggested that private school participants were more active than public school participants. Therefore, type of school was associated with physical activity at the higher and lower ends of the participation spectrum. This is in contrast to Peiró-Velert et al.'s (2008) findings although they did point out that the percentage of participants considered inactive was higher among public school participants. In addition, these findings are also in contrast to Devís-Devís et al.'s (2010) findings. Juan et al. (2010) stressed that there is a need for more research into ascertaining the specific circumstances within each type of school setting that are linked with physical activity participation during adolescence. They also suggested that studies into the type of school attended are of upmost importance in terms of including broader macrosystemic factors in studies investigating correlates of youth physical activity.

5.16 School type and adolescents' screen viewing

There are fewer studies examining the association of school type and adolescents' screen viewing than there are with adolescents' physical activity. In fact, there appear to be only two studies that have specifically examined school type (public versus private) in relation to adolescents' screen time (Devís-Devís et al., 2009; Karaca et al., 2011). Firstly, Devís-Devís et al. (2009) showed that among Spanish adolescents aged 12 to 16 years attending a public/state school spent more time on screen-based media (i.e., TV/video viewing, playing PC/video games and using a computer) than their private school counterparts. Conversely, Karaca et al. (2011) found that adolescents with a mean age of 15.02 years in Turkey attending a private school had a higher screen time than those attending public schools. When screen time was reduced to its components (i.e., TV viewing, computer and video use), they found that participants from private school spent more time using computers and video games while participants from public schools spent more time watching TV. Clearly, due to the lack of research investigating this demographic variable as a possible correlate of adolescents' screen time, there is a need for more studies to investigate this variable.

5.17 Area of residence and adolescents' physical activity

As identified in the review of environmental correlates of adolescents' physical activity by Ferreira et al. (2006) and Davison and Lawson (2006), few studies have investigated differences in physical activity levels between adolescents' residence location. As detailed earlier, Ferreira et al. (2006) reported no association and

Davison and Lawson (2006) reported an inconclusive association between residence location and adolescents' physical activity. Positive associations have been reported in one study (Vilhjalmsson and Kristjansdottir, 2003) whereas other studies have demonstrated no association between residence location and adolescents' physical activity (Vilhjalmsson and Thorlindsson, 1998; Gordon-Larsen et al., 2000; Vilhjalmsson and Kristjansdottir, 2003).

Overall there is a lack of research into urban or rural area of residence as a possible factor associated with adolescents' physical activity. This is confirmed by Sallis et al. (2000b) who suggested that it would be valuable for studies to report on subgroups within the same study that differ on ethnicity, socioeconomic status and environmental characteristics (e.g., urban versus rural) from a physical activity perspective. Tammelin et al. (2003) investigated place of residence (urban versus rural) and found that place of residence was associated with participation in types of sports in adolescence. They found that, in rural areas, outdoor sports were more popular and in urban areas, people frequently participated in sports demanding special facilities and organised guidance (for e.g., dancing, riding). Further, those who lived in an urban environment have more opportunities to participate in various organised activities to utilise sports facilities compared to their rural counterparts. On the other hand, Thibault et al. (2010) reported in a recent study that significance was borderline for place of residence (rural versus urban) in relation to being overweight. This therefore provides justification for having area of residence as a possible correlate in the present study. As studies into the association between physical activity and area of residence (urban versus rural) are lacking there is little more to report here.

5.18 Area of residence and adolescents' screen viewing

The review of correlates of TV/video viewing among youth by Gorely et al. (2004) classified residential location as a 'physical environment' factor. From the studies they reviewed (of which there were only three), they concluded that the evidence is equivocal as to whether or not young people in urban areas watch more or less TV than those in rural areas. Some studies have been undertaken with children regarding screen time and urban/rural residence (Bathrellou et al., 2007; Davis et al., 2008). However, with relation to an adolescent population, Tenorio et al. (2010) identified factors associated with sedentary behaviour (TV viewing) among Spanish adolescents aged 14 to 19 years. Place of residence (urban/rural) was significantly associated with exposure to watching three or more hours of TV per day on weekdays but was not related on weekend days. In relation to screen time specifically, there appeared to be only one study that had been undertaken. Carson et al. (2011) examined urban/rural differences in individual screen time behaviours (watching TV (including videos and DVDs); playing games on a computer or games console; and using a computer for chatting online, internet, emailing, homework etc.) among U.S. and Canadian adolescents aged 11 to 16 years. U.S. participants from the most rural areas were more likely to be higher TV users and less likely to be high computer users. In contrast, high TV use was less likely and high computer use was more likely for Canadian participants living in large and medium metropolitan areas. Overall, due to the paucity of research investigating area of residence as a factor associated with screen time, there is a need for future research with adolescents' screen time investigating this.

5.19 Summary

This second part of the chapter has concentrated on four specific demographic factors and two specific environmental factors in relation to adolescents' physical activity and screen viewing. However, before progressing further with the chapter, it is important to highlight that the inconsistencies reported among the factors focused on in this entire chapter and adolescents' physical activity and screen viewing may be due to the different physical activity and screen viewing measures used across studies. For example, from a screen time perspective in some studies, a summary screen time measure (e.g., TV + computer + video games) has been used while other studies have examined individual screen time activities (e.g., TV viewing) (Carson, 2011).

It has been highlighted that the demographic factors of gender, ethnicity and socioeconomic status have all been investigated as correlates of adolescents' physical activity and/or screen viewing behaviours. Gender has been shown to be associated with physical activity with males being more active than females during adolescence. Positive associations have been found between gender and TV viewing and screen time with males partaking in more TV viewing and screen time than females during adolescence. Ethnicity has been shown to be both associated and not associated with adolescents' physical activity and/or screen viewing behaviours. In addition, socioeconomic status as a correlate has shown mixed associations with adolescents' physical activity and/or screen viewing behaviours. Consequently, although these three demographic factors have been investigated before in relation to adolescents' physical activity and/or screen viewing behaviours, more studies (particularly longitudinal studies) of these factors regarding physical activity and screen time are required among targeted high-risk subgroups that require special attention (e.g., adolescents making the transition out of the compulsory education setting) (Van der Horst et al., 2007). In addition, studies examining educational attainment as a possible demographic correlate of adolescents' physical activity are minimal and screen viewing appears to be non-existent. Therefore, exploration of this possible correlate is required to add to a depleted evidence base. Similarly, the environmental factors of school type (private versus public) and area of residence (urban versus rural) require extensive further exploration regarding adolescents' physical activity and screen time. As demonstrated in the studies presented, both of these factors have only been investigated in a handful of studies. Overall, the evidence provided in both main sections of this chapter has provided a justification for the sole focus on demographic and environmental factors (variables) in the present study. There is currently a dearth of evidence regarding these six factors among adolescents aged 15 to 17 years in the U.K. in relation to physical activity and screen time. Furthermore, these factors have rarely been explored in relation to changes in physical activity and screen time through longitudinal studies.

5.20 Rationale for the present study and the transition out of compulsory education

Historically, in the late 1950s, there were concerns about the opportunities for participating in sport for young people leaving school. This was the main driver behind the Central Council for Physical Recreation establishing the Wolfenden Committee, whose report ('Sport and the Community') recommended a Sports Development Council (Collins and Buller, 2000). The Wolfenden Committee (Central Council of Physical Recreation, 1960: p23) also identified a 'gap' between school and adult provision as the:

> *...manifest break between, on one hand, the participation in recreative physical activities which is normal for boys and girls at school, and on the other hand, their participation in similar, though not identical, activities some years later when they are more adult*

This 'gap' was concerned with the notion that, young people, when they leave school, have considerable difficulty in establishing themselves as members of adult clubs unless they are particularly skilful and take the sport they play further with senior teams (Central Council of Physical Recreation, 1960). However, in 1987, Wade (1987) questioned whether there was actually a 'gap' or temporary break from sport in the teenage years in response to the findings of the General Household Survey which highlighted that the sharpest decline in sport occurred between the ages of 30-44 and 45-59. A decade later, however, Kremer et al. (1997) argued that current sports policies and strategies had failed to address a post-school fall in participation (Collins and Buller, 2000).

The Sports Council (1985) attempted to demonstrate youth sport participation via a project called Active Lifestyles in Coventry, U.K. This research showed that at baseline in 1985, 73% of the 960 pupils interviewed intended to continue playing at least one sport, 37% intended to 'take up' a sport on a regular basis and 64% wanted to try a new sport upon leaving school. Following this project in 1985, the follow-up project called 'Active Lifestyles Post-School Sports Participation: A Case Study in Coventry' (The Sports Council, 1991) was undertaken. This follow-up involved a survey of sporting interests conducted among ex-pupils from four Coventry schools who had previously been interviewed in 1985, whilst they were in the fifth (aged 15 to 16 years) and sixth forms (aged 16 to 18 years) at school. This therefore became a longitudinal study of young people's sporting lifestyles. This follow-up sought to find out whether participants had realised their intentions or whether their views and sporting interests had changed in any way since leaving school at the end of either fifth or sixth form. Of the original 960 interviews at baseline, 380 completed responses were received. Findings revealed that 71% still played at least one sport, 30.5% had taken up another, but only 16% had tried a new. As the report from the follow-up survey by the Sport Council suggests 'These high participation rates go a long way to dispel the myth that most young people stop playing sport when they leave school' (1991: p18). This longitudinal project concluded that despite the widely held belief for many years that the post-school (i.e., after leaving fifth form or sixth form) drop-out is indicative of a rejection of sport, the evidence of this project shows this to be a 'myth' and points to an significant involvement amongst 18 to 21 year olds in active sport and recreation. However, as Collins and Buller pointed out 'Reality fell short of intention, not so much in continuing to play sports undertaken at school, but in much lower take up or trying of new activities' (2000: p201). It is also important to note an issue raised from this research is that many school-leavers believed they were given insufficient information about places they could continue their sporting interests after completing compulsory education (Collins and Buller, 2000).

A survey of particular importance which has investigated this 'post compulsory education' gap in physical activity levels is the PE and Sport Survey 2008/2009 (Department for Children, Schools and Families, 2009). The PE and Sport Survey 2008/2009 aimed to collect information about the level of participation in physical education and school sport in schools taking part in the School Sport Partnership programme in England. In total 21,464 schools and further education colleges took part in the survey between May and July 2009. The key findings of relevance to the present study are that pupils in years 1 to 13 in the partnership schools surveyed spent an average of 115 minutes in a typical week in 2008/2009 on curriculum physical education. Rates were similar across years 1 to 9, but were lower in years 10 and 11, then falling substantially in years 12 and 13 to just 31 minutes in year 12 and 27 minutes in year 13 of curriculum time per week (The NHS Information Centre, 2010). Although this data is useful in terms of providing evidences for declining levels in physical activity, it was cross-sectional and only focused on physical education curriculum time and did not take into consideration time outside of the school setting. This research finding is consistent with the statement made by the Chief Medical Officer in his 2009 Annual Report on the 'State of Public Health' (Department of Health, 2010a: p25) which stated:

> *Over the adolescent period, sport drop-out rates are high. This has informed a recent Sport England target to have 25% fewer 16-18 year olds dropping out of at least five selected sports.*

In this report, the Chief Medical Officer (Department of Health, 2010a) also stressed the influence of age on physical activity and the diverse motivating factors and barriers to physical activity at different stages of life. During the period of adolescence, the Chief Medical Officer points out that the key motivating factors in keeping physically active are team and peer influences and role models. In contrast, the Chief Medical Officer suggested that the likely barriers to keeping physically active during adolescence are 'buddies' and popular sedentary activities (for e.g., TV viewing). In addition, a recent publication by the Department of Health ('Start Active, Stay Active'), recognition is demonstrated of the decline during the period of interest in the present study when it is stated that '...the transition from compulsory education into employment for young people who leave school coincides with a general decrease in physical activity in both boys and girls' (2011: p28).

The completion of compulsory education (i.e., the movement out of high school) is characterised by many life transitions that may influence health behaviours (Baranowski et al., 1997). Major life transitions (e.g., starting further education, work-based training, employment) are times when changes occur in various aspects of a person's life and thereby may contribute to behaviour change (Hamburg, 1980). In particular, some transitions have been understudied, such as the transition from late adolescence to adulthood, especially that from high school (Baranowski et al., 1997). Furthermore, graduation, or other departure, from high school is one of the major life transitions between adolescence and adulthood, especially for adolescents who do not proceed to college (Baranowski et al., 1997*)*. Education is one of the strongest predictors of health because the more schooling people have the better their health is likely to be (Freudenberg and Ruglis, 2007). The less schooling people have, the higher their levels of risky health behaviours such as smoking, being overweight or having a lower level of physical activity (Lantz et al., 1998).

In relation to the adoption of a physically active lifestyle, the early years of adulthood are crucial. During this period, significant changes in life circumstances may be strongly influencing physical activity patterns. In particular, the patterns for the years around the time of finishing school and either entering the workforce or starting tertiary studies have not been documented (Leslie et al., 2001). In addition, what adolescents do in their teenage years may set the pattern for long periods of adulthood, as people establish many of their lifestyle choices as they proceed through adolescence (Hallal et al., 2006a).

The need for future research into physical activity and sedentary behaviour of adolescents, among the period between completing compulsory education and beyond is required (Daley, 2002). More specifically, the impact of leaving school upon physical and sports participation is unknown (Foster et al., 2005). To date, there do not appear to have been any large-scale longitudinal studies of changes in physical activity and sedentary behaviour in U.K. youth apart from one (i.e., Henning Brodersen et al., 2007). This gap in the evidence base is further confirmed by the recently formed Sedentary Behaviour and Obesity Expert Working Group who state that in relation to correlates of sedentary behaviour 'Longitudinal studies are sparse' (2010a: p45). In addition, few studies have followed adolescents longitudinally, in addition to examining multiple predictors of physical activity simultaneously (Kahn et al., 2008). Longitudinally investigating physical activity and sedentary behaviour of adolescents during the critical period between completing compulsory education and entering further education, training, employment or unemployment is required because of the potential to highlight the most critical period for interventions to halt the decline in physical activity (Telama and Yang, 2000). Further, identifying factors that are associated with changes in physical activity and sedentary behaviour will enable the development of specific and effective prevention strategies for specific groups such as adolescents transitioning from compulsory education in the U.K. (Tammelin, 2005).

5.21 Summary

Considering the evidence provided in this literature review, it is clear that the transition out of compulsory education in the U.K. is a key period in adolescents' lives. From a physical activity and sedentary behaviour perspective, the changes that possibly occur over a longitudinal period in this important transitional phase are under-researched in the U.K., and research into these two crucial life-enhancing behaviours are greatly required to add to a depleted evidence base. In addition, this particular section has demonstrated that the majority of the research undertaken has been in relation to 'sport' rather than 'sport and physical activity' and 'sedentary behaviour'. This is a clear limitation of the current evidence base that exists during the period of adolescence when completing compulsory education. Chapter 6 focuses on the methods used in the present study.

CHAPTER 6: METHODS

This chapter sets out the design of the study from the planning phase through to completion. The procedures followed for data collection, participant selection and recruitment, and the methods adopted for processing the data are presented, explained and justified. Relevant ethical considerations are also detailed.

6.1 Introduction to the study design

The present study adopted a prospective population-based longitudinal design using a large cohort of adolescents in Gloucestershire. Population surveys are typically used to determine the prevalence, sociodemographic distribution and trends in physical activity participation (Booth, 2000). Population-based longitudinal designs are becoming more popular within an applied research setting (James et al., 2008; James et al., 2009). Longitudinal study designs have many advantages in comparison to cross-sectional designs. The longitudinal design adopted in the present research involved self-administration of a 'Sport and Physical Activity Questionnaire' to a cohort of adolescents at two time points, following a two-staged planning phase and pilot study. The first time point was at baseline when adolescents were in their final year of compulsory education (Year 11) and the same adolescents were followed up approximately six months later, at the second time point, when they were either in sixth form education, employment, training or unemployment. This second-time point involved two stages as detailed later in Section 6.5. The pilot study was undertaken with two groups of Year 11 pupils in two secondary schools in Gloucestershire prior to commencing data collection at baseline. In essence, the sequence of research phases involved four key stages (two-staged planning phase, pilot study, baseline and follow-up stages one and two) as indicated in Figure 6.1 below. Each stage is explained in the following four sections.

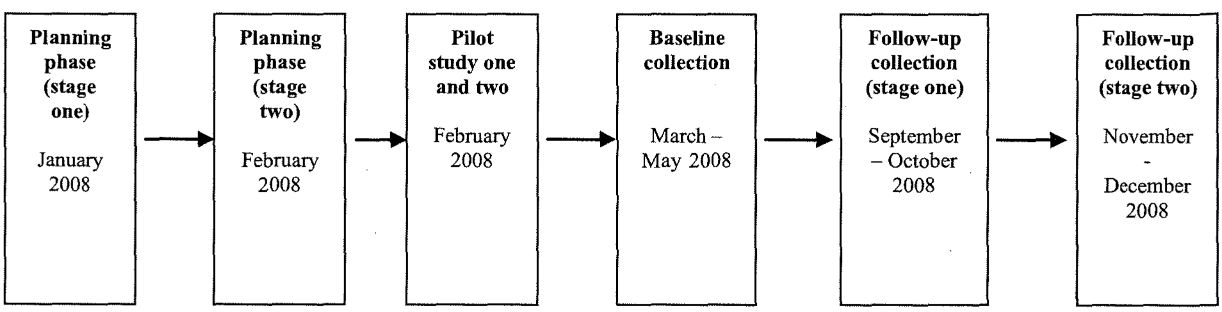

Figure 6.1 – The sequence of research phases

6.2 Planning phase and procedures

The planning phase included two stages, investigation and selection and invitation and recruitment. The initial planning phase was the investigation and selection stage, which identified all educational establishments residing within the county of Gloucestershire, U.K. The process for this involved consulting Gloucestershire County Council's 2007/2008 Directory of Gloucestershire schools and establishments (Gloucestershire County Council, 2007). From inspection of this Directory, it was identified that 43 mainstream secondary schools were eligible for inclusion in the study. The next stage involved identification of all independent (private) schools residing within Gloucestershire that educated Year 11 pupils. Various web sites were consulted for independent schools in Gloucestershire and numerous telephone calls were made to independent schools to establish if they taught Year 11 pupils. At the completion of the investigative process into independent schools in Gloucestershire, it was decided that 10 independent schools were eligible for inclusion in the study. As a result of this process, 53 secondary schools (43 mainstream, 10 independent) were identified as meeting the inclusion criteria for the study. The main inclusion criteria consisted of the following:

- Mainstream secondary school / independent school establishment educating a cohort of Year 11 pupils undertaking their GCSEs in the period between September 2007 – June 2008.
- Mainstream secondary school / independent school establishment residing within the county of Gloucestershire and one of the six districts in Gloucestershire (Cheltenham, Gloucester, Stroud, Cotswolds, Forest of Dean, Tewkesbury).

In the next phase of planning, the invitation and recruitment stage, involved inviting all 53 schools to participate in the study. Firstly, the Headteacher at each school was contacted via a telephone call and asked for permission/consent to approach their respective school. Following consent being granted by the Headteacher, a letter was sent to the Head of Year 11 at each school inviting them formally to take part in the study. The invitation letter sent was slightly different for the state/mainstream schools (Appendix 1) compared to the private/independent schools (Appendix 2).

This was because the procedures were different for the option to return completed questionnaires as state schools had the option to send the questionnaires to the County Council in the postal system. In comparison, private schools did not have this option. Among schools where there was no distinguished Head of Year 11, the invite letter was addressed to the relevant Year 11 Tutor, Deputy Headteacher or Personal, Social and Health Education (PSHE) Tutor. Telephone calls were made to obtain a named person to increase the likelihood of a response being received from each school. This invite letter explained the purpose of the study and what Year 11 pupils would be required to do. A reply slip was enclosed with the invitation letter (Appendix 1 and Appendix 2) which asked for an answer within two weeks of the letter being issued, in addition to a detailed list of dates when the researcher could visit the school. A stamped self addressed envelope was also included for ease of return and to maximise response likelihood.

After the two week deadline had elapsed, the responses received were recorded and then began the process of making follow-up telephone calls to all 53 schools either to confirm dates and times to visit for data collection for those schools that had responded via the reply slip or for those schools that had not responded, to investigate if they were interested in taking part and to arrange dates for visit(s) to the schools for data collection. Following this process, 24 (22 mainstream, 2 independent) of the 53 schools approached agreed to take part (a 45.3% success rate). Arrangements were then finalised for baseline data collection to begin.

6.3 Pilot study

Prior to beginning baseline data collection, the questionnaire (entitled *'Sport and Physical Activity Participation and Sedentarism Questionnaire for Adolescents'*) was piloted over two stages with two Year 11 groups at two secondary schools in Gloucestershire in February 2008. The pilot questionnaire administered at the first school is provided in Appendix 3 and the pilot questionnaire administered at the second school is provided in Appendix 4. The purpose of both pilot visits was two-fold. Firstly, to test how easy pupils in Year 11 found the questionnaire to complete and, secondly, to make alterations to the questionnaire in response to the feedback received. These pilot visits helped to identify issues of validity as well as other possible problems with the questionnaire so that they could addressed prior to the start of the main study (Matthews and Ross, 2010). As a consequence, the pilot questionnaire was altered after the first pilot study visit, amended where changes were required and then the amended pilot questionnaire was administered to Year 11 pupils at the second school. An information sheet was also included with both the first pilot questionnaire and second pilot questionnaire (Appendix 5), in addition to a name and home address form (Appendix 6). This information sheet and name and home address form was the same at both schools. A total of 187 Year 11 pupils completed the pilot questionnaire at the first school and a total of 27 Year 11 pupils completed the amended pilot questionnaire at the second school.

The first school administered the questionnaire via teachers. The feedback received was that pupils found it relatively simple to complete although the wording of some questions was altered in response to feedback confirming that some Year 11 pupils found it difficult to understand the words used. For example, Question 7 in the pilot questionnaire administered at the first school (Appendix 3) that asks *'How many of the past 14 days have you done at least 60 minutes...'* was amended to *'On how many of the past 7 days have you done at least 60 minutes'* in the pilot questionnaire administered at the second school (Appendix 4) . This was based on pupils finding it difficult to recall what physical activity they had participated in over a 14 day period. Other alterations made to the pilot questionnaire administered at the second school (Appendix 4) based on feedback from pupils at the first pilot school included the classification of ethnic origin which was extended and altered, in addition to the inclusion of a question asking *who* pupils took part in sport or physical activity with (e.g., parents, friends etc.). Also, Question 10 on the pilot questionnaire administered at the first school that asks about 'screen time' '*during a normal week'* was split into two separate questions so that screen time could split into time during the week and weekend. The wording on the information sheet was also altered slightly due to feedback received from teachers in response to what teachers had been told by the pupils. These alterations to the information sheet took place at the completion of the pilot stage. Only one minor change was deemed necessary to the name and home address form (i.e., wording changed from *'postcode'* to '*home postcode'*). It was also suggested that an instruction sheet for teachers should be provided. Therefore, a teacher instruction sheet was created in response to this feedback, this can be found in Appendix 7.

After changes were made to the original pilot questionnaire, the second school allowed the researcher to visit the school and self-administer the amended pilot questionnaire (Appendix 4). This situation provided equally valuable feedback as pupils were able to provide direct feedback to the researcher regarding questions that were difficult to understand. Although pupils had to ask questions regarding some of the questions, these were covered through the instructions provided in the teacher instruction sheet (Appendix 7). No other issues were highlighted with the amended pilot questionnaire. The only change that was made was to the title of the amended pilot questionnaire from *'Sport and Physical Activity Participation and Sedentarism Questionnaire for Adolescents'* to *'Sport and Physical Activity Questionnaire'*. This change was made to make the questionnaire easier for pupils to understand at first glance. The questionnaire was then adjusted finally in preparation for baseline data collection.

6.4 Baseline data collection procedures and participants

Baseline data collection took place between mid-March 2008 and early-May 2008, covering a period of approximately seven weeks. At baseline, Year 11 pupils completed the questionnaire designed by the researcher (Appendix 8) at each of the 24 schools. Also included with the questionnaire was an information sheet detailing the purpose of the study and thanking the pupils for taking part in the study (Appendix 9). In addition, a name and address form was included with the questionnaire (Appendix 10). The purpose of asking for this confidential information consisted of two reasons. Firstly, so that it provided a point of contact at follow-up due to the study's longitudinal design. Secondly, each participating pupil's postcode was needed to determine socioeconomic status and area of residence. A statement was included on the information sheet explaining why this confidential information was required and it was made clear both on this letter and through verbal communication with the researcher that pupils did not have to give this information if they were not happy to. Only one of the 24 schools was not willing to allow pupils to divulge their name, home address and postcode. This was a girls' secondary school and it was agreed that the researcher could visit to administer the questionnaire and then code each questionnaire which corresponded to the name of each pupil. This list of codes and names were held by the school for the purposes of contacting these pupils at follow-up. This was deemed most appropriate because at follow-up (when the female pupils were in sixth form education etc.), they could make their own decision as to whether or not they wanted to divulge their name, home address and postcode.

The questionnaire was administered via two methods. Firstly, the researcher visited Year 11 assemblies, PSHE lessons and physical education lessons and administered questionnaires directly to participants. Secondly, where the school preferred for the researcher not to visit the school (for time constraint reasons), the questionnaire was administered by teachers with the aid of an instruction sheet provided by the researcher (Appendix 7). The instruction sheet contained strict and clear instructions for administration of the questionnaire. This ensured that the teacher(s) administering the questionnaire followed the same procedure as the researcher. Of the 24 schools that were involved in baseline data collection, 18 granted permission for the researcher to administer the questionnaire and visit the school. Six schools decided that they would assign their teachers to administer the questionnaires to their pupils. These particular questionnaires were then collected at a convenient time agreed with these six schools. It is important to highlight that each school's collection of completed questionnaires were immediately (usually within one day of collection) visually examined by the researcher to identify participants that had not answered some questions on the questionnaire. Therefore, providing that these participants had provided their name and home address, a letter was sent out requesting a response to these missing answers (Appendix 11). Their completed questionnaire was photocopied and the responses required were highlighted in red. At the completion of baseline data collection, a total of 2204 Year 11 pupils (aged 14 to 17 years) completed the questionnaire. Two weeks after the last school visit during baseline data collection, a letter of thanks was sent by the researcher to the person at each of the 24 schools who had enabled the researcher to collect baseline data from their Year 11 pupils (Appendix 12 (schools with no sixth form provision), 13 (schools with sixth form provision but no specific contact in sixth form) and 14 (schools with sixth form provision and a specific contact in sixth form). Of these 24 schools who also had sixth form centres within their school, the researcher also included the following statements (the one included depended on whether or not a specific name of a school official had been given for the follow-up stage during the baseline visit):

I would really appreciate it if I could come back into [name of school] between September and December of this year when some of the pupils that completed the questionnaire are in sixth form. I could then give the same questionnaire out again, which will only take ten minutes to complete.

Between September and December of this year, I will be attempting to follow up the same pupils that completed the questionnaire at baseline. In relation to those pupils that will have continued into the sixth form at [name of school], I will contact [name of contact given for follow-up visit] as suggested to enquire about arranging a follow up visit to the school.

6.5 Follow-up data collection procedures and participants

Follow-up data collection took place between late-September 2008 and mid-December 2008 covering a period of approximately 12 weeks. The follow-up stage involved a time phased approach with two stages adopted (shown in Figure 6.1). The first stage took place between late-September 2008 and late-October 2008 and involved a starting point of establishing which of the 24 schools involved in baseline data collection educated sixth form age pupils. This approach was decided upon because it would provide a 'captive' audience in which the same participants that completed the questionnaire at baseline would be likely to have continued into the sixth form at the school where they were in Year 11 previously. Through a process of elimination, it was found that 15 of the 24 schools had sixth form centres. 13 of these were mainstream schools and two were independent schools. As a letter of thanks had been sent to these 15 schools at the completion of baseline data collection expressing the researcher's interest in visiting each of these schools again for follow-up data collection, follow-up telephone calls were made to the contacts made at each school and proved effective as 13 of the 15 schools agreed to participate in the first stage of follow-up. Eleven of the schools (all mainstream) agreed that the researcher could visit the school and administer the questionnaire again and the other two schools (one mainstream and one independent) chose for the teachers to administer the questionnaire using a teacher instruction sheet again. However, this teacher instruction sheet was altered slightly at the follow-up stage from the instruction sheet used at baseline. For example, the paragraph instructing teachers to tell pupils not to complete the question relating to whether or not they have five or more A* to C GCSE passes in the baseline instruction sheet was deleted in the follow-up instruction sheet. Please see Appendix 15 for the teacher instruction sheet at follow-up.

Each of the 15 schools where necessary were contacted a minimum of five times each via a telephone call. Among some schools the number of telephone calls made was far greater because of the difficulty posed in managing to speak to the appropriate person that was dealt with during baseline data collection. Despite persistently contacting two of the 15 schools to enquire about their participation in the follow-up stage, no response was received from the one school (an independent school) and the sample size collected at baseline from the other school, although a response was received, was so small (n = 26), it was deemed more practical to contact the pupils from this school via the post rather than visit in-person. To facilitate the process and in order to target the specific pupils that completed the baseline questionnaire, the researcher provided each of the 13 schools with a list of the pupils that had completed the questionnaire at baseline. This was issued prior to attending the school or prior to delivering the questionnaires to the two schools in which teachers administered the questionnaire. Each school then organised for the pupils on the list to come together in a sixth form assembly or organised 'session' on a date and time agreed with the researcher.

The questionnaire administered at follow-up was consistent with the questionnaire administered at baseline except for two minor changes. Instead of asking *'School name/College name'* and *'School/College Sixth Form name/Workplace name'* the question *'What are you doing now?'* with the options of *'Studying full-time in Sixth Form/College'*, *'Working (including apprenticeship/trainee programme)'* or *'Unemployed/not working or studying'* was included. This was changed so that the status of each participant at follow-up could be recorded for statistical analysis purposes. The follow-up questionnaire is included in Appendix 16. The administration of the questionnaire by the researcher took place in a range of situations within the school including an organised group meeting, a sixth form assembly and in sixth form lessons. An information sheet/letter was included with the questionnaire for participants which thanked them for taking part in baseline and explained the purpose of the follow-up questionnaire (Appendix 17). A statement explaining that there was an incentive of a prize draw for a £30 Amazon voucher was included on the letter. A name, home address and home postcode were also requested again (Appendix 10) for two main reasons; firstly, it enabled the researcher to connect names of participants provided on the follow-up questionnaire with their corresponding baseline questionnaire, and secondly, postcodes not given by some participants in their baseline questionnaire could be given in the follow-up questionnaire which was needed for determination of socioeconomic status and area of residence. At the completion of this first stage of follow-up data collection, a total of 544 participants of the baseline cohort completed the questionnaire again (24.7% of the baseline cohort). The same process as used at baseline was adopted here regarding missing responses on questionnaires. Within one day of collecting each school's questionnaires, the researcher visually examined each questionnaire for missing answers to questions and providing that a name and address had been provided, sent a letter to each participant requesting the missing answers (Appendix 18). A photocopy of the questionnaire was sent with the missing answers highlighted in red.

The second stage involved mailing out the follow-up questionnaire (Appendix 16) to those participants who did not complete the follow-up questionnaire in stage one of follow-up and took place once the follow-up questionnaires from stage one had been matched with the baseline cohort through the data inputting process. This approach of using two stages (i.e., school-based survey and through mail) has been successfully undertaken in longitudinal studies measuring physical activity among adolescents (e.g., Sagatun et al., 2007; Sagatun et al., 2008). The second stage took place between mid-November 2008 to mid-December 2008.

It is important here to refer to Figure 6.2 which details the process for determining the number of questionnaires to mail out. From the original 2204 participants at baseline, 405 participants could not be contacted due to no contact details being provided (name, address and /or postcode) and 544 participants had already been followed up through sixth form visits in stage one. As a result of this process of elimination, 1255 (2204 – (405 + 544)) questionnaires were mailed out to the baseline cohort. Seventy-five of these questionnaires were sent out by the girls' secondary school that held the list of names and codes for each female pupil that completed the questionnaire at baseline. The researcher prepared all of the materials for this particular school and handed them to the Head of Year 11 who had been willing to co-operate in sending these questionnaires out. The follow-up questionnaire was sent out and included an information sheet thanking the participant for taking part at baseline and explained the purpose of the follow-up questionnaire (Appendix 19). This information sheet included minor differences to the information sheet utilised at stage one of follow-up (via in schools). The main difference included a return deadline date of Friday 12th December 2008 and the information sheet was personally addressed to the recipient. On the back of each questionnaire, the researcher also assigned a unique identifier code so that upon return of the questionnaire, it could be connected with each participant's baseline questionnaire. Consistently with the information sheet administered in stage one of follow-up, the information sheet in stage two of follow-up included a statement offering an incentive of a £30 voucher in a prize draw for returned questionnaires. A stamped self addressed envelope was also included with the follow-up questionnaire at stage two of follow-up with the intention to improve response rate. A name and home address form (Appendix 10) was included again with the questionnaire due to different reasons compared to those reasons at stage one of follow-up. Firstly, it was not requested for the purposes of collecting each participant's name as the unique identifier code had already been assigned but because it aided in verifying addresses provided at baseline that were not easy to read. A final deadline of December 12th 2008 was stressed again on this name and address form by including a pre printed sticker with this date on. At the completion of this second stage of follow-up data collection, a total of 342 questionnaires were received back from the 1255 sent out (a 27.3% response rate). As each questionnaire was received, the researcher visually examined each questionnaire as previously undertaken in the baseline and first stage of follow-up points to identify missing responses. The questionnaire was sent out again in the form of a letter and photocopy requesting these answers (Appendix 18). Following this additional data collection procedure was critical at this stage to improve the final sample size eligible for statistical analysis. At the completion of the two stages of follow-up, a total of 886 participants (aged 15 to 17 years) completed the questionnaire at baseline and follow-up, representing 40.2% of the cohort overall.

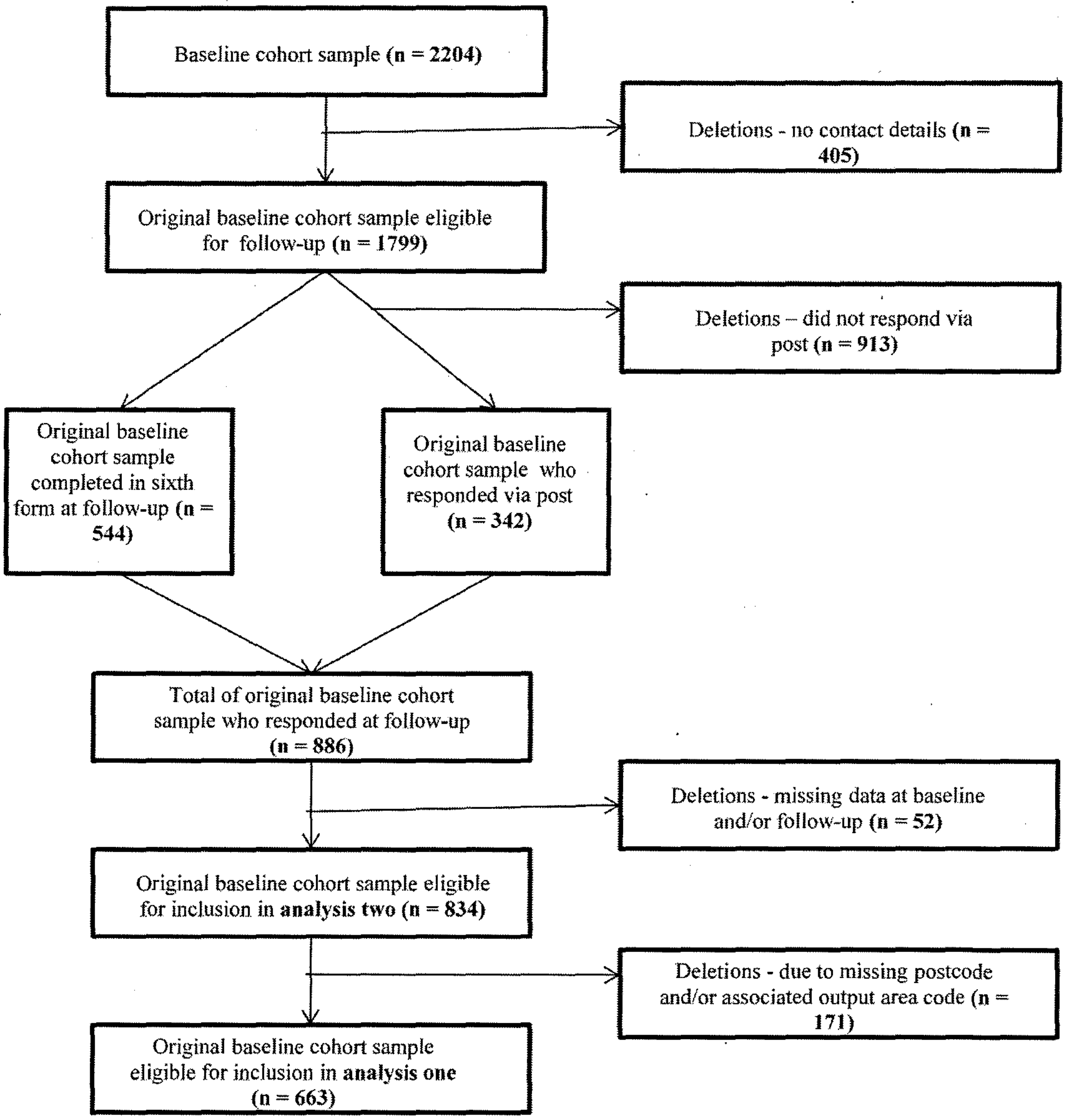

Figure 6.2 – Cohort progress and inclusion in final analyses

6.6 Data collection methods

As referred to previously, data was collected via the use of a self-administered questionnaire as designed by the researcher (Appendix 8 (baseline) and Appendix 16 (follow-up)). The questionnaire was designed by the researcher to meet the aims of the research, drawing on questions from an existing physical activity questionnaire; the 'Modifiable Activity Questionnaire for Adolescents' (Aaron et al., 1995b - see Section 3.1.1 for a detailed description of the questionnaire and its background). The main rationale for using the Modifiable Activity Questionnaire for Adolescents was because it contains questions on both physical activity and sedentary behaviour (i.e., screen time – watching TV and videos, playing computer or video games). In addition, validity and reliability of the questionnaire has been reported on use with adolescent populations (Aaron et al., 1993; Aaron et al., 1995b; Simon et al., 2004). This particular questionnaire developed by Aaron et al. (1995b) was ideally suited to the present study because it contains questions about physical activity regarding the number of times participated in for 20 minutes over a 14 day period and sedentary behaviour (screen time behaviours including watching TV and videos, playing computer or video games) regarding hours a day during a 'normal week' before or after school. However, the present study was interested in participants recall over the previous seven day period for physical activity of 60 minutes duration at 'moderate intensity' and screen time regarding hours a day during a 'normal week' and at weekends. Therefore, the physical activity question (question 6 on the present study's questionnaire) was re-designed and tailored to suit the dependent variable in the present study. Similarly, the screen time questions (question 10 and 11 on the present study's questionnaire) were re-designed and tailored to suit the dependent variable in the present study. Other data collected on the questionnaire (at baseline and follow-up) included the following:

- Age
- Gender
- Illness or disability status
- Ethnicity
- Name of school attended at ***baseline*** (determining type of school attended – mainstream/independent and sports college status)
- Status at ***follow-up*** (e.g., studying full-time in Sixth Form/College; Working (including apprenticeship/trainee programme); or unemployed/not working or studying)
- Home postcode (determining socioeconomic status (Townsend score) and area of residence (urban or rural))
- Educational attainment at ***follow-up*** (determined as 5 or more A* to C passes in GCSEs at follow-up)
- Participation in organised team or individual sports
- Participation in physical activity that was not an organised team or individual sport

- Groups that participants took part in sport or physical activity with (such as parent(s),sibling(s), classmates/workmates, teammate(s)/clubmate(s), boy/ girlfriend, friend(s), nobody
- Transportation to and from school/college/work (bus, train, car, bike, walk or other)
- Sessions of 30 minutes in sport and active recreation during an average week
- Intensity of sport and active recreation participated in (low intensity, moderate intensity and vigorous intensity)

Being faced with the task of designing and developing a questionnaire for the purpose of measuring physical activity and sedentary behaviour is difficult. In particular, measuring physical activity precisely and reliably is an almost impossible task when using survey designs (Anderssen et al., 2006). This is mainly because physical activity can be defined in several ways and consequently there is no single standard for measuring physical activity (Kriska and Caspersen, 1997). The same situation exists with the complexity and inconsistency of defining sedentary behaviour (as detailed in Section 2.1.3 of Chapter 2) and the consequent issues this has for the measurement of sedentary behaviour. The decision by the researcher to design a questionnaire for the present study was based on a number of important factors. Firstly, after researching validated questionnaires designed for an adolescent population, none of them included or enabled the specific research questions to be addressed that the present study was asking. For instance, because the present study was interested in investigating compliance with the U.K. (English) recommended guidelines for physical activity and recommended guidelines for screen time, it was not possible to find a questionnaire that was worded appropriately, not only for an adolescent to understand, but also that was consistent with the published statement on physical activity guidelines for young people in the U.K. (England) (Department of Health, 2004) and published statements on screen time guidelines for young people in Australia and the U.S. (American Academy of Pediatrics, 2001a, 2001b; Department of Health and Ageing, 2005a). Measurement of both behaviours added difficulty concerning the use of an existing validated questionnaire because very few questionnaires exist examining sedentary behaviour let alone both physical activity and sedentary behaviour. Numerous published studies which have focused on physical activity and/or sedentary behaviour among an adolescent population have designed their own questionnaires or have used questions modified from other validated questionnaires (Henning Brodersen et al., 2007; Lubans et al., 2007; Smith et al., 2007). Secondly, the researcher was interested in a number of different independent variables including socioeconomic status (determined through postcode), urban and rural classification (determined through postcode), educational attainment, gender, school type and ethnicity, which resulted in the questionnaire needing to be developed by the researcher. Thirdly, as the sample size required was large (in excess of 2,000 at baseline), a questionnaire was seen as the only feasible method of assessing physical activity and sedentary behaviour (Shephard, 2003).

Considering that self-report physical activity recall instruments can assess compliance with physical activity recommended guidelines (Dollman et al., 2009), and because there was no 'off the peg' questionnaire available, it was necessary for the researcher to construct their own questionnaire (Boynton and Greenhalgh, 2004). The researcher therefore made this decision based on the factors mentioned and consideration of other factors such as the purpose of the assessment, target group, research questions, resources available, time frame and context (Dollman et al., 2009). Success of the questionnaire design, in terms of participants understanding the questions, was ensured through the piloting of the questionnaire at two schools prior to baseline data collection (Boynton, 2004).

6.7 Inputting, cleaning and extraction of data

All baseline and follow-up data was input, cleaned and extracted through a logical process (identified in Figure 6.2). Firstly, all baseline data was manually input into a Microsoft Excel spreadsheet after the completion of the baseline data collection. This took place between May 2008 and August 2008. This included the inputting of all data collected on the questionnaire. Secondly, once the first stage of follow-up data collection (in school sixth forms) had been completed, the 544 questionnaires collected were matched to the cohort already in the spreadsheet and follow-up data was input. This took place between October 2008 and November 2008. Some data extraction then took place as 405 participants of the baseline cohort did not have any contact details and could not therefore be contacted at the follow-up stage. All 405 were therefore excluded from the spreadsheet. This consequently left 1255 participants who did not have any follow-up data inputted. Once the 342 follow-up questionnaires had been received for the second stage of follow-up, they were matched to the baseline cohort and the questionnaire data was input into the spreadsheet. This took place between December 2008 and February 2009. It was after this stage, between May 2009 and September 2009, that socioeconomic status measurement took place using the postcodes collected (please see Section 6.11). Following this process, the 913 participants that did not respond to the follow-up questionnaire were deleted from the spreadsheet. A total of 886 participants (represented by rows in spreadsheet) were therefore ready for final data cleaning and extraction.

Throughout the entire data inputting process, missing data was coded in the Excel spreadsheet as a '0' and participants with any cells in the spreadsheet with a '0' were double checked with the original questionnaire and then deleted/excluded from the final spreadsheet. In total 52 participants (i.e., 52 rows) were excluded at this stage from the final spreadsheet. This left 834 participants that were eligible for final analysis. However, only 663 of the 834 participants had postcodes that were able to be assigned to an output area (OA) code (needed for calculating socioeconomic status and area of residence (urban or rural) (both explained in Section 6.11)). As a consequence it was decided that two separate analyses would be conducted. These consisted of analysis one (sample of 663 who had an associated OA code to include in statistical analyses) and analysis two (sample of 834 which did not have an associated OA code included in statistical analyses). As a result of the cleaning and extraction of the data undertaken, two Microsoft Excel spreadsheets (analysis one and analysis two) were finalised with fully complete data sets (i.e., no missing data).

6.8 Selection of independent variables

The independent variables included for analysis one (Research Question 2 and Research Question 4) included: gender; ethnicity; educational attainment; school type attended (at baseline); area of residence; and socioeconomic status. Gender was entered as a categorical variable ('male' or 'female'), ethnicity was entered as a categorical variable ('White' or 'other'), educational attainment was entered as a categorical variable ('no' or 'yes' regarding 5 or more A* to C passes at GCSE); and school type attended at baseline was entered as a categorical variable ('state/mainstream' or 'private/independent') in the final data set. Socioeconomic status was entered as a categorical variable ('least deprived' to 'most deprived' in four quartiles) as was area of residence ('urban' or 'rural'). The independent variables for analysis two (Research Question 2 and Research Question 4) included: gender; ethnicity; educational attainment; and school type attended at baseline. They were entered using the same format as described for analysis one. The rationale for choosing each of these demographic independent variables (i.e., gender, ethnicity, socioeconomic status and educational attainment) and the environmental independent variables (i.e., school type and area of residence) in relation to their possible association with adolescents' physical activity and sedentary behaviour has been previously provided in Sections 5.6 and 5.19 of Chapter 5. In addition, both of these sections also provided a rationale for the majority of independent variables being demographic variables. One other independent variable was also considered (status at follow-up) for the main analysis but was rejected on the basis of an uneven distribution (i.e., those in education versus those in employment or unemployed). However, it was included in the further analysis section (Section 7.5.2) of Chapter 7. In addition, physical activity at baseline and screen time status at baseline were included as an independent variable in the further analysis section (Section 7.5.3) of Chapter 7.

6.9 Dependent variables

The dependent variables included physical activity at baseline and follow-up (for the purposes of answering Research Question 1), physical activity at follow-up (for the purposes of answering Research Question 2), screen time status at baseline and follow-up (for the purposes of answering Research Question 3) and screen time status at follow-up (for the purposes of answering Research Question 4).

6.9.1 Physical activity at baseline / follow-up (post compulsory education completion)

Physical activity at baseline and physical activity at follow-up were the dependent variables used in Research Question 1. Physical activity at follow-up was the dependent variable used for Research Question 2. This dependent variable (baseline and follow-up) was expressed as a binary outcome (i.e., those participants meeting U.K. (English) (Department of Health, 2004) recommended guidelines of a total of at least 60 minutes of at least moderate intensity physical activity on each day of the week and those not meeting this criterion). In order to determine this dependent variable, Question 6 on the questionnaire was used which stated:

> ***Question 6***
>
> *On how many of the past 7 days have you done* ***at least 60 minutes (in a number of bouts or in total)*** *of sport or physical activity, which has made you slightly out of breath, made your heart beat faster, made you feel warmer* ***but did not necessarily*** *make you feel exhausted or tired? (Sport or physical activity includes, for example, walking to and from school/college/work, organised sports and games [including time in PE class], a newspaper delivery round, exercise classes, and recreational activities such as dancing, which can also be included in this)*
>
> *( ) None   ( ) 1 to 2 days   ( ) 3 to 4 days   ( ) 5 to 6 days*
>
> *( ) 7 days*

It was simple to categorise this dependent variable consistently with the U.K. (English) recommended guidelines by categorising those participants that indicated '7 days' as 'meeting guidelines'. Those participants that ticked other options to this question were categorised as 'not meeting guidelines'.

6.9.2 Screen time status at baseline / follow-up (post compulsory education completion)

Screen time status at baseline and screen time status at follow-up were the dependent variables used in Research Question 3. Screen time status at follow-up was the dependent variable used for Research Question 4. This dependent variable (baseline and follow-up) was also expressed as a binary outcome (i.e., those participants meeting the recommended guidelines ((U.S.) American Academy of Pediatrics, 2001a, 2001b; (Australia) Department of Health and Ageing, 2005a) of no more than two hours a day (i.e., 14 hours or less a week) of screen time and those not meeting this recommended guideline (i.e., more than 14 hours a week)). In order to determine this dependent variable, Questions 10 and 11 on the questionnaire were used which stated:

Question 10
*How many **<u>hours a day</u>** do you watch television and DVDs, play computer or video games, or use a computer **before or after** school/college/work **(you can also include lunchtime and break times at school/college/work)**?*

( ) None ( ) 1 hour or less ( ) 2 to 3 hours ( ) 4 to 5 hours

( ) 6 or more hours

Question 11
*How many **<u>hours a day</u>** do you watch television and DVDs, play computer or video games, or use a computer **<u>at the weekend?</u>***

( ) None ( ) 1 hour or less ( ) 2 to 3 hours ( ) 4 to 5 hours

( ) 6 or more hours

6.9.3 Calculation of screen time status quantification

The technique undertaken for quantifying the amount of screen time participated in by participants at baseline and follow-up followed a logical process devised by the researcher. Firstly, a 'crib' sheet was devised by the researcher (Appendix 21) which indicated a total amount of screen time depending on which options had been ticked by each participant for Question 10 and Question 11 on the questionnaire at both baseline and follow-up. For the option ticked for Question 10 (which referred to the number of hours a day spent on screen time during a 'weekday'), the middle value of this option was taken and multiplied by five (for five weekdays) with the exception of the 'none', '1 hour or less' and '6 or more hours' options because no specific middle value could be assigned to any of these options. The option of 'none' was treated as '0', '1 hour or less' as '1 hour' and '6 or more hours' as '6 hours' and multiplied by 5. For the option ticked for Question 11 (which referred to the number of hours a day spent being on screen time during the 'weekend'), the middle value of this option was taken and multiplied by two (for two weekend days). The same procedure was applied to the 'none', '1 hour or less' and '6 or more hours' options as previously explained. The two calculated values were then added together and this gave the total amount of screen time for the whole seven day period. A cut-off point of 14 hours a week was set as the categorisation for whether a participant was classed as 'meeting guidelines' or 'not meeting guidelines'. More precisely, it was decided by the researcher, using all available evidence to classify those participating in 14 hours or less of screen time as 'meeting guidelines' and those participating in more than 14 hours of screen time as 'not meeting guidelines'. This decision was mainly made based on the recommendation by the (Australian) Department of Health and Ageing (2005a) of spending no more than two hours a day using electronic media for entertainment and the American Academy of Pediatrics (2001a, 2001b) of less than two hours of total media time (screen time) per day for children and adolescents (i.e., in both cases, seven days multiplied by two hours). This classification of screen time status is similar to the method used by Gordon-Larsen et al. (2004) and Scully et al. (2007). Gordon-Larsen et al. (2004) classified respondents in their study as achieving 14 hours or less or more than 14 hours of weekly screen time. The criterion (the most desirable) set in their study was those respondents achieving 14 hours or less of screen time per week in adolescence (i.e., the category of 'meeting guidelines'). Scully et al. (2007) classified respondents in their study as achieving two hours or less a day (the recommended maximum level) or not. It was reasoned that 14 hours a week was a sensible cut-off point considering that only one type of sedentary behaviour (i.e., 'screen time') was measured.

6.10 Background to socioeconomic status measurement

Socioeconomic status is one of a number of terms (e.g., social class, social stratification, social status) used interchangeably despite the differences that exist regarding theoretical bases and, therefore, interpretations (Galobardes et al., 2006a). Socioeconomic position is another term used and this refers to the social and economic factors that influence positions individuals or groups hold within the structure of a society (Krieger et al., 1997; Kriska and Caspersen, 1997; Lynch and Kaplan, 2000). The terms 'socioeconomic position' and 'socioeconomic status' are used interchangeably in this particular section of the chapter. Following this section, socioeconomic status was used for a consistent approach. Importantly, it is suggested that when choosing a socioeconomic position measurement, it is best informed by consideration of the specific research question and the proposed mechanisms linking socioeconomic position to the outcome (Galobardes et al., 2006a).

A number of different measures of socioeconomic position have been adopted in health research (Adams et al., 2005). These measures consist of individual level measures (indicators) and area level measures (indicators). Individual level measures include education, occupation-based indicators (e.g., U.K. National Statistics Socio-Economic Classification), income and wealth, unemployment, housing, overcrowding, composite indicators (at individual level such as Hollingshead Index of Social Position) and proxy indicators (e.g., number of siblings). Firstly, education is commonly used as a generic indicator of socioeconomic position in epidemiological studies due to the capturing the knowledge-related assets of an individual (Lynch and Kaplan, 2000). Education can be measured as a continuous variable (years of completed education) or, on the other hand, as a categorical variable through assessing educational milestones such as completion of high school, higher education diplomas or degrees (Galobardes et al., 2006a). Through measuring as a continuous variable, there is the assumption that every year of education contributes similarly to a person's attained socioeconomic position and that time spent in education has greater importance than educational achievements (Liberatos et al., 1988). Through using categorical variables, there is the assumption that specific achievements are important in determining socioeconomic position (Liberatos et al., 1988). The level of education attained by an individual therefore captures the social opportunities for education, and parents' choices and constraints over how they can influence their children's socioeconomic circumstances as education will be a strong determinant of an individual's future employment and income (Davey-Smith et al., 1998). The level of educational attainment achieved by an individual is therefore arguably the most widely used indicator of socioeconomic status (Shavers, 2007). This is also because the use of education as indicator of socioeconomic position is relatively easy to measure in self-administered questionnaires, and response rates to educational questions have a tendency to be high in comparison to more difficult-to-assess measurements (e.g., income) (Galobardes et al., 2006c).

Secondly, occupational-based indicators are widely adopted in the U.K. This is because social stratification has historically been conceptualised in terms of a person's occupation and is recorded systematically on all death certificates (Galobardes et al., 2007). There is a long list of indicators based on occupation but there are numerous limitations such as: (1) classifications such as 'manual' and 'non manual' may lose some of their meaning due to a large number of low paid non-manual service jobs and (2) unemployed people are often excluded in occupation-based classifications thus resulting in an underestimation of socioeconomic differentials (Martikainen and Valkonen, 1999). Other groups that are commonly excluded include students and people who work inside the home. Occupational classifications measure specific aspects of socioeconomic position but they also explain the association between occupation and health-related outcomes. For instance, occupation (parental or own adult) is strongly related to income and consequently any association between occupation-based socioeconomic position and health could indicate a direct relationship between material resources and health (Galobardes et al., 2006c).

Thirdly, the indicator of income and wealth directly measure the material resources circumstances (Lynch and Kaplan, 2000). Income is the indicator that can change most on a short term basis although this is rarely taken into account in epidemiological studies and its effect on health may accumulate over the lifecourse (Lynch et al., 1997; Duncan et al., 2002). Income represents the 'flow' of economic resources over a period of time (Shavers, 2007). On the other hand, wealth includes, in addition to income, financial and physical assets such as the value of housing, cars, investments, inheritance and pension rights (Muntaner et al., 1998). Whereas income captures the resources at a particular point in time, wealth measures the accumulation of these resources (Galobardes et al., 2007). In relation to income, most often, household income rather than individual income is measured (Galobardes et al., 2006c). However, income for young people and older adults is a less reliable indicator of true socioeconomic position due to income typically following a curvilinear trajectory with age (Galobardes et al., 2006c). The relative importance of wealth versus income is likely to change across the lifecourse (i.e., wealth being more important in older age due to accumulation of assets over time and impact of retirement on income (Lynch, 2001).

Fourthly, there are housing characteristics. The most popular characteristic is housing tenure. Housing tenure encompasses whether housing is owner occupied (owned outright or being bought with a mortgage) or rented from a private or social landlord (Galobardes et al., 2006a). Next, there is household amenities, which are predominantly used in epidemiological studies. Amenities include access to hot and cold water in the house, having central heating and carpets, sole use of bathrooms and toilets, having a refrigerator, washing machine or telephone (Galobardes et al., 2006c). Household conditions (e.g., presence of damp and condensation, rooms in the dwelling) and overcrowding are housing related indicators of material resources (Galobardes et al., 2006a). Crowding is calculated using the method of the number of persons living in the household per number of rooms available in the house (usually excluding kitchen and bathrooms) (Galobardes et al., 2006a). Put more specifically, overcrowding is defined as being above a specific threshold (commonly two or more people per room) (Galobardes et al., 2006c). Another amenity that has been shown to be a useful socioeconomic position indicator is car access (Abramson et al., 1982; Davey Smith et al., 1990; Macintyre et al., 1998). Overall, housing characteristics and amenities are used extensively as measures of socioeconomic position because they are relatively easy to collect but the main limitation is that the results from studies using housing indicators are difficult to compare when the context varies (Galobardes et al., 2006c).

Overall, occupation, education and income are the most traditional indicators of socioeconomic position. However, there are some major limitations in individual level measure such as these, particularly when the population being studied are older children and adolescents. For example, asking older children and adolescents about their parent's education, occupation or income may result in non-trivial levels of missing data and greater measurement error (Wardle et al., 2002). Another limitation of individual level measures is that if considered in isolation they provide only a partial view of socioeconomic inequalities in health (Galobardes et al., 2007).

In contrast to these limitations of individual level measures, area level measures are used when the object of analysis is not the individual but a geographical area socioeconomic position (Strong et al., 2006; Galobardes et al., 2007). Therefore, area level measures of socioeconomic position are needed when the aim is to investigate whether socioeconomic aspects of the place where a person lives (e.g., region, county etc.) over and above individual characteristics, affect that person's health (e.g., physical activity behaviour or sedentary behaviour) (Diez-Roux, 2002; Tunstall et al., 2004). Area level measures include aggregated individual level measures of socioeconomic status such as the proportion of unemployed and proportion with higher education which are aggregated to the required area level (e.g., census ward, county etc.) (Galobardes et al., 2007). Whilst in the U.S., median income of residents of areas such as census tracts zip codes have been used, in the U.K., researchers have mainly relied on aggregate deprivation scores based on census measures such as housing tenure, car ownership and social class (Ben-Shlomo and Smith, 1999). More specifically, composite measures can be created by using aggregates of several individual-level measures, where these area measures are referred to as indices of deprivation (Galobardes et al., 2006c). These indices of deprivation characterise areas on a continuum from deprived to affluent with the individual level indicators obtained from routine data, census or other administrative databases (Galobardes et al., 2006c). Examples of indices of deprivation include the Townsend Deprivation Index (Townsend et al., 1988) and the Index of Multiple Deprivation (Department of the Environment, Transport and the Regions, 2000). From a U.K. perspective, the geographical variations in deprivation obtained with these individual level indicators have important policy implications (i.e., in allocating public resources to areas) and have been used in health-related research (Galobardes et al., 2006b).

Through area level measures, it is possible for individuals to be linked via their residential postcode to a geographical area (e.g., census OA code) and consequently assigned a deprivation score representative of the area in which they live (Strong et al., 2006). An example of an area level measure where this is possible is the Townsend Deprivation Index (also referred to as the 'Townsend score'). The Townsend Deprivation Index is a simple census-based index of material deprivation calculated by the combination of four census variables and has been widely used (Norman, 2008). It is a measure of multiple deprivation using four variables, originally taken from the (British) 1991 Census (Townsend et al., 1988; Shaw et al., 2007). Firstly, 'unemployment' defined as the proportion of economically active people aged 16-74 years who are unemployed (representing lack of material resources and insecurity). Secondly, 'car ownership' defined as the proportion of households who do not own a car (a proxy indicator of income). Thirdly, 'home ownership' defined as the proportion of households not owner-occupied (a proxy indicator of wealth). Finally, 'overcrowding' defined as the proportion of households with an occupancy rating of -1 or less (representing material living conditions). The Townsend score for each area is a summation of the standardised scores (z scores) for each variable with a greater score indicating a higher level of material deprivation (Galobardes et al., 2006b). The average is 0, and scores may be negative (less deprived) or positive (more deprived) (Shaw et al., 2007). Similar indices to the Townsend Deprivation Index are the Carstairs deprivation index, the Jarman or Underprivileged Area score and the Index of Multiple Deprivation (Galobardes et al., 2006b). In particular, the Index of Multiple Deprivation is a summary measure of area-level deprivation that combines weighted scores in seven deprivation domains at the Lower Super Output Area level (Noble et al., 2004). These seven domains comprise of: income deprivation; employment deprivation; health deprivation and disability; education, skills and training deprivation; barriers to housing and services; living environment deprivation; and crime (Lake et al., 2009). In comparison to the Townsend Deprivation Index, the main distinct weakness of the Index of Multiple Deprivation is that it only covers England, and similar indices for the other three countries in the U.K. are derived separately thus making them incomparable (Shaw et al., 2007).

The Townsend score was selected as the indicator of socioeconomic status in the present study. The main reasons to support this decision included that the Townsend score: (1) is considered as one of the best available measures of deprivation; (2) has been used extensively across British epidemiology; and (3) is arguably the most widely used area-based measure of deprivation in studies of health (Hoare, 2003; Shaw et al., 2007). This is mainly due to a consistent demonstration of construct validity through gradients of increasing morbidity (Morris and Carstairs, 1991; Eachus et al., 1996; Hoare, 2003) and mortality (Morris and Carstairs, 1991; Saul and Payner, 1999) in areas of increasing deprivation. It can also be calculated for the whole of the U.K. (Shaw et al., 2007). Importantly for the present study and the ultimate determination of rural and urban classification, there is evidence that the Townsend score performs similarly in urban and rural areas (Martin et al., 2000; Gilthorpe and Wilson, 2003). The Townsend index can be constructed for any geographical area for which census data are available and has been extensively used with the 1981, 1991 and 2001 censuses throughout the U.K., most usually calculated for OAs (Norman, 2008). In relation to physical activity and sedentary behaviour research, the use of the Townsend Score is becoming increasingly popular to determine socioeconomic status (Henning Brodersen et al., 2005; Henning Brodersen et al., 2007). Furthermore, physical activity research has recently utilised the Townsend score in order to determine rural and urban classification based on OA codes (Gidlow et al., 2007).

6.11 Socioeconomic status measurement and area of residence (urban/rural) classification

Methods to determine socioeconomic status followed the method used by Gidlow et al. (2007). This involved a number of stages. Firstly, an attempt was made to verify postcodes collected among the 2204 participants at baseline using the Post Office® (Royal Mail Group Ltd., 2008) address/postcode finder on the Post Office® website. This method of postcode verification had its limitations such as an inability to locate a postcode even with a participant's name and address present. Also there was the problem of ineligibility of participants' handwriting. The checking of postcodes was undertaken over a long period between May 2008 and February 2009. This was because the Post Office's 'Address/Postcode finder' is restricted to 15 searches a day for noncommercial use, therefore only 15 could be undertaken per day and 1799 were required (due to 405 participants not providing contact details) to be sought for completion of the database. Where a particular postcode could not be verified through the address/postcode finder on the Post Office® website, the 'Residential Numbers' checking facility through the BT phone book website (British Telecommunications Plc, 2008) was used to verify a postcode.

Verified postcodes were then used to determine the OAs in which participants lived. This took place between May 2009 and September 2009. Following the launch of the 2001 Census, OAs (of which there are 175,434 in England and Wales) have been introduced as the smallest statistical geography (The Countryside Agency et al., 2004). The determination of OAs from postcode data involved using lookup tables (ordered from the Office for National Statistics) which contained all postcodes in England and Wales that existed on the Census night 2001. These lookup tables were contained on a compact disc that also comprised population estimates for each postcode and the OA in which a postcode lies. The next step involved the assigning of OA codes to participants' postcodes in Microsoft Access. A 'query' was run in Microsoft Access to achieve this and successfully matched 1505 postcodes to the relevant OA code to the baseline sample of 2204. Of the baseline cohort of 2204, a total of 405 participants did not provide their postcode at baseline and consequently

1799 postcodes were eligible for connection to an OA code. Overall, 294 postcodes could not be connected to an OA code. This was mainly due to the 2001 Census being used which, at the time of undertaking the analysis in 2009, was eight years old. This is one of the main limitations to be expected when using census data due to the potential for data to become 'out of date' as a consequence of the 10-year time lag (Gidlow, 2006). This was justified though as the 2001 Census was the most recent Census available at the time of the present study.

The next step involved assigning socioeconomic data to participants in order to construct the Townsend score. Therefore, Univariate Census Area Statistics tables were downloaded from the Casweb website for Census 2001 data (Casweb, 2009). These tables were downloaded as comma separated files and saved as Excel spreadsheets. They provide a detailed breakdown for a single topic and are available at OA level (Gidlow, 2006). The Univariate Census Area Statistics tables downloaded are indicated in Table 6.1.

Table 6.1

Specific Univariate Census Area Statistics tables downloaded from Casweb website

Data Source	***Variable***	***Units of output***	***Output level***	***Townsend score***
Census 2001	UV028 - Economic activity	Residents	OA	✓
Census 2001	UV059 - Occupancy	Households	OA	✓
Census 2001	UV062 - Cars and vans	Households	OA	✓
Census 2001	UV063 - Tenure (households)	Households	OA	✓

6.11.1 Townsend score construction

The Census 2001 defines the four variables used to construct the Townsend score as including unemployment, proportion of households with no car, proportion of households that are not owner occupied and the proportion of households with overcrowding. The Townsend score for each area is a summation of the standardised scores (z scores) for each of the four variables; a greater score indicates higher levels of material deprivation (Galobardes et al., 2006b). The four tables downloaded (as indicated in Table 6.1) contained the relevant socioeconomic data required to calculate the Townsend score. The four stages followed are explained next, which identify the precise calculations that were performed in the construction of the Townsend score for each of the OAs. All calculations were undertaken in Microsoft Excel between May 2009 and September 2009.

Stage one involved the calculation of percentage values for each component (Table 6.1). Stage two created four variables by transforming the proportions for unemployment and overcrowding using a logarithmic transformation creating symmetrical distributions before the next step of standardisation. In Stage three, each variable was standardised to a mean of zero with a standard deviation of one. This ensured that all four variables contributed equal weight in the index. The resultant standardised Zscores were then simply summed in the final stage (Stage four) to produce a Townsend score for each OA (n = 1503) (for two of the OA codes it was not possible to calculate a Townsend score), which ranged from -7.19 to +6.25, higher values indicating high levels of deprivation. In summary, each of the four variables was divided by the appropriate count of households or persons to obtain a percentage score. A 'query' was then run again in Microsoft Access to assign this socioeconomic data (the four variables of interest in Table 6.1) and the calculated Townsend score to participants based on their associated OA code. Please see Appendix 22 for a more detailed breakdown of the stages followed in the Townsend score construction.

6.11.2 Area of residence (urban/rural) classification

Area of residence (urban and rural) classification was calculated using the Rural and Urban Area Classification 2004 (Bibby and Shepherd, 2004). Data on urban/rural classification and settlement type were obtained from the Office for National Statistics website (Office for National Statistics, 2009). The rural-urban classification was used to make a dichotomous variable on the basis of settlement population size (i.e., less than 10,000 or 10,000 or more). Populations of 10,000 or more are classified as 'urban' whereas populations of less than 10,000 are classified as 'rural'. However, the data that is downloaded at OA level comprised of four settlement types: urban (population over 10,000), town and fringe, village and hamlet and isolated dwellings. The latter three were categorised as rural and the former was categorised as urban. The 1505 OAs were classified according to the proportion of the population in settlements of various kinds within each OA. In other words, each OA was classified as urban or rural based on the population size of the settlement within which the OA resided (Gidlow et al., 2007). As the data source in the present study was based on unit postcodes (which produced results at the OA level through the 2001 Census), the OA was linked with the rural/urban classification through a simple lookup table and a breakdown by type of urban/rural area (The Countryside Agency et al., 2004). A final 'query' was run in Microsoft Access to assign urban/rural classification to participants based on OA codes. This took place between May 2009 and September 2009. The main data table containing all the participant data and assigned external data were then exported back into Microsoft Excel before finally being exported into the Statistical Package for the Social Sciences (SPSS) Version 16.0 for subsequent coding and data analysis.

6.12 Statistical analyses

Following the completion of data cleaning and extraction, the spreadsheet for analysis one and spreadsheet for analysis two were exported into SPSS Version 16.0 for analysis. The following research questions were then answered using the relevant statistical tests. Please note that Research Question 1 and Research Question 3 are dealt with first as they adopt the same statistical technique. Research Question 2 and Research Question 4 are then explained, for the same reasons.

6.12.1 Research Question 1 and Research Question 3

Research Question 1: Is there a change in physical activity in the transition between Year 11 and the period post compulsory education completion?

Research Question 3: Is there a change in screen time status in the transition between Year 11 and the period post compulsory education completion?

Research Question 1 investigated if there was a 'change' in physical activity (meeting guidelines or not meeting U.K. (English) recommended guidelines for physical activity) between baseline and follow-up (i.e., during the transition between completing Year 11 and starting sixth form, going into employment or training etc.). Similarly, Research Question 3 investigated if there was a 'change' in screen time status (meeting guidelines or not meeting recommended guidelines for screen time) between baseline and follow-up (i.e., during the transition between completing Year 11 and starting sixth form, going into employment or training etc.).

When deciding on the appropriate statistical test, it was deemed most appropriate that the McNemar test of significance of changes should be used. The McNemar test was suited to answering both of these research questions because they are both looking at change over time (baseline and follow-up) of the categories of a nominal variable (i.e., meeting or not meeting recommended U.K. (English) recommended guidelines for physical activity / meeting or not meeting recommended guidelines for screen time) in which a sample is placed (Howitt and Cramer, 2008). This test requires that the nominal variable can only have two different categories and this assumption is therefore met through the two nominal variables included in each of these research questions. In addition, the McNemar test assesses the significance of the difference between two dependent samples when the variable of interest is a dichotomy. For both Research Question 1 and Research Question 3, this is the case in both. The McNemar test is the chi-square equivalent of a related test (Howitt and Cramer, 2008). This test is an ideal choice of statistical test to measure changes in physical activity and screen time status during this transitional period because the present study is essentially a 'before-after' study in which the same people (cohort) were surveyed at two different points in time. The McNemar test only considers those pairs (e.g., meeting guidelines at baseline to not meeting guidelines at follow-up) for which a change has occurred, in addition to analysing whether any changes tend to occur in one direction or the other (Argyrous, 2011). Both analysis one and analysis two were used for both research questions. For reasons explained previously in Section 6.7, analysis one contained the sample of 663 participants whom have a full data set including an associated OA code to each participant's relevant postcode. Analysis two contained the sample of 834 participants with a full data set but not all postcodes have an associated OA code.

6.12.2 Research Question 2 and Research Question 4

Research Question 2: How is physical activity post compulsory education completion associated with a range of independent variables?

Research Question 4: How is screen time status post compulsory education completion associated with a range of independent variables?

Research Question 2 examined associations between the independent variables referred to in Section 6.8 and the dependent variable (physical activity at follow-up). Research Question 4 also examined associations between the independent variables referred to in Section 6.8 and the dependent variable (screen time status at follow-up). In order to examine associations between the independent variables and the dependent variable, binary logistic regression (BLR) was used. Binomial (or binary) logistic regression is a form of regression which is used when the dependent variable is dichotomous and the independent variables are of any type (Garson, 2006). Studies that have used BLR are becoming more popular in the area of physical activity (Harrison et al., 2005; Gidlow et al., 2007; James et al., 2009). Further, its popularity is increasing, particularly among studies using prospective population-based longitudinal designs (Gidlow et al., 2008a; James et al., 2008). BLR is used to predict (and hence to explain) the presence or not of any event (i.e., dependent variable, "Y") by other variables (i.e., independent or explanatory variables, "X1"...., Xp") (Mesa, 2004). The dependent variable is a discrete variable (i.e., dichotomous, with dummy variables coded 0, 1, where 0 is either the presence or absence of the event, and 1 is the opposite) (Mesa, 2004). On the other hand, the independent or explanatory variables may be continuous or discrete (categorical) (with dummy variables) (Mesa, 2004). Howitt and Cramer (2008) reinforce that any type of variable (continuous or nominal/categorical) may be used as the predictor variables in BLR.

Mesa (2004) stress that because the model for BLR assumes that the dependent variable, Y, is dichotomous, BLR analysis does not model this dependent variable directly as other non-logistic regression models (e.g., linear models). Logistic regression is suited to the design of the present study because a simple random sample of subjects was chosen and the values of the independent variables were determined, with subjects being followed for a fixed period of time and the outcome variables were measured (also known as the 'regression sampling model') (Hosmer and Lemeshow, 2000). The use of BLR results in easily interpreted odds ratios and confidence intervals, which are commonly reported in population studies. As the purpose of the analysis was to obtain the best set of predictors to categorise participants, it was justified to enter all the predictors at the same time into the analysis (Howitt and Cramer, 2008). This is known as the 'Enter' method or 'forced entry method', and was used in these analyses. In the 'Enter' method, all of the predictors are put into the regression model in one block with parameter estimates calculated for each block (Field, 2009). Other methods of entering predictors in a regression model include stepwise methods. The 'forward stepwise' method involves starting with a constant and then adding single predictors to the model based on a specific criterion (i.e., the value of the score statistic). The variable with the most significant score statistic is then added to the model (Field, 2009). During this forward method, the variables in the model are examined to see whether any should be removed. The 'backward method' involves beginning with all predictors included and then predictors are removed if they have a substantial effect on how well the model fits the observed data (Field, 2009). Both of these stepwise procedures have been criticised as they have the potential to be heavily influenced by random variation in the data with variables being included or removed from the model on purely statistical grounds (Pallant, 2007).

For both Research Question 2 and Research Question 4, analysis one and analysis two were conducted for reasons explained earlier in Section 6.7. As a result, six independent variables were entered into analysis one (Model 1 and Model 3) for both Research Question 2 and Research Question 4. Four independent variables were entered into analysis two (Model 2 and Model 4) for both Research Question 2 and Research Question 4. Consequently, the analysis comprised four models with binary dependent outcomes (as shown in Figure 6.3). Five of the six independent variables were dichotomies (coded '0' and '1') and one of the independent variables (socioeconomic status) consisted of four quartiles (coded '0', '1', '2' and '3').

Model 1

Dependent variable (0 = not meeting guidelines; 1 = meeting guidelines)
Physical activity at follow-up

Independent variables
Gender (0 = male; 1 = female), Ethnicity (0 = White; 1 = other), Educational attainment (0 = no; 1 = yes), School type (0 = state/mainstream; 1 = private/independent), Socioeconomic status (0 = Q1 – least deprived; 1 = Q2; 2 = Q3; 3 = Q4 – most deprived), Area of residence (0 = urban; 1 = rural)

Model 2

Dependent variable (0 = not meeting guidelines; 1 = meeting guidelines)
Physical activity at follow-up

Independent variables
Gender (0 = male; 1 = female), Ethnicity (0 = White; 1 = other), Educational attainment (0 = no; 1 = yes), School type (0 = state/mainstream; 1 = private/independent)

Model 3

Dependent variable (0 = not meeting guidelines; 1 = meeting guidelines)
Screen time status at follow-up

Independent variables
Gender (0 = male; 1 = female), Ethnicity (0 = White; 1 = other), Educational attainment (0 = no; 1 = yes), School type (0 = state/mainstream; 1 = private/independent), Socioeconomic status (0 = Q1 – least deprived; 1 = Q2; 2 = Q3; 3 = Q4 – most deprived), Area of residence (0 = urban; 1 = rural)

Model 4

Dependent variable (0 = not meeting guidelines; 1 = meeting guidelines)
Screen time status at follow-up

Independent variables
Gender (0 = male; 1 = female), Ethnicity (0 = White; 1 = other), Educational attainment (0 = no; 1 = yes), School type (0 = state/mainstream; 1 = private/independent)

Figure 6.3 - Four logistic regression models and the coding system assigned for BLR analysis

The number of independent variables entered into each analysis was restricted due to a checking method that was carried out prior to running the analyses. The checking method put forward by Peduzzi et al. (1996) was used. This involved dividing the number of the least common of the possible outcomes for the dependent variable by the number of independent variables. The resultant figure should be at least 10 (Peduzzi et al., 1996). In addition, it is advised that there should be at least 50 cases in each category of the independent variable (Tabachnick and Fidell, 1996). The precise calculations undertaken for these checking stages in the present study are detailed in Section 7.2 of the Results Chapter. Goodness of fit tests were reported on each model (the Hosmer and Lemeshow Test) which SPSS reports is the most reliable test of model fit available in SPSS (Pallant, 2007). Residuals were examined in the 'casewise list' produced as part of the SPSS output to investigate the fit of the data. Following the main analyses undertaken for Research Questions 1, 2, 3 and 4, a series of further analyses were undertaken to interrogate the data further in light of the findings revealed for these main research questions which are detailed in Chapter 7.

6.13 Ethical considerations

As adolescents were aged approximately 15 to 16 years at baseline and 16 to 17 years at follow-up, ethical concerns were particularly important to consider. The researcher was granted ethical approval by the University of Gloucestershire's Research Ethics Sub-Committee in February 2008 prior to making initial contact with schools. This ethical approval was granted based on adherence to the University of Gloucestershire's (2006) 'Guidelines for Involving Children and Young People in Research'. The researcher was also granted clearance to make contact and visit schools through a Criminal Records Bureau clearance check. This was granted in February 2008.

At the baseline stage, an information letter (Appendix 20) about the study was sent to parents, which was sent to the home of each participant via each participant. The 24 schools involved in baseline data collection agreed this would be the most practical way of administering this letter. This letter provided the parent or guardian with the opportunity to exclude their child from the study or contact with the researcher. Participants were also given an information sheet with the questionnaire (at baseline and follow-up) which was short, easy to understand and written in an appropriate language for the pupil. Consequently, there was no need for a consent form. Care was also taken in respect of personal identifiers on the questionnaire by having a separate name and address form on which participants completed their full name, home address and postcode. This ensured the anonymity of each participant and confidentiality of the responses provided. However, it was necessary for each participant's postcode to also be on the questionnaire due to the determination of socioeconomic status and area of residence. Additionally, each participant's questionnaire and corresponding name were coded in order for the researcher to undertake relevant data analysis at a later stage. All completed questionnaires and name and address forms were stored separately in a locked cupboard within a locked office.

Overall, this chapter has focused on the methods adopted in the present study. The next chapter presents the results in relation to the four research questions and further analyses.

CHAPTER 7: RESULTS

This chapter presents the results of the statistical analyses undertaken to answer the four research questions proposed, along with the further analyses undertaken. Please note that the term 'post compulsory education completion' as stated in all four research questions is referred to as 'follow-up'. Likewise, physical activity and screen time status during Year 11 (referred to in Research Question 1 and Research Question 3) are referred to as 'baseline'. As a reminder, analysis one included the final sample of participants who all had an associated OA code to include in statistical analyses (for socioeconomic status (i.e., Townsend score) and area of residence (urban or rural) determination). Analysis two included the final sample of participants who did not have an associated OA code included in statistical analysis.

The original baseline sample (n = 2204) included the following characteristics: gender (male: n = 1191; female: n =1009; missing answers: n = 4); age (14 years: n = 1; 15 years: n = 884; 16 years: n = 1307; 17 years: n = 9; missing answers: n = 3); and ethnicity (White: n = 2059; Mixed: n = 58; Asian or Asian British: n = 43; Black or Black British; n = 24; Chinese: n = 6; other ethnic group: n = 7; missing answers: n = 7). The baseline sample for analysis one included the following characteristics: gender (male: n = 362; female: n = 301); age (15 years: n = 253; 16 years: n = 408; 17 years: n = 2); and ethnicity (White: n = 625; Mixed: n = 14; Asian or Asian British: n = 13; Black or Black British: n = 7; Chinese: n = 3; other ethnic group: n = 1). The baseline sample for analysis two included the following characteristics: gender (male: n = 447; female: n = 387); age (14 years: n = 1; 15 years: n = 324; 16 years: n = 507; 17 years: n = 2); and ethnicity (White: n = 792; Mixed: n = 17; Asian or Asian British: n = 13; Black or Black British: n = 8; Chinese: n = 3; other ethnic group: n = 1). Table 7.87 contains a more detailed breakdown of the sample characteristics at baseline and follow-up.

7.1 Research Question 1: *Is there a change in physical activity in the transition between Year 11 and the period post compulsory education completion?*

The change in physical activity between baseline and follow-up was investigated using the McNemar test of significance of changes. Preliminary analyses were performed to ensure no violation of the assumptions. This included making sure that expected cell frequencies were five or more (Argyrous, 2011). Following preliminary analyses, through inspecting the output of a cross tabulation, this assumption was not violated (Appendix 23 for analysis one and Appendix 24 for analysis two). The descriptive breakdown of the variables included for analysis one and analysis two is detailed below in Table 7.1 and Table 7.2 respectively.

Table 7.1

Dependent variable frequencies (Research Question 1 – analysis one)

Dependent variable category	***Number***	***Percentage***
Physical activity at baseline		
Not meeting guidelines	570	86.0%
Meeting guidelines	93	14.0%
Physical activity at follow-up		
Not meeting guidelines	604	91.1%
Meeting guidelines	59	8.9%

Table 7.2

Dependent variable frequencies (Research Question 1 – analysis two)

Dependent variable category	***Number***	***Percentage***
Physical activity at baseline		
Not meeting guidelines	713	85.5%
Meeting guidelines	121	14.5%
Physical activity at follow-up		
Not meeting guidelines	757	90.8%
Meeting guidelines	77	9.2%

For the sample included in analysis one (n = 663), there was a significant change in the number of participants who were meeting guidelines for physical activity at baseline but were not meeting guidelines for physical activity at follow-up (χ^2 = 10.89, $df = 1$, $p = 0.001$). An inspection of Table 7.3 for analysis one clearly shows that the direction of change is from meeting guidelines for physical activity at baseline to not meeting guidelines for physical activity at follow-up. For the SPSS output, please refer to Appendix 23.

For the sample included in analysis two (n = 834), there was a significant change in the number of participants who were meeting guidelines for physical activity at baseline but were not meeting guidelines for physical activity at follow-up (χ^2 = 13.80, $df = 1$, $p < 0.001$). An inspection of Table 7.4 for analysis two clearly shows that the direction of change is from meeting guidelines for physical activity at baseline to not meeting guidelines for physical activity at follow-up. For the SPSS output, please refer to Appendix 24.

For both analysis one and analysis two, cross tabulations were performed to investigate the percentages in each category for descriptive purposes. For analysis one, 3.9% (26 participants) were meeting guidelines for physical activity at baseline and follow-up. 10.1% (67 participants) were meeting guidelines for physical activity at baseline but not meeting guidelines for physical activity at follow-up whilst 5.0% (33 participants) were not meeting guidelines for physical activity at baseline but were meeting guidelines for physical activity at follow-up. Further, 81.0% (537 participants) were not meeting guidelines for physical activity at either baseline or follow-up. Please refer to Appendix 23 for cross tabulations from the SPSS output for Research Question 1 (analysis one). Table 7.3 contains the relevant percentages in parentheses.

For analysis two, 3.8% (32 participants) were meeting guidelines for physical activity at baseline and follow-up. 10.7% (89 participants) were meeting guidelines for physical activity at baseline but were not meeting guidelines for physical activity at follow-up whilst 5.4% (45 participants) were not meeting guidelines for physical activity at baseline but were meeting guidelines for physical activity at follow-up. Further, 80.1% (668 participants) were not meeting guidelines for physical activity at either baseline or follow-up. Please refer to Appendix 24 for cross tabulations from the SPSS output for Research Question 1 (analysis two). Table 7.4 contains the relevant percentages in parentheses.

Table 7.3

Physical activity at baseline and follow-up (analysis one)

Baseline	**Follow-up**	
	Not meeting guidelines	***Meeting guidelines***
Not meeting guidelines	537 (81.0%)	33 (5.0%)
Meeting guidelines	67 (10.1%)	26 (3.9%)

Table 7.4

Physical activity at baseline and follow-up (analysis two)

Baseline	**Follow-up**	
	Not meeting guidelines	***Meeting guidelines***
Not meeting guidelines	668 (80.1%)	45 (5.4%)
Meeting guidelines	89 (10.7%)	32 (3.8%)

7.2 Research Question 2: *How is physical activity post compulsory education completion associated with a range of independent variables?*

BLR was performed to assess the association of a number of factors on the likelihood that participants would meet the U.K. (English) recommended guidelines for physical activity at follow-up. It is important to highlight here that prior to running the analysis for the BLR for Model 1 and Model 2 which are both covered here in Research Question 2, and Model 3 and Model 4 which are covered in Research Question 4, important underlying assumptions were checked such as sample size (please refer to Appendix 25) and multicollinearity (please refer to Appendix 26). Further, with a view to determine that there were sufficient cases for the number of variables included in the BLR analysis, a checking method was carried out. To calculate this, the technique advised by Peduzzi et al (1996) was followed. Peduzzi et al. (1996) suggested that the number of the least common of the possible outcomes (i.e., the dependent variable) divided by the number of independent variables should be at least 10. As the least common of the possible outcomes was 59 (participants not meeting guidelines for physical activity at follow-up), six independent variables were eligible to be included in analysis one (i.e., 59/6 = 9.83).

For each independent variable, it is advised that there should be at least 50 cases (participants) in each category (Tabachnick and Fidell, 1996). This observation was checked prior to running the analyses. The only category that had less than 50 was the 'other' category for ethnicity which accounted for 38 participants. This was the greatest number that could be achieved due to collapsing of the categories that were originally recorded when the categories were set at a broad level (i.e., White, Mixed, Asian or Asian British, Black or Black British, Chinese and other ethnic group). The descriptive breakdown of the independent variables and dependent variable included for analysis one (for Model 1) is detailed below in Table 7.5 and Table 7.6 respectively.

Table 7.5

Independent variable frequencies – Model 1 (analysis one)

Independent variable category	*Number*	*Percentage*
Gender		
Male	362	54.6%
Female	301	45.4%
Ethnicity		
White	625	94.3%
Other	38	5.7%
Educational attainment (5 or more A* - C GCSE passes at follow-up)		
No	54	8.1%
Yes	609	91.9%
School type		
State/Mainstream	604	91.1%
Private/Independent	59	8.9%
Area of residence		
Urban	462	69.7%
Rural	201	30.3%
Socioeconomic status		
1st quartile (least deprived)	166	25.0%
2nd quartile	167	25.2%
3rd quartile	164	24.7%
4th quartile (most deprived)	166	25.0%

Table 7.6

Dependent variable frequencies – Model 1 (analysis one)

Dependent variable category	***Number***	***Percentage***
Physical activity at follow-up		
Not meeting guidelines	604	91.1%
Meeting guidelines	59	8.9%

Model 1 contained six independent variables (gender, ethnicity, educational attainment, school type, socioeconomic status and area of residence) and explored the association between these independent variables and the dependent variable (physical activity at follow-up). As shown in Table 7.7, the inferential goodness of fit test yielded an insignificant result ($p = 0.685$), suggesting that the model was fit to the data well. Two further measures of goodness of fit (R^2 indices) are presented in Table 7.7 (Cox and Snell R^2 and Nagelkerke R^2) and although neither relates to predictive efficiency of variance explained, they are provided here to supplement the goodness of fit statistic. The model as a whole correctly classified 91.1% of cases.

Table 7.7

Goodness of fit (Model 1 – analysis one)

Goodness of fit test	χ^2	***df***	***p-value***
Hosmer and Lemeshow	5.660	8	0.685

Note: Cox and Snell $R^2 = 0.020$, Nagelkerke $R^2 = 0.043$

As shown in Table 7.8, only one of the independent variables made a statistically significant contribution to the model (i.e., gender). Females were associated with the likelihood of not meeting guidelines for physical activity at follow-up (Exp(β)=0.476; 0.266-0.854; $p < 0.05$). When compared to males, females were 52.4% less likely to meet recommended guidelines for physical activity at follow-up. Please refer to Appendix 27 for the SPSS output for Model 1.

Table 7.8

Model 1 (analysis one) (association with outcome of physical activity at follow-up)

Variables	*Exp (β)*	*95% CI*	*p-value*
Gender (ref – male)	0.476	0.266-0.854	0.013*
Ethnicity (ref – White)	0.507	0.116-2.206	0.365
Educational attainment (ref – no)	0.911	0.337-2.462	0.855
School type (ref – state/mainstream)	0.340	0.079-1.452	0.145
Area of residence (ref – urban)	0.947	0.516-1.738	0.861
Socioeconomic status			0.338
1st quartile (least deprived) (ref)	1.000		
2nd quartile	2.064	0.941-4.530	0.071
3rd quartile	1.442	0.636-3.270	0.381
4th quartile (most deprived)	1.416	0.609-3.293	0.419

$p < 0.05$*

Model 2 contained four independent variables (gender, ethnicity, educational attainment and school type) and explored the association between these independent variables and the dependent variable (physical activity at follow-up). The descriptive breakdown of the independent variables and dependent variable included for analysis two (for Model 2) is detailed below in Table 7.9 and Table 7.10 respectively.

Table 7.9

Independent variable frequencies – Model 2 (analysis two)

Independent variable category	***Number***	***Percentage***
Gender		
Male	447	53.6%
Female	387	46.4%
Ethnicity		
White	792	95.0%
Other	42	5.0%
Educational attainment (5 or more A* - C GCSE passes at follow-up)		
No	66	7.9%
Yes	768	92.1%
School type		
State/Mainstream	764	91.6%
Private/Independent	70	8.4%

Table 7.10

Dependent variable frequencies – Model 2 (analysis two)

Dependent variable category	***Number***	***Percentage***
Physical activity at follow-up		
Not meeting guidelines	757	90.8%
Meeting guidelines	77	9.2%

As shown in Table 7.11, the inferential goodness of fit test yielded an insignificant result (p = 0.934), suggesting that the model was fit to the data well. Two further measures of goodness of fit (R^2 indices) are presented in Table 7.11 (Cox and Snell R^2 and Nagelkerke R^2) and although neither relates to predictive efficiency of variance explained, they are provided here to supplement the goodness of fit statistic. The model as a whole correctly classified 90.8% of cases.

Table 7.11

Goodness of fit (Model 2 – analysis two)

Goodness of fit test	χ^2	*df*	*p-value*
Hosmer and Lemeshow	0.432	3	0.934

Note: Cox and Snell $R^2 = 0.014$, Nagelkerke $R^2 = 0.030$

As shown in Table 7.12, only one of the independent variables made a statistically significant contribution to the model (i.e., gender). Females were associated with the likelihood of not meeting guidelines for physical activity at follow-up (Exp(β)=0.529; 0.321-0.872; $p < 0.05$). When compared to males, females were 47.1% less likely to meet recommended guidelines for physical activity at follow-up. Please refer to Appendix 28 for the SPSS output of Model 2.

Table 7.12

Model 2 (analysis two) (association with outcome of physical activity at follow-up)

Variables	*Exp (β)*	*95% CI*	*p-value*
Gender (ref – male)	0.529	0.321-0.872	0.012*
Ethnicity (ref – White)	0.725	0.217-2.420	0.601
Educational attainment (ref – no)	1.021	0.424-2.462	0.963
School type (ref – state/mainstream)	0.277	0.066-1.157	0.078

$p < 0.05$*

7.3 Research Question 3: *Is there a change in screen time status in the transition between Year 11 and the period post compulsory education completion?*

The change in screen time status between baseline and follow-up was investigated using the McNemar test of significance of changes. Preliminary analyses were performed to ensure no violation of the assumptions as described earlier for Research Question 1 (Appendix 29 for analysis one and Appendix 30 for analysis two). The

McNemar test was deemed most appropriate, again for the same reasons described earlier in the previous chapter. The descriptive breakdown of the variables included for analysis one and analysis two is detailed below in Table 7.13 and Table 7.14 respectively.

Table 7.13

Dependent variable frequencies (Research Question 3 – analysis one)

Dependent variable category	***Number***	***Percentage***
Screen time status at baseline		
Not meeting guidelines	535	80.7%
Meeting guidelines	128	19.3%
Screen time status at follow-up		
Not meeting guidelines	541	81.6%
Meeting guidelines	122	18.4%

Table 7.14

Dependent variable frequencies (Research Question 3 – analysis two)

Dependent variable category	***Number***	***Percentage***
Screen time status at baseline		
Not meeting guidelines	665	79.7%
Meeting guidelines	169	20.3%
Screen time status at follow-up		
Not meeting guidelines	670	80.3%
Meeting guidelines	164	19.7%

For the sample included in analysis one (n = 663), there was no significant change in screen time status between baseline and follow-up ($\chi^2 = 0.179$, $df = 1$, $p = 0.673$). For the SPSS output, please refer to Appendix 29. Similarly, for the sample included in analysis two (n = 834), there was no significant change in screen time status between baseline and follow-up ($\chi^2 = 0.086$, $df = 1$, $p = 0.769$). For the SPSS output, please refer to Appendix 30.

For both analysis one and analysis two, cross tabulations were performed to investigate the percentages in each category for descriptive purposes. For analysis one, 8.3% (55 participants) were meeting guidelines for screen time at baseline and follow-up. 11.0% (73 participants) were meeting guidelines for screen time at baseline but were not meeting guidelines for screen time at follow-up whilst 10.1% (67 participants) were not meeting guidelines for screen time at baseline but were meeting guidelines for screen time at follow-up. Further, 70.6% (468 participants) were not meeting guidelines for screen time at baseline or follow-up. Please refer to Appendix 29 for cross tabulations from the SPSS output for Research Question 3 (analysis one). Table 7.15 contains the relevant percentages in parentheses.

For analysis two, 8.9% (74 participants) were meeting guidelines for screen time at baseline and follow-up. 11.4% (95 participants) were meeting guidelines for screen time at baseline but were not meeting guidelines for screen time at follow-up whilst 10.8% (90 participants) were not meeting guidelines for screen time at baseline but were meeting guidelines for screen time at follow-up. Further, 68.9% (575 participants) were not meet guidelines for screen time at baseline or follow-up. Please refer to Appendix 30 for cross tabulations from the SPSS output for Research Question 3 (analysis two). Table 7.16 contains the relevant percentages in parentheses.

Table 7.15

Screen time status at baseline and follow-up (analysis one)

Baseline	**Follow-up**	
	Not meeting guidelines	***Meeting guidelines***
Not meeting guidelines	468 (70.6%)	67 (10.1%)
Meeting guidelines	73 (11.0%)	55 (8.3%)

Table 7.16

Screen time status at baseline and follow-up (analysis two)

Baseline	**Follow-up**	
	Not meeting guidelines	***Meeting guidelines***
Not meeting guidelines	575 (68.9%)	90 (10.8%)
Meeting guidelines	95 (11.4%)	74 (8.9%)

7.4 Research Question 4: *How is screen time status post compulsory education completion associated with a range of independent variables?*

BLR was performed to assess the association of a number of factors on the likelihood that participants would meet recommended guidelines for screen time at follow-up. The descriptive breakdown of the independent variables and dependent variable included for analysis one (for Model 3) is detailed below in Table 7.17 and Table 7.18 respectively.

Table 7.17

Independent variable frequencies – Model 3 (analysis one)

Independent variable category	*Number*	*Percentage*
Gender		
Male	362	54.6%
Female	301	45.4%
Ethnicity		
White	625	94.3%
Other	38	5.7%
Educational attainment (5 or more A* - C GCSE passes)		
No	54	8.1%
Yes	609	91.9%
School type		
State/Mainstream	604	91.1%
Private/Independent	59	8.9%
Area of residence		
Urban	462	69.7%
Rural	201	30.3%
Socioeconomic status		
1st quartile (least deprived)	166	25.0%
2nd quartile	167	25.2%
3rd quartile	164	24.7%
4th quartile (most deprived)	166	25.0%

Table 7.18

Dependent variable frequencies – Model 3 (analysis one)

Dependent variable category	*Number*	*Percentage*
Screen time status at follow-up		
Not meeting guidelines	541	81.6%
Meeting guidelines	122	18.4%

Model 3 contained six independent variables (gender, ethnicity, educational attainment, school type, socioeconomic status and area of residence) and explored the association between these independent variables and the dependent variable (screen time status at follow-up). As shown in Table 7.19, the inferential goodness of fit test yielded an insignificant result (p = 0.863), suggesting that the model was fit to the data well. Two further measures of goodness of fit (R^2 indices) are presented in Table 7.19 (Cox and Snell R^2 and Nagelkerke R^2) and although neither relates to predictive efficiency of variance explained, they are provided here to supplement the goodness of fit statistic. The model as a whole correctly classified 81.6% of cases.

Table 7.19

Goodness of fit (Model 3 – analysis one)

Goodness of fit test	χ^2	*df*	*p-value*
Hosmer and Lemeshow	3.936	8	0.863

Note: Cox and Snell R^2 = 0.006, Nagelkerke R^2 = 0.009

As shown in Table 7.20, none of the independent variables made a statistically significant contribution to the model. Please refer to Appendix 31 for the SPSS output for Model 3.

Table 7.20

Model 3 (analysis one) (association with outcome of screen time status at follow-up)

Variables	***Exp (β)***	***95% CI***	***p-value***
Gender (ref – male)	0.987	0.662-1.472	0.949
Ethnicity (ref – White)	1.300	0.571-2.961	0.532
Educational attainment (ref – no)	0.833	0.408-1.701	0.617
School type (ref – state/mainstream)	1.216	0.626-2.362	0.564
Area of residence (ref – urban)	1.273	0.830-1.955	0.269
Socioeconomic status			0.764
1st quartile (least deprived) (ref)	1.000		
2nd quartile	1.102	0.625-1.946	0.737
3rd quartile	1.282	0.734-2.238	0.383
4th quartile (most deprived)	0.975	0.539-1.762	0.932

Model 4 contained four independent variables (gender, ethnicity, educational attainment and school type) and explored the association between these independent variables and the dependent variable (screen time status at follow-up). The descriptive breakdown of the independent variables and dependent variable included for analysis two (for Model 4) is detailed below in Table 7.21 and Table 7.22 respectively.

Table 7.21

Independent variable frequencies – Model 4 (analysis two)

Independent variable category	*Number*	*Percentage*
Gender		
Male	447	53.6%
Female	387	46.4%
Ethnicity		
White	792	95.0%
Other	42	5.0%
Educational attainment (5 or more A* - C GCSE passes at follow-up)		
No	66	7.9%
Yes	768	92.1%
School type		
State/Mainstream	764	91.6%
Private/Independent	70	8.4%

7.22

Dependent variable frequencies – Model 4 (analysis two)

Dependent variable category	*Number*	*Percentage*
Screen time status at follow-up		
Sedentary	670	80.3%
Not sedentary	164	19.7%

As shown in Table 7.23, the inferential goodness of fit test yielded an insignificant result (p = 0.862), suggesting that the model was fit to the data well. Two further measures of goodness of fit (R^2 indices) are presented in Table 7.23 (Cox and Snell R^2 and Nagelkerke R^2) and although neither relates to predictive efficiency of variance explained, they are provided here to supplement the goodness of fit statistic. The model as a whole correctly classified 80.3% of cases.

Table 7.23

Goodness of fit (Model 4 – analysis two)

Goodness of fit test	χ^2	***df***	***p-value***
Hosmer and Lemeshow	0.748	3	0.862

Note: Cox and Snell $R^2 = 0.003$, Nagelkerke $R^2 = 0.006$

As shown in Table 7.24, none of the independent variables made a statistically significant contribution to the model. Please refer to Appendix 32 for the SPSS output of Model 4.

Table 7.24

Model 4 (analysis two) (association with outcome of screen time status at follow-up)

Variables	***Exp (β)***	***95% CI***	***p-value***
Gender (ref – male)	1.262	0.896-1.778	0.183
Ethnicity (ref – White)	0.964	0.437-2.127	0.927
Educational attainment (ref – no)	0.900	0.484-1.671	0.738
School type (ref – state/mainstream)	1.339	0.751-2.385	0.322

7.5 Further analyses

Considering the results of these analyses, further statistical analyses were conducted. These further analyses are divided into seven distinct categories.

7.5.1 First further analysis

Due to the outcome of Research Question 1 (i.e., the significant decline in physical activity through the transition period from 'meeting guidelines at baseline' to 'not meeting guidelines at follow-up'), BLR was performed to assess the association of a number of factors (consistent independent variables for each model for analysis one and two as previously included in Models 1, 2, 3 and 4) on the likelihood that participants would move from meeting guidelines for physical activity at baseline to not meeting guidelines for physical activity at follow-up. Prior to running the analysis for the BLR for Model F1 and Model F2 in this category (and all other BLR analyses in further categories of the further analysis sections), important underlying assumptions were checked such as sample size (please refer to Appendix 33) and multicollinearity (please refer to Appendix 34). The descriptive breakdown of the independent variables and dependent variable included for analysis one (for Model F1) is detailed below in Table 7.25 and Table 7.26.

Table 7.25

Independent variable frequencies – Model F1 (analysis one)

Independent variable category	*Number*	*Percentage*
Gender		
Male	362	54.6%
Female	301	45.4%
Ethnicity		
White	625	94.3%
Other	38	5.7%
Educational attainment (5 or more A* - C GCSE passes)		
No	54	8.1%
Yes	609	91.9%
School type		
State/Mainstream	604	91.1%
Private/Independent	59	8.9%
Area of residence		
Urban	462	69.7%
Rural	201	30.3%
Socioeconomic status		
1st quartile (least deprived)	166	25.0%
2nd quartile	167	25.2%
3rd quartile	164	24.7%
4th quartile (most deprived)	166	25.0%

Table 7.26

Dependent variable frequencies – Model F1 (analysis one)

Dependent variable category	***Number***	***Percentage***
Change in physical activity through transition		
Other combinations	596	89.9%
Meeting to not meeting guidelines	67	10.1%

Model F1 contained six independent variables (gender, ethnicity, educational attainment, school type, socioeconomic status and area of residence) and explored the association between these independent variables and the dependent variable (change in physical activity through the transition). As shown in Table 7.27, the inferential goodness of fit test yielded an insignificant result (p = 0.697), suggesting that the model was fit to the data well. Two further measures of goodness of fit (R^2 indices) are presented in Table 7.27 (Cox and Snell R^2 and Nagelkerke R^2) and although neither relates to predictive efficiency of variance explained, they are provided here to supplement the goodness of fit statistic. The model as a whole correctly classified 89.9% of cases.

Table 7.27

Goodness of fit (Model F1 – analysis one)

Goodness of fit test	χ^2	***df***	***p-value***
Hosmer and Lemeshow	5.555	8	0.697

Note: Cox and Snell R^2 = 0.025, Nagelkerke R^2 = 0.052

As shown in Table 7.28, only one of the independent variables made a statistically significant contribution to the model (i.e., gender). Females were associated with the likelihood of not moving from meeting guidelines for physical activity at baseline to not meeting guidelines for physical activity at follow-up (i.e., no significant decrease in their physical activity through the transition) (Exp(β)=0.576; 0.335-0.989; p <

0.05). When compared to males, females were 42.4% less likely to move from meeting guidelines for physical activity at baseline to not meeting guidelines for physical activity at follow-up. Please refer to Appendix 35 for the SPSS output of Model F1.

Table 7.28

Model F1 (analysis one) (association with outcome of change in physical activity through the transition)

Variables	*Exp (β)*	*95% CI*	*p-value*
Gender (ref – male)	0.576	0.335-0.989	0.046*
Ethnicity (ref – White)	0.242	0.032-1.824	0.169
Educational attainment (ref – no)	0.836	0.333-2.099	0.703
School type (ref – state/mainstream)	0.501	0.150-1.674	0.262
Area of residence (ref – urban)	0.691	0.382-1.250	0.221
Socioeconomic status			0.168
1st quartile (least deprived) (ref)	1.000		
2nd quartile	0.537	0.249-1.161	0.114
3rd quartile	1.118	0.583-2.143	0.738
4th quartile (most deprived)	0.622	0.294-1.316	0.214

$p < 0.05$*

Model F2 contained four independent variables (gender, ethnicity, educational attainment and school type) and explored the association between these independent variables and the dependent variable (change in physical activity through the transition). The descriptive breakdown of the independent variables and dependent variable included for analysis two (for Model F2) is detailed below in Table 7.29 and Table 7.30 respectively.

Table 7.29

Independent variable frequencies – Model F2 (analysis two)

Independent variable category	*Number*	*Percentage*
Gender		
Male	447	53.6%
Female	387	46.4%
Ethnicity		
White	792	95.0%
Other	42	5.0%
Educational attainment (5 or more A* - C GCSE passes at follow-up)		
No	66	7.9%
Yes	768	92.1%
School type		
State/Mainstream	764	91.6%
Private/Independent	70	8.4%

Table 7.30

Dependent variable frequencies – Model F2 (analysis two)

Dependent variable category	*Number*	*Percentage*
Change in physical activity through transition		
Other combinations	745	89.3%
Meeting to not meeting guidelines	89	10.7%

As shown in Table 7.31, the inferential goodness of fit test yielded an insignificant result (p = 0.824), suggesting that the model was fit to the data well. Two further measures of goodness of fit (R^2 indices) are presented in Table 7.31 (Cox and Snell R^2 and Nagelkerke R^2) and although neither relates to predictive efficiency of variance explained, they are provided here to supplement the goodness of fit statistic. The model as a whole correctly classified 89.3% of cases.

Table 7.31

Goodness of fit (Model F2 – analysis two)

Goodness of fit test	χ^2	*df*	*p-value*
Hosmer and Lemeshow	0.905	3	0.824

Note: Cox and Snell R^2 = 0.013, Nagelkerke R^2 = 0.026

As shown in Table 7.32, only one of the independent variables made a statistically significant contribution to the model (i.e., gender). Females were associated with the likelihood of not moving from meeting guidelines for physical activity at baseline to not meeting guidelines for physical activity at follow-up (i.e., no significant decrease in their physical activity through the transition) (Exp(β)=0.524; 0.329-0.836; $p <$ 0.05). When compared to males, females were 47.6% less likely to move from meeting guidelines for physical activity at baseline to not meeting guidelines for physical activity at follow-up. Please refer to Appendix 36 for the SPSS output of Model F2.

Table 7.32

Model F2 (analysis two) (association with outcome of change in physical activity through the transition)

Variables	*Exp (β)*	*95% CI*	*p-value*
Gender (ref – male)	0.524	0.329-0.836	0.007*
Ethnicity (ref – White)	0.613	0.185-2.038	0.425
Educational attainment (ref – no)	0.996	0.438-2.267	0.992
School type (ref – state/mainstream)	0.498	0.176-1.407	0.188

$p < 0.05$*

7.5.2 Second further analysis

Due to sample size restrictions regarding the number of independent variables that could be included in the BLR performed for Research Questions 2 and 4 (for reasons explained in Section 7.2), it was deemed necessary to explore 'status at follow-up' (i.e., in education or in employment or unemployed) as a binary independent variable. It was decided that this particular independent variable should not be used in the main statistical analysis because of the uneven distribution for the sample size within this variable for both analyses even after collapsing this variable from its original coding classification (i.e., analysis one = 641 in education and 22 in employment or unemployment; analysis two = 806 in education and 28 in employment or unemployment). Therefore, BLR analysis was repeated for the purposes of further analysis with the removal of school type and the replacement of status at follow-up as one of the six independent variables in analysis one and one of the four independent variables in analysis two. The other independent variables remained the same as those used previously. Two models were created for physical activity at follow-up (analysis one (Model F3) and analysis two (Model F4)) and two models were also created for screen time status at follow-up (analysis one (Model F5) and analysis two (Model F6)). The descriptive breakdown of the independent variables and dependent variable included for analysis one (for Model F3) is detailed below in Table 7.33 and Table 7.34 respectively.

Table 7.33

Independent variable frequencies – Model F3 (analysis one)

Independent variable category	*Number*	*Percentage*
Gender		
Male	362	54.6%
Female	301	45.4%
Ethnicity		
White	625	94.3%
Other	38	5.7%
Educational attainment (5 or more A* - C GCSE passes at follow-up)		
No	54	8.1%
Yes	609	91.9%
Status at follow-up		
Education	641	96.7%
Employment or unemployment	22	3.3%
Area of residence		
Urban	462	69.7%
Rural	201	30.3%
Socioeconomic status		
1st quartile (least deprived)	166	25.0%
2nd quartile	167	25.2%
3rd quartile	164	24.7%
4th quartile (most deprived)	166	25.0%

Table 7.34

Dependent variable frequencies – Model F3 (analysis one)

Dependent variable category	***Number***	***Percentage***
Physical activity at follow-up		
Not meeting guidelines	604	91.1%
Meeting guidelines	59	8.9%

Model F3 contained six independent variables (gender, ethnicity, educational attainment, status at follow-up, socioeconomic status and area of residence) and explored the association between these independent variables and the dependent variable (physical activity at follow-up). As shown in Table 7.35, the inferential goodness of fit test yielded an insignificant result (p = 0.815), suggesting that the model was fit to the data well. Two further measures of goodness of fit (R^2 indices) are presented in Table 7.35 (Cox and Snell R^2 and Nagelkerke R^2) and although neither relates to predictive efficiency of variance explained, they are provided here to supplement the goodness of fit statistic. The model as a whole correctly classified 91.1% of cases.

Table 7.35

Goodness of fit (Model F3 – analysis one)

Goodness of fit test	χ^2	***df***	***p-value***
Hosmer and Lemeshow	4.445	8	0.815

Note: Cox and Snell $R^2 = 0.015$, Nagelkerke $R^2 = 0.034$

As shown in Table 7.36, only one of the independent variables made a statistically significant contribution to the model (i.e., gender). Females were associated with the likelihood of not meeting guidelines for physical activity at follow-up (Exp(β)=0.471; 0.263-0.844; $p < 0.05$). When compared to males, females were 52.9% less likely to meet recommended guidelines for physical activity at follow-up. Please refer to Appendix 37 for the SPSS output for Model F3.

Table 7.36

Model F3 (analysis one) (association with outcome of physical activity at follow-up)

Variables	*Exp (β)*	*95% CI*	*p-value*
Gender (ref – male)	0.471	0.263-0.844	0.011*
Ethnicity (ref – White)	0.501	0.115-2.178	0.357
Educational attainment (ref – no)	0.869	0.312-2.424	0.789
Status at follow-up (ref – education)	0.979	0.207-4.627	0.979
Area of residence (ref – urban)	0.880	0.481-1.607	0.676
Socioeconomic status			0.361
1st quartile (least deprived) (ref)	1.000		
2nd quartile	2.034	0.928-4.456	0.076
3rd quartile	1.467	0.648-3.325	0.358
4th quartile (most deprived)	1.440	0.620-3.346	0.396

$p < 0.05$*

Model F4 contained four independent variables (gender, ethnicity, educational attainment and status at follow-up) and explored the association between these independent variables and the dependent variable (physical activity at follow-up). The descriptive breakdown of the independent variables and dependent variable included for analysis two (for Model F4) is detailed below in Table 7.37 and Table 7.38 respectively.

Table 7.37

Independent variable frequencies – Model F4 (analysis two)

Independent variable category	*Number*	*Percentage*
Gender		
Male	447	53.6%
Female	387	46.4%
Ethnicity		
White	792	95.0%
Other	42	5.0%
Educational attainment (5 or more A* - C GCSE passes at follow-up)		
No	66	7.9%
Yes	768	92.1%
Status at follow-up		
Education	806	96.6%
Employment or unemployment	28	3.4%

Table 7.38

Dependent variable frequencies – Model F4 (analysis two)

Dependent variable category	*Number*	*Percentage*
Physical activity at follow-up		
Not meeting guidelines	757	90.8%
Meeting guidelines	77	9.2%

As shown in Table 7.39, the inferential goodness of fit test yielded an insignificant result (p = 0.298), suggesting that the model was fit to the data well. Two further measures of goodness of fit (R^2 indices) are presented in Table 7.39 (Cox and Snell R^2 and Nagelkerke R^2) and although neither relates to predictive efficiency of variance explained, they are provided here to supplement the goodness of fit statistic. The model as a whole correctly classified 90.8% of cases.

Table 7.39

Goodness of fit (Model F4 – analysis two)

Goodness of fit test	χ^2	*df*	*p-value*
Hosmer and Lemeshow	2.422	2	0.298

Note: Cox and Snell $R^2 = 0.009$, Nagelkerke $R^2 = 0.019$

As shown in Table 7.40, only one of the independent variables made a statistically significant contribution to the model (i.e., gender). Females were associated with the likelihood of not meeting guidelines for physical activity at follow-up (Exp(β)=0.522; 0.317-0.860; $p < 0.05$). When compared to males, females were 47.8% less likely to meet recommended guidelines for physical activity at follow-up. Please refer to Appendix 38 for the SPSS output of Model F4.

Table 7.40

Model F4 (analysis two) (association with outcome of physical activity at follow-up)

Variables	*Exp (β)*	*95% CI*	*p-value*
Gender (ref – male)	0.522	0.317-0.860	0.011*
Ethnicity (ref – White)	0.721	0.216-2.400	0.594
Educational attainment (ref – no)	0.909	0.362-2.285	0.840
Status at follow-up (ref – education)	0.703	0.152-3.258	0.653

$p < 0.05$*

Model F5 contained six independent variables (gender, ethnicity, educational attainment, status at follow-up, socioeconomic status and area of residence) and explored the association between these independent variables and the dependent variable (screen time status at follow-up). The descriptive breakdown of the independent variables included for analysis one (for Model F5) has been detailed previously in Table 7.33. The descriptive breakdown of the dependent variables included in analysis one (for Model F5) is detailed in Table 7.41 below.

Table 7.41

Dependent variable frequencies – Model F5 (analysis one)

Dependent variable category	***Number***	***Percentage***
Screen time status at follow-up		
Not meting guidelines	541	81.6%
Meeting guidelines	122	18.4%

As shown in Table 7.42, the inferential goodness of fit test yielded an insignificant result (p = 0.509), suggesting that the model was fit to the data well. Two further measures of goodness of fit (R^2 indices) are presented in Table 7.42 (Cox and Snell R^2 and Nagelkerke R^2) and although neither relates to predictive efficiency of variance explained, they are provided here to supplement the goodness of fit statistic. The model as a whole correctly classified 81.6% of cases.

Table 7.42

Goodness of fit (Model F5 – analysis one)

Goodness of fit test	χ^2	***df***	***p-value***
Hosmer and Lemeshow	7.256	8	0.509

Note: Cox and Snell $R^2 = 0.005$, Nagelkerke $R^2 = 0.008$

As shown in Table 7.43, none of the independent variables made a statistically significant contribution to the model. Please refer to Appendix 39 for the SPSS output for Model F5.

Table 7.43

Model F5 (analysis one) (association with outcome of screen time status at follow-up)

Variables	*Exp (β)*	*95% CI*	*p-value*
Gender (ref – male)	0.991	0.665-1.477	0.964
Ethnicity (ref – White)	1.309	0.574-2.982	0.522
Educational attainment (ref – no)	0.837	0.399-1.755	0.637
Status at follow-up (ref – education)	0.943	0.295-3.016	0.921
Area of residence (ref – urban)	1.299	0.850-1.983	0.227
Socioeconomic status			0.766
1st quartile (least deprived) (ref)	1.000		
2nd quartile	1.109	0.629-1.956	0.721
3rd quartile	1.278	0.732-2.232	0.388
4th quartile (most deprived)	0.972	0.537-1.760	0.926

Model F6 contained four independent variables (gender, ethnicity, educational attainment and status at follow-up) and explored the association between these independent variables and the dependent variable (screen time status at follow-up). The descriptive breakdown of the independent variables included for analysis two (for Model F6) has been detailed previously in Table 7.37. A descriptive breakdown of the dependent variables included in analysis two (for Model F6) is detailed in Table 7.44 below.

Table 7.44

Dependent variable frequencies – Model F6 (analysis two)

Dependent variable category	***Number***	***Percentage***
Screen time status at follow-up		
Not meeting guidelines	670	80.3%
Meeting guidelines	164	19.7%

As shown in Table 7.45, the inferential goodness of fit test yielded an insignificant result (p = 0.789), suggesting that the model was fit to the data well. Two further measures of goodness of fit (R^2 indices) are presented in Table 7.45 (Cox and Snell R^2 and Nagelkerke R^2) and although neither relates to predictive efficiency of variance explained, they are provided here to supplement the goodness of fit statistic. The model as a whole correctly classified 80.3% of cases.

Table 7.45

Goodness of fit (Model F6 – analysis two)

Goodness of fit test	χ^2	***df***	***p-value***
Hosmer and Lemeshow	0.473	2	0.789

Note: Cox and Snell $R^2 = 0.002$, Nagelkerke $R^2 = 0.004$

As shown in Table 7.46, none of the independent variables made a statistically significant contribution to the model. Please refer to Appendix 40 for the SPSS output of Model F6.

Table 7.46

Model F6 (analysis two) (association with outcome of screen time status at follow-up)

Variables	*Exp (β)*	*95% CI*	*p-value*
Gender (ref – male)	1.270	0.902-1.788	0.172
Ethnicity (ref – White)	0.971	0.440-2.143	0.942
Educational attainment (ref – no)	0.933	0.482-1.805	0.837
Status at follow-up (ref – education)	1.078	0.403-2.883	0.882

7.5.3 Third further analysis

For the same reasons as explained earlier for the second further analysis (i.e., restrictions in sample size for the number of independent variables that could be included in the BLR performed for Research Questions 2 and 4), baseline physical activity was included as a binary independent variable (meeting guidelines or not meeting guidelines) for physical activity at follow-up (Research Question 2 analysis one and analysis two). Additionally, baseline screen time status was included as a binary independent variable (meeting guidelines or not meeting guidelines) for screen time status at follow-up (Research Question 4 analysis one and analysis two). For each of these research questions, BLR analysis was performed with the removal of educational attainment as the independent variable in analysis one and analysis two for both research questions. The decision to remove educational attainment as the independent variable was based on two reasons. Firstly, all other independent variables were baseline measures (e.g., gender, ethnicity, school type, area of residence, socioeconomic status) whereas educational attainment was the only follow-up measure. Therefore, the replacement of educational attainment with baseline physical activity resulted in the representation of complete baseline measures as the independent variables used. Secondly, education attainment was the only independent variable represented in both analysis one and analysis two which was collected at the follow-up point. The other independent variables remained the same as those used previously for both analysis one and analysis two. Two models were created for physical activity at follow-up (analysis one (Model F7) and analysis two (Model F8)) and two models were also created for screen time status at follow-up (analysis one (Model F9) and analysis two (Model F10)). The descriptive breakdown of the independent variables and dependent variable included for analysis one (for Model F7) is detailed below in Table 7.47 and Table 7.48 respectively.

Table 7.47

Independent variable frequencies – Model F7 (analysis one)

Independent variable category	*Number*	*Percentage*
Gender		
Male	362	54.6%
Female	301	45.4%
Ethnicity		
White	625	94.3%
Other	38	5.7%
Physical activity at baseline		
Not meeting guidelines	570	86.0%
Meeting guidelines	93	14.0%
School type		
State/Mainstream	604	91.1%
Private/Independent	59	8.9%
Area of residence		
Urban	462	69.7%
Rural	201	30.3%
Socioeconomic status		
1st quartile (least deprived)	166	25.0%
2nd quartile	167	25.2%
3rd quartile	164	24.7%
4th quartile (most deprived)	166	25.0%

Table 7.48

Dependent variable frequencies – Model F7 (analysis one)

Dependent variable category	***Number***	***Percentage***
Physical activity at follow-up		
Not meeting guidelines	604	91.1%
Meeting guidelines	59	8.9%

Model F7 contained six independent variables (gender, ethnicity, physical activity at baseline, school type, socioeconomic status and area of residence) and explored the association between these independent variables and the dependent variable (physical activity at follow-up). As shown in Table 7.49, the inferential goodness of fit test yielded an insignificant result (p = 0.692), suggesting that the model was fit to the data well. Two further measures of goodness of fit (R^2 indices) are presented in Table 7.49 (Cox and Snell R^2 and Nagelkerke R^2) and although neither relates to predictive efficiency of variance explained, they are provided here to supplement the goodness of fit statistic. The model as a whole correctly classified 91.1% of cases.

Table 7.49

Goodness of fit (Model F7 – analysis one)

Goodness of fit test	χ^2	***df***	***p-value***
Hosmer and Lemeshow	5.597	8	0.692

Note: Cox and Snell R^2 = 0.065, Nagelkerke R^2 = 0.144

As shown in Table 7.50, only one of the independent variables made a statistically significant contribution to the model (i.e., physical activity at baseline). Participants meeting guidelines for physical activity at baseline were associated with the likelihood of meeting guidelines for physical activity at follow-up (Exp(β)=5.847; 3.231-10.581; $p < 0.001$). When compared to participants not meeting guidelines for physical activity at baseline, participants meeting guidelines for physical activity at baseline were 5.8 times more likely to meet recommended guidelines for physical activity participation at follow-up. Please refer to Appendix 41 for the SPSS output for Model F7.

Table 7.50

Model F7 (analysis one) (association with outcome of physical activity at follow-up)

Variables	*Exp (β)*	*95% CI*	*p-value*
Gender (ref – male)	0.574	0.314-1.049	0.071
Ethnicity (ref – White)	0.730	0.163-3.269	0.681
Physical activity at baseline (ref – not meeting guidelines)	5.847	3.231-10.581	0.000*
School type (ref – state/mainstream)	0.408	0.94-1.766	0.231
Area of residence (ref – urban)	1.027	0.546-1.931	0.934
Socioeconomic status			0.267
1st quartile (least deprived) (ref)	1.000		
2nd quartile	2.210	0.978-4.991	0.056
3rd quartile	1.346	0.579-3.133	0.490
4th quartile (most deprived)	1.427	0.604-3.374	0.418

$p < 0.001$*

Model F8 contained four independent variables (gender, ethnicity, physical activity at baseline and school type) and explored the association between these independent variables and the dependent variable (physical activity at follow-up). The descriptive breakdown of the independent variables and dependent variable included for analysis two (for Model F8) is detailed below in Table 7.51 and Table 7.52 respectively.

Table 7.51

Independent variable frequencies – Model F8 (analysis two)

Independent variable category	*Number*	*Percentage*
Gender		
Male	447	53.6%
Female	387	46.4%
Ethnicity		
White	792	95.0%
Other	42	5.0%
Physical activity at baseline		
Not meeting guidelines	713	85.5%
Meeting guidelines	121	14.5%
School type		
State/Mainstream	764	91.6%
Private/Independent	70	8.4%

Table 7.52

Dependent variable frequencies – Model F8 (analysis two)

Dependent variable category	*Number*	*Percentage*
Physical activity at follow-up		
Not meeting guidelines	757	90.8%
Meeting guidelines	77	9.2%

As shown in Table 7.53, the inferential goodness of fit test yielded an insignificant result (p = 0.834), suggesting that the model was fit to the data well. Two further measures of goodness of fit (R^2 indices) are presented in Table 7.39 (Cox and Snell R^2 and Nagelkerke R^2) and although neither relates to predictive efficiency of variance explained, they are provided here to supplement the goodness of fit statistic. The model as a whole correctly classified 90.8% of cases.

Table 7.53

Goodness of fit (Model F8 – analysis two)

Goodness of fit test	χ^2	*df*	*p-value*
Hosmer and Lemeshow	0.865	3	0.834

Note: Cox and Snell $R^2 = 0.052$, Nagelkerke $R^2 = 0.113$

As shown in Table 7.54, only one of the independent variables made a statistically significant contribution to the model (i.e., physical activity at baseline). Participants meeting guidelines for physical activity at baseline were associated with the likelihood of meeting guidelines for physical activity at follow-up (Exp(β)=4.803; 2.878-8.015; $p < 0.001$). When compared to participants not meeting guidelines for physical activity at baseline, participants meeting guidelines for physical activity at baseline were 4.8 times more likely to meet recommended guidelines for physical activity at follow-up. Please refer to Appendix 42 for the SPSS output of Model F8.

Table 7.54

Model F8 (analysis two) (association with outcome of physical activity at follow-up)

Variables	*Exp (β)*	*95% CI*	*p-value*
Gender (ref – male)	0.634	0.379-1.062	0.083
Ethnicity (ref – White)	0.819	0.239-2.808	0.751
Physical activity at baseline (ref – not meeting guidelines)	4.803	2.878-8.015	0.000*
School type (ref – state/mainstream)	0.321	0.076-1.359	0.123

$p < 0.001$*

Model F9 contained six independent variables (gender, ethnicity, screen time status at baseline, school type, socioeconomic status and area of residence) and explored the association between these independent variables and the dependent variable (screen time status at follow-up). The descriptive breakdown of the independent variables and dependent variable included for analysis one (for Model F9) is detailed below in Table 7.55 and Table 7.56 respectively.

Table 7.55

Independent variable frequencies – Model F9 (analysis one)

Independent variable category	***Number***	***Percentage***
Gender		
Male	362	54.6%
Female	301	45.4%
Ethnicity		
White	625	94.3%
Other	38	5.7%
Screen time status at baseline		
Not meeting guidelines	535	80.7%
Meeting guidelines	128	19.3%
School type		
State/Mainstream	604	91.1%
Private/Independent	59	8.9%
Area of residence		
Urban	462	69.7%
Rural	201	30.3%
Socioeconomic status		
1st quartile (least deprived)	166	25.0%
2nd quartile	167	25.2%
3rd quartile	164	24.7%
4th quartile (most deprived)	166	25.0%

Table 7.56

Dependent variable frequencies – Model F9 (analysis one)

Dependent variable category	***Number***	***Percentage***
Screen time status at follow-up		
Not meeting guidelines	541	81.6%
Meeting guidelines	122	18.4%

As shown in Table 7.57, the inferential goodness of fit test yielded an insignificant result (p = 0.475), suggesting that the model was fit to the data well. Two further measures of goodness of fit (R^2 indices) are presented in Table 7.57 (Cox and Snell R^2 and Nagelkerke R^2) and although neither relates to predictive efficiency of variance explained, they are provided here to supplement the goodness of fit statistic. The model as a whole correctly classified 81.4% of cases.

Table 7.57

Goodness of fit (Model F9 – analysis one)

Goodness of fit test	χ^2	***df***	***p-value***
Hosmer and Lemeshow	7.580	8	0.475

Note: Cox and Snell R^2 = 0.081, Nagelkerke R^2 = 0.132

As shown in Table 7.58, only one of the independent variables made a statistically significant contribution to the model (i.e., screen time status at baseline). Participants meeting guidelines for screen time at baseline were associated with the likelihood of meeting guidelines for screen time at follow-up (Exp(β)=5.181; 3.344-8.025; p < 0.001). When compared to participants not meeting guidelines for screen time at baseline, participants meeting guidelines for screen time at baseline were 5.2 times more likely to meet recommended guidelines for screen time at follow-up. Please refer to Appendix 43 for the SPSS output of Model F9.

Table 7.58

Model F9 (analysis one) (association with outcome of screen time status at follow-up)

Variables	*Exp (β)*	*95% CI*	*p-value*
Gender (ref – male)	0.986	0.648-1.500	0.947
Ethnicity (ref – White)	1.191	0.500-2.834	0.693
Screen time status at baseline (ref – not meeting guidelines)	5.181	3.344-8.025	0.000*
School type (ref – state/mainstream)	1.168	0.579-2.357	0.664
Area of residence (ref – urban)	1.611	0.738-1.827	0.519
Socioeconomic status			0.906
1st quartile (least deprived) (ref)	1.000		
2nd quartile	1.040	0.574-1.886	0.896
3rd quartile	1.087	0.605-1.954	0.780
4th quartile (most deprived)	0.875	0.474-1.616	0.670

$p < 0.001$*

Model F10 contained four independent variables (gender, ethnicity, screen time status at baseline and school type) and explored the association between these independent variables and the dependent variable (screen time status at follow-up). The descriptive breakdown of the independent variables and dependent variable included for analysis two (for Model F10) is detailed below in Table 7.59 and Table 7.60 respectively.

Table 7.59

Independent variable frequencies – Model F10 (analysis two)

Independent variable category	***Number***	***Percentage***
Gender		
Male	447	53.6%
Female	387	46.4%
Ethnicity		
White	792	95.0%
Other	42	5.0%
Screen time status at baseline		
Not meeting guidelines	665	79.7%
Meeting guidelines	169	20.3%
School type		
State/Mainstream	764	91.6%
Private/Independent	70	8.4%

Table 7.60

Dependent variable frequencies – Model F10 (analysis two)

Dependent variable category	***Number***	***Percentage***
Screen time status at follow-up		
Not meeting guidelines	670	80.3%
Meeting guidelines	164	19.7%

As shown in Table 7.61, the inferential goodness of fit test yielded an insignificant result (p = 0.969), suggesting that the model was fit to the data well. Two further measures of goodness of fit (R^2 indices) are presented in Table 7.61 (Cox and Snell R^2 and Nagelkerke R^2) and although neither relates to predictive efficiency of variance explained, they are provided here to supplement the goodness of fit statistic. The model as a whole correctly classified 80.8% of cases.

Table 7.61

Goodness of fit (Model F10 – analysis two)

Goodness of fit test	χ^2	*df*	*p-value*
Hosmer and Lemeshow	0.915	5	0.969

Note: Cox and Snell $R^2 = 0.080$, Nagelkerke $R^2 = 0.127$

As shown in Table 7.62, only one of the independent variables made a statistically significant contribution to the model (i.e., screen time status at baseline). Participants meeting guidelines for screen time at baseline were associated with the likelihood of meeting guidelines for screen time at follow-up (Exp(β)=4.913; 3.369-7.165; $p < 0.001$). When compared to participants not meeting guidelines for screen time at baseline, participants meeting guidelines for screen time at baseline were 4.9 times more likely to meet recommended guidelines for screen time at follow-up. Please refer to Appendix 44 for the SPSS output of Model F10.

Table 7.62

Model F10 (analysis two) (association with outcome of screen time status at follow-up)

Variables	*Exp (β)*	*95% CI*	*p-value*
Gender (ref – male)	1.182	0.825-1.694	0.361
Ethnicity (ref – White)	0.931	0.405-2.138	0.866
Screen time status at baseline (ref – not meeting guidelines)	4.913	3.369-7.165	0.000*
School type (ref – state/mainstream)	1.270	0.692-2.330	0.440

$p < 0.001$*

7.5.4 Fourth further analysis

This stage of further analysis involved undertaking cross-tabulation analysis with the aim to investigate a possible link between physical activity and screen time status of participants at baseline and follow-up. Cross-tabulations were performed for analysis one and two in the form of a 'hybrid' (please see Appendix 45 for analysis one SPSS outputs and Appendix 46 for analysis two SPSS outputs). The hybrid classified participants into four groups at baseline and follow-up respectively: (1) not meeting guidelines for physical activity and meeting screen time guidelines; (2) not meeting guidelines for physical activity and not meeting screen time guidelines; (3) meeting guidelines for physical activity and meeting screen time guidelines; and (4) meeting guidelines for physical activity and not meeting screen time guidelines.

An inspection of Table 7.63 clearly shows that for analysis one (at baseline) almost three quarters of the participants (468 in total) (70.6%) were not meeting guidelines for physical activity or screen time. 15.4% (102 participants) were not meeting guidelines for physical activity but were meeting guidelines for screen time. 10.1% (67 participants) were meeting guidelines for physical activity but were not meeting guidelines for screen time. Only 3.9% (26 participants) were meeting guidelines for physical activity and were also meeting guidelines for screen time. Table 7.63 contains the relevant percentages in parentheses.

An inspection of Table 7.64 representing analysis two (at baseline) shows a similar picture to those of analysis one. The vast majority of participants (576 in total) (69.1%) were not meeting guidelines for physical activity and were not meeting guidelines for screen time. 16.4% (137 participants) were not meeting guidelines for physical activity and were meeting guidelines for screen time. 10.7% (89 participants) were meeting guidelines for physical activity but were not meeting guidelines for screen time. Only 3.8% (32 participants) were meeting guidelines for physical activity and were also meeting guidelines for screen time. Table 7.64 contains the relevant percentages in parentheses.

Table 7.63

Hybrid of physical activity and screen time status at baseline (analysis one)

Physical activity at baseline	**Screen time status at baseline**	
	Not meeting guidelines	***Meeting guidelines***
Not meeting guidelines	468 (70.6%)	102 (15.4%)
Meeting guidelines	67 (10.1%)	26 (3.9%)

Table 7.64

Hybrid of physical activity and screen time status at baseline (analysis two)

Physical activity at baseline	**Screen time status at baseline**	
	Not meeting guidelines	***Meeting guidelines***
Not meeting guidelines	576 (69.1%)	137 (16.4%)
Meeting guidelines	89 (10.7%)	32 (3.8%)

An inspection of Table 7.65 clearly shows that for analysis on (at follow-up) almost three quarters of the participants (496 in total) (74.8%) were not meeting guidelines for physical activity or screen time. 16.3% (108 participants) were not meeting guidelines for physical activity but were meeting guidelines for screen time. 6.8% (45 participants) were meeting guidelines for physical activity but were not meeting guidelines for screen time. Only 2.1% (14 participants) were meeting guidelines for physical activity and were also meeting guidelines for screen time.

An inspection of Table 7.66 shows a similar picture for analysis two (at follow-up). The vast majority of participants (609 in total) (73.0%) were not meeting guidelines for physical activity and were not meeting guidelines for screen time. 17.7% (148 participants) were not meeting guidelines for physical activity but were meeting guidelines for screen time. 7.3% (61 participants) were meeting guidelines for physical activity but were not meeting guidelines for screen time. Only 1.9% (16 participants) were meeting guidelines for physical activity and were also meeting guidelines for screen time. Tables 7.65 and 7.66 contain the relevant percentages in parentheses.

Table 7.65

Hybrid of physical activity and screen time status at follow-up (analysis one)

Physical activity at follow-up	**Screen time status at follow-up**	
	Not meeting guidelines	***Meeting guidelines***
Not meeting guidelines	496 (74.8%)	108 (16.3%)
Meeting guidelines	45 (6.8%)	14 (2.1%)

Table 7.66

Hybrid of physical activity and screen time status at follow-up (analysis two)

Physical activity at follow-up	**Screen time status at follow-up**	
	Not meeting guidelines	***Meeting guidelines***
Not meeting guidelines	609 (73.0%)	148 (17.7%)
Meeting guidelines	61 (7.3%)	16 (1.9%)

7.5.5 Analysis of travel data (fifth further analysis)

Further analysis was also undertaken on the travel data collected at baseline and follow-up. This further analysis involved descriptive frequency analysis and cross-tabulation analysis of the travel data collected for analysis one and analysis two (please see Appendix 47 for the analysis one SPSS outputs and Appendix 48 for the analysis two SPSS outputs). On the questionnaire from which this travel data was collected, each participant indicated all forms of transport that they 'normally' travelled to and from school/college/work at baseline and follow-up. Therefore, participants indicated all forms of transport that applied to them.

Firstly, descriptive frequency analysis, as shown in Table 7.67 (analysis one) below, highlights that the most popular modes of transport at baseline among participants for analysis one were walking (44.3% of participants), car (36.8% of participants) and bus (32.9% of participants). Conversely, the least popular modes of transport were train (0% of participants), 'other' modes (1.1% of participants) and bike (7.7% of participants). At follow-up, the most popular modes of transport among participants were bus (45.4% of participants), walking (42.4% of participants) and car (34.8% of participants). On the other hand, the least popular modes of transport among participants were train (1.1% of participants), 'other' modes (1.7% of participants) and bike (8.6% of participants). Table 7.67 contains the relevant percentages in parentheses.

An inspection of Table 7.68 (analysis two) below highlights that the most popular modes of transport at baseline among participants for analysis one were walking (40.8% of participants), bus (38.5% of participants) and car (36.3% of participants). Conversely, the least popular modes of transport were train (0.1% of participants), 'other' modes (1.0% of participants) and bike (6.6% of participants). At follow-up, the most popular modes of transport among participants were bus (47.1% of participants), walking (39.3% of participants) and car (38.1% of participants). On the other hand, the least popular modes of transport among participants were train (1.1% of participants), 'other' modes (1.9% of participants) and bike (7.4% of participants). Table 7.68 contains the relevant percentages in parentheses.

Table 7.67

Frequency of participants who travelled by each mode of transport at baseline and follow-up (analysis one)

Mode of transport	***Frequency of participants at** baseline **who travelled by particular mode of transport***	***Frequency of participants at** follow-up **who travelled by particular mode of transport***
Bus	218 (32.9%)	301 (45.4%)
Train	0 (0%)	7 (1.1%)
Car	244 (36.8%)	231 (34.8%)
Bike	51 (7.7%)	57 (8.6%)
Walk	294 (44.3%)	281 (42.4%)
Other	7 (1.1%)	11 (1.7%)

Table 7.68

Frequency of participants who travelled by each mode of transport at baseline and follow-up (analysis two)

Mode of transport	***Frequency of participants at*** *baseline* ***who travelled by particular mode of transport***	***Frequency of participants at*** *follow-up* ***who travelled by particular mode of transport***
Bus	321 (38.5%)	393 (47.1%)
Train	1 (0.1%)	9 (1.1%)
Car	303 (36.3%)	318 (38.1%)
Bike	55 (6.6%)	62 (7.4%)
Walk	340 (40.8%)	328 (39.3%)
Other	8 (1.0%)	16 (1.9%)

Secondly, cross-tabulation analysis was undertaken with a focus on each mode of transport reported by participants at baseline and follow-up for analysis one and analysis two. Active modes of transport such as walking and biking were focused on, in addition to passive modes of transport including bus, train and car. The 'other' category was not focused on because the percentage of participants in this category was very small. Cross-tabulations performed for active modes of transport (analysis one and two) included: bike at baseline and follow-up; and walk at baseline and follow-up. Cross-tabulations performed for passive modes of transport (analysis one and two) included: car at baseline and follow-up; bus at baseline and follow-up; and train at baseline and follow-up. The aim of these analyses was to investigate the proportion of participants who used the same mode of transport at baseline and follow-up and those who changed.

From an active transport perspective for analysis one, as shown below in Table 7.69, the majority of participants (88.8%) did not bike to school/college/work at both baseline and follow-up and only 5.1% of participants biked at both baseline and follow-up. However, Table 7.70 shows that 33.0% of participants actively travelled to school/college/work at both baseline and follow-up by walking although 46.3% did not walk at either baseline or follow-up. Further, 9.4% of participants moved from not walking at baseline to walking at follow-up although 11.3% of participants who walked at baseline did not walk at follow-up.

From a passive transport perspective, Table 7.71 highlights that 26.4% of participants travelled to school/college/work by car at baseline and follow-up and 54.8% of participants did not travel by car at either baseline or follow-up. In addition, 10.4% of participants moved from travelling by car at baseline to not travelling by car at follow-up. A similar picture is shown in Table 7.72 for the proportion of participants using the bus with 28.2% of participants using the bus at both baseline and follow-up and 49.9% not using a bus at either baseline or follow-up. Finally, Table 7.73 evidences that no participants used a train at baseline, with only 1.1% using a train at follow-up. In total, 98.9% of participants did not use a train at either baseline or follow-up. Tables 7.69, 7.70, 7.71, 7.72 and 7.73 contain the relevant percentages in parentheses.

From an active transport perspective for analysis two, as shown below in Table 7.74, the majority of participants (90.3%) did not bike to school/college/work at both baseline and follow-up and only 4.3% of participants biked at both baseline and follow-up. However, Table 7.75 shows that 30.1% of participants actively travelled to school/college/work at both baseline and follow-up by walking although 50.0% did not walk at either baseline or follow-up. Furthermore, 9.2% of participants moved from not walking at baseline to walking at follow-up. Conversely, 10.7% of participants who walked at baseline did not at follow-up.

From a passive transport perspective, Table 7.76 highlights that 26.7% of participants travelled to school/college/work by car at baseline and follow-up and 52.3% of participants did not travel by car at either baseline or follow-up. Additionally, 11.4% of participation travelled by car at follow-up but did not at baseline whereas 9.6% of participants who travelled by car did not at follow-up. A similar picture is shown in Table 7.77 for the proportion of participants using the bus with 31.9% of participants using the bus at both baseline and follow-up and 46.3% not using a bus at either baseline or follow-up. Further, 15.2% of participants who travelled by bus at follow-up did not at baseline. Finally, Table 7.78 evidences that

98.9% of participants did not use a train at either baseline or follow-up. Tables 7.74, 7.75, 7.76, 7.77 and 7.78 contain the relevant percentages in parentheses.

Table 7.69

Cross-tabulation of frequency of participants who used a 'bike' as their mode of transport at baseline and follow-up (analysis one)

Bike at baseline	**Bike at follow-up**	
	Yes	***No***
Yes	34 (5.1%)	17 (2.6%)
No	23 (3.5%)	589 (88.8%)

Table 7.70

Cross-tabulation of frequency of participants who 'walked' as their mode of transport at baseline and follow-up (analysis one)

Walk at baseline	**Walk at follow-up**	
	Yes	***No***
Yes	219 (33.0%)	75 (11.3%)
No	62 (9.4%)	307 (46.3%)

Table 7.71

Cross-tabulation of frequency of participants who used a 'car' as their mode of transport at baseline and follow-up (analysis one)

Car at baseline	**Car at follow-up**	
	Yes	***No***
Yes	175 (26.4%)	69 (10.4%)
No	56 (8.4%)	363 (54.8%)

Table 7.72

Cross-tabulation of frequency of participants who used a 'bus' as their mode of transport at baseline and follow-up (analysis one)

Bus at baseline	**Bus at follow-up**	
	Yes	***No***
Yes	187 (28.2%)	31 (4.7%)
No	114 (17.2%)	331 (49.9%)

Table 7.73

Cross-tabulation of frequency of participants who used a 'train' as their mode of transport at baseline and follow-up (analysis one)

Train at baseline	**Train at follow-up**	
	Yes	***No***
Yes	n/a	n/a
No	7 (1.1%)	656 (98.9%)

Table 7.74

Cross-tabulation of frequency of participants who used a 'bike' as their mode of transport at baseline and follow-up (analysis two)

Bike at baseline	**Bike at follow-up**	
	Yes	***No***
Yes	36 (4.3%)	19 (2.3%)
No	26 (3.1%)	753 (90.3%)

Table 7.75

Cross-tabulation of frequency of participants who 'walked' as their mode of transport at baseline and follow-up (analysis two)

Walk at baseline	**Walk at follow-up**	
	Yes	***No***
Yes	251 (30.1%)	89 (10.7%)
No	77 (9.2%)	417 (50.0%)

Table 7.76

Cross-tabulation of frequency of participants who used a 'car' as their mode of transport at baseline and follow-up (analysis two)

Car at baseline	**Car at follow-up**	
	Yes	***No***
Yes	223 (26.7%)	80 (9.6%)
No	95 (11.4%)	436 (52.3%)

Table 7.77

Cross-tabulation of frequency of participants who used a 'bus' as their mode of transport at baseline and follow-up (analysis two)

Bus at baseline	**Bus at follow-up**	
	Yes	***No***
Yes	266 (31.9%)	55 (6.6%)
No	127 (15.2%)	386 (46.3%)

Table 7.78

Cross-tabulation of frequency of participants who used a 'train' as their mode of transport at baseline and follow-up (analysis two)

Train at baseline	**Train at follow-up**	
	Yes	***No***
Yes	1 (0.1%)	0 (0%)
No	8 (1.0%)	825 (98.9%)

7.5.6 Analysis of other physical activity data (sixth further analysis)

Descriptive analysis was also undertaken on the other measures of physical activity collected. These included data from the following questions asked: (1) number of times participated in organised team or individual sports in the previous seven days (when having participated in at least 60 minutes of sport or physical activity); (2) number of times participated in physical activity that was not an organised team or individual sport in the previous seven days (when having participated in at least 60 minutes of sport or physical activity); (3) number of sessions of 30 minutes of sport and active recreation participated in during an average week; (4) and the general intensity of the sport and active recreation undertaken during an average week. For each of these questions, descriptive frequency analysis was undertaken to demonstrate the proportions of participants within the categories of each question at baseline and follow-up, in addition to cross-tabulations, which investigated the numbers of participants in each category at both baseline and follow-up. More specifically, the cross-tabulations consisted of: (1) organised team or individual sports at baseline and follow-up; (2) physical activity that was not an organised team or individual sport at baseline and follow-up; (3) sessions of 30 minutes of sport and active recreation at baseline and follow-up; and (4) intensity of sport and active recreation at baseline and follow-up. Each cross-tabulation was undertaken for analysis one and analysis two (please see Appendix 49 for the analysis one SPSS outputs and Appendix 50 for the analysis two SPSS outputs).

Firstly, Table 7.79 (analysis one) below shows that the largest proportion of participants at both baseline (44.6%) and follow-up (36.7%) took part in organised team or individual sports 1 to 2 times in the previous seven days. The second largest proportion of participants at both baseline (25.8%) and follow-up (34.8%) took part in no organised team or individual sports in the previous seven days. Further, the third largest proportion of participants at both baseline (20.4%) and follow-up (21.0%) took part in organised team or individual sports 3 to 4 times in the previous seven days. The lowest proportion of participants at both baseline (3.3%) and follow-up (2.3%) were those part those participating in organised team or individual sports 5 to 6 times in the previous seven days. The same pattern of findings is reflected in Table 7.80 below for analysis two. Cross-tabulation analysis (as shown in the SPSS output in Appendix 49 for analysis one) revealed that 137 participants (20.7% of all participants and the largest amount of participants) took part in organised team or individual sports 1 to 2 times in the previous seven days at baseline and follow-up. On the other hand, 107 participants (16.1% of all participants) took part in no organised team or individual sports in the previous seven days at baseline and follow-up. Only 3 participants (0.5% of all participants) took part in organised team or individual sports 7 or more times in the previous seven days at baseline and follow-up. The same pattern of findings was evident for analysis two as well, as shown in the SPSS output in Appendix 50. Tables 7.79 and 7.80 contain the relevant percentages in parentheses.

Table 7.79

Frequency of participants at baseline and follow-up who indicated the number of times they had taken part in organised team or individual sports in the previous seven days (when having done at least 60 minutes of sport or physical activity) (analysis one)

Number of times taken part in organised team or individual sports in the previous seven days (when having done at least 60 minutes of sport or physical activity)	***Baseline frequency***	***Follow-up frequency***
None	171 (25.8%)	231 (34.8%)
1 to 2 times	296 (44.6%)	243 (36.7%)
3 to 4 times	135 (20.4%)	139 (21.0%)
5 to 6 times	39 (5.9%)	35 (5.3%)
7 or more times	22 (3.3%)	15 (2.3%)

Table 7.80

Frequency of participants at baseline and follow-up who indicated the number of times they had taken part in organised team or individual sports in the previous seven days (when having done at least 60 minutes of sport or physical activity) (analysis two)

Number of times taken part in organised team or individual sports in the previous seven days (when having done at least 60 minutes of sport or physical activity)	***Baseline frequency***	***Follow-up frequency***
None	198 (23.7%)	282 (33.8%)
1 to 2 times	377 (45.2%)	311 (37.3%)
3 to 4 times	181 (21.7%)	171 (20.5%)
5 to 6 times	51 (6.1%)	45 (5.4%)
7 or more times	27 (3.2%)	25 (3.0%)

An inspection of Table 7.81 (analysis one) for physical activity that was not an organised team or individual sport identifies a similar pattern to the findings reported previously for organised team or individual sports. More specifically, the largest proportion of participants at both baseline (46.6%) and follow-up (46.5%) were those undertaking physical activity that was not an organised team or individual sport 1 to 2 times in the previous seven days. The second largest proportion of participants at both baseline (23.2%) and follow-up (21.7%) were those participants who undertook physical activity that was not an organised team or individual sport 3 to 4 times. Additionally, the third largest proportion were those participants reporting 'none' at both baseline (15.4%) and follow-up (19.9%). The lowest proportion of participants at both baseline (5.7%) and follow-up (3.9%) were those part those participating in physical activity that was not an organised team or individual sport 5 to 6 times in the previous seven days. The same pattern of findings is reflected in Table 7.82 for analysis two. Cross-tabulation analysis (as shown in the SPSS output in Appendix 49 for analysis one) revealed that 158 participants (23.8% of all participants and the largest amount of participants) took part in physical activity that was not an organised team or individual sport 1 to 2 times in the previous seven days at baseline and follow-up. A total of 71 participants (10.7% of all participants) took part 3 to 4 times whereas 61 participants (9.2% of all participants) moved from undertaking physical activity that was not an organised team or individual sport 1 to 2 times at baseline to 3 to 4 times at follow-up in the previous seven days. Only 5 participants (0.8% of all participants) participated in 7 or more times at baseline and follow-up. The same pattern of findings was evident for analysis two as well, as shown in the SPSS output in Appendix 50. Tables 7.81 and 7.82 contain the relevant percentages in parentheses.

Table 7.81

Frequency of participants at baseline and follow-up who indicated the number of times they had taken part in physical activity that was not an organised team or individual sport (when having done at least 60 minutes of sport or physical activity) (analysis one)

Number of times taken part in physical activity that was not an organised team or individual sport in the previous seven days (when having done at 60 minutes of sport or physical activity)	***Baseline frequency***	***Follow-up frequency***
None	102 (15.4%)	132 (19.9%)
1 to 2 times	309 (46.6%)	308 (46.5%)
3 to 4 times	154 (23.2%)	144 (21.7%)
5 to 6 times	60 (9.0%)	53 (8.0%)
7 or more times	38 (5.7%)	26 (3.9%)

Table 7.82

Frequency of participants at baseline and follow-up who indicated the number of times they had taken part in physical activity that was not an organised team or individual sport (when having done at least 60 minutes of sport or physical activity) (analysis two)

Number of times taken part in physical activity that was not an organised team or individual sport in the previous seven days (when having done at least 60 minutes of sport or physical activity)	*Baseline frequency*	*Follow-up frequency*
None	129 (15.5%)	165 (19.8%)
1 to 2 times	390 (46.8%)	393 (47.1%)
3 to 4 times	191 (22.9%)	178 (21.3%)
5 to 6 times	77 (9.2%)	62 (7.4%)
7 or more times	47 (5.6%)	36 (4.3%)

An inspection of Table 7.83 (analysis one) below highlights that at both baseline (29.1%) and follow-up (30.0%) the largest proportion of participants participated in 3 to 4 sessions of 30 minutes of sport and active recreation during an average week. This was closely followed by the proportion of participants participating in 1 to 2 sessions at baseline (26.7%) and follow-up (27.3%). 5 to 6 sessions were participated in by 18.6% of participants at baseline and 16.9% of participants at follow-up whereas 7 or more sessions were participated in by 19.5% of participants at baseline and 15.7% of participants at follow-up. A similar pattern is shown in Table 7.84 for analysis two with the exception that slightly more participants participated in 5 to 6 sessions or than 7 or more sessions at baseline (20.4%). In addition, more participants participated in 7 or more sessions than 5 to 6 sessions at follow-up (16.8%). Cross-tabulation analysis (as shown in the SPSS output in Appendix 49 for analysis one) revealed that 82 participants (12.4% of all participants and the largest amount of participants) took part in 1 to 2 sessions of 30 minutes of sport and active recreation during an average week, closely followed by 72 participants (10.9% of all participants) participating in 3 to 4 sessions at both baseline and follow-up. 51 participants (7.7% of all participants) participated in 7 or more sessions and 26 participants (3.8% of all participants) participated in 5 to 6 sessions at both baseline and follow-up. The same pattern of findings was evident for analysis two as well, as shown in the SPSS output in Appendix 50. Tables 7.83 and 7.84 contain the relevant percentages in parentheses.

Table 7.83

Frequency of participants at baseline and follow-up who indicated the number of sessions of 30 minutes of sport and active recreation undertaken during an average week (analysis one)

Number of sessions of 30 minutes of sport and active recreation during an average week	***Baseline frequency***	***Follow-up frequency***
None	41 (6.2%)	67 (10.1%)
1 to 2 sessions	177 (26.7%)	181 (27.3%)
3 to 4 sessions	193 (29.1%)	199 (30.0%)
5 to 6 sessions	123 (18.6%)	112 (16.9%)
7 or more sessions	129 (19.5%)	104 (15.7%)

Table 7.84

Frequency of participants at baseline and follow-up who indicated the number of sessions of 30 minutes of sport and active recreation undertaken during an average week (analysis two)

Number of sessions of 30 minutes of sport and active recreation during an average week	***Baseline frequency***	***Follow-up frequency***
None	46 (5.5%)	80 (9.6%)
1 to 2 sessions	221 (26.5%)	223 (26.7%)
3 to 4 sessions	233 (27.9%)	253 (30.3%)
5 to 6 sessions	170 (20.4%)	138 (16.5%)
7 or more sessions	164 (19.7%)	140 (16.8%)

Table 7.85 for analysis one below shows that the greatest proportion of participants undertook sport and active recreation of a moderate intensity at baseline (54.9%) and follow-up (49.2%). The second greatest proportion of participants participated in sport and active recreation of a vigorous intensity at baseline (33.3%) and follow-up (35.3%). Table 7.86 for analysis two shows the same pattern of proportions as analysis one. Cross-tabulation analysis (as shown in the SPSS out in Appendix 49 for analysis one) shows that 214 participants (32.3% of all participants and the largest amount of participants) took part in moderate intensity sport and active recreation at baseline and follow-up, in contrast to the 133 participants (20.1% of all participants) who indicated that they undertook vigorous intensity sport and active recreation at baseline and follow-up. A total of 88 participants (13.3% of all participants) moved from undertaking moderate intensity sport and active recreation at baseline to undertaking vigorous intensity sport and active recreation at follow-up. The same pattern of findings was evident for analysis two as well, as shown in the SPSS output in Appendix 50. Tables 7.85 and 7.86 contain the relevant percentages in parentheses.

Table 7.85

Frequency of participants at baseline and follow-up who indicated the general intensity of the sport and active recreation undertaken during an average week (analysis one)

General intensity of sport and active recreation undertaken during an average week	***Baseline frequency***	***Follow-up frequency***
Vigorous intensity (out of breath and sweating)	221 (33.3%)	234 (35.3%)
Moderate intensity (slightly out of breath and feel warm)	364 (54.9%)	326 (49.2%)
Light intensity (not out of breath and not sweating)	45 (6.8%)	53 (8.0%)
Not applicable	33 (5.0%)	50 (7.5%)

Table 7.86

Frequency of participants at baseline and follow-up who indicated the general intensity of the sport and active recreation undertaken during an average week (analysis two)

General intensity of sport and active recreation undertaken during an average week	***Baseline frequency***	***Follow-up frequency***
Vigorous intensity (out of breath and sweating)	273 (32.7%)	293 (35.1%)
Moderate intensity (slightly out of breath and feel warm)	467 (56.0%)	419 (50.2%)
Light intensity (not out of breath and not sweating)	56 (6.7%)	63 (7.6%)
Not applicable	38 (4.6%)	59 (7.1%)

7.5.7 Seventh further analysis

This final piece of further analysis attempted to investigate whether the larger original sample at baseline was similar to the sub-sample used for the longitudinal analysis (i.e., participants at baseline and follow-up – analysis one and analysis two). Consequently, the aim was to investigate if the participants included in the longitudinal analysis representative of the broader sample at baseline in relation to the key independent variables (i.e., the extent to which the sample was likely to suffer from bias for the independent variables included in all analyses). Descriptive analyses were undertaken to show the proportions in each category within each independent variable at baseline and follow-up (analysis one and two). Table 7.87 shows a comparison between baseline and follow-up for the independent variables of interest in the present study. Please see Appendix 51 for the SPSS output of the independent variables (baseline, follow-up (analysis one) and follow-up (analysis two)). Table 7.87 contains the relevant percentages in parentheses.

Table 7.87 demonstrates that among the independent variables of interest in the present study, no bias was introduced at follow-up. This is demonstrated through no significant change in the percentage of participants for each independent variable at baseline, follow-up (analysis one) and follow-up (analysis two). Therefore, the percentage of participants for each independent variable at follow-up is representative of the percentage of participants for the same independent variable at baseline thus no bias was introduced at follow-up.

Table 7.87

Independent variables breakdown for baseline, follow-up (analysis one) and follow-up (analysis two)

Independent variables	*Baseline (n = 2204)*	*Follow-up (analysis one) (n = 663)*	*Follow-up (analysis two) (n = 834)*
Gender			
Male	1191 (54.1%)	362 (54.6%)	447 (53.6%)
Female	1009 (45.9%)	301 (45.4%)	387 (46.4%)
Missing responses	4	0	0
Ethnicity			
White	2059 (93.7%)	625 (94.3%)	792 (95.0%)
Other	138 (6.3%)	38 (5.7%)	42 (5.0%)
Missing responses	7	0	0
Educational attainment			
Yes	n/a	609 (91.9%)	768 (92.1%)
No	n/a	54 (8.1%)	66 (7.9%)
School type			
State/Mainstream	2068 (93.8%)	604 (91.1%)	764 (91.6%)
Private/Independent	136 (6.2%)	59 (8.9%)	70 (8.4%)
Area of residence			
Urban	1090 (72.4%)	462 (69.7%)	n/a
Rural	415 (27.6%)	201 (30.3%)	n/a
Missing responses	699	0	n/a
Socioeconomic status			
1st quartile (least deprived)	376 (25.0%)	166 (25.0%)	n/a
2nd quartile	376 (25.0%)	167 (25.2%)	n/a
3rd quartile	376 (25.0%)	164 (24.7%)	n/a
4th quartile (most deprived)	375 (25.0%)	166 (25.0%)	n/a
Missing responses	701	0	n/a

Status at follow-up			
Education	n/a	641 (96.7%)	806 (96.6%)
Employment or unemployment	n/a	22 (3.3%)	28 (3.4%)
Physical activity at baseline			
Not meeting guidelines	1881 (85.3%)	570 (86.0%)	713 (85.5%)
Meeting guidelines	294 (13.3%)	93 (14.0%)	121 (14.5%)
Missing responses	29 (1.3%)	0	0
Screen time status at baseline			
Not meeting guidelines	1746 (79.3%)	535 (80.7%)	665 (79.7%)
Meeting guidelines	430 (19.4%)	128 (19.3%)	169 (20.3%)
Missing responses	28 (1.3%)	0	0

n/a indicates figures not available due to no associated OA code or data was not available at either baseline or follow-up

7.6 Supporting analyses

7.6.1 Residuals

Residuals were examined for each model in order to isolate any points where the model may have fit the data poorly. For each BLR analysis on each model, the residuals were examined (produced in a casewise list at the end of each BLR output) as residuals (outliers) can affect the results significantly. Only Model 1 and Model 2 from the main analysis were examined for residuals as Model 3 and Model 4 did not have any identified outliers. All further analyses BLR models except for Model F5 and Model F6 were also examined for residuals. Models F5 and F6 did not have any identified outliers. Standardized residuals (ZResid) were analysed for each casewise list and those that were greater than 2.58 at the 0.01 level (the customary level) were removed. The BLR analyses were then repeated for Model 1, Model 2 and models F1, F2, F3, F4, F7, F8, F9 and F10 (further analyses BLR models) and the results (outputs) were interpreted in comparison to the analyses containing the full set of residuals. Removing these residuals (outliers) did not make a notable difference to the percentage of correctly classified cases, inferential goodness of fit test and significant associations between the dependent and independent variables for each model.

The following chapter considers the results of this chapter through interpretation of the findings. In addition, the following chapter details the limitations of the study, the implications for future research and practice and final conclusions.

CHAPTER 8: DISCUSSION AND CONCLUSIONS

In this chapter, the four main research questions that were investigated in the present study are outlined as a reminder before providing a detailed overview of the main findings in relation to these research questions and the further analyses undertaken. The findings are critically reflected upon and interpreted in light of previous research findings. The chapter then focuses on the limitations of the study and the implications for future research and practice. Final conclusions are then made regarding the main findings and the primary implications.

8.1 Re-cap of four main research questions

The first research question determined if there was a significant change in physical activity between during Year 11 (baseline) at school and after completing compulsory education (follow-up), when in sixth form, employment, training or unemployment. This 'change' in physical activity was determined by whether or not a participant had achieved the U.K. (English) recommended guidelines for physical activity of a total of at least 60 minutes of at least moderate intensity on each day of the week (i.e., seven hours a week).

The second research question assessed the association between a number of factors and whether or not participants met the U.K. (English) recommended guidelines for physical activity post compulsory education completion (follow-up) of a total of at least 60 minutes of at least moderate intensity on each day of the week (i.e., seven hours a week). The factors of interest (independent variables) were gender, ethnicity, educational attainment, school type, area of residence and socioeconomic status.

The third research question determined if there was a significant change in screen time status between during Year 11 (baseline) at school and after completing compulsory education (follow-up), when in sixth form, employment, training or unemployment. This 'change' in screen time status was determined by whether or not a participant had achieved recommended guidelines for screen time of two hours per day (i.e., 14 hours per week).

The fourth research question assessed the association between a number of factors and whether or not participants met recommended guidelines for screen time post compulsory education completion (follow-up) of two hours per day (i.e., 14 hours per week). The factors of interest (independent variables) were gender, ethnicity, educational attainment, school type, area of residence and socioeconomic status.

8.2 Overview of main findings

This section reinforces the main findings from the main statistical analysis undertaken for Research Questions 1 (Section 7.1), 2 (Section 7.2), 3 (Section 7.3) and 4 (Section 7.4), in addition to the further statistical analysis conducted (Section 7.5). All of the findings are summarised in a table (Table A1) which can be found in Appendix 52.

8.2.1 Research Question 1

For Research Question 1 (analysis one), as shown in Table 7.3, the main finding was that there was a significant change from meeting guidelines for physical activity during Year 11 to not meeting guidelines for physical activity after completing compulsory education. In addition, it was found that, as shown in Table 7.3 (analysis one) and Table 7.4 (analysis two), 81.0% (for analysis one) and 80.1% (for analysis two) of participants were not meeting guidelines for physical activity either during Year 11 or after completing compulsory education (i.e., there had been 'no change' in their physical activity). Overall, as shown in Table 7.1 (analysis one) and Table 7.2 (analysis two), there was a decline in the number of participants meeting guidelines for physical activity (14.0% at baseline to 8.9% at follow-up for analysis one; and 14.5% at baseline to 9.2% at follow-up for analysis two) and an increase in the number of participants not meeting guidelines for physical activity (86.0% at baseline to 91.1% at follow-up for analysis one; and 85.5% at baseline to 90.8% at follow-up for analysis two) between baseline and follow-up.

8.2.2 Research Question 2

For Research Question 2 (analysis one), the main finding was that females were 52.4% less likely to meet the recommended guidelines for physical activity post compulsory education completion than males (Table 7.8). Males were therefore more physically active than females after finishing Year 11. No significant associations were found between the other independent variables of ethnicity, educational attainment, school type, area of residence or socioeconomic status and physical activity post compulsory education completion. Meanwhile, for analysis two, the findings are similar to analysis one. Females were 47.1% less likely to meet the recommended guidelines for physical activity post compulsory education completion than males (Table 7.12). No significant associations were found between ethnicity, educational attainment or school type and physical activity.

8.2.3 Research Question 3

For Research Question 3 (analysis one), the main finding was that there was no significant change in screen time status between during Year 11 and after completing compulsory education. However, what is most apparent, as shown in Table 7.15 for analysis one, is that 70.6% of participants were not meeting guidelines for screen time both during Year 11 and after completing compulsory education (i.e., there had been 'no change' in their screen time status). Similarly to analysis one, the main finding for analysis two was that there was no significant change in screen time status between during Year 11 and after completing compulsory education. Similar to analysis one, it was recognised, as shown in Table 7.16, that 68.9% of participants were not meeting guidelines for screen time both during Year 11 and after completing compulsory education. Overall, as shown in Table 7.13 (analysis one) and Table 7.14 (analysis two), there was a slight increase in the number of participants who were not meeting guidelines for screen time (80.7% at baseline to 81.6% at follow-up for analysis one; and 79.7% at baseline to 80.3% at follow-up for analysis two) and a slight decrease in the number of participants who were meeting guidelines for screen time (19.3% at baseline to 18.4% at follow-up for analysis one; and 20.3% at baseline to 19.7% at follow-up for analysis two) between baseline and follow-up. However, it should be remembered that these 'slight' increases and decreases are marginal and do not represent any significant shift in screen time in either direction for the sample as a whole.

8.2.4 Research Question 4

For Research Question 4 (analysis one), the main finding was that there were no significant associations found between the independent variables of gender, ethnicity, educational attainment, school type, socioeconomic status or area of residence and screen time status post compulsory education completion (Table 7.20). Meanwhile, for analysis two, the findings are consistent with analysis one. No significant associations were found between gender, ethnicity, educational attainment or school type and screen time status post compulsory education completion (Table 7.24).

8.2.5 Further analyses

From the further analyses undertaken, additional findings were revealed. Firstly, given the significant decline in physical activity through the transition period (identified in Research Question 1), the first further analysis focused on assessing the association of a number of factors with whether or not participants would move from meeting guidelines for physical activity at baseline to not meeting guidelines for physical activity at follow-up (i.e., decline in physical activity through the transition period). Findings revealed that despite females being less likely to meet guidelines for physical activity at follow-up (as previously stated in Section 8.2.2), females were 42.4% (analysis one) and 47.6% (analysis two) less likely to move from meeting guidelines for physical activity at baseline to not meeting guidelines for physical activity at follow-up (Table 7.28 for analysis one and Table 7.32 for analysis two). Consequently, males were more likely than females to move from meeting recommended guidelines for physical activity at baseline to not meeting guidelines for physical activity at follow-up (i.e., decline through the transition).

The second further analysis, with the inclusion of 'status at follow-up' (determined as those participants either in 'education' or 'employment or unemployment') rather than 'school type' as a factor, focused on assessing the association between a number of factors and whether or not participants met the recommended guidelines for physical activity post compulsory education completion. Screen time status post compulsory education completion was also focused upon using these same independent variables. Regarding physical activity at follow-up, findings for both analysis one and analysis two identified that females were 52.9% (analysis one) and 47.8% (analysis two) less likely to meet recommended guidelines for physical activity post compulsory education completion (Table 7.36 for analysis one and Table 7.40 for analysis two). Males were therefore more physically active than females after finishing Year 11. In relation to screen time status post compulsory education completion, findings for both analysis one and analysis two, revealed there were no significant associations between any of the independent variables and screen time status post compulsory education completion for analysis one (Table 7.43) or analysis two (Table 7.46). All findings summarised here for category two are consistent with those found for Research Question 2.

The third further analysis involved the inclusion of baseline physical activity (i.e., determined as meeting guidelines or not meeting guidelines) as an independent variable and the removal of educational attainment as an independent variable. This analysis, similar to the second further analysis, investigated associations between the independent variables and physical activity at follow-up. Screen time status post compulsory education completion was also focused upon using these same independent variables with screen time status at baseline (i.e., determined as meeting guidelines for screen time or not meeting guidelines for screen time) included as an independent variable in place of educational attainment. As illustrated in Table 7.50 (analysis one) and Table 7.54 (analysis two) for physical activity at follow-up, those participants meeting guidelines for physical activity at baseline were 5.8 times (analysis one) and 4.8 times (analysis two) more likely to meet recommended guidelines for physical activity at follow-up. Similarly, as identified in Table 7.58 (analysis one) and Table 7.62 (analysis two) for screen time status at follow-up, participants meeting guidelines for screen time at baseline were 5.2 times (analysis one) and 4.9 times (analysis two) more likely to meet recommended guidelines for screen time at follow-up.

The fourth further analysis focused on investigating the possible link between physical activity and screen time status at baseline and follow-up in the form of a 'hybrid'. Two main findings stand out. Firstly, a large proportion of participants (70.6% for analysis one and 69.1% for analysis two) (Table 7.63 and Table 7.64) at baseline were not meeting recommended guidelines for physical activity or screen time. At follow-up, a similar picture was evident (74.8% for analysis one and 73.0% for analysis two) (Table 7.65 and Table 7.66). Secondly, the proportion of participants (10.1% for analysis one and 10.7% for analysis two) (Table 7.63 and Table 7.64) who at baseline met guidelines for physical activity but were not meeting screen time guidelines. At follow-up, a marginal decrease could be seen for the participants who fell into this category (6.8% for analysis one and 7.3% for analysis two) (Table 7.65 and Table 7.66).

The fifth further analysis (analysis of travel data) provided a breakdown of the modes of transport to and from school/college/work adopted by participants at both baseline and follow-up. The main findings are: (1) at baseline, the most popular modes of transport consisted of walking (44.3% and 40.8% of participants), car (36.8% and 38.5% of participants) and bus (32.9% and 36.3% of participants) for analysis one and analysis two (Table 7.67 and Table 7.68) whereas the least popular modes of transport were train (0% and 0.1% of participants), 'other' modes (1.1% and 1.0% of participants) and bike (7.7% and 8.6% of participants) for analysis one and analysis two (Table 7.67 and Table 7.68); and (2) at follow-up, the most popular modes of transport consisted of bus (45.4% and 47.1% of participants), walking (42.4% and 39.3% of participants) and car (34.8% and 38.1% of participants) for analysis one and two (Table 7.67 and Table 7.68) whereas the least popular modes of transport were train (1.1% of participants in both analyses), 'other' modes (1.7% and 1.9% of participants) and bike (8.6% and 7.4% of participants) for analysis one and analysis two (Table 7.67 and Table 7.68). Therefore, at baseline and follow-up, the main modes of transport taken were the same although there were a mixture of active (e.g., walking) and passive (e.g., car and bus) being used. The cross-tabulations undertaken highlight the modes of transport (active versus passive independently) adopted at both baseline and follow-up further. Particular findings that stand out from an active transport perspective were: (1) 88.8% (analysis one) and 90.3% (analysis two) of participants did not bike at either baseline or follow-up (Table 7.69 and Table 7.74); (2) 33.0% (analysis one) and 30.1% (analysis two) of participants walked at both baseline and follow-up (Table 7.70 and Table 7.75), however, 46.3% (analysis one) and 50.0% (analysis two) did not walk at either baseline or follow-up (Table 7.70 and Table 7.75). From a passive transport perspective, the main findings are that: (1) 26.4% (analysis one) and 26.7% (analysis two) of participants travelled by car at baseline and follow-up (Table 7.71 and Table 7.76), however, 54.8% (analysis one) and 52.3% (analysis two) of participants did not travel by car at either baseline or follow-up (Table 7.71 and Table 7.76); (2) 28.2% (analysis one) and 31.9% (analysis two) of participants travelled by bus at baseline and follow-up (Table 7.72 and Table 7.77), however, 49.9% (analysis one) and 46.3% (analysis two) of participants did not travel by bus at either baseline or follow-up (Table 7.72 and Table 7.77); and (3) 98.9% (analysis one and analysis two) of participants did not use the train at either baseline or follow-up (Table 7.73 and Table 7.78).

The sixth further analysis (analysis of other physical activity data) concentrated on the other physical activity data collected. Key findings were that in relation to organised team or individual sports, the largest proportion of participants (44.6% at baseline and 36.7% at follow-up (analysis one)) took part one to two times in the previous seven days (Table 7.79). This was followed by 25.8% of participants at baseline and 34.8% of participants at follow-up taking part in no organised team or individual sports in the previous seven days for analysis one (Table 7.79). Meanwhile, only 3.3% of participants at baseline and 2.3% of participants at follow-up reported participating five to six times in the previous seven days for analysis one (Table 7.79). Analysis two (Table 7.80) reflected similar proportions as those reported for analysis one. Further cross-tabulations revealed that 20.7% of participants reported taking part in organised team or individual sports one to two times in the previous seven days at baseline and follow-up and 16.1% of participants took part in none at baseline and follow-up for analysis one (and similar pattern of findings for analysis two shown in Appendix 50). Conversely, in relation to physical activity that was not an organised team or individual sport, the largest proportion of participants (46.6% at baseline and 46.5% at follow-up (analysis one)) took part one to two times in the previous seven days for analysis one (Table 7.81). The second largest proportion of participants reported three to four times in the last seven days for analysis one (23.7% of participants at baseline and 21.7% of participants at follow-up) (Table 7.81). The smallest proportion (5.7% at baseline 3.9% at follow-up) reported participating in physical activity that was not an organised team or individual sport five to six times in the previous seven days for analysis one (Table 7.81). Cross-tabulations highlighted that the highest proportion of participants (23.8%) took part in physical activity that was not an organised team or individual sport on one to two times in the previous seven days at baseline and follow-up for analysis (Appendix 49 and for analysis two in Appendix 50). Only 0.8% of participants reported participating seven or more times at both baseline and follow-up for analysis one (Appendix 49).

In relation to the question on the number of sessions of 30 minutes sport and active recreation participated in during an average week, the largest proportion of participants participated in three to four sessions at baseline and follow-up (29.1% at baseline and 30.0% at follow-up) (Table 7.83 for analysis one). Further, five to six sessions were reported by 18.6% of participants at baseline and 16.9% of participants at follow-up (Table 7.83 for analysis one). Interestingly, nearly 19.5% of participants at baseline and 15.7% of participants at follow-up reported seven or more sessions (Table 7.83 for analysis one). Overall, cross-tabulations showed that 12.4% of participants took part in one to two sessions of 30 minutes of sport and active recreation during an average week at baseline and follow-up, 10.9% of participants took part in three to four sessions, 3.8% of participants took part in five to sessions and 7.7% of participants in seven or more sessions (Appendix 49 for analysis one and Appendix 50 for analysis two). Finally, regarding the intensity of sport and active recreation at baseline and follow-up, the greatest majority of participants took part in sport and active recreation of a moderate intensity at baseline (54.9%) and follow-up (35.3%) for analysis one (Table 7.85 for analysis one and Table 7.86 for analysis two which shows similar proportions). Also, 33.3% at baseline and 35.3% (follow-up) reported sport and active recreation of a vigorous intensity (Table 7.85 for analysis one and Table 7.86 for analysis two which shows similar proportions). Cross-tabulations illustrated that 32.3% of participants took part in moderate intensity sport and active recreation at baseline and follow-up, in contrast to 20.1% who indicated that they undertook vigorous intensity sport and active recreation at baseline and follow-up for analysis one (Appendix 49).

Finally, the seventh further analysis investigated possible bias for the independent variables (gender, ethnicity, educational attainment, school type, area of residence, socioeconomic status, status at follow-up, physical activity at baseline and screen time status at baseline) between the total baseline sample and the baseline sub-sample used for the longitudinal analyses. From the descriptive analyses undertaken (shown in Table 7.87), no bias was introduced at follow-up for any of the independent variables, suggesting that the sub-sample used for longitudinal analyses was representative of the broader baseline sample.

8.3 Interpretation of main findings

As demonstrated in the overview of the main findings, the present study has resulted in numerous key findings in the area of adolescents' physical activity and sedentary behaviour (using screen time as the proxy measure of sedentary behaviour). These key findings are directly related to the theoretical framework underpinning this thesis

(Section 2.3 in Chapter 2). More specifically, this theoretical framework included the social determinants of health model (for the determination of demographic and environmental factors examined) and the link with phase three of the behavioural epidemiology framework (i.e., (1) identifying factors associated with physical activity and sedentary behaviour; and (2) examining the descriptive epidemiology of physical activity and sedentary behaviour). This section interprets the main findings separately in relation to physical activity (Research Question 1, Research Question 2, first further analysis, second further analysis and third further analysis) and screen time status (Research Question 3, Research Question 4, second and third further analysis) before moving on to interpreting the main findings from the fourth, fifth and sixth further analyses.

8.3.1 Adolescents' physical activity

The first finding of the present study was the longitudinal decline in physical activity during this important transitional period (i.e., the significant change from meeting guidelines for physical activity at baseline to not meeting guidelines for physical activity at follow-up for Research Question 1). This finding is important because this is the first prospective population-based longitudinal study in the U.K. which has measured physical activity compliance with guidelines among an adolescent population during the transition from Year 11 and out of compulsory education. Consequently, the evident decline demonstrated will have implications for policy and practice. The decline in physical activity during this period of adolescence (i.e., age 15 years until age 17 years) is supported by previous longitudinal studies in other countries (Dovey et al., 1998 (New Zealand); Aarnio et al.,. 2002 (Finland); Nelson et al., 2006 (U.S.); Duncan et al., 2007 (U.S.); Kahn et al., 2008 (U.S.); Sagatun et al., 2008 (Norway)). There is one study (Henning Brodersen et al., 2007) that has been undertaken in the U.K. using a longitudinal design which did find a decline in physical activity among adolescents but this study only followed adolescents from the age of 11 to 12 years until 15 to 16 years (i.e., adolescents had not completed compulsory education) and did not measure physical activity in relation compliance with recommended guidelines. Consequently, the findings of the present study are unique from a U.K. perspective.

On the other hand, although there was a significant change (decline) in physical activity in which 10.1% of participants met the guidelines at baseline but did not meet the guidelines at follow-up, it is important to take note that 80.1% of participants were not meeting the guidelines at either baseline or follow-up. This is concerning because this indicates that the vast majority of adolescents were already not meeting the guidelines when still at school (i.e., in Year 11). Although school is not the only place where physical activity is undertaken whilst still in compulsory education, school curricula (e.g., compulsory physical education in the U.K.) should influence physical activity levels (Dovey et al., 1998) and therefore it is concerning that this figure was so high. This high percentage of participants who were not meeting the guidelines at either time point also reinforces the importance of learned behaviours such as physical activity which are believed to be adopted during adolescence and then continued for many years after (Berkey et al., 2000). Unfortunately, there have been no studies undertaken which have longitudinally examined adolescents' compliance with physical activity recommendations during the period of adolescence studied in the present study. Therefore, direct comparisons were not possible to make.

As reported earlier, only 14% of participants (analysis one) and 14.5% of participants (analysis two) at baseline (when in Year 11) were meeting the recommended guidelines for physical activity. Further, only 8.9% of participants (analysis one) and 9.2% (analysis two) at follow-up (after completing compulsory education) were meeting the recommended guidelines for physical activity. This is not surprising considering that approximately 80% of participants were not meeting the guidelines across the transition. However, this low percentage at baseline of the total population in the study (although slightly better than at follow-up) is concerning for the same reasons as described in the previous paragraph (i.e., school curricula influencing physical activity levels). When taking the compliance rates at either baseline or follow-up, the percentages reported at each time point can be treated as cross-sectional (i.e., at one point in time). Consequently, the compliance rates in the present study can be compared to other cross-sectional studies of adolescents' compliance with physical activity guidelines. For instance, these low percentages of compliance at baseline (14% and 14.5%) and follow-up (8.9% and 9.2%) are supported by previous cross-sectional research findings in other countries

(Scully et al., 2007 (Australia); Tammelin et al., 2007 (Finland)). In particular, Scully et al. (2007) reported that only 14% of participants (aged 12 to 17 years) reported engaging in at least 60 minutes of MVPA each day in the previous week (i.e., seven days x 60 minutes). However, the age period studied is a key difference between the present study and that of Scully et al. (2007) because they focused on a broader age period of 12 to 17 years. Other cross-sectional research has indicated considerably higher compliance rates of adolescents meeting physical activity guidelines in numerous countries (Li et al., 2007 (China); Bastos et al., 2008 (Brazil); Butcher et al., 2008 (U.S.); Roman et al., 2008 (Spain); Gorely et al., 2009c). For instance, the study by Roman et al. (2008) reported that 48.8% of participants aged 14 to 18 years complied with the physical activity recommendation of at least 60 minutes of physical activity of at least moderate intensity daily. However, although the recommendation is consistent with the present study, there is a distinct difference because Roman et al. (2008) used a different calculation method for the accumulation of at least 60 minutes. More specifically, Roman et al. (2008) summed the time spent practicing sports during leisure time only plus the number of minutes walked a day and the number of hours spent practicing sports at school thus distinctly different to the present study's calculation of at least 60 minutes.

The second main finding from the present study is that gender was significantly associated with physical activity at follow-up (i.e., Research Question 2 and second further analysis). Therefore, gender was found to be a correlate of adolescents' physical activity at follow-up. More specifically, females were 52.4% (analysis one – Research Question 1), 52.9% (analysis one – second further analysis), 47.4% (analysis two – Research Question 1) and 47.8% (analysis two – second further analysis) less likely to meet the recommended guidelines for physical activity post compulsory education completion than males. In other words, males were more likely to meet the recommended guidelines for physical activity participation after completing compulsory education (i.e., males were more physically active than females at follow-up). This finding supports previous reviews of correlates of adolescents' physical activity which have concluded gender is positively associated with physical activity. More specifically, males are known to be more active than females (Sallis et al, 2000b; Biddle et al., 2005; Van der Horst et al., 2007; Biddle et al., 2011a). As this particular analysis involves the outcome (dependent variable) of physical activity at only one time point (i.e., follow-up), the finding is effectively cross-sectional. As a consequence, this finding can be compared to evidence in the cross-sectional literature that supports this finding (Michaud et al., 1999; Trost et al., 2003; Higgins et al., 2003; Molnar et al., 2004; Seabra et al., 2007; Li et al., 2007; Scully et al., 2007; Tammelin et al., 2007; Bastos et al., 2008; Roman et al., 2008; Juan et al., 2010; Thibault et al., 2010). Studies that are most appropriate to compare to are those for which differences in gender compliance with physical activity guidelines are reported. For example, Scully et al. (2007) reported that males were more likely than females to meet the physical activity recommendation of 60 minutes of MVPA each day in their study among Australian adolescents. However, consistent with the point made earlier in relation to this study, the age period of adolescence was 12 to 17 years in the study of Scully et al (2007) and therefore it is difficult to make a direct comparison despite a similar dichotomous outcome being utilised. Conversely, there is also evidence from a cross-sectional study that contradicts the findings of the present study (and the majority of the existing literature) which shows that female adolescents are more active than male adolescents (Eiðsdóttir et al., 2008). However, this study was based on a sample of adolescents aged 14 to 15 years in relation to vigorous physical activity.

From an U.K. perspective, there do not appear to be any studies that have demonstrated a gender association in relation to physical activity during the age period of 16 to 17 years thus this finding stimulates discussion of potential reasons for this gender difference in physical activity levels after completing compulsory education in the U.K. One possible reason could be due to a lack of early-in-life participation in sports and other forms of physical activity which are known to be important for the maintenance of physical activity during adolescence in girls (Pate et al., 2007). Another possible reason could be due to the progression from 16 years of age in terms of adolescents (among females particularly) having a time schedule which is heavily loaded by professional learning tasks, in addition to other social activities like going out and spending time with friends (Michaud et al., 1999).

The next main finding uncovered a further difference in gender regarding physical activity. However, this was concentrated on the decline in physical activity through the transition period. Therefore, this was analysis undertaken as a further analysis following the finding of Research Question 1 and focused on investigating the factors associated with the longitudinal change (i.e., decline) in physical activity previously established (first further analysis). The main finding revealed there was an association between gender and the longitudinal decline in physical activity (i.e., gender was found to be a determinant of the decline in physical activity). More specifically, despite females being less likely to meet guidelines for physical activity at follow-up, females were 42.4% (analysis one) and 47.6% (analysis two) less likely to move from meeting guidelines for physical activity at baseline to not meeting guidelines for physical activity at follow-up. In other words, males were more likely than females to move from meeting recommended guidelines for physical activity at baseline to not meeting guidelines at follow-up (i.e., decline through the transition).

This is an important finding because it appears to suggest that although females were less active than males after completing compulsory education (aged 16 to 17 years), males' physical activity actually declined more than females through the transition period. This finding is surprising because the majority of previous longitudinal research undertaken on adolescents' physical activity has shown that female adolescents' physical activity declines more than male adolescents' physical activity during adolescence (Aaron et al., 1993; Dovey et al., 1998; Van Mechelen et al., 2000; Henning Brodersen et al., 2007; Sagatun et al., 2008). This is particularly the case between the adolescent period of ages 15 to 18 years as shown in the studies by Dovey et al. (1998) and Sagatun et al. (2008). Furthermore, due to research consistently demonstrating a decline in female adolescents' physical activity, studies have specifically focused on female adolescents to investigate this drop off in physical activity further (Kimm et al., 2000; Kimm et al., 2002; Pfeiffer et al., 2006; Pate et al., 2007). The findings of the present study also challenge the conclusions made in reviews of correlates and determinants of adolescents' physical activity that gender (male) is positively associated with adolescents' physical activity (Sallis et al, 2000b; Biddle et al., 2005; Van der Horst et al., 2007; Biddle et al., 2011a; Uijtdewilligen et al., 2011). However, some longitudinal studies do exist that support the finding in the present study (Caspersen et al., 2000; Kahn et al., 2008). In particular, Kahn et al. (2008) found that boys demonstrated a steeper decline in physical activity than girls between the ages of 15 to 18 years thus by the age of 18 years, girls had a higher level of physical activity than boys. However, methodologically Kahn et al.'s (2008) study is different to the present study (i.e., they assessed the time spent during the past year in 18 separate individual and team activities (outside of school gym or physical education class)) thus direct comparisons are not possible to make. Another longitudinal study investigated physical activity from adolescence to adulthood and identified a decline in physical activity among males and females but a steeper decline in males from the age of 12 years up until age 27 years (Telama and Yang, 2000). The finding in the present study therefore suggests a similar pattern of decline among males if the trend was to continue.

To date, this particular finding is the first in a U.K. longitudinal study which has identified an association between gender and the decline (change) in adolescents' physical activity across this period of adolescence (i.e., 15 to 17 years). There are numerous possible reasons for males demonstrating a greater decline than females across the transition from Year 11 (compulsory education) to the period post compulsory education completion. Firstly, it is possible that this finding is attributable to a 'floor effect' in the females' data (i.e., lower levels of physical activity (meeting guidelines) in females at baseline) thus explaining the greater decline in males' physical activity levels. However, as shown in the further exploration of the baseline data (for analysis one (Table A2 and the associated SPSS output) and analysis two (Table A3 and the associated SPSS output)) in Appendix 53, both males and females were rarely meeting guidelines for physical activity at baseline. More specifically, for analysis one, only 9.6% of females (4.4% as a proportion of the whole sample) and 17.7% of males (9.7% as a proportion of the whole sample) were meeting guidelines at baseline (Table A2). Further, for analysis two, only 6.5% of females (3.0% as a proportion of the whole sample) and 11.6% of males (6.2% as a proportion of the whole sample) were meeting guidelines at baseline (Table A3). As these proportions demonstrate, there was little difference between the proportions of males and females meeting guidelines at baseline. Therefore, as a consequence of this further exploration of the baseline data, and the finding that being male was associated with the decline, it is unlikely that a floor effect was present in the females' data. Secondly, because the completion of compulsory education is a major life transition, this can influence health behaviours such as physical activity due to the changes that occur at this time. For example, lifestyle behaviours related to affiliation needs (e.g., alcohol consumption, smoking) may occur during this important transitional period thus reducing interest in undertaking physical activity (Cullen et al., 1999). Thirdly, even though the vast majority of adolescents were still in education (i.e., sixth form) post compulsory education completion, school curriculum physical education is not compulsory at this point and therefore adolescents were not obliged to undertake physical activity in school. Even so, the further education environment is not the only situation where physical activity could have been undertaken so the absence of compulsory physical education cannot be the only reason.

Another possible reason for the declining levels of males could be due to an increase in academic work and other social activities although because this particular transition point is an understudied area, specific reasons are difficult to establish for the decline (Baranowski et al., 1997). However, as identified earlier in relation to females being less active than males at follow-up, it was hypothesised that this specific reason could be attributable to this finding. Therefore, an increase in responsibilities after completing compulsory education could be attributable to both the greater decline in physical activity among males through the transition and females being less active at follow-up. It is also important to clarify that although males declined more than females in physical activity through the transition, there was still a decline in physical activity among both genders through the transition. Consequently, the increase in academic and non academic responsibilities could be the reason for both the general decline (among males and females) and females being associated with less of a decline in physical activity.

The other key finding (via the third further analysis) was that physical activity at baseline was associated with physical activity at follow-up. More precisely, those participants meeting guidelines for physical activity at baseline were 5.8 times (analysis one) and 4.8 times (analysis two) more likely to meet recommended guidelines for physical activity at follow-up. It therefore appears that baseline (i.e., earlier) physical activity was an indicator of future physical activity. This finding supports previous reviews of correlates and determinants of adolescents' physical activity which have reported that 'previous physical activity' is consistently positively associated with adolescents' physical activity (Sallis et al., 2000b; Biddle et al., 2011a; Uijtdewilligen et al., 2011). This finding also has implications when investigating the association between physical activity during adolescence and physical activity during adulthood. Some studies have demonstrated that there is an association between physical activity in adolescence and physical activity during adulthood (Tammelin et al., 2003a; Telama et al., 2005). However, what this association reveals is the importance of a learned behaviour (i.e., physical activity) in shaping future lifestyle choices which in turn have important consequences for reducing the risk of chronic disease later in life. If physical activity is habitually adopted in an adolescent's life, they are more likely to continue leading a physically active lifestyle into late adolescence and then adulthood. This finding also has important implications for policy because it has provided evidence of a longitudinal link between physical activity at both time points; an important finding that no other study in the U.K. has established to date with this particular age group of adolescents.

Still continuing with the findings relating to the third further analysis, gender disappeared as a factor associated with physical activity at follow-up (i.e., as a correlate) when baseline physical activity was accounted for. This is an interesting finding because, as shown previously in this chapter, when gender has been included as an independent variable in the other BLR models, it has been found to be significantly associated from both a cross-sectional and longitudinal perspective. Although gender was not significantly associated with physical activity at follow-up in the third further analysis, it was still bordering on statistical significance ($p = 0.071$). Therefore, it was approaching statistical significance. This is an interesting finding because it suggests that the inclusion of baseline behaviour (i.e., physical activity) in the BLR model impacted on the shift from gender being associated with physical activity at follow-up (as shown in Research Question 2) to not being associated in the third further analysis. Attempting to provide a reason for gender disappearing as a correlate due to the inclusion of baseline physical activity is difficult. As shown previously in Chapter 5, numerous systematic reviews of correlates of adolescents' physical activity have found that previous physical activity is a correlate of adolescents' physical activity (Sallis et al., 2000b), in addition to systematic reviews of determinants of adolescents' physical activity identifying it as a determinant of adolescents' physical activity (Uijdewilligen et al., 2011).

Therefore, this finding is not unusual from the perspective that this variable is consistently positively associated with adolescents' physical activity. However, it is important to highlight that it is uncommon for BLR models to include baseline behaviour, particularly physical activity, mainly due to a lack of longitudinal studies (Uijtdewilligen et al., 2011). Overall, baseline behaviour is rarely included in BLR models and even when it is, such as in the present study, gender is borderline significant.

In terms of the findings in relation to the lack of significant association found for all other independent variables (except gender as this has been previously explained in relation to its disappearance as a correlate in the third further analysis) in relation to physical activity at follow-up (i.e., Research Question 2, second further analysis and third further analysis) and the decline in physical activity through the transition (i.e., first further analysis), it is most appropriate to relate these two specific outcomes (i.e., (1) physical activity at follow-up; and (2) decline in physical activity through the transition) to the type of study design associated with each outcome for the future discussion that is provided. Firstly, a cross-sectional analysis was effectively undertaken for physical activity at follow-up. Secondly, a longitudinal analysis was undertaken for the decline in physical activity through the transition.

Firstly, from a cross-sectional perspective no associations were found between ethnicity (Research Question 2, second and third further analysis), educational attainment (Research Question 2, second further analysis), school type (Research Question 2, third further analysis), socioeconomic status (Research Question 2, second and third further analysis), area of residence (Research Question 2, second and third further analysis) and status at follow-up (second further analysis) and physical activity at follow-up for Research Question 2, the second further analysis and the third further analysis.

Secondly, from a longitudinal perspective no associations were found between ethnicity (first further analysis), education attainment (first further analysis), school type (first further analysis), socioeconomic status (first further analysis) and area of residence (first further analysis) and the decline in physical activity through the transition for the first further analysis. Therefore, it can be concluded from these findings that none of these factors were associated with adolescents' physical activity post compulsory education completion (i.e., cross-sectional) or the decline in physical activity through the transition (i.e., longitudinal) in the present study. However, as shown previously in Chapter 7, some of these factors were approaching significance.

In relation to ethnicity having no association from a cross-sectional and longitudinal perspective, this is partially supported by the conclusions of Van der Horst et al. (2007) in their review of correlates of physical activity among adolescents who reported that the evidence was inconclusive for an association between ethnicity and adolescents' physical activity. There are also numerous studies which have reported no association between ethnicity and adolescents' physical activity (Sallis et al., 1999; Gordon-Larsen et al., 2000 (males only); Booth et al., 2002b (males only); Neumark-Sztainer et al., 2003 (girls only); Molnar et al., 2004). Conversely, this finding contradicted earlier reviews which reported a positive association (White) for ethnicity with adolescents' physical activity (Sallis et al., 2000b; Biddle et al., 2005). Further, specific longitudinal studies have also reported a positive association between White adolescents and increased physical activity (Aaron et al., 1993; Henning Brodersen et al., 2007) and a cross-sectional study showing compliance with recommended guidelines for physical activity among non-Hispanic White adolescents (Butcher et al., 2008). Although not a reason for no association being found, it is important to highlight that there were a small number of participants classified in the 'other' category (i.e., non-White) for analysis one (n = 38) and analysis two (n = 42), in comparison to the 'White' category (analysis one: n = 625; analysis two: n = 792). The seventh further analysis, however, has shown that the percentage of participants for each category of ethnicity at follow-up is representative of the percentage of participants for the same categories of this independent variable at baseline thus no bias was introduced at follow-up.

The non association found for educational attainment from a cross-sectional and longitudinal perspective is notable because no other previous study has been identified that has investigated this factor as a possible correlate of adolescents' physical activity. Consequently, educational attainment has not been reported in any of the systematic reviews on correlates of adolescents' physical activity. Although one longitudinal study (Zimmermann-Sloutskis et al., 2010) did attempt to include education as a possible determinant, this was decided against because of its strong correlation with age. Due to the dearth of evidence investigating this factor, it is not possible to report on any findings that support or contradict this particular finding. Similar to the point made earlier for ethnicity, although not a reason for no association being found may have been found there were a small number of participants who did not achieve the criterion (i.e., 5 or more A* to C grades at GCSE level) (analysis one: n = 54; analysis two: n = 66) as opposed to the majority of participants who did (analysis one: n = 609; analysis two: n = 768).

The lack of associations reported for school type, socioeconomic status, area of residence and status at follow-up are also important findings for the area of correlates of adolescents' physical activity. Regarding school type (i.e., state/mainstream versus private/independent), the main conclusion of one review (i.e., Ferreira et al., 2006) was that there had only been one study undertaken indicating a inverse association thus was not consistent with the finding in the present study. Other cross-sectional studies have also reported opposing findings. For example, Juan et al. (2010) concluded that private school adolescents were more active than public school adolescents. Other research has indicated there are no significant differences in physical activity levels between adolescents from public schools and those from private schools (Peiró-Velert et al., 2008). Similarly, there is agreement from a more recent study that school type is not associated with adolescents' physical activity (Devís-Devís et al., 2010). However, all three of these studies (Peiró-Velert et al., 2008; Devís-Devís et al., 2010; Juan et al., 2010) were undertaken in Spain with adolescents still in school; a distinct difference from the present study. Overall, there is a lack of previous evidence on which to compare findings (particularly from a longitudinal stance) and no other studies have been undertaken in the U.K. previously with this particular age cohort of adolescents. Although no bias was introduced at follow-up regarding school type, participants in the category of 'private/independent school' (analysis one: n = 59; analysis two: n = 70) was small compared to those in the 'state/mainstream' school category (analysis one: n = 604; analysis two: n = 764).

The lack of association between socioeconomic status from a cross-sectional and longitudinal perspective is supported by reviews of correlates of adolescents' physical activity reporting no association (Sallis et al., 2000b; Van der Horst et al., 2007). However, associations between socioeconomic status and adolescents' physical activity are likely to be dependent on the measurement or indicator of socioeconomic status used. For example, other reviews (Biddle et al., 2005; Ferreira et al., 2006; Gustafson and Rhodes, 2006) and one particular study (Santos et al., 2004) have concluded that there is a positive association for socioeconomic status and adolescents' physical activity but this appears to be related to higher family income, higher parental education and parental employment; all measures or proxies of socioeconomic status not used in the present study. This is an important point because the variation in measures of socioeconomic status can possibly be the reason for differences in associations being found or not. Two studies in particular (Henning Brodersen et al., 2007 in the U.K. using a longitudinal design; Scully et al., 2007 in Australia using a cross-sectional design) both supported the finding of the present study because they both found that socioeconomic status was not associated with adolescents' physical activity. Both of these studies used the postcode of an adolescent to determine socioeconomic status and, in particular, the study by Henning Brodersen et al. (2007) used the Townsend Deprivation Index (i.e., the Townsend Score). Therefore, this particular finding is both supported and contradicted by the literature but from the perspective of the measurement of socioeconomic status utilised, it is supported by previous similar studies in the U.K. and Australia.

Following on from socioeconomic status, area of residence (urban versus rural) was also found to be not associated from a cross-sectional and longitudinal perspective. Due to the lack of cross-sectional and longitudinal studies investigating this environmental factor (also commonly termed 'residence location') as a possible correlate of adolescents' physical activity, there is little to base this finding on. Even so, some reviews of correlates of adolescents' physical activity have concluded that for residence location (i.e., urban or rural) there is no association (Ferreira et al., 2006) thus supporting the finding of the present study of a lack of an association (Davison and Lawson, 2006). Furthermore, the majority of studies (all cross-sectional) have shown the same finding as the present study (i.e., that there is no association between residence location and adolescents' physical activity) (Gordon-Larsen et al., 2000; Vilhjalmsson and Kristjansdottir, 2003). The lack of research into this particular factor from both a cross-sectional and longitudinal perspective indicates that more extensive work is required, particularly when considering the measurement used. As for socioeconomic status, making comparisons between studies is difficult for area of residence. The urgent need for research into environmental determinants of adolescents' physical activity, such as area of residence, is echoed in a recent review on prospective studies of determinants of adolescents' physical activity (Uijtdewilligen et al., 2011). To date, there do not appear to be any U.K. studies (cross-sectional or longitudinal) undertaken which have investigated this factor as a possible correlate of adolescents' physical activity, in particular after completing compulsory education, thus this finding adds to the evolving evidence base.

Finally, status at follow-up (i.e., in 'education' or 'employment or unemployment') was only investigated as a factor in relation to the cross-sectional further analysis (i.e., physical activity at follow-up) within the first further analysis. No association was found for this independent variable. This is not surprising considering that only 22 participants (analysis one) and 28 participants (analysis two) were in 'employment or unemployment' compared to 641 participants (analysis one) and 806 participants (analysis two) in education.

8.3.2 Adolescents' screen time status

From a sedentary behaviour perspective, in comparison to the significant decline in physical activity from baseline to follow-up, there was no significant change in screen time status from baseline to follow-up (Research Question 3). Therefore, participants had not shifted their screen time behaviour in a more favourable or unfavourable direction over this longitudinal period (i.e., they had remained in the same category for screen time). This finding is surprising considering that the majority of the longitudinal literature in some countries in relation to screen time has shown an increase across adolescence (Nelson et al., 2006 (U.S.); Henning Brodersen et al., 2007 (U.K.)). However, a recent longitudinal study provides support for no change in screen time across adolescence over a three year period in Portuguese adolescents (Aires et al., 2010). Although Aires et al.'s (2010) demonstrates a similar finding, different methods for calculating screen time were used. For example, compliance with screen time guidelines were not adopted and only one previous weekday screen time use was measured. Although there was no change in screen time in the present study, a closer inspection of the proportions of participants not meeting recommended guidelines for screen time illustrates that approximately 70% of participants (analysis one = 70.6%; analysis two = 68.9%) were not meeting the guidelines for screen time in either Year 11 or after completing compulsory education. Similarly to the high levels of non compliance reported earlier for participants not meeting recommended guidelines for physical activity at either time point, the high levels of participants not meeting screen time guidelines at either time point is concerning. It evidences that screen time was already too high among participants, even when still in compulsory education and that this behaviour had become learnt when having completed compulsory education. Similar to the suggestions made earlier with reference to physical activity being 'learned' during compulsory education, the same process of a learned behaviour may have occurred with screen time despite no significant change over the longitudinal period.

As the present study is believed to be the first longitudinal study of adolescents' screen time in the U.K. in relation to compliance with recommended screen time guidelines, there is no previous literature to compare this high percentage to. However, in contrast to other longitudinal research in other countries using the same categorisation for screen time, this high level of screen time in the present study far exceeds what has been previously reported. For example, Gordon Larsen et al.'s (2004) longitudinal study in the U.S. found that only approximately 25% of participants were not meeting the recommended guidelines of 14 hours or less of screen time per week. A distinct difference between the two studies is that Gordon Larsen et al. (2004) were measuring a larger age range of adolescents (i.e., ages 11 to 21 years and ages 18 to 26 years) as their interest was in the transition from adolescence to adulthood. This finding from the present study is important for understanding the longitudinal nature of screen time among adolescents, particularly in the U.K. because this is the first study to have investigated this particular sedentary behaviour over a longitudinal period during the transition from compulsory education completion.

From a cross-sectional perspective, when looking at the compliance with recommended guidelines at baseline and follow-up respectively, it has been shown that at baseline, 80.7% (analysis one) and 79.7% (analysis two) of participants were not meeting screen time guidelines. At follow-up, 81.6% (analysis one) and 80.3% (analysis two) of participants were not meeting the screen time guidelines. Therefore, when viewed as the percentage of participants meeting guidelines, 19.3% (analysis one) and 20.3% (analysis two) met the screen time guidelines at baseline. On the other hand, 18.4% (analysis one) and 19.7% (analysis two) met the screen time guidelines at follow-up. When viewing the high proportions of participants not meeting screen time guidelines at baseline and follow-up, this indicates that this particular cohort of participants were participating in high levels screen time both in compulsory education and following completion of compulsory education. In comparison to other cross-sectional studies of adolescents' screen time in different countries who have used a similar cut-off point for screen time or a similar guideline, the proportions of adolescents meeting a screen time guideline are very similar ranging from 14% to 29% across studies (Mark et al., 2006 (Canada); Scully et al., 2007 (Australia); Hardy et al., 2010 (Australia); Ullrich-French et al., 2010 (U.S.)). Conversely, some studies have used a similar guideline but only in relation to TV viewing on its own and have shown that as low as 24% of adolescents are in fact meeting the guidelines of two hours or less a day of TV viewing (Li et al., 2007). However, although the proportions of participants compliant with screen time guidelines may be similar, it is challenging to make direct comparisons (even when using the same guideline) because different self-report questionnaires are used with different methods used for calculating screen time.

The other main finding regarding screen time status was that screen time at baseline was associated with screen time at follow-up (third further analysis). More specifically, participants meeting guidelines for screen time at baseline were 5.2 times (analysis one) and 4.9 times (analysis two) more likely to meet recommended guidelines for screen time at follow-up. Therefore, baseline screen time was an indicator or predictor of follow-up screen time. This result would suggest that the lifestyle behaviour adopted (i.e., below recommended guideline for screen time) during compulsory education is likely to be continued into the next period of adolescence post compulsory education. This is a positive finding because it reinforces the importance of healthier lifestyle habits being adopted whilst an adolescent is still in compulsory education. From the literature review undertaken previously, there do not appear to be any previous studies (cross-sectional or longitudinal) that have investigated 'earlier/previous screen time' in relation to a later measure of screen time. Consequently, this finding cannot be related to any literature. This lack of previous research is due to a lack of longitudinal prospective and cross-sectional studies into the factors associated with screen time. Even the four reviews of correlates (and determinants) of adolescents' sedentary behaviour (Gorely et al., 2004; Van der Horst et al., 2007; Pate et al., 2011; Uijtdewilligen et al., 2011) do not report previous sedentary behaviour (e.g., screen time) as a correlate that has been investigated previously, mainly due to the lack of longitudinal studies and dominance of cross-sectional studies investigating sedentary behaviour among adolescents. In addition, the finding cannot be explained in relation to longitudinal studies demonstrating an association between screen time in adolescence and screen time in adulthood due to no studies being published in this area. Despite the lack of previous research demonstrating this finding among adolescents, potential reasons for the association found could be attributable to screen time being a learned behaviour (i.e., participating in below recommended levels of screen time whilst in compulsory education and continuing this behaviour into the period post compulsory education completion).

As explained previously, unlike physical activity, there was no significant change in screen time status from baseline to follow-up. Therefore, the factors of interest in the present study were not examined in relation to a longitudinal change in screen time status. With reference to the lack of associations for all of the independent variables in relation to screen time status at follow-up (i.e., Research Question 4, second further analysis and third further analysis), all of the analyses undertaken were cross-sectional in nature and thus are interpreted in this context. The factors that were not associated with adolescents' screen time status at follow-up were gender (Research Question 4, second and third further analysis), ethnicity (Research Question 4, second and third further analysis), educational attainment (Research Question 4 and second further analysis), school type (Research Question 4 and third further analysis), socioeconomic status (Research Question 4, second and third further analysis), area of residence (Research Question 4, second and third further analysis) and status at follow-up (second further analysis).

Firstly, the non significant association for gender with screen time at follow-up is consistent with the conclusions of the review of correlates of adolescents' TV/video viewing by Gorely et al. (2004) and other cross-sectional studies that have demonstrated no association between adolescents' screen time and gender (Biddle et al., 2009c; Ceschini et al., 2009). Conversely, the review by Van der Horst et al. (2007) reported that there was a positive association (male) and TV/video viewing. There are also a range of cross-sectional studies which indicate there is a positive association between gender (male) and screen time (Gordon-Larsen et al., 1999, Gordon-Larsen et al., 2000; Lowry et al., 2002; Marshall et al., 2006; Hardy et al., 2010; Olds et al., 2010). However, the recent review of correlates of adolescents' screen-based sedentary behaviours by Pate et al. (2011) illustrated the inconsistency between studies for this factor when concluding that there is a 'mixed' picture with positive associations for male or female and no association. The finding is the present study shows that there was no significant association between males and females in their screen time status at follow-up (after completing compulsory education). Therefore, the screen time behaviours of both genders are similar and do not significantly differ. Secondly, ethnicity was found not to be associated with screen time status at follow-up. Two reviews identify different findings to the present study for this factor with a positive association reported for ethnicity (non-White) and TV/video viewing (Gorely et al., 2004) and similarly an inverse association for ethnicity (Caucasian) and TV/video viewing (Van der Horst et al., 2007). From a longitudinal perspective, one study in the U.K. has similarly shown that White adolescents are associated with participating in less screen time than non-White adolescents (Henning Brodersen et al., 2007). A range of cross-sectional studies have also indicated that non-White adolescents are more likely to participate in more screen time (Gordon-Larsen et al., 2000; Carson et al., 2010). Despite not being a reason for no association being found, there were considerably more participants classified as 'White' (analysis one: n = 625; analysis two: n = 792) compared to 'non-White' (analysis one: n = 38; analysis two: n = 42). However, no bias was found to be introduced for this variable at follow-up.

Regarding educational attainment and screen time status at follow-up, no association was found. To the knowledge of the researcher, this was the first study to have investigated educational attainment as a correlate of screen time among adolescents in the U.K. There are therefore no studies to compare this finding to. It is surprising that education attainment is not related to screen time due to the higher proportion of adolescents who were still in education at follow-up thus it could be theorised that those who stayed on in education (presumably with 5 or more A* to C grades) would be participating in more screen time due to the increase in studying required in sixth form at school and college. However, due to the lack of previous studies measuring this factor, further reasons are difficult to find for no association being found. Similarly, the non association for school type and screen time status at follow-up is supported by little previous research. Two reviews of correlates of adolescents' TV/video viewing (Gorely et al., 2004) and screen-based sedentary behaviours (Pate et al., 2011) have shown different associations for school type. Gorely et al. (2004) concluded there was no association and Pate et al. (2011) reported a positive association. However, as highlighted in the systematic review of correlates of TV/video viewing by Gorely et al. (2004), school type has been typically used a measure of socioeconomic status rather than a factor in its own right. Consequently, there are few studies that have investigated this factor as a correlate of adolescents' screen time. However, a cross-sectional study has recently shown that adolescents attending a private school had a higher screen time than those attending state schools (Karaca et al., 2011). Although not a reason for no association being found, the number of participants in 'private/independent' schools was smaller (analysis one: n = 59; analysis two: n = 70) than the number of participants in 'state/mainstream' schools (analysis one: n = 604; analysis two: n = 764) although, as shown, no bias was introduced at follow-up for this variable.

The non significant association found for socioeconomic status and screen time status at follow-up is contradicted by the review of Van der Horst et al. (2007) and Pate et al. (2011) who concluded there was a negative association with adolescents' TV/video viewing. In particular, proxies of socioeconomic status such as lower parental education have been shown to be negatively associated with adolescents' TV/video viewing/screen-based sedentary behaviours (Gorely et al., 2004; Van der Horst et al., 2007; Pate et al., 2011). Even so, some studies have reported no association (Ceschini et al., 2009). From a cross-sectional perspective, one study that does support this finding which, having used the postcode of Australian adolescents to determine socioeconomic status, revealed that the proportion of participants meeting the screen time guideline of (i.e., two hours a day) did not differ significantly according to socioeconomic status (Scully et al., 2007). The choice of socioeconomic status measurement is an issue for any study measuring this factor and may be one reason for the differences in associations reported. Finally, area of residence (urban versus rural) was not associated with screen time status at follow-up. Therefore, living in an urban or rural area did not make any significant difference to screen time status after completing compulsory education. This is partially supported by the review of correlates of adolescents' TV/video viewing undertaken by Gorely et al. (2004) and adolescents' screen-based sedentary behaviours by Pate et al. (2011) who concluded that the evidence remains equivocal as to whether young people in urban areas watch more or less TV than those in rural areas (i.e., Gorely et al., 2004) and evidence showing a positive association between region (urban) and screen-based sedentary behaviour in two studies but no association in two other studies (i.e., Pate et al., 2011). Overall, there are few studies examining urban and rural associations with adolescents' screen time. However, in relation to TV viewing only, a recent cross-sectional study has shown that area of residence (sometimes referred to as 'place of residence') is significantly associated with adolescents watching three or more hours of TV per day on weekdays but not weekends (Tenorio et al., 2010). Furthermore, in relation screen time, another cross-sectional study has examined individual screen time behaviours in relation to urban and rural differences among adolescents, for example showing that adolescents from the most rural areas were more likely to be higher TV users and less likely to be high computer users (Carson et al., 2011). However, both of these studies cannot be related to the present study because the focus was on a combination of screen time behaviours including TV/video viewing and computer use as a whole in the present study and was categorised in accordance with the recommended guidelines for screen time.

8.3.3 Further analyses main findings

Considering that the main findings from the first, second and third further analyses have already been discussed, this section is concerned with the main findings from the fourth, fifth and sixth further analysis. The fourth analysis investigated the possible link between physical activity and screen time status at baseline and follow-up in the form of a 'hybrid'. The main finding that emerged from this analysis was the large proportion of participants (70.6% for analysis one and 69.1% for analysis two) at baseline who were not meeting recommended guidelines for physical activity or screen time. At follow-up, a similar picture was evident (74.8% for analysis one and 73.0% for analysis two) who were not meeting recommended guidelines for physical activity or screen time. It could be suggested that this finding at both baseline and follow-up supports the theory of the 'displacement hypothesis' (i.e., sedentary behaviours such as TV viewing, using computers and playing video games (screen time) reduce the time devoted to physical activity). Therefore, it could be argued that the time spent by these particular participants in screen time possibly replaced the time that could have been used for physical activity. However, it is important to acknowledge that no association was investigated between physical activity and screen time status and therefore it is not possible to determine whether a decrease in physical activity resulted in an actual increase in screen time in the present study. On the other hand, the fourth further analysis has also highlighted that it is possible to meet physical activity recommendations and still engage in high amounts of screen time; acknowledged by other researchers in the field (Pate et al., 2008; Salmon et al., 2011). This is illustrated through the proportion of participants (10.1% for analysis one and 10.7% for analysis two) who at baseline met guidelines for physical activity but were not meeting screen time guidelines. This finding is insightful when looking at the two behaviours because it shows how high levels of sedentary behaviour and physical activity can co-occur in an adolescent's life. At follow-up, a marginal decrease could be seen for the participants who fell into this category (6.8% for analysis one and 7.3% for analysis two). In contrast, only a small proportion (baseline: analysis one = 3.9%; analysis two = 3.8% and follow-up: analysis one = 2.1%; analysis two = 1.9%) met the guidelines for both physical activity and screen time. Of all the categories observed this combination is the desired combination of both behaviours because participants were undertaking the recommended amount of physical activity and screen time. It can therefore be inferred that a very low proportion of participants in the present study were falling into this category at baseline and follow-up.

The findings from the analysis conducted in the fifth further analysis also need highlighting. From the results presented, it appears that at baseline, the most popular modes of transport to and from school were walking (analysis one = 44.3%; analysis 2 = 40.8%), followed by car (analysis one = 36.8%; analysis two = 38.5%) and bus (analysis one = 32.9%; analysis two = 36.3%). Biking was only reported by 7.7% (analysis one) and 8.6% (analysis two) of participants. At follow-up, a similar picture was evident in terms of the most common forms of transport although the bus was the most popular (analysis one = 45.4%; analysis two = 47.1%) followed by walking (analysis one = 42.4%; analysis two = 39.3%) and car (analysis one = 34.8%; analysis two = 38.1%). Similar to baseline figures, biking was only reported by 8.6% (analysis one) and 7.4% (analysis two). It can therefore be concluded that the main modes of transport used at baseline and follow-up were a mix of active (i.e., walking) and passive (i.e., car, bus) forms of transport. The main difference between baseline and follow-up was the increase in the percentage of participants using a bus at follow-up. Walking remained similar at baseline and follow-up and the percentage of participants using a bike was low at both time points. Previous studies have shown that passive transport is the most popular among adolescents getting to and from school. For instance, Mota et al. (2006) found that approximately 76.3% of participants took passive forms of transport (bus, riding in a vehicle) and 23.8% of participants used passive forms of transport (walking, cycling) to and from school which is distinctly higher for passive modes and lower for active modes than the present study when looking at the proportions of participants. However, in the present study, the use of each mode of transport is reported separately rather than being categorised distinctly into either 'active' or 'passive' transport. Therefore, direct comparisons are not possible to make with these studies. The reason for this is because participants reported all modes of transport they used rather than only one mode of transport thus some participants may have used more than one active mode or passive mode of transport at baseline or follow-up or even a combination of the two. A distinct categorisation was therefore not possible.

The cross-tabulations undertaken also flag up transport mode adoptions over a longitudinal period. In relation to active modes of transport, approximately 30% of participants walked at both time points but approximately 50% of participants did not walk at either time point. Further, approximately 90% did not bike at either time point. On the other hand, regarding passive modes of transport, approximately 27% of participants travelled by car at both time point and approximately 55% of participants did not travel by car at both time points. In relation to travelling by bus, approximately 30% did at both time points. These findings indicate that approximately a third of participants either walked, travelled by car or travelled by bus at both baseline and follow-up. From these figures, it does not appear that any one particular mode of transport dominated transport to and from school. Little previous research has examined longitudinal modes of transport during the transition between compulsory education and the short period after, thus comparisons with other studies are not able to be made. However, it is concerning that approximately 50% of participants did not walk to and from school/college/work at either time baseline or follow-up. This suggests that these participants were using passive modes instead. Therefore, having demonstrated earlier that there was a decline in physical activity over the longitudinal period, this is not a surprising finding.

Finally, the sixth further analysis has highlighted differences in the other measures of physical activity among participants. Most notably, it is not surprising that the two largest proportions of participants (accounting for approximately 70% in total) at baseline and follow-up reported participating in only one to two sessions in the previous seven days in organised team or individual sports. This is mainly because of the low percentage of participants who were meeting the recommended guidelines for physical activity earlier thus this low compliance is reflected in the outcome of this analysis. The finding is similar for physical activity that was not an organised team or individual sport although it is notable that the second largest proportion of participants (approximately 27%) reported participating in physical activity that was not an organised team or individual sport three to four times in the previous seven days. The low level of participation in both organised team or individual sports and physical activity that was not an organised team or individual sports is reflected in the pattern across the longitudinal period with the low level option (i.e., one to two times in the previous seven days) occupying the highest proportions. On the other hand, the findings from the sport and active recreation question reflect a different picture of participation in physical activity among participants in the present study with the largest proportions of participants participating in three to four sessions, five to six sessions and seven or more sessions at baseline and follow-up (accounting for approximately 65% in total). However, when looking at the cross-tabulations the proportion of participants maintaining these 'higher' levels at baseline and follow-up (i.e., three to four sessions; five to six sessions; and seven or more sessions) account for only approximately 20% of all participants thus these high levels were not maintained across the transition period. In addition, the intensity of this sport and active recreation is important to note with moderate intensity and vigorous intensity at baseline and follow-up occupying high proportions. Longitudinally, approximately 30% of participants reported moderate intensity and approximately 20% reported vigorous intensity at both time points. The main reason why the sport and active recreation findings appear to show more 'positive' physical activity could be because this question was based on 30 minutes of sport and active recreation as opposed to 60 minutes in the main physical activity question thus these 'improved' proportions should be treated with caution. Despite this, this is a finding of considerable interest because it suggests that not meeting the U.K. (English) recommended guidelines for physical activity (i.e., a total of at least 60 minutes of at least moderate intensity on each day of the week) does not mean that participants undertake 'no' physical activity especially when considering from a health benefits perspective that even a small amount of physical activity is much better than none and that steep health benefit gradients persist.

8.4 Summary

Overall, the findings for Research Question 1 were consistent with the majority of previous research in the area (i.e., that physical activity declines among this particular age group over a longitudinal period). However, as demonstrated in this chapter, studies with a longitudinal design are lacking with this particular age group when investigating physical activity. This is due to a number of reasons, most notably that: collecting longitudinal data on physical activity with this particular age group is notoriously difficult due to mobility increases (house moves, changes in studying, working locations etc.); attrition rates at follow-up; and other competing demands on late adolescent's time, to name but a few. In addition, there is a lack (if any at all) of longitudinal studies in the U.K. among this particular age group of adolescents. Also highlighted in this chapter has been the high proportion of participants (approximately 80%) not meeting the recommended guidelines for physical activity at either baseline or follow-up. Further, a closer inspection highlighted that the low compliance rates of only approximately 14% at baseline and 8% at follow-up who met the recommended guidelines overall. As shown, there is both support and opposition for these figures from previous cross-sectional research. Therefore, the findings of the present study in relation Research Question 1 add valuable and supporting findings to the evidence-base in this area, particularly as longitudinal studies on compliance with recommended guidelines are lacking.

In relation to Research Question 2, the literature appears to be consistent with the findings in the present study regarding female adolescents being less likely to meet recommended guidelines for physical activity although some other research has found conflicting evidence. On the whole, this particular cross-sectional finding supports the evidence base in this area. The lack of associations identified for ethnicity, educational attainment, school type, socioeconomic status and area of residence with physical activity at follow-up provide a significant contribution to the evidence base (in addition to status at follow-up as an independent variable for the second further analysis). There is particularly conflicting evidence from other studies and reviews regarding ethnicity and socioeconomic status and adolescents' physical activity thus there is some support within the evidence base for the present study's findings. However, crucially there are a lack of studies which have investigated the factors of educational attainment (GCSE achievement), school type and area of residence in this particular area of research in the U.K. and worldwide, and the present findings vitally provide a valuable contribution to understanding physical activity post compulsory education completion (from a cross-sectional perspective). The other factor found to be associated with physical activity at follow-up (i.e., a cross-sectional analysis) was physical activity at baseline through the third further analysis. At first, this finding does not seem surprising but little evidence has shown that the two are associated apart from the main reviews of correlates and determinants of adolescents' physical activity as discussed.

Staying with the area of adolescents' physical activity, the first further analysis has demonstrated that gender was associated with the decline (i.e., change) in physical activity through the transition of interest in the present study. This finding is important because it has found a factor that is associated with a longitudinal change in physical activity; a component of the evidence base of adolescents' physical activity that is needed. The finding that females were less likely to decline during the transition from compulsory education completion challenges the majority of the literature that currently exists which has shown the opposite (i.e., that females decline more than males during adolescence). As a consequence, this finding is a key finding of the present study.

The findings of the present study for Research Question 3 has highlighted that, although there was no significant change in screen time status from baseline to follow-up (over a longitudinal period) (which is in the majority, in contrast to the minimal literature available showing an increase), approximately 70% of participants were not meeting screen time guidelines at either baseline or follow-up. This is of particular concern because it reflects the situation that nearly three quarters of participants were failing to meet screen time guidelines when still at school. On the other hand, the low compliance rates at baseline and follow-up of approximately 20% reflect similarity with other cross-sectional studies reporting similar rates of compliance in adolescence. Considering that few (if any) longitudinal studies during adolescence have been undertaken on screen time compliance in the U.K. and worldwide, the findings of the present study contribute substantially to the evidence base.

Regarding Research Question 4, none of the independent variables (including status at follow-up as an independent variable in the second further analysis) were associated with screen time status at follow-up (from a cross-sectional perspective). As correlates of adolescents' sedentary behaviour (screen viewing behaviours) are an evolving research area, some factors had been studied little before. However, for those which there is more of an evidence base (e.g., gender, ethnicity, socioeconomic status), the findings of the present study are both consistent and at odds with prior findings. However, there was a significant association found for screen time status at baseline and screen time status at follow-up which was found through the third further analysis. This finding is novel because few reviews of correlates (and determinants) of adolescents' sedentary behaviour have identified 'earlier/previous screen time' as a correlate, possibly because of the lack of longitudinal prospective studies among adolescents.

The fourth further analysis conducted provided a mixed picture with some support for the displacement hypothesis (demonstrated by the high proportion of participants not meeting guidelines for physical activity or screen time) and also provided evidence that physical activity and sedentary behaviour can co-exist through the hybrid constructed (shown with the lower proportion of participants meeting physical activity guidelines but not meeting screen time guidelines). This particular further analysis provided important information regarding the nature of physical activity and sedentary behaviour during this transitional period.

8.5 Limitations

The present study had many advantages in comparison to other studies that have investigated physical activity and sedentary behaviour among adolescents. Firstly, the present study adopted a prospective population-based longitudinal design over approximately, a nine month period. This enabled physical activity and screen time to be monitored over a period of time thus enabling the researcher to investigate if there were significant changes in each behaviour. In addition, because the data was collected at two different time points, it was possible to treat the data as cross-sectional (i.e., baseline or follow-up) or longitudinal (i.e., baseline and follow-up). For instance, Research Question 2 and Research Question 4 both used cross-sectional data in their analyses using only follow-up data whereas Research Question 1 and Research Question 3 used longitudinal data in their analyses using baseline and follow-up data. Rather than using a longitudinal design, many other studies use cross-sectional designs with an adolescent population due to the difficulties of following one particular cohort during this life transitional period. Therefore, the combination of both types of analysis within one study is a distinct strength. Secondly, another major strength of the present study is having achieved a final sample size (before deletions) that comprised 40.2% of the original baseline cohort. As demonstrated in the seventh further analysis, it was shown that no bias was introduced at follow-up (i.e., there was a representative sub-sample at follow-up for analysis one and analysis two) thus this final sample of 40.2% is representative of the baseline sample. Thirdly, the present study is also, to the best knowledge of the researcher, the first study to have longitudinally measured physical activity and screen time and the factors associated with physical activity and screen time over a longitudinal period in the U.K. with this particular age group of adolescents. Nevertheless, as is the case with all research, the present study has some limitations.

The questionnaire used in the present study was designed by the researcher drawing on some questions from the 'Modifiable Activity Questionnaire for Adolescents' (Aaron et al., 1995b). These included the question on physical activity and the question on screen time. The wording was then adjusted to meet the aims of the present study regarding the recommended guidelines for physical activity and screen time and in order to differentiate between weekday screen time and weekend screen time. Although no validity or reliability tests were undertaken on the present questionnaire, it was piloted among two groups of Year 11 pupils at two different schools in Gloucestershire to confirm the readability and coherency of the questionnaire for this age group. It was necessary for the questionnaire to be designed by the researcher because it needed to be designed, worded and tailored to meet the aims of the study and the specific research questions proposed. In addition, because self-report among young people is known to be prone to errors in subject recall, a decision was made to base recall on a previous seven day period for this reason rather than the 14 day period on the original Modifiable Activity Questionnaire for Adolescents. The aim of this decision was to increase the accuracy of each participant's response regarding the quantity of time they spent in physical activity and screen time. There was also the limitation of social desirability and self-report bias for questions asked on the questionnaire. Social desirability bias can occur when a participant is influenced to over-report the amount of physical activity they have undertaken or under-report the amount of screen time participated in. In order to limit social desirability bias, the researcher explained clearly to all participants at baseline, where possible in the school setting, that they were not being assessed or tested on the basis of their responses on the questionnaire. The researcher was also present at each school visit to answer and explain any questions that participants did not understand with the aim of increasing their understanding of the question so that they could provide their most accurate and honest response.

Another limitation of the study was that only 'screen time' was measured as the specific sedentary behaviour. It would have been insightful to have investigated other types of sedentary behaviour such as 'social sedentary behaviours' (e.g., using the telephone) or 'communication-based sedentary behaviours' (e.g., mobile phone texting). However, these types of sedentary behaviour are typically measured, with 'technology-based sedentary behaviours', through ecological momentary assessment which is used in smaller validation studies and not large population studies such as the present study. At the time of designing the study, little literature was available in this area to assist in choosing an alternative to screen time or a combination of screen time and other sedentary behaviours. As a consequence, screen time was the most appropriate measure to use for representing sedentary behaviour considering that it has been reported to account for approximately 40% of total sedentary time (Olds et al.,. 2010).

There was a limitation in relation to the type of school recruited at baseline. A total of 24 out of 53 schools agreed to participate in the study at baseline. However, only two of the 24 were private/independent schools. Despite the researcher approaching 10 private/independent schools, only two replied and agreed to participate at baseline. Consequently, the sample of participants at baseline and follow-up was unevenly distributed towards those participants who attended a mainstream/state school at baseline and follow-up if they continued into further education. However, the researcher did provide and offer every opportunity to the eight private/independent schools who decided not to take part to participate in the study.

Using postcode data as the method for determining socioeconomic status through linking with OAs based on the Census 2001 data was also a limitation. Postcodes were analysed using the latest Census (2001) in 2009. Consequently, some of the postcodes collected and verified could not be connected to an OA code as they may not have existed on the Census night 2001. This practical limitation resulted in some participants, despite providing a fully completed questionnaire at baseline and follow-up, being excluded from entering 'analysis one' of the final statistical analysis. This resulted in the analysis one sample size containing fewer participants than if a more recent Census was available. However, the 2001 Census was the most recent Census available at the time of constructing the present study with the next one not due until 2011. Even so, the final connection of 1505 postcodes to OAs was achieved, in addition to the final sample size of 663 participants in analysis one (i.e., with an associated OA code and Townsend score).

Regarding the factors that were chosen in the present study (gender, ethnicity, educational attainment, school type, area of residence and socioeconomic status), it was only possible to look at the impact of these six independent variables on the dependent variables. This was a limitation which could not be overcome due to sample size restriction calculations that were performed following the guidelines by Peduzzi et al. (1996). If the sample size had been greater, possibly through a more recent Census being available for reasons explained earlier, a greater number of independent variables could have been investigated such as participation in organised team or individual sports and/or transportation to and from school/college/work. In addition, as referred to in relation to the theoretical framework for this thesis in Section 2.3 of Chapter 2, additional factors could have been investigated so that the ecological framework/model was covered more comprehensively through a mixture of intrapersonal, interpersonal and physical-environmental factors. More specifically, interpersonal factors such as social support from peers were not included in the present study. Furthermore, although the independent variables chosen were considered to be the most important ones that needed to be investigated, few significant associations were found. The only associations found were for gender and: (1) physical activity at follow-up; and (2) the decline in physical activity through the transition. In addition, the further analyses highlighted associations for: (1) physical activity at baseline with physical activity at follow-up; and (2) screen time status at baseline and screen time status at follow-up.

There was also a limitation concerning the U.K. (English) recommended guidelines for physical activity (Department of Health, 2004). At the time of planning and designing the study (September 2007 to January 2008) and then when collecting the data and analysing the data (March 2008 to June 2009), the recommended guidelines for adolescents from the U.K. (English) Chief Medical Officer were a total of at least 60 minutes of at least moderate intensity physical activity each day. As a consequence, this was the recommended guideline adopted which was used in the main analysis to categorise a participant as meeting or not meeting guidelines. In relation to screen time (being used as the proxy for sedentary behaviour), the most common recommended guideline used at the time of planning and designing the study and collecting and analysing the data as above was the recommended guideline of no more than two hours a day screen time (American Academy of Pediatrics, 2001a, 2001b; Department of Health and Ageing, 2005a). Therefore, this recommended guideline was used to determine whether or not a participant had met the guideline or not. However, since undertaking the study, and during the latter stages of writing this thesis, a new report was published in July 2011 titled 'Start Active, Stay Active' (Department of Health, 2011) (including supporting reports from the Physical Activity Guidelines Editorial Group (Bull and the Expert Working Groups, 2010) and the 'final report' from the Sedentary Behaviour and Obesity Expert Working Group (2010b)), which is a report on physical activity for health from the four home countries' (England, Scotland, Wales and Northern Ireland) Chief Medical Officers in the U.K. This report published new guidelines on both physical activity and sedentary behaviour for children and young people (aged five to 18 years). The new guideline for physical activity stated by the Department of Health is 'All children and young people should engage in moderate to vigorous intensity physical activity for at least 60 minutes and up to several hours every day' (2011: p26). Clearly, the new guideline has developed further since the 2004 recommendation used in the present study but importantly the question asked in the questionnaire (Question 6) and the categorisation used is still broadly aligned to this new recommendation. On the other hand, the new sedentary behaviour guideline stated by the Department of Health is 'All children and young people should minimise the amount of time spent being sedentary (sitting) for extended periods' (2011: p26). This new guideline does not specify a time limit for sedentary behaviour due to insufficient evidence but does suggest reducing total sedentary time and breaking up extended periods of sitting. For the purposes of the present study, the approach that was taken in terms of using a categorisation of screen time was appropriate as there is still no U.K. recommendation which quantifies sedentary behaviour for adolescents.

A significant limitation of the present study is seasonality. There is some evidence from the literature that there is seasonal variation in physical activity with the lowest physical activity levels among adolescents being witnessed in the winter season and higher levels in the summer season (Rifas-Shirman et al., 2001; Peiró-Velert et al., 2008; Belanger et al., 2010; Carson and Spence, 2010). Therefore, ideally studies of a longitudinal nature should take into account seasonal variation when repeatedly measuring physical activity. For example, Kimm et al. (2002) collected habitual physical activity data in the school year and in summer months and therefore potential differences in seasonal variation were able to be accounted for. However, in relation to season being associated with physical activity, the conclusions of some reviews of correlates is that the association with adolescents' physical activity is undetermined (Ferreira et al., 2006) and inconsistent (Davison and Lawson, 2006). Furthermore, in a recent systematic review of determinants of adolescents' physical activity in prospective studies, season (winter) was reported on in only one study sample thus there was insufficient evidence to comment further (Uijtdewilligen et al., 2011). In the present study, seasonal variation is particularly important when attempting to explain the potential impact of season on the main findings. Firstly, the decline in physical activity from baseline to follow-up could be potentially explained by seasonal variation. This is because the decline took place between a period heading towards the summer (i.e., at baseline) when participants would be possibly more active to a period heading into the winter (i.e., at follow-up) when participants would possibly be less active. Recent research has indicated that a decline in physical activity during adolescence between ages 12 to 13 years to ages 16 to 17 years is possibly due, in part, to a decline during winter activity (Belanger et al., 2009). Secondly, from the perspective of physical activity taking place outdoors, seasonal variation could also account for females being less likely to meet recommended guidelines for physical activity at follow-up (i.e., autumn to winter period) as there may have been less opportunities for them to undertake physical activity due to shorter daylight hours thus potentially deterring females from participating due to, for example, safety issues in the dark (Evenson et al., 2007).

Conversely, males declining more than females in their physical activity through the transition could also be potentially linked to the season in which baseline physical activity and follow-up physical activity data was collected. More specifically, because GCSE examinations were being prepared for during baseline collection (i.e., in the Spring season), and follow-up collection took place in the period after the summer break (i.e., in the Autumn to Winter season) when participants would be starting in further education or employment, the seasonal impact during this life transition itself may have contributed to physical activity declining more among males than females. The seasonal changes during this life transition may have impacted on males more than females because there would have been decreased opportunity to undertake structured and organised sport and physical activities due to the absence of compulsory physical education in further education or employment (i.e., at follow-up in the Autumn to Winter season) as opposed to when there was more opportunity to undertake structured and organised sport and physical activity in Year 11 at school (i.e., at baseline in the Spring season) (Cullen et al., 1999). On the other hand, the potential impact of season on the findings concerning screen time is more complex as this factor has not been examined in many studies regarding sedentary behaviour. Further, to date, reviews of determinants of adolescents' sedentary behaviour have highlighted that there is a dearth of studies examining environmental determinants (such as season) of sedentary behaviour (Uijtdewilligen et al., 2011). However, the limited number of studies that have been undertaken in relation to screen time specifically have shown conflicting findings such as adolescents participating in more screen time in the autumn than the winter (Devis-Devis et al., 2009) or there being no association between season and screen time (Gordon-Larsen et al., 2000). The dearth of studies measuring sedentary behaviour during different seasons in order to account for seasonal variation is reflected in Chapter 4. In addition, season was not a factor referred to in the reviews of Gorely et al. (2004) or Van der Horst et al. (2007). This was because of the lack of studies addressing this important issue. Considering that screen time did not significantly change from baseline to follow-up, seasonal variation is difficult to attribute. However, potentially, seasonal variation could have been an issue if data had been collected in the present study during the main winter period (i.e., January and February) when participants would have been likely to have remained indoors for longer periods thus increasing the number of hours of screen time. Overall, despite the possibility that this was a limitation, there was no consistent message from the literature suggesting that it was necessary to design the study to control for the factor of season.

The final point to highlight in this section is the fact that the sample at baseline and follow-up was drawn from the whole population of Gloucestershire and is thus only generalisable to Gloucestershire. Although this can be viewed as a delimitation, it is also a strength. If the present study was to be repeated in other similarly characterised areas of the U.K. where the population profile is similar to

Gloucestershire, it is likely that sample characteristics would be similar as well as the findings. However, the findings would not be generalisable to a population drawn from areas characterised by different characteristics. Further, the sample drawn in Gloucestershire for the present study may not be representative of other areas of the U.K. if the present study were to be repeated. This could be the case in areas where there are significant areas of deprivation in the inner city regions of some large cities and where there are different ethnic minorities that constitute the population (for e.g., in Manchester, Birmingham and Leeds). Therefore, throughout the present study, because the sample was drawn from the whole population of Gloucestershire covering five of the six districts, the researcher was confident that the sample was broadly representative of the U.K. population. However, it is recognised that a large nationally representative sample would be required to investigate physical activity and sedentary behaviour across the whole of the U.K.

8.6 Implications of findings for future research and practice

The findings that have been interpreted and critically reflected upon from the present study have significant implications for future research and practice. Firstly, the present study investigated six main factors in relation to physical activity and sedentary behaviour (screen time) (post compulsory education completion in the U.K.), which were appropriately framed, as explained previously in Section 2.3 of Chapter 2, within the theoretical framework underpinning this thesis. The same factors were investigated for each type of behaviour (i.e., physical activity and screen time). However, as referred to previously in the limitations section, it was not possible to investigate more than six factors due to restrictions on the sample size. Therefore, as it was not possible to investigate further factors (despite collecting the relevant data) in the present study, and as supported by the theoretical framework underpinning this thesis in Section 2.3 of Chapter 2, future research could investigate a host of additional factors regarding their association with physical activity and/or screen time during this transitional period. Some suggested factors could be social influences/support (e.g., friends/peers), parental influences, active transportation and seasonal conditions thus reflecting a mixture of intrapersonal, interpersonal and physical environment factors (i.e., the ecological framework/model approach). The present study also investigated factors which have rarely been investigated before such as school type (state/mainstream versus private/independent), educational attainment, area of residence (urban versus rural) and status at follow-up (education, employment/unemployment). In addition, 'previous physical activity' and 'previous screen time' have rarely been examined before as factors associated with each respective behaviour at a follow-up point (i.e., longitudinally) thus future studies should investigate these factors further. Therefore, more studies among the adolescent population are required with additional factors to add to the evidence base.

Secondly, the outcome measure for the dependent variables in the present study was based solely on self-report. This method of measuring the outcome variables was ideally suited to the present study due to a direct comparison being made with physical activity and screen time of participants in line with the recommended guidelines for each behaviour. Using a self-report also enabled this compliance with recommended guidelines to be assessed among a large population-based sample. The self-report tool was also designed specifically in order to capture all the data required to answer the research questions proposed. However, future research could investigate physical activity levels and the sedentary behaviour of adolescents through a different self-report measure and another measurement tool. For example, in addition to a questionnaire being administered, accelerometers could be utilised in a sub-sample thus adding more objectivity to the data collected (i.e., a type of cross-validation study). However, future research in this area should also take into consideration the expense and limitations of using accelerometers such as the difficulty in administering them among a large population of adolescents, particularly in prospective population-based longitudinal studies such as the present study.

Other measures that could be used in future research for physical activity and sedentary behaviour include ecological momentary assessment which has the advantage of capturing a wider range of behaviours. Although this measurement approach has advantages such as participants being able to record what they are doing at an exact point in time and reducing sources of bias (Baranowski, 1985; Smyth and Stone, 2003), it also has disadvantages such as the difficulty in recruiting participants and the implications for generating large sample sizes in large scale longitudinal research. Future research could also investigate a wider range of sedentary behaviours both during the week and at the weekend. Although the present study did ask separate questions for a weekday and a weekend on screen time, the differences were not looked at separately as they did not provide an 'overall sedentary behaviour picture'. Physical activity differences in the week and weekend could also be investigated whether by self-report methods or objective measurements among the adolescent population.

Thirdly, future research would be extremely beneficial if consistent cut-off points were used for measuring an adolescent as 'physically active'. The prevalence of studies is increasing among studies, such as this one, using compliance with recommended guidelines for physical activity (e.g., 60 minutes of MVPA each day) determining being physically active. Even so, there is still a lack of consistency around this area, evidenced throughout this thesis with different cut-off points being assigned to physical activity and different classification measures being used. In relation to sedentary behaviour, future research needs to be consistent with its approach to defining sedentary behaviour (rather than physical inactivity – i.e., not meeting a criterion of physical activity) and the quantification of a cut-off point for determining if an adolescent is 'sedentary' or not. A range of cut-offs are used at the moment but more transparency is needed. For example, in relation to proxy measures of sedentary behaviour such as screen time, there is inconsistency between studies in how cut-offs are calculated for screen time use. The work of the Sedentary Behaviour and Obesity Expert Working Group (2010a) and the subsequent publication of the new U.K. recommended guidelines for sedentary behaviour is a positive step forward for this.

Fourthly, future research could consider using other measures of socioeconomic status. Although the use of an area based measure (Townsend score) in the present study was useful, it was very labour intensive due to the collection, inputting, cleaning, verification and connecting of postcodes to OAs. Future research among adolescent populations could consider an individual level measure such as parental income, parental occupation or parental highest qualification (educational attainment). There are numerous limitations to the use of these types of individual level measures such as not being as useful in some contexts (e.g., if you believe the characteristics of the geographical area is a key factor). A further limitation of using individual level measures is a participant's ability to recall or know this type information. However, the use of individual level measures such as education or income would reduce attrition rates among prospective population-based studies over a longitudinal period because the collection of postcodes in the present study presented problems such as a reduction in the final sample size.

Fifthly, more prospective population-based longitudinal studies are needed among this particular age group of adolescents. As shown in the literature review, longitudinal studies among adolescents during this transitional period are sparse and lacking in the U.K. They are lacking from both a physical activity perspective and even more importantly, a sedentary behaviour perspective. Future studies could investigate both behaviours or could investigate the behaviours independently. The present study has provided original evidence among this population of adolescents but a great deal more evidence is needed.

Finally, the present study demonstrated a decline in physical activity through this transition period out of compulsory education at age 16 years and the vast majority of participants at follow-up were still in education. This finding has implications for future research considering the 'Raising of the Participation Age' from 16 years to 18 years of age (Department for Education, 2011). The increase in the participation age means that adolescents will continue in education or training to age 17 years from 2013 and to age 18 years from 2015. However, this extension of time in education will not just be restricted to the school setting as adolescents will be able to choose to stay in full time education (school, college, home education), work based learning (e.g., apprenticeship), part-time education or training, or employed, self-employed or volunteering for more than 20 hours a week (Department for Education, 2011). Considering these potential changes to the 'post compulsory education completion' period investigated in the present study, future research could longitudinally investigate physical activity and/or sedentary behaviour of adolescents as they continue into this 'extended' period of education from Year 11 and beyond the age of 18 years of age. This would be interesting to monitor as the present study has shown a drop-off in physical activity post Year 11 but another longitudinal study might show that there is no drop off in physical activity once education becomes compulsory post Year 11 due to the increased opportunity to remain physically active. Future research may identify a different point in age where physical activity participation decreases or even increases or sedentary behaviour increases or declines. The potential changes that are due to take place in education system make this a very interesting time for the physical activity and sedentary behaviour of adolescents in the future in the U.K. In conclusion, the potential increase in the school leaving age provides a 'golden opportunity' to reverse the decline in physical activity and to limit the time in sedentary behaviours among adolescents in the U.K. as highlighted in the findings of the present study.

The main findings of the present study also have implications for intervention design in practice. Firstly, due to the decline in physical activity through the transition period studied, interventions should be targeted primarily at the school environment and more specifically, National Curriculum Physical Education to assist in reducing/limiting this decline. Although the proportion of adolescents meeting the recommended guidelines was higher at baseline (i.e., in Year 11 at school) than follow-up (i.e., after finishing Year 11), the proportion of those adolescents meeting guidelines was already very low. Therefore, secondary schools should facilitate the opportunity for adolescents to achieve the recommended guidelines of at least 60 minutes on each day of the week. Currently, National Curriculum Physical Education in secondary schools should be aiming to achieve the 'Five Hour Offer', which includes physical education and sport provision. The provision of physical activity and sport within secondary schools is closely aligned to the recent Department of Health (2011b) U.K.-wide report on physical activity guidelines for children and young people. This report recognises the importance of structured physical activity for the adolescent age period but physical education and sport are not the only routes specified to improve physical activity levels of adolescents. Further, other structured activities such as active travel and dance need to be incorporated into meeting this aim. The report also reinforces the importance of the lifecourse approach. This is important to consider in the content of this implication for practice because enabling adolescents to establish the principle that physical activity is something that should be a natural part of everyday life throughout the lifecourse, emphasises the crucial responsibility that schools have of providing the required level of physical activity needed for health benefit.

Secondly, the coupling of the decline in physical activity and the high proportion of adolescents not meeting guidelines for screen time both during Year 11 and in the period afterwards (post compulsory education), further highlights the importance of physical education and extracurricular activities before the transition point (i.e., when adolescents are still in compulsory education) and the opportunities for physical activity that exist post Year 11. Currently, the Five Hour Offer includes a suite of activities in the education setting including core/curriculum physical education, timetabled physical education and sport related courses and extracurricular sport. However, also included in this Five Hour Offer are structured sport in a community sports club, non-sports club community sport activities and community settings where sport is part of a wider range of activities. When an adolescent leaves compulsory education at age 16 years, the aim is to offer three hours of sport and physical activity in these settings although physical education is not compulsory at this stage. Therefore, the importance of this pre-compulsory education completion stage is critical for adolescents to adopt physically active lifestyles which they then continue with through the lifecourse. As shown in the findings of the present study, females were less likely to meet recommended guidelines after completing compulsory education. Therefore, there should be increased efforts to target females staying active post compulsory education completion in a range of settings. Further, males were more likely to decline in physical activity through the transition and therefore similar efforts should be targeted with males. More specifically, when adolescents have completed compulsory education and moved into further education, employment or training, the opportunity needs to remain for adolescents to stay physically active and limit sedentary behaviour. In this context, sixth forms at school, colleges, and workplaces/employers need to provide the opportunity for physical activity and sport, in addition to limiting the amount of time that adolescents are sedentary (sitting) for extended periods. If this not adopted by these particular communities, screen time will continue to increase (particularly due to the 'sedentary' activity of sitting whether for study or work) and physical activity will remain low/decline further.

Finally, the main findings have also revealed implications of correlates research for future interventions. As demonstrated in the theoretical framework for this thesis in

Section 2.3 of Chapter 2, once phase three of the behavioural epidemiology framework has identified determinants or correlates of adolescents' physical activity, this helps to focus intervention efforts on factors most likely to bring about behaviour change (phase four). The present study investigated factors associated with adolescents' physical activity and sedentary behaviour from a cross-sectional perspective and adolescents' physical activity from a longitudinal perspective. In relation to adolescents' sedentary behaviour, the factors associated with longitudinal screen time could not be investigated because there was no significant change. The present study is unique from the perspective that it measured factors associated with a longitudinal change in adolescents' physical activity and found a significant association for gender. Therefore, future correlates research should aim to investigate longitudinal changes in adolescents' physical activity and/or sedentary behaviour and the factors associated with these changes. Through doing this, interventions can be targeted at specific factors that are longitudinally associated with each behaviour. For example, in the present study, the specific factor associated with the change (decline) in adolescents' physical activity was gender (i.e., males declining more than females through the transition). Therefore, the implication of this finding is that gender can be targeted in future interventions regarding reducing the decline in male adolescents' physical activity (e.g., through school-based interventions). As referred to earlier, future correlates research should aim to include a range of intrapersonal, interpersonal and physical-environmental factors (i.e., the ecological framework/ model) when investigating adolescents' physical activity and/or sedentary behaviour as it is largely unknown whether many of these factors are associated from a longitudinal perspective and the changes in these behaviours that can be determined from longitudinal studies. Finally, in relation to phases three and four of the behavioural epidemiology framework, it is important that future studies focus on modifiable correlates of adolescents' physical activity and sedentary behaviour and then test intervention strategies that leverage these correlates in different settings (e.g., home, work, school) (Salmon et al., 2011).

8.7 Conclusions

The first conclusion that can be drawn from the findings of the present study is that physical activity declines during the transition period out of compulsory education (i.e., there was a 'drop-off' in the proportion of participants meeting physical activity guidelines between completing GCSE examinations and entering further education, employment, training or unemployment). However, although there was a decline, a large proportion of participants were not meeting guidelines for physical activity during Year 11 or after completing compulsory education. Secondly, females were less active than males (i.e., less likely to meet recommended guidelines for physical activity) after completing compulsory education. Thirdly, however, compared to males, females were less likely to move from meeting recommended guidelines for physical activity at baseline to not meeting recommended guidelines for physical activity at follow-up. Therefore, males were more likely to decline in their physical activity through the transition. Fourthly, no associations were found between physical activity post compulsory education completion or with the decline in physical activity through the transition and factors such as ethnicity, type of school, educational attainment, socioeconomic status, area of residence or status at follow-up. Fifthly, meeting guidelines for physical activity in Year 11 was associated with meeting recommended guidelines post compulsory education.

Regarding sedentary behaviour during the transition period, there was no significant change in screen time. However, a large proportion of participants were already not meeting screen time guidelines during Year 11 as well as after completing compulsory education. Meanwhile, no associations were found post compulsory education completion between screen time status and factors such as gender, ethnicity, type of school, educational attainment, socioeconomic status, area of residence or status at follow-up. Although no change in screen time was detected over the transitional period, the large proportion of participants not meeting guidelines at both time points is insightful and important to report. Therefore, sedentary behaviour has already well developed during compulsory education, reducing the influence of the transitional period. Also, meeting screen time guidelines in Year 11 was associated with meeting guidelines for screen time post compulsory education. Finally, the present study provided some support for the 'displacement hypothesis', with approximately three quarters of participants not meeting guidelines for physical activity also being classified as 'not meeting screen time guidelines'. However, some evidence was also found for the two behaviours co-existing at both baseline and follow-up. In conclusion, as demonstrated through the main findings, all four objectives of the present study have been met. Further, the novel methods used to approach the area of adolescents' physical activity and sedentary behaviour during the period of transition out of compulsory education will add to the knowledge base in this field.

The primary implications of the findings from the present study include the following:

- A need for further investigation into under researched factors in relation to physical activity and/or sedentary behaviour among adolescents in this particular age group. In particular, intrapersonal, interpersonal and physical-environmental factors (the ecological framework/model) need to be investigated further in relation to adolescents' physical activity and sedentary behaviour. Some of the particular factors investigated in the present study such as school type, educational attainment, area of residence, 'status' of an adolescent (i.e., in education, employment, unemployment), previous physical activity and previous sedentary behaviour should be investigated further with regards to physical activity and/or sedentary behaviour.
- The adoption of consistent cut-off points for measuring physical activity and/or sedentary behaviour (i.e., screen time) among adolescents in the future. These should be in line with official recommended guidelines to enable the findings of studies to be validly compared.
- A need for more prospective population-based longitudinal studies among the age group of adolescents in the present study in relation to physical activity and certainly sedentary behaviour.
- Similar studies in relation to physical activity and sedentary behaviour of adolescents during the age period (stage of life) of the present study in other geographical areas (i.e., counties) of the U.K. to enable comparisons to be made between different areas. This would assist in addressing the issue of generalisability of findings between studies.
- The potential 'Raising of the Participation Age' from 16 years to 18 of years of age in the future provides a 'golden opportunity' to reverse the decline in physical activity demonstrated in the present study and to attempt to limit the time spent in sedentary behaviours such as screen time among adolescents in the U.K.

- Physical education and extracurricular sport and physical activity in schools is important in determining the lifecourse approach to physical activity among adolescents whilst still in compulsory education and schools, colleges and workplaces/employers need to provide opportunities for this lifecourse approach to physical activity to be continued post compulsory education.

CHAPTER 9: REFERENCES

Aarnio, M., Kujala, U.M. and Kaprio, J. (1997). Associations of health-related behaviors, school type and health status to physical activity patterns in 16 year old boys and girls. *Scandinavian Journal of Social Medicine*, **25** (3), 156-167.

Aarnio, M., Winter, T., Peltonen, J., Kujala, U. and Kaprio, J. (2002). Stability of leisure-time physical activity during adolescence: a longitudinal study among 16-, 17- and 18 year-old Finnish youth. *Scandinavian Journal of Medicine and Science in Sports,* **12** (3), 179-185.

Aaron, D. J., Kriska, A. M., Dearwater, S. R., Anderson, R. L., Olsen, T. L., Cauley, J. A. and Laporte, R. E. (1993). The epidemiology of leisure physical activity in an adolescent population. *Medicine and Science in Sports and Exercise,* **25** (7), 847-853.

Aaron, D. J., Dearwater, S. R., Anderson, R., Olsen, T., Kriska, A. M. and Laporte, R. E. (1995a). Physical activity and the initiation of high-risk health behaviors in adolescents. *Medicine and Science in Sports and Exercise,* **27** (12), 1639-1645.

Aaron, D. J., Kriska, A. M., Dearwater, S. R., Cauley, J. A., Metz, K. F. and LaPorte, R. E. (1995b). Reproducibility and validity of an epidemiologic questionnaire to assess past year physical activity in adolescents. *American Journal of Epidemiology,* **142** (2), 191-201.

Aaron, D. J., Storti, K. L., Robertson, R. J., Kriska, A. M. and LaPorte, R. E. (2002). Longitudinal study of the number and choice of leisure time physical activities from mid to late adolescence: implications for school curricula and community recreation programs. *Archives of Pediatrics and Adolescent Medicine,* **156** (11), 1075-1080.

Abramson, J.H., Gofin, R., Habib, J., Pridan, H. and Gofin, J. (1982). Indicators of social class. A comparative appraisal of measures for use in epidemiological studies. *Social Science and Medicine*, **16** (20), 1739-1746.

Adams, J., Ryan, V. and White, M. (2005). How accurate are Townsend Deprivation Scores as predictors of self-reported health? A comparison with individual level data. *Journal of Public Health*, **27** (1), 101-106.

Affuso, O., Stevens, J., Catellier, D., McMurray, R.G., Ward, D.S., Lytle, L., Sothern, M.S. and Young, D.R. (2011). Validity of self-reported leisure-time physical activity in adolescents. *Journal of Negative Results in BioMedicine*, **10**, 2.

Ainsworth, B. E., Haskell, W. L., Whitt, M. C., Irwin, M. L., Swartz, A. M., Strath, S. J., O'Brien, W. L., Bassett, D. R., Jr., Schmitz, K. H., Emplaincourt, P. O., Jacobs, D. R., Jr. and Leon, A. S. (2000). Compendium of physical activities: an update of activity codes and MET intensities. *Medicine and Science in Sports and Exercise,* **32** (9 suppl.), S498-S504.

Aires, L., Andersen, L. B., Mendonca, D., Martins, C., Silva, G. and Mota, J. (2010). A 3-year longitudinal analysis of changes in fitness, physical activity, fatness and screen time. *Acta Paediatrica,* **99** (1), 140-144.

Allison, K. R. and Adlaf, E. M. (1997). Age and sex differences in physical inactivity among Ontario teenagers. *Journal of Public Health,* **88** (3), 177-180.

Allison, K.R., Dwyer, J.J. and Makin, S. (1999). Self-efficacy and participation in vigorous physical activity by high school students. *Health Education and Behavior,* **26** (1), 12-24.

Allison, K. R., Adlaf, E. M., Dwyer, J. J. M., Lysy, D. C. and Irving, H. M. (2007). The decline in physical activity among adolescent students: a cross-national comparison. *Canadian Journal of Public Health,* **98** (2), 97-100.

Allison, S. L., Roeger, G. and Martin, J. (2001). Gender differences in the relationship between depression and suicidal ideation in young adolescents. *Australian and New Zealand Journal of Psychiatry,* **35** (4), 498-503.

American Academy of Pediatrics (1984). Children, adolescents and television. *News and Comment,* **35** (8).

American Academy of Pediatrics (1986). *Television and the Family.* Elk Grove Village, IL: American Academy of Pediatrics.

American Academy of Pediatrics (2001a). Policy statement/Committee on Public Education. Children, adolescents, and television. *Pediatrics,* **107** (2), 423-426.

American Academy of Pediatrics (2001b). Committee on Public Education. Media violence. *Pediatrics,* **108** (5), 1222-1226.

American Academy of Pediatrics, Committee on Nutrition. (2003). Prevention of pediatric overweight and obesity. *Pediatrics,* **112**, 424-430.

American College of Sports Medicine (1978). Position statement on the recommended quantity and quality of exercise for developing and maintaining fitness in healthy adults. *Medicine and Science in Sports and Exercise,* **10** (3), vii-x.

Andersen, L. B., Harro, M., Sardinha, L. B., Froberg, K., Ekelund, U., Brage, S. and Anderssen, S. A. (2006). Physical activity and clustered cardiovascular risk in children: a cross-sectional study (The European Youth Heart Study). *Lancet,* **368** (9532), 299-304.

Andersen, R. E., Crespo, C. J., Bartlett, S. J., Cheskin, L. J. and Pratt, M. (1998). Relationship of physical activity and television watching with body weight and level of fatness among children: results from the Third National Health and Nutrition Examination Survey. *Journal of the American Medical Association,* **279** (12), 938-942.

Anderssen, J. B. and Metz, J. A. (1993). Contributions of dietary calcium and physical activity to primary prevention of osteoperosis in females. *Journal of the American College of Nutrition,* **12** (4), 378-383.

Anderssen, N., Wold, B. and Torsheim, T. (2005). Tracking of physical activity in adolescence. *Research Quarterly for Exercise and Sport,* **76** (2), 119-129.

Anderssen, N., Wold, B. and Torsheim, T. (2006). Are parental health habits transmitted to their children? An eight year longitudinal study of physical activity in adolescents and their parents. *Journal of Adolescence,* **29** (4), 513-524.

Argyrous, G. (2011). Frequency tests for two dependent variables. In: *Statistics for Research with a Guide to SPSS* (3rd edn.) (edited by G. Argyrous), pp.461-468. London: Sage Publications.

Asmussen, K., Corlyon, J., Hauari, H. and La Placa, V. (2007). *Supporting Parents of Teenagers*, Research Report 830. London: Department for Education and Skills.

Azevedo, M. R., Araujo, C. L., Cozzensa da Silva, M. and Hallal, P. C. (2007). Tracking of physical activity from adolescence to adulthood: a population-based study. *Revista de Saude Publica,* **41** (1), 69-75.

Bambra, C., Gibson, M., Sowden, A., Wright, K., Whitehead, M. and Petticrew, M. (2010). Tackling the wider social determinants of health and health inequalities: evidence from systematic reviews. *Journal of Epidemiology and Community Health*, **64**, 284-291.

Bar-Or, O. and Rowland, T. W. (2004). *Pediatric Exercise Science: From Physiologic Principles to Health Care Application,* Champaign, IL: Human Kinetics.

Baranowski, T. (1985). Methodologic issues in self-report of health behavior. *The Journal of School Health,* **55** (5), 179-182.

Baranowski, T. (1988). Validity and reliability of self report measures of physical activity: an information-processing approach. *Research Quarterly for Exercise and Sport,* **59** (4), 314-327.

Baranowski, T., Cullen, K. W., Basen-Engquist, K., Wetter, D. W., Cummings, S., Martineau, D. S., Prokhorov, A. V., Chorley, J., Beech, B. and Hergenroeder, A. C. (1997). Transitions out of high school: time of increased cancer risk? *Preventive Medicine,* **26** (5 pt 1), 694-703.

Bassett Jr, D.R., Ainsworth, B.E., Swartz, A.M., Strath, S.J., O'Brien, W.L. and King, G.A. (2000). Validity of four motion sensors in measuring moderate intensiy physical activity. *Medicine and Science in Sports and Exercise,* **32** (9 suppl.), S471-S480.

Bastos, J. P., Araujo, C. L. and Hallal, P. C. (2008). Prevalence of insufficient physical activity and associated factors in Brazilian adolescents. *Journal of Physical Activity and Health,* **5** (6), 777-794.

Bathrellou, E., Lazarou, C., Panagiotakos, D.B. and Sidossis, L.S. (2007). Physical activity patterns and sedentary behaviors of children from urban and rural areas of Cyprus. *Central European Journal of Public Health,* **15** (2), 66-70.

Bauer, K. W., Nelson, M. C., Boutelle, K. N. and Neumark-Sztainer, D. (2008). Parental influences on adolescents' physical activity and sedentary behavior: longitudinal findings from Project EAT-II. *Internatioal Journal of Behavioral Nutrition and Physical Activity,* **5**, 12.

Bauman, A. E. (1988). Use of population attributable risk (PAR) in understanding the health benefits of physical activity. *British Journal of Sports Medicine,* **32** (4), 279-280.

Bauman, A.E., Sallis, J.F., Dzewaltowski, D.A. and Owen, N. (2002). Toward a better understanding of the influences on physical activity – the role of determinants, correlates, causal variables, mediators, moderators, and confounders. *American Journal of Preventive Medicine,* **23** (2S), 5-14.

Baur, L. A. (2002). Child and adolescent obesity in the 21st century: an Australian perspective. *Asia Pacific Journal of Clinical Nutrition,* **11** (suppl. 3), S524-S528.

Bélanger, M., Gray-Donald, K., O'Loughlin, J., Paradis, G. and Hanley, J. (2009). When adolescents drop the ball: sustainability of physical activity in youth. *American Journal of Preventive Medicine,* **37** (1), 41-49.

Bélanger, M., Gray-Donald, K., O'Loughlin, J., Paradis, G. and Hanley, J. (2009). Influence of weather conditions and season on physical activity in adolescents. *Annals of Epidemiology,* **19** (3), 180-186.

Ben-Shlomo, Y. and Smith, G. D. (1999). Commentary: socioeconomic position should be measured accurately. *British Medical Journal,* **318** (7187), 844-845.

Berkey, C. S., Rockett, H. R., Field, A. E., Gillman, M. W., Frazier, A. L., Camargo, C. A., Jr. and Colditz, G. A. (2000). Activity, dietary intake, and weight changes in a longitudinal study of preadolescent and adolescent boys and girls. *Pediatrics,* **105** (4), E56.

Bibby, P. and Shepherd, J. (2004). *Developing a New Classification of Urban and Rural Areas for Policy Purposes: The Methodology.* London: Department for Rural Affairs, Office of the Deputy Prime Minister, Office for National Statistics, Welsh Assembly Government and Countryside Agency.

Biddle, S. J. (2007). Sedentary behavior. *American Journal of Preventive Medicine,* **33** (6), 502-504.

Biddle, S. J., Gorely, T., Marshall, S. J., Murdey, I. and Cameron, N. (2004a). Physical activity and sedentary behaviours in youth: issues and controversies. *Journal of the Royal Society for the Promotion of Health,* **124** (1), 29-33.

Biddle, S. J., Gorely, T. and Stensel, D. J. (2004b). Health-enhancing physical activity and sedentary behaviour in children and adolescents. *Journal of Sports Sciences,* **22** (8), 679-701.

Biddle, S. J. H., Whitehead, S. H., O'Donovan, T. M. and Nevill, M. E. (2005). Correlates of participation in physical activity for adolescent girls: a systematic review of recent literature. *Journal of Physical Activity and Health,* **2** (4), 423-434.

Biddle, S.J.H. and Mutrie, N. (2008). *Psychology of Physical Activity: Determinants, Well-being and Interventions* (2nd edn.). Oxon: Routledge.

Biddle, S.J.H., Gorely, T. and Marshall, S.J. (2009a). Is television viewing a suitable marker of sedentary behavior in young people?. *Annals of Behavioral Medicine*, **38** (2), 147-153.

Biddle, S. J., Gorely, T., Marshall, S. J. and Cameron, N. (2009b). The prevalence of sedentary behavior and physical activity in leisure time: a study of Scottish adolescents using ecological momentary assessment. *Preventive Medicine,* **48** (2), 151-155.

Biddle, S.J.H., Marshall, S.J., Gorely, T. and Cameron, N. (2009c). Temporal and environmental patterns of sedentary and active behaviors during adolescents' leisure time. *International Journal of Behavioral Medicine*, **16** (3), 278-286.

Biddle, S.J.H., Pearson, N., Ross, G.M. and Braithwaite, R. (2010). Tracking of sedentary behaviours of young people: A systematic review. *Preventive Medicine*, **51** (5), 345-351.

Biddle, S.J.H., Atkin, A.J., Cavill, N. and Foster, C. (2011a). Correlates of physical activity in youth: a review of quantitative systematic reviews. *International Review of Sport and Exercise Psychology*, **4** (1), 25-49.

Biddle, S.J.H., Gorely, T., Pearson, N. and Bull, F. (2011b). An assessment of self-reported physical activity in young people for poulation surveillance: Project ALPHA. *International Journal of Behavioral Nutrition and Physical Activity*, **8**, 1.

Biddle, S.J.H., O'Connell, S. and Braithwaite, R.E. (2011c). Sedentary behaviour interventions in young people: a meta-analysis. *British Journal of Sports Medicine*, **45** (11), 937-942.

Bonomo, Y. and Proimos, J. (2005). Substance misuse: alcohol, tobacco, inhalants, and other drugs. *British Medical Journal,* **330** (7494), 777-780.

Boone, J. E., Gordon-Larsen, P., Adair, L. S. and Popkin, B. M. (2007). Screen time and physical activity during adolescence: longitudinal effects on obesity in young adulthood. *International Journal of Behavioral Nutrition and Physical Activity,* **4**, 26.

Booth, M. (2000). Assessment of physical activity: an international perspective. *Research Quarterly for Exercise and Sport,* **71** (2 suppl.), S114-S120.

Booth, M. L., Okely, A. D., Chey, T. N. and Bauman, A. (2002a). The reliability and validity of the Adolescent Physical Activity Recall Questionnaire. *Medicine and Science in Sports and Exercise,* **34** (12), 1986-1995.

Booth, M.L., Okely, A.D., Chey, T., Bauman, A. and Macaskill, P. (2002b). Epidemiology of physical activity participation among New South Wales school students. *Australian and New Zealand Journal of Public Health,* **26** (4), 371-374.

Boreham, C., Savage, J. M., Primrose, D., Cran, G. and Strain, J. (1993). Coronary risk factors in schoolchildren. *Archives of Disease in Childhood,* **68** (2), 182-186.

Boreham, C., Twisk, J., Neville, C., Savage, M., Murray, L. and Gallagher, A. (2002). Associations between physical fitness and activity patterns during adolescence and cardiovascular risk factors in young adulthood: the Northern Ireland Young Hearts Project. *International Journal of Sports Medicine,* **23** (suppl. 1), S22-S26.

Boreham, C., Robson, P. J., Gallagher, A. M., Cran, G. W., Savage, J. M. and Murray, L. J. (2004). Tracking of physical activity, fitness, body composition and diet from adolescence to young adulthood: the Young Hearts Project, Northern Ireland. *International Journal of Behavioral Nutrition and Physical Activity,* **1** (1), 14.

Bouchard, C., Blair, S.N. and Haskell, W.L. (2007). *Physical Activity and Health.* Champaign, IL: Human Kinetics.

Boynton, P. M. (2004). Administering, analysing, and reporting your questionnaire. *British Medical Journal,* **328** (7452), 1372-1375.

Boynton, P. M. and Greenhalgh, T. (2004). Selecting, designing, and developing your questionnaire. *British Medical Journal,* **328** (7451), 1312-1315.

British Heart Foundation (2009a). Couch Kids: The Nation's Future. London: British Heart Foundation.

British Heart Foundation (2009b). New work to commence to update physical activity guidelines in the UK. *Personal email received on 07-09-2009.*

British Heart Foundation (2010). Update on the development of new physical activity guidelines. *British Heart Foundation National Centre for Physical Activity and Health[online]*, [accessed 14-02-2011]. Available from URL: http://www.bhfactive.org.uk/homepage-latest-news-item/40/index.html

British Telecommunications Plc (2008). Residential Numbers –The Phone Book from BT. *BT [online]*, [accessed 2008-2009]. Available from URL: http://www.thephonebook.bt.com/publisha.content/en/search/residential/search.publisha

Brown, W. J. and Trost, S. G. (2003). Life transitions and changing physical activity patterns in young women. *American Journal of Preventive Medicine,* **25** (2), 140-143.

Brown, W. J., Bauman, A. E. and Owen, N. (2009). Stand up, sit down, keep moving: turning circles in physical activity research? *British Journal of Sports Medicine,* **43** (2), 86-88.

Brunner, D., Manelis, G., Modam, M. and Levin, S. (1974). Physical activity at work and the incidence of myocardial infarction, angina pectoris and death due to ischemic heart disease. An epidemiological study in Israeli Collective Settlements (Kibbutzim). *Journal of Chronic Diseases,* **27** (4), 217-233.

Buckworth, J. and Dishman, R.K. (2002). *Exercise Psychology*. Champaign, IL: Human Kinetics.

Bull, F.C. and the Expert Working Groups (2010). *Physical Activity Guidelines in the U.K.: Review and Recommendations.* British Heart Foundation National Centre for Physical Activity and Health: School of Sport, Exercise and Health Sciences, Loughborough University.

Bundred, P., Kitchiner, D. and Buchan, I. (2001). Prevalence of overweight and obese children between 1989 and 1998: population based series of cross sectional studies. *British Medical Journal,* **322** (7282), 326-328.

Butcher, K., Sallis, J. F., Mayer, J. A. and Woodruff, S. (2008). Correlates of physical activity guideline compliance for adolescents in 100 U.S. Cities. *The Journal of Adolescent Health,* **42** (4), 360-368.

Carson, V. and Spence, J.C. (2010). Seasonal variation in physical activity among children and adolescents. *Pediatric Exercise Science*, **22** (1), 81-92.

Carson, V., Iannotti, R.J., Pickett, W. and Janssen, I. (2011). Urban and rural differences in sedentary behavour among American and Canadian youth. *Health and Place*, **17** (4), 920-928.

Carlson, S.A., Fulton, J.E., Lee, S.M., Foley, J.T., Heitzler, C. and Huhman, M. (2010). Influence of limit-setting and participation in physical activity on youth screen time. *Pediatrics*, **126** (1), e89-96.

Caspersen, C. J., Powell, K. E. and Christenson, G. M. (1985). Physical activity, exercise, and physical fitness: definitions and distinctions for health-related research. *Public Health Reports,* **100** (2), 126-131.

Caspersen, C. J., Christenson, G. M. and Pollard, R. A. (1986). Status of the 1990 physical fitness and exercise objectives: evidence from NHIS 1985. *Public Health Reports,* **101** (6), 587-592.

Caspersen, C. J., Pereira, M. A. and Curran, K. M. (2000). Changes in physical activity patterns in the United States, by sex and cross-sectional age. *Medicine and Science in Sports and Exercise,* **32** (9), 1601-1609.

Casweb (2009) Casweb: web interface to Census agggregate outputs and digital boundary data. *Casweb [online],* [accessed 08-05-2009]. Available from URL: http://casweb.mimas.ac.uk/

Cavill, N., Biddle, S. J. H. and Sallis, J. F. (2001). Health enhancing physical activity for young people: Statement of the United Kingdom Expert Consensus Conference. *Pediatric Exercise Science,* **13** (1), 12-25.

Cavill, N., Buxton, K., Bull, F. and Foster, C. (2006). *Promotion of physical activity among adults – Evidence into Practice Briefing.* London: National Institute for Health and Clinical Excellence.

Central Council of Physical Recreation (1960). *Sport and the Community: The Report of the Wolfenden Committee on Sport - 1960 [web edition 2009].* London: Central Council of Physical Recreation.

Ceschini, F.L., Andrade, D.R., Oliveira, L.C. , Araujo Junior, J.F. and Matsudo, V.K. (2009). Prevalence of physical inactivity and associated factors among high school students from state's public schools. *Jornal de Pediatria (Rio J),* **85** (4), 301-306.

Chestnut, C. I. (1989). Is osteoperosis a pediatric disease? Peak bone mass attainment in the adolescent female. *Public Health Reports*, **104** (suppl.), 50-54.

Chinapaw, M.J.M, Mokkink, L.B., Van Poppel, M.N.M., Van Mechelen, W. and Terwee, C.B. (2010). Physical activity questionnaires for youth – A systematic review of measurement properties. *Sports Medicine*, **40** (7), 539-563.

Chinapaw, M.J.M., Proper, K.I., Brug, J., Van Mechelen, W. and Singh, A.S. (2011). Relationship between young peoples' sedentary behaviour and biomedical health indicators: a systematic review of prospective studies. *Obesity Reviews*, **12** (7), e621-e632.

Chinn, S. and Rona, R. J. (2001). Prevalence and trends in overweight and obesity in three cross sectional studies of British Children, 1974-94. *British Medical Journal,* **322** (7277), 24-26.

Christakis, D. (2009). The effects of infant media usage: what do we know and what should we learn? *Acta Paediatrica*, **98** (1), 8-16.

Clark, C., Haines, M. H., Head, J., Klineberg, E., Arephin, M., Viner, R., Taylor, S. J. C., Booy, R., Bhui, K. and Stansfeld, S. A. (2007). Psychological symptoms and physical health and health behaviours in adolescents: a prospective 2-year study in East London. *Addiction,* **102** (1), 126-135.

Clarke, A. (2010). *The Sociology of Healthcare.* London: Pearson Education Limited.

Coakley, J. and White, A. (1992). Making decisions: gender and sport participation among British adolescents. *Sociology of Sport Journal,* **9** (1), 20-35.

Coon, K.A. and Tucker, K.L. (2002). Television and children's consumption patterns. A review of the literature. *Minerva Pediatrica,* **54** (5), 423-436.

Coleman, L., Cox, L. and Roker, D. (2008). Girls and young women's participation in physical acivity: psychological and social influences *Health Education Research,* **23** (4), 633-647.

Collins, M. F. and Buller, J. R. (2000). Bridging the post-school institutional gap in sport: evaluating champion coaching in Nottinghamshire. *Managing Leisure,* **5** (4), 200-221.

Commonwealth Scientific Industrial Research Organisation (2008). *2007 Australian National Children's Nutrition and Physical Activity Survey.* Canberra: Australian Government Department of Health and Ageing, Department of Agriculture, Fisheries and Forestry, and Australian Food and Grocery Council.

Council on Sports Medicine and Fitness and Council on School Health (2006). Active healthy living: prevention of childhood obesity through increased physical activity. *Pediatrics,* **117** (5), 1834-1842.

Crespo, C. J., Smit, E., Troiano, R. P., Bartlett, S. J., Macera, C. A. and Andersen, R. E. (2001). Television watching, energy intake, and obesity in US children: results from the third National Health and Nutrition Examination Survey, 1988-1994. *Archives of Pediatrics and Adolescent Medicine,* **155** (3), 360-365.

Crocker, P. R., Bailey, D. A., Faulkner, R. A., Kowalski, K. C. and McGrath, R. (1997). Measuring general levels of physical activity: preliminary evidence for the Physical Activity Questionnaire for Older Children. *Medicine and Science in Sports and Exercise,* **29** (10), 1344-1349.

Croft, J. B., Foster, T. A., Parker, F. C., Cresanta, J. L., Hunter, S. M., Webber, L. S., Srinivasan, S. R. and Berenson, G. S. (1986). Transitions of cardiovascular risk from adolescene to young adulthood: the Bogalusa Heart Study: I. effects of alterations in lifestyle. *Journal of Chronic Diseases,* **39** (2), 81-90.

Cross-Government Obesity Unit (2009). *Healthy Weight, Healthy Lives: One Year On.* London: Department of Health.

Cui, Z., Hardy, L.L., Dibley, M.J. and Bauman, A. (2011). Temporal trends and recent correlates in sedentary behaviors in Chinese children. *International Journal of Behavioral Nutrition and Physical Activity*, **8**, 93.

Cullen, K. W., Koehly, L. M., Anderson, C., Baranowski, T., Prokhorov, A., Basen-Engquist, K., Wetter, D. and Hergenroeder, A. (1999). Gender differences in chronic disease risk behaviors through the transition out of high school. *American Journal of Preventive Medicine,* **17** (1), 1-7.

Dahlgren, G. and Whitehead, M. (1991). *European Strategies for Tackling Social Inequalities in Health: Levelling up Part 1.* Copenhagen: World Health Organisation Regional Office for Europe.

Daly, R.M. and Petit, M.A. (2007). Optimising bone mass and strength: the role of physical activity and nutrition during growth. *Medicine and Sport Science,* **51**, 1-10.

Daley, A. J. (2002) School based physical activity in the United Kingdom: can it create physically active adults? *Quest,* **54** (1), 21-33.

Davey Smith, G., Shipley, M.J. and Rose, G. (1990). Magnitude and causes of socioeconomic differentials in mortality: Further evidence from the Whiteheall Study. *Journal of Epidemiology and Community Health*, **44** (4), 265-270.

Davey Smith, G., Hart, C., Hole, D., MacKinnon, P., Gillis, C., Watt, G., Blane, D. and Hawthorne, V.(1998). Education and occupational social class: Which is the mosr important indicator of mortality risk?. *Journal of Epidemiology and Community Health*, **52** (3), 153-160.

Davis, A.M., Boles, R.E., James, R.L., Sullivan, D.K., Donnelly, J.E., Swirczynski, D.L. and Goetz, J. (2008). Health Behaviors and weight status among urban and rural children. *Rural Remote Health*, **8** (2), 810.

Davison, K.K. and Lawson, C.T. (2006). Do attributes in the physical environment influence children's physical activity? A review of the literature. *International Journal of Behavioral Nutrition and Physical Activity*, **3**, 19.

DeMattia, L., Lemont, L. and Meurer, L. (2007). Do interventions to limit sedentary behaviours change behaviour and reduce childhood obesity? A critical review of the literature. *Obesity Reviews*, **8** (1), 69-81.

Department for Children, Schools and Families (2009). *The PE and Sport Survey.* London: Department for Children, Schools and Families.

Department for Culture, Media and Sport (2000). *A Sporting Future For All.* London: Department for Culture, Media and Sport.

Department for Culture, Media and Sport Strategy Unit (2002). *Game Plan: A Strategy for Delivering Government's Sport and Physical Activity Objectives.* London: Department for Culture, Media and Sport.

Department for Education (2011). Raising the participation age. *Department for Education [online],* [cited 06-09-2011]. Available from URL: http://www.education.gov.uk/16to19/participation/rpa

Department of Health (1992). *The Health of the Nation.* London: HMSO.

Department of Health (2003). *Annual Report of the Chief Medical Officer 2002.* London: Department of Health.

Department of Health (2004). *At Least Five a Week: Evidence on the Impact of Physical Activity and its Relationship to Health. A Report from the Chief Medical Officer.* London: Department of Health.

Department of Health (2009). *Be Active, Be Healthy: A Plan for Getting the Nation Moving.* London: Department of Health.

Department of Health (2010a). *2009 Annual Report of the Chief Medical Officer - On the State of Public Health.* London: Department of Health.

Department of Health (2010b). *Change4Life One Year On.* London: Department of Health.

Department of Health (2010c). *Healthy Lives, Healthy People: Our Strategy for Public Health in England.* London: Department of Health.

Department of Health (2011). *Start Active, Stay Active: A report on physical activity from the four home countries' Chief Medical Officers.* London: Department of Health.

Department of Health and Ageing (2004). *Australia's Physical Activity Recommendations for 12-18 Year Olds.* Canberra, Australia: Department of Health and Ageing.

Department of Health and Ageing (2005a). Australia's Physical Activity Recommendations for Children and Young People. *Department of Health and Ageing [online]*, [cited 30-07-2010]. Available from URL: http://www.health.gov.au/internet/main/publishing.nsf/Content/health-pubhlth-strateg-active-recommend.htm

Department of Health and Ageing (2005b). *Discussion paper for the development of recommendations for children's and youths' participation in health promoting physical activity.* Canberra, Australia: Department of Health and Ageing.

Department of the Environment, Transport and the Regions (2000). *Indices of Deprivation 2000.* London: HMSO.

Devís-Devís, J., Peiró-Velert, C., Beltrán-Carillo, V.J. and Tomás, J.M. (2009). Screen media time usage of 12-16 year-old Spanish school adolescents: Effects of personal and socioeconomic factors, season and type of day. *Journal of Adolescence*, **32** (2), 213-231.

Devís-Devís, J., Peiró-Velert, C., Beltrán-Carillo, V.J. and Tomás, J.M. (2010). Association between socio-demographic factors, screen media usage and physical activity by type of day in Spanish adolescents. *Journal of Adolescence*, in press.

Dietz, W.H. and Gortmaker, S.L. (1985). Do we fatten our children at the television set? Obesity and television viewing in children and adolescents. *Pediatrics*, **75** (5), 807-812.

Diez-Roux, A.V. (2002). A glossary for multilevel analysis. *Journal of Epidemiology and Community Health*, **56** (8), 588-594.

Dishman, R.K. and Sallis, J.F. (1994). Determinants and interventions for physical activity and exercise. In: *Physical activity, fitness, and health: international proceedings and consensus statement* (edited by C. Bouchard, R.J. Shephard and T. Stephens), pp.214-238. Champaign, IL: Human Kinetics.

Dollman, J., Okely, A. D., Hardy, L., Timperio, A., Salmon, J. and Hills, A. P. (2009). A hitchhiker's guide to assessing young people's physical activity: deciding what method to use. *Journal of Science and Medicine in Sport,* **12** (5), 518-525.

Dovey, S. M., Reeder, A. I. and Chalmers, D. J. (1998). Continuity and change in sporting and leisure time physical activities during adolescence. *British Journal of Sports Medicine,* **32** (1), 53-57.

Dugdill, L. and Stratton, G. (2007). *Evaluating Sport and Physical Activity Interventions: A Guide for Practitioners.* Salford: The University of Salford.

Dumith, S.C., Domingues, M.R., Gigante, D.P., Hallal, P.C., Menezes, A.M.B. and Kohl, H.W. (2010). Prevalence and correlates of physical activity among adolescents in Southern Brazil. *Rev Saúde Pública,* **44** (3), 457-467.

Duncan, G.J., Daly, M.C., McDonough, P. and Williams, D.R. (2002). Optimal indicators of socioeconomic status for health research. *American Journal of Public Health,* **92** (7), 1151-1157.

Duncan, S. C., Duncan, T. E., Strycker, L. A. and Chaumeton, N. R. (2007). A cohort-sequential latent growth model of physical activity from ages 12 to 17 years. *Annals of Behavioral Medicine,* **33** (1), 80-89.

Dunn, A. and Blair, S. (2002). Translating evidence based physical activity interventions into practice. The 2010 challenge. *American Journal of Preventive Medicine,* **22** (4 suppl.), S8-S9.

Dunton, G.F., Jamner, M.S. and Cooper, D.M. (2003). Assessing the perceived environment among minimally active adolescent girls: validity and relations to physical activity outcomes. *American Journal of Health Promotion,* **18** (1), 70-73.

Dunton, G., Whalen, C., Jamner, L., Henker, B. and Floro, J. (2005). Using ecologic momentary assessment to measure physical activity during adolescence. *American Journal of Preventive Medicine,* **29** (4), 281-287.

Eachus, J., Williams, M., Chan, P., Smith, G. D., Grainge, M., Donovan, J. and Frankel, S. (1996). Deprivation and cause specific morbidity: evidence from the Somerset and Avon survey of health. *British Medical Journal,* **312** (7026), 287-292.

Earle, S. and O'Donnell, T. (2007). The factors that influence health. In: *Theory and Research in Promoting Public Health* (edited by S. Earle, C.E. Lloyd, M. Sidell and S. Spurr), pp.67-100. London: Sage Publications.

Edwardson, C.L. and Gorely, T. (2010). Parental influences on different types and intensities of physical activity in youth: a systematic review. *Psychology of Sport and Exercise,* **11** (6), 522-535.

Eiðsdóttir, S. P., Kristjánsson, A. L., Sigfúsdóttir, I. D. and Allegrante, J. P. (2008). Trends in physical activity and participation in sports clubs among Icelandic adolescents. *European Journal of Public Health,* **18** (3), 289-293.

Ekelund, U., Neovius, M., Linné, Y., Brage, S., Wareham, N.J. and Rossner, S. (2005). Associations between physical activity and fat mass in adolescents: The Stockholm Weight Development Study. *American Journal of Clinical Nutrition,* **81** (2), 355-360.

Ekelund, U., Brage, S., Froberg, K., Harro, M., Anderssen, S. A., Sardinha, L. B., Riddoch, C. and Andersen, L. B. (2006). TV viewing and physical activity are independently associated with metabolic risk in children: the European Youth Heart Study. *PLoS Medicine,* **3** (12), e488.

Ekelund, U., Anderssen, S. A., Froberg, K., Sardinha, L. B., Andersen, L. B. and Brage, S. (2007). Independent associations of physical activity and cardiorespiratory fitness with metabolic risk factors in children: the European youth heart study. *Diabetologia,* **50** (9), 1832-1840.

Ekelund, U., Tomkinson, G.R. and Armstrong, N. (2011). What proprtion of youth are physically active? Measurement issues, levels and recent time trends. *British Journal of Sports Medicine*, **45** (11), 859-865.

Elgar, F. J., Roberts, C., Moore, L. and Tudor-Smith, C. (2005). Sedentary behaviour, physical activity and weight problems in adolescents in Wales. *Public Health,* **119** (6), 518-524.

Epstein, L.H. and Roemmich, J.N. (2001). Reducing sedentary behaviour: Role in modifying physical activity. *Exercise and Sports Sciences Reviews,* **29** (3), 103-108.

EU Working Group "Sport and Health" (2008). *EU Physical Activity Guidelines - Recommended Policy Actions in Support of Health-Enhancing Physical Activity. Fourth Consolidated Draft.* Approved at its meeting on 25 September 2008.

Evenson, K.R., Scott, M.M., Cohen, D.A. and Voorhees, C.C. (2007). Girls' perception of neighborhood factors on physical activity, sedentary behavior, and BMI. *Obesity,* **15** (2), 430-445.

Fairclough, S. J., Boddy, L. M., Hackett, A. F. and Stratton, G. (2009). Associations between children's socioeconomic status, weight status, and sex, with screen-based sedentary behaviours and sport participation. *International Journal of Pediatric Obesity,* **4** (4), 299-305.

Fairweather, S. C., Reilly, J. J., Grant, S., Whittaker, A. and Paton, J. Y. (1999). Using the Computer Science and Applications (CSA) activity monitor in pre-school children. *Pediatric Exercise Science,* **11**, 413-420.

Feldman, D. E., Barnett, T., Shrier, I., Rossignol, M. and Abenhaim, L. (2003). Is physical activity differentially associated with different types of sedentary pursuits? *Archives of Pediatrics and Adolescent Medicine,* **157** (8), 797-802.

Fergusson, D. M. and Woodward, L. J. (2002). Mental health, educational, and social role outcomes of adolescents with depression. *Archives of General Psychiatry,* **59** (3), 225-231.

Ferreira, I., Van der Horst, K., Wendel-Vos, W., Kremers, S., Van Lenthe, F. J. and Brug, J. (2006). Environmental correlates of physical activity in youth - a review and update. *Obesity Reviews,* **8** (2), 129-154.

Field, A. (2009). *Discovering Statistics Using SPSS* (3rd edn.). London: Sage Publications.

Foster, C., Hillsdon, M., Cavill, N., Allender, S. and Cowburn, G. (2005). *Understanding Participation in Sport: A Systematic Review*. London: Sport England.

Fox, K. R. and Riddoch, C. (2000). Charting the physical activity patterns of contemporary children and adolescents. *Proceedings of the Nutrition Society,* **59** (4), 497-504.

Freedson, P.S. and Miller, K. (2000). Objective monitoring of physical activity using motion sensors and heart rate. *Research Quarterly in Exercise and Sport,* **71** (2 suppl.), S21-S29.

Freudenberg, N. and Ruglis, J. (2007). Reframing school dropout as a public health issue. *Preventing Chronic Disease,* **4** (4), A107.

Fulkerson, J. A., Sherwood, N. E., Perry, C. L., Neumark-Sztainer, D. and Story, M. (2004). Depressive symptoms and adolescent eating and health behaviors: a multifaceted view in a population-based sample. *Preventive Medicine,* **38** (6), 865-875.

Galobardes, B., Shaw, M., Lawlor, D. A., Lynch, J. W. and Davey Smith, G. (2006a). Indicators of socioeconomic position (part 1). *Journal of Epidemiology and Community Health,* **60** (1), 7-12.

Galobardes, B., Shaw, M., Lawlor, D. A., Lynch, J. W. and Davey Smith, G. (2006b). Indicators of socioeconomic position (part 2). *Journal of Epidemiology and Community Health,* **60** (2), 95-101.

Galobardes, B., Shaw, M., Lawlor, D.A., Davey Smith, G. and Lynch, J. (2006c). Indicators of Socioeconomic Position. In: *Methods in Social Epidemiology* (edited by J.M. Oakes and J.S. Kaufman), pp. 47-85. San Francisco: Jossey-Bass.

Galobardes, B., Lynch, J. and Davey Smith, G. (2007). Measuring socioeconomic position in health research. *British Medical Bulletin,* **81-82**, 21-37.

Galuska, D. A. and Fulton, J. E. (2009). Physical activity surveillance: providing public health data for decision makers. *Journal of Physical Activity and Health,* **6** (suppl. 1), S1-S2.

Garson, G. D. (2006) Logistic Regression. *Statnotes from North Carolina State University [online]*, [cited 30-07-2010]. Available from URL: http://faculty.chass.ncsu.edu/garson/PA765/logistic.htm.

Gidlow, C. (2006). *Physical Activity Referral Schemes: Socio-demographic Patterns of Exposure, Update and Attendance.* Unpublished PhD thesis. Sheffield Hallam University.

Gidlow, C., Johnston, L. H., Crone, D., Morris, C., Smith, A., Foster, C. and James, D. V. (2007). Socio-demographic patterning of referral, uptake and attendance in Physical Activity Referral Schemes. *Journal of Public Health,* **29** (2), 107-113.

Gidlow, C., Johnston, L. H., Crone, D. and James, D. V. B. (2008a). Methods of evaluation: issues and implications for physical activity referral schemes. *American Journal of Lifestyle Medicine,* **2** (1), 46-50.

Gidlow, C. J., Cochrane, T., Davey, R. and Smith, H. (2008b). In-school and out-of-school physical activity in primary and secondary school children. *Journal of Sports Sciences,* **26** (13), 1411-1419.

Gilthorpe, M. S. and Wilson, R. C. (2003). Rural/urban differences in the association between deprivation and healthcare utilisation. *Social Science and Medicine,* **57** (11), 2055-2063.

Girman, C. J., Rhodes, T., Mercuri, M., Pyorala, K., Kjekshus, J., Pedersen, T. R., Beere, P. A., Gotto, A. M. and Clearfield, M. (2004). The metabolic syndrome and risk of major coronary events in the Scandinavian Simvastatin Survival Study (4S) and the Air Force/Texas Coronary Atherosclerosis Prevention Study (AFCAPS/TexCAPS). *American Journal of Cardiology,* **93** (2), 136-141.

Gloucestershire County Council (2007). *Directory - A Name and Address Guide to Gloucestershire Schools and Establishments 2007/2008.* Gloucester: Gloucestershire County Council.

Going, S.B., Levin, S., Harrell, J., Stewart, D., Kushi, L., Cornell, C.E., Hunsberger, S., Corbin, C. and Sallis, J. (1999). Physical activity assessment in American Indian schoolchildren in the Pathways study. *American Journal of Clinical Nutrition,* **69** (4 suppl.), S788-S795.

Gordon-Larsen, P., McMurray, R.G. and Popkin, B.M. (1999). Adolescent physical activity and inactivity vary by ethnicity: the National Longitudinal Study of Adolescent Health. *Journal of Pediatrics,* **135** (3), 301-306.

Gordon-Larsen, P., McMurray, R. G. and Popkin, B. M. (2000). Determinants of adolescent physical activity and inactivity patterns. *Pediatrics,* **105** (6), E83.

Gordon-Larsen, P., Nelson, M. C. and Popkin, B. M. (2004). Longitudinal physical activity and sedentary behavior trends: adolescence to adulthood. *American Journal of Preventive Medicine,* **27** (4), 277-283.

Gorely, T., Marshall, S. J. and Biddle, S. J. H. (2004). Couch kids: correlates of television viewing among youth. *International Journal of Behavioral Medicine,* **11** (3), 152-163.

Gorely, T., Marshall, S. J., Biddle, S. J. and Cameron, N. (2007a). The prevalence of leisure time sedentary behaviour and physical activity in adolescent girls: an ecological momentary assessment approach. *International Journal of Pediatric Obesity,* **2** (4), 227-234.

Gorely, T., Marshall, S. J. and Biddle, S. J. H. (2007b). Patterns of sedentary behaviour and physical activity among adolescents in the United Kingdom: Project STIL. *Journal of Behavioral Medicine,* **30** (6), 521-531.

Gorely, T., Atkin, A. J., Biddle, S. J. and Marshall, S. J. (2009a). Family circumstance, sedentary behaviour and physical activity in adolescents living in England: Project STIL. *International Journal of Behavioral Nutrition and Physical Activity,* **6**, 33.

Gorely, T., Biddle, S., Marshall, S., Cameron, N. and Cassey, L. (2009b). The association between distance to school, physical activity and sedentary behaviors in adolescents: Project STIL. *Pediatric Exercise Science,* **21** (4), 450-461.

Gorely, T., Biddle, S. J., Marshall, S. J. and Cameron, N. (2009c). The prevalence of leisure time sedentary behaviour and physical activity in adolescent boys: an ecological momentary assessment approach. *International Journal of Pediatric Obesity,* **4** (4), 289-298.

Gortmaker, S. L., Must, A., Sobol, A. M., Peterson, K., Colditz, G. A. and Dietz, W. H. (1996). Television viewing as a cause of increasing obesity among children in the United States, 1986-1990. *Archives of Pediatric and Adolescent Medicine,* **150** (4), 356-362.

Government Office for Science and U.K. Government's Foresight Programme (2007). *Foresight - Tackling Obesities: Future Choices - Project Report.* London: Government Office for Science and U.K. Government's Foresight Programme.

Green, K., Smith, A. and Roberts, K. (2005b). Young people and lifelong participation in sport and physical activity: a sociological perspective on contemporary physical education programmes in England and Wales. *Leisure Studies,* **24** (1), 27-43.

Grund, A., Krause, H., Siewers, M., Rieckert, H. and Muller, M.J. (2001). Is TV viewing an index of physical activity and fitness in overweight and normal weight children? *Public Health Nutrition,* **4** (6), 1245-1251.

Gustafson, S.L. and Rhodes, R.E. (2006). Parental correlates of physical activity in children and early adolescents. *Sports Medicine,* **36** (1), 79-97.

Guthold, R., Cowan, M.J., Autenrieth, C.S., Kann, L. and Riley, L.M. (2010). Physical activity and sedentary behavior among schoolchildren: a 34-country comparison. *Journal of Pediatrics*, **157** (1), 43-49.

Hall, G. S. (1904). *Adolescence: Its Psychology and its Relations to Physiology, Anthropology, Sociology, Sex, Crime, Religion and Education.* New York: Appleton-Century-Crofts.

Hallal, P. C., Victora, C. G., Azevedo, M. R. and Wells, J. C. (2006a). Adolescent physical activity and health: a systematic review. *Sports Medicine,* **36** (12), 1019-1030.

Hallal, P. C., Wells, J. C. K., Reichert, F. F., Anselmi, L. and Victora, C. G. (2006b). Early determinants of physical activity in adolescence: prospective birth cohort study. *British Medical Journal,* **332** (7548), 1002-1007.

Hamar, P., Biddle, S., Soos, I., Takacs, B. and Huszar, A. (2010). The prevalence of sedentary behaviours and physical activity in Hungarian youth. *European Journal of Public Health,* **20** (1), 85-90.

Hamburg, B. A. (1980). Early adolescence as a life stress. In: *Coping and Health* (edited by S. Levine and H. Ursin), pp. 121-143. New York: Plenum.

Hancox, R. J., Milne, B. J. and Poulton, R. (2004). Association between child and adolescent television viewing and adult health: a longitudinal birth cohort study. *The Lancet,* **364** (9430), 257-262.

Hancox, R., Milne, B. and Poulton, R. (2005). Association of television viewing during childhood and poor educational acievement. *Archives Pediatric and Adolescent Medicine*, **159** (7), 614-618.

Hardman, A. E. (2001). Physical activity and cancer risk. *Proceedings of the Nutrition Society,* **60** (1), 107-113.

Hardy, L.L., Dobbins, T., Booth, M.L., Denney-Wilson, E. and Okely, A.D. (2006). Sedentary behaviours among Australian adolescents. *Australian and New Zealand Journal of Public Health*, **30**, 534-540.

Hardy, L. L., Bass, S. L. and Booth, M. L. (2007a). Changes in sedentary behavior among adolescent girls: a 2.5-year prospective cohort study. *Journal of Adolescent Health,* **40** (2), 158-165.

Hardy, L. L., Booth, M. L. and Okely, A. D. (2007b). The reliability of the Adolescent Sedentary Activity Questionnaire (ASAQ). *Preventive Medicine,* **45** (1), 71-74.

Hardy, L. L., Okely, A. D., Dobbins, T. A. and Booth, M. L. (2008). Physical activity among adolescents in New South Wales (Australia): 1997 and 2004. *Medicine and Science in Sports and Exercise,* **40** (5), 835-841.

Hardy, L.L., Denney-Wilson, E., Thrift, A.P., Okely, A.D. and Baur, L.A. (2010). Screen time and metabolic risk factors among adolescents. *Archives of Pediatrics and Adolescent Medicine*, **164** (7), 643-649.

Harrison, R. A., McNair, F. and Dugdill, L. (2005). Access to exercise referral schemes: a population based analysis. *Journal of Public Health,* **27** (4), 326-330.

Hasselstrom, H., Hansen, S. E., Froberg, K. and Andersen, L.B. (2002). Physical fitness and physical activity during adolescence as predictors of cardiovascular disease risk in young adulthood. Danish Youth and Sports Study. An eight-year follow-up study. *International Journal of Sports Medicine,* **23** (suppl. 1), S27-S31.

Health Canada and the Canadian Society for Exercise Physiology (2002a). *Canada's Physical Activity Guide for Children.* Ottawa, Canada: Minister of Public Works and Government Services.

Health Canada and the Canadian Society for Exercise Physiology (2002b). *Canada's Physical Activity Guide for Youth.* Ottawa, Canada: Minister of Public Works and Government Services.

Henning Brodersen, N., Steptoe, A., Williamson, S. and Wardle, J. (2005). Sociodemographic, developmental, environmental, and psychosocial correlates of physical activity and sedentary behaviour at age 11 to 12. *Annals of Behavioral Medicine*, **29** (1), 2-11.

Henning Brodersen, N., Steptoe, A., Boniface, D. R. and Wardle, J. (2007). Trends in physical activity and sedentary behaviour in adolescence: ethnic and socioeconomic differences. *British Journal of Sports Medicine,* **41** (3), 140-144.

Higgins, J.W., Gaul, C., Gibbons, S. and Van Gyn, G. (2003). Factors influencing physical activity levels among Canadian youth. *Canadian Journal of Public Health*, **94** (1), 45-51.

Hill, J. O., Wyatt, H. R., Reed, G. W. and Peters, J. C. (2003). Obesity and the environment: where do we go from here? *Science,* **299** (5608), 853-855.

Hinkley, T., Salmon, J., Okely, A.D. and Trost, S.G. (2010). Correlates of sedentary behaviours in preschool children: a review. *International Journal of Behavioral Nutrition and Physical Activity*, **7**, 66.

Hinkley, T., Crawford, D., Salmon, J., Okely, A.D. and Hesketh, K. (2008). Preschool children and physical activity: a review of correlates. *American Journal of Preventive Medicine*, **34** (5), 435-441.

Hoare, J. (2003). Comparison of area-based inequality measures and disease morbidity in England, 1994-1998. *National Statistics Quarterly,* **18**, 18-24.

Hogan, D. P. and Astone, N. M. (1986). The transition to adulthood. *Annual Review of Sociology,* **12**, 109-130.

Holmen, T. L., Barrett-Connor, E., Clausen, J., Langhammer, A., Holmen, J. and Bjermer, L. (2002). Gender differences in the impact of adolescent smoking on lung function and respiratory symptoms: the Nord-Trondelag Health Study, Norway, 1995-1997. *Respiratory Medicine,* **96** (10), 796-804.

Hosmer, D. W. and Lemeshow, S. (2000). Application of logistic regression with different sampling models. In: *Applied Logistic Regression* (edited by D.W. Hosmer and S. Lemeshow), pp. 203-222. Chichester: John Wiley and Sons.

Howitt, D. and Cramer, D. (2008). *Introduction to SPSS in Psychology for Version 16 and Earlier*. Harlow: Pearson Education Limited.

Hume, C., Singh, A., Brug, J., Mechelen, W. and Chinapaw, M. (2009). Dose-response associations between screen time and overweight among youth. *International Journal of Pediatric Obesity,* **4** (1), 61-64.

Huston, A. C., Wright, J. C., Marquis, J. and Green, S. B. (1999). How young children spend their time: television and other activities. *Developmental Psychology,* **35** (4), 912-925.

Iannotti, R.J., Kogan, M.D., Janssen, I. and Boyce, W.F. (2009).Patterns of adolescent physical activity, screen-based media use, and positive and negative health indicators in the U.S. and Canada. *Journal of Adolescent Health,* **44** (5), 493-499.

Inchley, J. C., Currie, D. B., Todd, J. M., Akhtar, P. C. and Currie, C. E. (2005). Persistent socio-demographic differences in physical activity among Scottish schoolchildren 1990-2002. *European Journal of Public Health,* **15** (4), 386-388.

Jackson, K. M., Sher, K. J., Cooper, L. and Wood, P. (2002). Adolescent alcohol and tobacco use: onset, persistence and trajectories of use across two samples. *Addiction,* **97** (5), 517-531.

Jago, R., Baranowski, T., Baranowski, J.C., Cullen, K.W. and Thompson, D.I. (2007). Social desirability is associated with some physical activity, psychosocial variables and sedentary behavior but not self-reported physical activity among adolescent males. *Health Education Research,* **22** (3), 438-449.

Jago, R., Wedderkopp, N., Kristensen, P. L., Møller, N. C., Andersen, L. B., Cooper, A. R. and Froberg, K. (2008). Six-year change in youth physical activity and effect on fasting insluin and HOMA-IR. *American Journal of Preventive Medicine,* **35** (6), 554-560.

James, D. V., Johnston, L. H., Crone, D., Sidford, A. H., Gidlow, C., Morris, C. and Foster, C. (2008). Factors associated with physical activity referral uptake and participation. *Journal of Sports Sciences,* **26** (2), 217-224.

James, D., Mills, H., Crone, D., Johnston, L. H., Morris, C. and Gidlow, C. J. (2009). Factors associated with physical activity referral completion and health outcomes. *Journal of Sports Sciences,* **27** (10), 1007-1017.

Janssen, I. (2007). Physical activity guidelines for children and youth. *Applied Physiology, Nutrition, and Metabolism,* **32** (suppl. 2), S109-S121.

Janz, K. F., Dawson, J. D. and Mahoney, L. T. (2002). Increases in physical fitness during childhood improve cardiovascular health during adolescence: the Muscatine Study. *International Journal of Sports Medicine,* **23** (suppl. 1), S15-S21.

Jeffery, R. W. and French, S. A. (1998). Epidemic obesity in the United States: are fast foods and television viewing contributing? *American Journal of Public Health,* **88** (2), 277-280.

Johnston, C. C. and Slemenda, C. W. (1995). Pathogenesis of osteoperosis. *Bone,* **17** (2) (suppl. 1), S19-S22.

Jolliffe, C.J. and Janssen, I. (2007). Development of age-specific adolescent metabolic syndrome criteria that are linked to the Adult Treatment Panel III and International Diabetes Federation crirteria. *Journal of the American College of Cardiology,* **49** (8), 891-898.

Juan, F. R., Bengoechea, E. G., Montes, M. E. G. and Bush, P. L. (2010). Role of individual and school factors in physical activity of Secondary-level Spanish students. *Journal of School Health,* **80** (2), 88-95.

Kahn, K.M., Bennell, K.L., Hopper, J.L., Flicker, L., Nowson, C.A., Sherwin, A.J., Crichton, K.J., Harcourt, P.R. and Wark, J.D. (1998). Self-reported ballet classes undertaken at age 10 and 12 years and hip bone mineral density in later life. *Osteoporosis International*, **8** (2), 165-173.

Kahn, J. A., Huang, B., Gillman, M. W., Field, A. E., Austin, S. B., Colditz, G. A. and Frazier, A. L. (2008). Patterns and determinants of physical activity in U.S. adolescents. *Journal of Adolescent Health,* **42** (4), 369-377.

Kalra, N. and Newman, M. (2009). *The Relationship Between Obesity and Sedentary Behaviour: A Systematic Map of Research.* Institute of Education, University of London: EPPI-Centre, Social Science Research Unit.

Karaca, A., Calgar, E., Bilgili, N. and Ayaz, S. (2011). Screen time of adolescents in an economically developing country: the case of Turkey. *Annals of Human Biology*, **38** (1), 28-33.

Kedler, S. D., Perry, C. L., Klepp, K. I. and Lytle, L. L. (1994). Longitudinal traking of adolescent smoking, physical activity, and food choice behaviors. *American Journal of Public Health,* **84** (7), 1121-1126.

Keeton, F. and Kennedy, C. (2009). Update on physical activity including special needs populations. *Current Opinion in Pediatrics*, **21** (2), 262-268.

Kemper, H.C.G., De Vente, W., Van Mechelen, W. and Twisk, J. (2001). Adolescent motor skill and performance: is physical activity in adolescence related to adult physical fitness?. *American Journal of Human Biology*, **13** (2), 1880-1889.

Kim-Cohen, J., Caspi, A., Moffitt, T. E., Harrington, H., Milne, B. J. and Poulton, R. (2003). Prior juvenile diagnoses in adults with mental disorder: developmental follow-back of a prospective-longitudinal cohort. *Archives of General Psychiatry,* **60** (7), 709-717.

Kimm, S. Y., Glynn, N. W., Kriska, A. M., Fitzgerald, S. L., Aaron, D. J., Similo, S. L., McMahon, R. P. and Barton, B. A. (2000). Longitudinal changes in physical activity in a biracial cohort during adolescence. *Medicine and Science in Sports and Exercise,* **32** (8), 1445-1454.

Kimm, S. Y., Glynn, N. W., Kriska, A. M., Barton, B. A., Kronsberg, S. S., Daniels, S. R., Crawford, P. B., Sabry, Z. I. and Liu, K. (2002). Decline in physical activity in black girls and white girls during adolescence. *New England Journal of Medicine,* **347** (10), 709-715.

Kimm, S.Y.S., Glynn, N.W., Obarzanek, E., Kriska, A.M., Daniels, S.R., Barton, B.A. and Liu, K. (2005). Relation between changes in physical activity and body-mass index during adolescence; A meluticentre longitudinal study. *Lancet,* **366** (9482), 301-307.

Kimm, S. Y., Glynn, N. W., McMahon, R. P., Voorhees, C. C., Striegel-Moore, R. H. and Daniels, S. R. (2006). Self-perceived barriers to activity participation among sedentary adolescent girls. *Medicine and Science in Sports and Exercise,* **38** (3), 534-540.

King, A., Wold, B., Tudor-Smith, C. and Harel, Y. (1996). The health of youth. A cross national study. *World Health Organisation Regional Publication,* **69**, 1-222.

Kirkcaldy, B. D., Shephard, R. J. and Siefen, R. G. (2002). The relationship between physical activity and self-image and problem behaviour among adolescents. *Social Psychiatry and Psychiatric Epidemiology,* **37** (11), 544-550.

Kjonniksen, L., Torsheim, T. and Wold, B. (2008). Tracking of leisure-time physical activity during adolescence and young adulthood: a 10-year longitudinal study. *International Journal of Behavioral Nutrition and Physical Activity,* **5**, 69.

Klein-Platat, C., Oujaa, M., Wagner, A., Haan, M.C., Arveiler, D., Schlienger, J.L. and Simon, C. (2005). Physical activity is inversely related to waist circumference in 12-y-old French adolescents. *International Journal of Obesity*, **29** (1), 9-14.

Klesges, L.M., Baranowski, T., Beech, B., Cullen, K., Murray, D., Rochon, J. and Pratt, C. (2004). Social desirability bias in self-reported dietary, physical activity and weight concern measures in 8- to 10-year old African American girls: results from the Girls Health Enrichment Multisite Studies (GEMS). *Preventive Medicine,* **38** (suppl.), S78-S87.

Koh, H.K. (2010). A 2020 vision for healthy people. *New England Journal of Medicine*, **362** (18), 1653-1656.

Kohl, H. W., Fulton, J. E. and Caspersen, C. J. (2000). Assessment of physical activity among children and adolescents: a review and synthesis. *Preventive Medicine,* **31** (2), S54-S76.

Kolbe, L. J. (1990). An epidemiological surveillance system to monitor the prevalence of youth behaviors that most affect health. *Health Education,* **12**, 44-48

Kowalski, K. C., Crocker, P. R. E. and Faulkner, R. A. (1997a). Validation of the Physical Activity Questionnaire for Older Children. *Pediatric Exercise Science,* **9** (2), 174-186.

Kowalski, K. C., Crocker, P. R. E. and Kowalski, N. P. (1997b). Convergent validity of the physical activity questionnaire for adolescents. *Pediatric Exercise Science,* **9** (4), 342-352.

Kremer, J., Trew, K. and Ogle, S. (1997). *Young People's Involvement in Sport.* London: Sports Council.

Kremers, S. P. J. and Brug, J. (2008). Habit strength of physical activity and sedentary behavior among children and adolescents. *Pediatric Exercise Science,* **20** (1), 5-17.

Krieger, N., Williams, D. R. and Moss, N. E. (1997). Measuring social class in US public health research: concepts, methodologies, and guidelines. *Annual Review of Public Health,* **18**, 341-378.

Kriska, A. M., Sandler, R. B., Cauley, J. A., Laporte, R. E., Hom, D. L. and Pambianco, G. (1988). The assessment of physical activity and its relation to adult bone parameters. *American Journal of Epidemiology,* **127** (5), 1053-1063.

Kriska, A. M., Knowler, W. C., Laporte, R. E., Drash, A.L., Wing, R.R., Blair, S.N., Bennett, P.H. and Kuller, L.H. (1990). Development of a questionnaire to examine relationship of physical activity and diabetes in Pima Indians. *Diabetes Care,* **13** (4), 401-411.

Kriska, A. M. and Bennett, P. H. (1992). An epidemiological perspective of the relationship between physical activity and NIDDM: from activity assessment to intervention. *Diabetes/Metabolism Reviews,* **8** (4), 355-372.

Kriska, A. M. and Caspersen, C. J. (1997). Introduction to a collection of physical activity questionnaires. *Medicine and Science in Sports and Exercise,* **29** (6), S5-S9.

Kristensen, P.L., Moller, N.C., Korsholm, L., Wedderkopp, N., Andersen, L.B. and Froberg, K. (2008). Tracking of objectively measured physical activity from childhood to adolescence: The European Youth Heart Study. *Scandinavian Journal of Medicine and Science in Sports*, **18** (2), 171-178.

Kristjansdottir, G. and Vilhjalmsson, R. (2001). Sociodemographic differences in patterns of sedentary and physically active behavior in older children and adolescents. *Acta Paediatrica,* **90** (4), 429-435.

Kristjánsson, A. L., Sigfúsdóttir, I. D., Allegrante, J. P. and Helgason, A. R. (2009). Adolescent health behavior, contentment in school, and academic achievement. *American Journal of Health Behavior,* **33** (1), 69-79.

Laakso, L., Telama, R., Nupponen, H., Rimpelä, A. and Pere, L. (2008). Trends in leisure time physical activity among young people in Finland 1977 2007. *European Physical Education Review,* **14** (2), 139-155.

Lachat, C. K., Verstraeten, R., Khanh le, N. B., Hagstromer, M., Khan, N. C., Van Ndo, A., Dung, N. Q. and Kolsteren, P. W. (2008). Validity of two physical activity questionnaires (IPAQ and PAQA) for Vietnamese adolescents in rural and urban areas. *International Journal of Behavioral Nutrition and Physical Activity,* **5**, 37.

Lake, A. A., Townshend, T., Alvanides, S., Stamp, E. and Adamson, A. J. (2009). Diet, physical activity, sedentary behaviour and perceptions of the environment in young adults. *Journal of Human Nutrition and Dietetics,* **22** (5), 444-454.

Lantz, P. M., House, J. S., Lepkowski, J. M., Williams, D. R., Mero, R. P. and Chen, J. (1998). Socioeconomic factors, health behaviors, and mortality: results from a nationally representative prospective study of US adults. *Journal of the American Medical Association,* **279** (21), 1703-1708.

Leatherdale, S.T. and Wong, S.L. (2008). Modifiable characteristics associated with sedentary behaviors among youth. *International Journal of Pediatric Obesity*, **3** (2), 91-101.

Lee, E. T., Welty, T. K., Fabsitz, R., Cowan, L.D., Le, N.A., Oopik, A.J., Cucchiara, A.J., Savage, P.J. and Howard, B.V. (1990). The Strong Heart Study: a study of cardiovascular disease in American Indians: design and methods. *American Journal of Epidemiology,* **321** (6), 1141-1155.

Lee, R. E. and Cubbin, C. (2002). Neighbourhood context and youth cardiovascular health behaviors. *American Journal of Public Health,* **92** (3), 428-436.

Lefevre, J., Philippaerts, R., Delvaux, K., Thomis, M., Claessens, A. L., Lysens, R., Renson, R., Vanden Eynde, B., Vanreusel, B. and Beunen, G. (2002). Relation between cardiovascular risk factors at adult age, and physical activity during youth and adulthood: the Leuven Longitudinal Study on Lifestyle, Fitness and Health. *International Journal of Sports Medicine,* **23** (suppl. 1), S32-S38.

Leslie, E., Fotheringham, M. J., Owen, N. and Bauman, A. (2001). Age-related differences in physical activity levels of young adults. *Medicine and Science in Sports and Exercise,* **33** (2), 255-258.

Levitsky, D. A., Halbmaier, C. A. and Mrdjenovic, G. (2004). The freshman weight gain: a model for the study of the epidemic of obesity. *International Journal of Obesity and Related Metabolic Disorders,* **28** (11), 1435-1442.

Lewinsohn, P. M., Rohde, P., Klein, D. N. and Seeley, J. R. (1999). Natural course of adolescent major depressive disorder I. Continuity into young adulthood. *Journal of the American Academy of Child and Adolescent Psychiatry,* **38** (1), 56-63.

Li, M., Dibley, M. J., Sibbritt, D. W., Zhou, X. and Yan, H. (2007). Physical activity and sedentary behavior in adolescents in Xi'an City, China. *Journal of Adolescent Health,* **41** (1), 99-101.

Li, S., Treuth, M.S. and Wang, Y. (2010). How active are American adolescents and have they become less active?. *Obesity Reviews*, **11** (12), 847-862.

Liberatos, P., Link, B. G. and Kelsey, J. L. (1988). The measurement of social class in epidemiology. *Epidemiologic Reviews,* **10**, 87-121.

Lobstein, T., Baur, L. and Uauy, R. (2004). Obesity in children and young people: a crisis in public health. *Obesity Reviews,* **5** (suppl. 1), S4-S104.

Lobstein, T. and Jackson-Leach, R. (2006). Estimated burden of paediatric obesity and co-morbidities in Europe. Part 2. Numbers of children with indicators of obesity-related disease. *International Journal of Pediatric Obesity,* **1** (1), 33-41.

Lollgen, H., Bockenhoff, A. and Knapp, G. (2009). Physical activity and all-cause mortality: an updated meta-analysis with different intensity categories. *International Journal of Sports Medicine,* **30** (3), 213-244.

Louie, L., Eston, R. G., Rowlands, A. V., Tony, K. K., Ingledew, D. K. and Fu, F. H. (1999). Validity of heart rate, pedometry, and accelerometry for estimating the energy cost of activity in Hong Kong Chinese boys. *Pediatric Exercise Science,* **11** (3), 229-239.

Lowry, R., Wechsler, H., Galuska, D.A., Fulton, J.E. and Kann, L. (2002). Television viewing and its associations with overweight, sedentary lifestyle, and insufficient consumption of fruits and vegatables among US high school students: differences by race, ethnicity, and gender. *Journal of School Health*, **72** (10), 413-421.

Lubans, D. R., Sylva, K. and Morgan, P. J. (2007). Factors associated with physical activity in a sample of British secondary school students. *Australian Journal of Educational and Developmental Psychology*, **7**, 22-30.

Lynch, J. (2001). Social position and health. *Annals of Epidemiology*, **6**, 21-23.

Lynch, J.W., Kaplan, G.A. and Shema, S.J. (1997). Cumulative impact of sustained economic hardship on physical, cognitive, psychological, and social functioning. *New England Journal of Medicine*, **337** (26), 1889-1895.

Lynch, J. and Kaplan, G. (2000). Socioeconomic position. In: *Social Epidemiology* (1st edn.) (edited by L.F. Berkman and L. Kawachi), pp. 13-35. Oxford: Oxford University Press.

Macdonald, H., Ashe, M. and McKay, H. (2009). The link between physical activity and bone strength across the lifespan. *International Journal of Clinical Rheumatology*, **4** (4), 437-463.

Macintyre, S., Ellaway, A., Der, G., Ford, G. and Hunt, K. (1998). Do housing tenure and car access predict health because they are simply markers of income or self-esteem? A Scottish study. *Journal of Epidemiology and Community Health*, **52** (10), 657-664.

Mark, A.E., Boyce, W.F. and Janssen, I. (2006). Television viewing, computer use and total screen time in Canadian youth. *Paediatric Child Health*, **11** (9), 595-599.

Mark, A. E. and Janssen, I. (2008). Relationship between screen time and metabolic syndrome in adolescents. *Journal of Public Health,* **30** (2), 153-160.

Marshall, S. J., Biddle, S. J. H., Sallis, J. F., McKenzie, T. L. and Conway, T. L. (2002). Clustering of sedentary behaviors and physical activity among youth: a cross-national study. *Pediatric Exercise Science,* **14** (4), 401-417.

Marshall, S. J., Biddle, S. J. H., Gorely, T., Cameron, N. and Murdey, I. (2004). Relationships between media use, body fatness and physical activity in children and youth: a meta-analysis. *International Journal of Obesity and Related Metabolic Disorders,* **28** (10), 1238-1246.

Marshall, S. J., Gorely, T. and Biddle, S. J. H. (2006). A descriptive epidemiology of screen-based media use in youth: a review and critique. *Journal of Adolescence,* **29** (3), 333-349.

Marshall, S. J. and Welk, G. J. (2008). Definitions and measurement. In: *Youth Physical Activity and Sedentary Behavior: Challenges and Solutions* (edited by A. Smith and S.J.H. Biddle), pp. 3-29. Champaign, IL: Human Kinetics.

Marshall, S.J. and Ramirez, E. (2011). Reducing sedentary behavior: a new paradigm in physical activity promotion. *American Journal of Lifestyle Medicine,* doi: 10.1177/1559827610395487.

Martin, D., Brigham, P., Roderick, P., Barnett, S. and Diamond, I. (2000). The (mis)representation of rural deprivation. *Environment and Planning,* **32** (4), 735-751.

Martinez-Gomez, D., Eisenmann, J.C., Gomez-Martinez, S., Veses, A., Marcos, A. and Veiga, O.L. (2010). Sedentary behavior, adiposity and cardiovascular risk factors in adolescents. The AFINOS study. *Revista Espanola de Cardiologia,* **63**, 277-285.

Martikainen, P. and Valkonen, T. (1999). Bias related to the exclusion of the economically inactive in studies on social class differences in mortality. *International Journal of Epidemiology,* **28** (5), 899-904.

Matkovic, V. (1992). Osteoperosis as a pediatric disease: role of calcium and heredity. *Journal of Rheumatology Supplement,* **33**, 54-59.

McClain, J. J. and Tudor-Locke, C. (2009). Objective monitoring of physical activity in children: considerations for instrument selection. *Journal of Science and Medicine in Sport,* **12** (5), 526-533.

McGill, H. C., Jr., McMahan, C. A., Herderick, E. E., Malcom, G. T., Tracy, R. E. and Strong, J. P. (2000). Origin of atherosclerosis in childhood and adolescence. *American Journal of Clinical Nutrition,* **72** (5 suppl.), S1307-S1315.

McMurray, R. G., Harrell, J. S., Bangdiwala, S. I. and Hu, J. (2003). Tracking of physical activity and aerobic power from childhood through adolescence. *Medicine and Science in Sports and Exercise,* **35** (11), 1914-1922.

Melanson Jr, E.L. and Freedson, P.S. (1995). Validity of the Computer Science and Applications, Inc. (CSA) activity monitor. *Medicine and Science in Sports and Exercise,* **27** (6), 934-940.

Mesa, J. L. (2004). Understanding data in clinical research: a simple graphical display for plotting data (up to four independent variables) after binary logistic regression analysis. *Medical Hypotheses,* **62** (2), 228-232.

Michaud, P. A., Narring, F., Cauderay, M. and Cavadini, C. (1999). Sports activity, physical activity and fitness of 9- to 19-year-old teenagers in the canton of Vaud (Switzerland). *Schweizerische Medizinische Wochenschrift,* **129** (18), 691-699.

Molnar, B.E., Gortmaker, S.L., Bull, F.C. and Buka, S.L. (2004). Unsafe to play? Neigborhood disorder and lack of safety predict reduced physical activity among urban children and adolescents. *American Journal of Health Promotion,* **18** (5), 378-386.

Molnar, D. and Livingstone, B. (2000). Physical activity in relation to overweight and obesity in children and adolescents. *European Journal od Pediatrics,* **159** (suppl. 1), S45-S55.

Montoye, H.J., Kemper, H.C.G., Saris, W.H.M. and Washburn, R.A. (1996). *Measuring Physical Activity and Energy Expenditure.* Champaign, IL: Human Kinetics.

MORI/Sport England (2002). *Young People and Sport in England/ Trends in Participation 1994-2002.* London: MORI/Sport England.

Morris, J. N., Heady, J. A., Raffle, P. A., Roberts, C. G. and Parks, J. W. (1953a). Coronary heart-disease and physical activity of work. *Lancet,* **265** (6795), 1053-1057; contd.

Morris, J. N., Heady, J. A., Raffle, P. A., Roberts, C. G. and Parks, J. W. (1953b). Coronary heart-disease and physical activity of work. *Lancet,* **265** (6796), 1111-1120; concl.

Morris, R. and Carstairs, V. (1991). Which deprivation? A comparison of selected deprivation indexes. *Journal of Public Health Medicine,* **13** (4), 318-326.

Mota, J., Ribeiro, J., Santos, M. P. and Gomes, H. (2006). Obesity, physical activity, and TV viewing in Portuguese adolescents. *Pediatric Exercise Science,* **18** (1), 113-121.

Mountjoy, M., Andersen, L.B., Armstrong, N., Biddle, S., Boreham, C., Bedenbeck, H.P.B., Ekelund, U., Engebretsen, L., Hardman, K., Hills, A., Kahlmeier, S., Lambert, E., Ljungqvist, A., Matsudo, V., McKay, H., Micheli, L., Pate, R., Riddoch, C., Schamasch, P., Sundberg, C.L., Tomkinson, G., Van Sluijs, E. and Van Mechelen, W. (2011). International Olympic Committee consensus statement on the health and fitness of young people through physical activity and sport. *British Journal of Sports Medicine*, **45** (11), 839-848.

Muntaner, C., Eaton, W.W., Diala, C., Kessler, R.C. and Sorlie, P.D. (1998). Social class, assets, organizational control and the prevalence of common groups of psychiatric disorders. *Social Science and Medicine*, **47** (12), 2043-2053.

Murphy, R., Dugdill, L. and Crone, D. (2009). Physical activity, health and health promotion. In: *Physical Activity and Health Promotion – Evidence-based Approaches to Practice* (edited by L. Dugdill, D. Crone and R. Murphy), pp. 3-20. Chichester: Wiley and Sons Ltd.

Must, A. and Tybor, D.J. (2005). Physical activity and sedentary behavior: a review of longitudinal stuidies of weight and adiposity in youth. *International Journal of Obesity*, **29** (suppl. 2), S84-S96.

National Board of Health (2003). *National Action Plan against Obesity – Recommendations and Perspectives (short version).* Copenhagen, Denmark: National Board of Health, Center for Health Promotion and Prevention.

National Heart Foundation of New Zealand (2004). *An Introduction to Active Movement: Koringo Hihiko*. Wellington, New Zealand: National Heart Foundation of New Zealand.

National Institute for Health and Clinical Excellence Public Health Collaborating Centre (2007). *Physical Activity and Children – Review 2 – Correlates of Physical Activity in Children: A Review of Quantitative Systematic Reviews.* London: National Institute for Health and Clinical Excellence Public Health Collaborating Centre – Physical Activity.

National Institute for Health and Clinical Excellence (2009). *Promoting Physical Activity, Active Play and Sport for Pre-school and School-age Children and Young People in Family, Pre-school, School and Community Settings - NICE Public Health Guidance 17.* London: National Institute for Health and Clinical Excellence.

Nelson, M. C., Gordon-Larsen, P., Adair, L. S. and Popkin, B. M. (2005). Adolescent physical activity and sedentary behavior: patterning and long-term maintenance. *American Journal of Preventive Medicine,* **28** (3), 259-266.

Nelson, M. C., Neumark-Stzainer, D., Hannan, P. J., Sirard, J. R. and Story, M. (2006). Longitudinal and secular trends in physical activity and sedentary behavior during adolescence. *Pediatrics,* 118 (6), e1627-1634.

Neumark-Sztainer, D., Story, M., Hannan, P. J., Tharp, T. and Rex, J. (2003). Factors associated with changes in physical activity: a cohort study of inactive adolescent girls. *Archives of Pediatric and Adolescent Medicine,* **157** (8), 803-810.

Nicklas, T. A., von Duvillard, S. P. and Berenson, G. S. (2002). Tracking of serum lipids and lipoproteins from childhood to dyslipidemia in adults: the Bogalusa Heart Study. *International Journal of Sports Medicine,* **23** (suppl. 1), S39-S43.

Noble, M., Wright, G., Dibben, C., Smith, G. A. N., Mclennan, D., Anttila, C., Barnes, H., Mokhtar, C., Noble, S., Avenell, D., Gardner, J., Covizzi, I. and Lloyd, M. (2004). *The English Indices of Deprivation 2004. Report to the Office of the Deputy Prime Minister*. London: Neighbourhood Renewal Unit.

Norman, G. J., Schmid, B. A., Sallis, J. F., Calfas, K. J. and Patrick, K. (2005). Psychosocial and environmental correlates of adolescent sedentary behaviors. *Pediatrics,* **116** (4), 908-916.

Norman, P. (2008). Townsend deprivation index. *University of Southampton School of Geography [online]*, [cited 05-01-2010]. Available from URL: http://www2.geog.soton.ac.uk/geo-refer/go3_142_c15p19819999snsw.html

Oehlschlaeger, M. H. K., Pinheiro, R. T., Horta, B. and San'Tana, G. E. P. (2004). Prevalence of sedentarism and its associated factors among urban adolescents. *Revista de Saude Publica,* **38** (2), 1-6.

Office for National Statistics (2009). Rural/Urban Definition and LA Classification. *Office for National Statistics [online]*, [accessed 08-05-2009]. Available from URL: http://www.ons.gov.uk/about-statistics/geography/products/area-classifications/rural-urban-definition-and-la-classification/index.html

Ogden, C.L., Carroll, M.D., Curtin, L.R., McDowell, M.A., Tabak, C.J. and Flegal, K.M. (2006). Prevalence of overweight and obesity in the United States, 1999-2004. *Journal of the American Medical Association,* **295** (13), 1549-1555.

Olds, T., Ridley, K. and Dollman, J. (2006). Screenieboppers and extreme screenies: the place of screen time in the time budgets of 10-13 year-old Australian children. *Australian and New Zealand Journal of Public Health,* **30** (2), 137-142.

Olds, T., Ridley, K., Wake, M., Hesketh, K., Waters, E., Patton, G. and Williams, J. (2007). How should activity guidelines for young people be operationalised? *International Journal of Behavioral Nutrition and Physical Activity,* **4**, 43.

Olds, T.S., Maher, C.A., Ridley, K. and Kittel, D.M. (2010). Descriptive epidemiology of screen and non-screen sedentary time in adolescents: a cross-sectional study. *International Journal of Behavioral Nutrition and Physical Activity,* **7**, 92

Owen, N., Leslie, E., Salmon, J. and Fotheringham, M.J. (2000). Environmental determinants of physical activity and sedentary behavior. *Exercise and Sports Sciences Reviews,* **28** (4), 165-170.

Owen, N., Bauman, A. and Brown, W. (2009). Too much sitting: a novel and important predictor of chronic disease risk? *British Journal of Sports Medicine,* **43** (2), 81-83.

Paffenbarger, R. S. and Hale, W. E. (1975). Work activity and coronary heart mortality. *New England Journal of Medicine,* **292** (11), 545-550.

Pallant, J. (2007). *SPSS Survival Manual - A Step-by-Step Guide to Data Analysis Using SPSS Version 15.* Maidenhead: Open University Press.

Pardee, P.E., Norman, G.J., Lustig, R.H., Preudhomme, D. and Schwimmer, J.B. (2007). Television viewing and hypertension in obese children. *American Journal of Preventive Medicine*, **33** (6), 439-443.

Pate, R. R. (1993). Physical activity assessment in children and adolescents. *Critical Reviews in Food Science and Nutrition,* **33** (4/5), 321-326.

Pate, R. R., Long, B. J. and Heath, G. (1994). Descriptive epidemiology of physical activity in adolescents. *Pediatric Exercise Science,* **6** (4), 434-447.

Pate, R. R., Dowda, M., O'Neill, J. R. and Ward, D. S. (2007). Changes in physical activity participation among adolescent girls from 8th to 12th grade. *Journal of Physical Activity and Health,* **4** (1), 3-16.

Pate, R.R., O'Neill, J.R. and Lobelo, F. (2008). The evolving definition of "sedentary". *Exercise and Sports Sciences Reviews*, **36** (4), 173-178.

Pate, R.R., Mitchell, J.A., Byun, W. and Dowda, M. (2011). Sedentary behaviour in youth. *British Journal of Sports Medicine,* **45** (11), 906-913.

Patrick, K., Norman, G.J., Calfas, K.J., Sallis, J.F., Zabinski, M.F., Rupp, J. and Cella, J. (2004). Diet, physical activity, and sedentary behaviors as risk factors for overweight in adolescence. *Archives of Pediatrics and Adolescent Medicine*, **158** (4), 385-390.

Peduzzi, P., Concato, J., Kemper, E., Holford, T. R. and Feinstein, A. R. (1996). A simulation study of the number of events per variable in logistic regression analysis. *Journal of Clinical Epidemiology,* **49** (12), 1373-1379.

Peiró-Velert, C., Devís-Devís, J., Beltrán-Carrillo, J. and Fox, K. R. (2008).Variability of Spanish adolescents' physical activity patterns by seasonality, day of the week and demographic factors. *European Journal of Sport Science,* **8** (3), 163-171.

Pereira, M. A., FitzerGerald, S. J., Gregg, E. W., Joswiak, M. L., Ryan, W. J., Suminski, R. R., Utter, A. C. and Zmuda, J. M. (1997). A collection of Physical Activity Questionnaires for health-related research. *Medicine and Science in Sports and Exercise,* **29** (6 suppl.), S1-S205.

Pfeiffer, K. A., Dowda, M., Dishman, R. K., McIver, K. L., Sirard, J. R., Ward, D. S. and Pate, R. R. (2006). Sport participation and physical activity in adolescent females across a four-year period. *Journal of Adolescent Health,* **39** (4), 523-529.

Pine, D. S., Cohen, P., Gurley, D., Brook, J. and Ma, Y. (1998). The risk for early-adulthood anxiety and depressive disorders in adolescents with anxiety and depressive disorders. *Archives of General Psychiatry,* **55** (1), 56-64.

Platat, C., Wagner, A., Klumpp, T., Schweitzer, B. and Simon, C. (2006). Relationships of physical activity with metabolic syndrome and low-grade inflammation in adolescents. *Diabetologia*, **49** (9), 2078-2085.

Poehlman, E. T., Melby, C. L. and Badylak, S. F. (1988). Resting metabolic rate and postprandial thermogenesis in highly trained and untrained males. *The American Journal of Clinical Nutrition,* **47** (5), 793-798.

Pratt, M., Macera, C. A. and Blanton, C. (1999). Levels of physical activity and inactivity in children and adults in the United States: current evidence and research issues. *Medicine and Science in Sports and Exercise,* **31** (11 suppl.), S526-S533.

Pratt, M. and Fulton, J. E. (2009). Staying on task: challenges of global physical activity surveillance. *Journal of Physical Activity and Health,* **6** (suppl. 1), S3-S4.

Primack, B.A., Swanier, B., Georgiopoulos, A.M. , Land, S.R. and Fine, M.J. (2009). Association between media use in adolescence and depression in young adulthood: a longitudinal study. *Archives of General Psychiatry,* **66** (2), 181-188.

Proper, K.I., Singh, A.S., van Mechelen, W. and Chinapaw, M.J.M. (2011). Sedentary behaviors and health outcomes among adults – a systematic review of prospective studies. *American Journal of Preventive Medicine*, **40** (2), 174-182.

Pugliese, J. and Tinsley, B. (2007). Parental socialization of child and adolescent physical activity: a meta-analysis. *Journal of Family Psychology*, **21** (3), 331-343.

Quick, S. (2008) The school sport partnership programme - raising levels of participation in physical education and sport in schools in England. In: *Public Opinion Polling in a Globalized World* (edited by M .Carball and U. Hjelmar), pp. 191-206. Berlin: Springer.

Raitakari, O. T., Porkka, K. V., Taimela, S., Telama, R., Rasanen, L. and Viikari, J. S. (1994). Effects of persistent physical activity and inactivity on coronary risk factors in children and young adults. The Cardiovascular Risk in Young Finns Study. *American Journal of Epidemiology,* **140** (3), 195-205.

Raitakari, O. T., Leino, M., Rakkonen, K., Porkka, K. V., Taimela, S., Rasanen, L. and Viikari, J. S. (1995). Clustering of risk habits in young adults. The Cardiovascular Risk in Young Finns Study. *American Journal of Epidemiology,* **142** (1), 36-44.

Ralston, S. H. (1997). Science, medicine and the future: osteoporosis. *British Medical Journal,* **315** (7106), 469-472.

Rangul, V., Holmen, T. L., Kurtze, N., Cuypers, K. and Midthjell, K. (2008). Reliability and validity of two frequently used self-administered physical activity questionnaires in adolescents. *BMC Medical Research Methodology,* **8**, 47.

Ravens-Sieberer, U., Torsheim, T., Hetland, J., Vollebergh, W., Cavallo, F., Jericek, H., Alikasifoglu, M., Välimas, R., Ottova, V., Erhart, M. and the Positive Health Focus Group. (2009). Subjective health, symptom load and quality of life in children and adolescents in Europe. *International Journal of Public Health*, **54** (suppl. 2), S151-S159.

Reilly, J. J. (2006). Obesity in childhood and adolescence: evidence based clinical and public health perspectives. *Postgraduate Medical Journal,* **82** (969), 429-437.

Reilly, J. J. and Dorosty, A. R. (1999). Epidemic of obesity in UK children. *Lancet,* **354** (9193), 1874-1875.

Reilly, J.J., Coyle, J., Kelly, L., Burke, G., Grant, S. and Paton, J.Y. (2003). An objective method for measurement of sedentary behavior in 3- to 4-year olds. *Obesity Research,* **11** (10), 1155-1158.

Rey-López, J. P., Vicente-Rodríguez, G., Biosca, M. and Moreno, L. A. (2008). Sedentary behaviour and obesity development in children and adolescents. *Nutrition, Metabolism and Cardiovascular Diseases,* **18** (3), 242-251.

Riddoch, C. J., Bo Andersen, L., Wedderkopp, N., Harro, M., Klasson-Heggebo, L., Sardinha, L. B., Cooper, A. R. and Ekelund, U. (2004). Physical activity levels and patterns of 9- and 15-yr-old European children. *Medicine and Science in Sports and Exercise,* **36** (1), 86-92.

Riddoch, C. J., Mattocks, C., Deere, K., Saunders, J., Kirkby, J., Tilling, K., Leary, S. D., Blair, S. N. and Ness, A. R. (2007). Objective measurement of levels and patterns of physical activity. *Archives of Disease in Childhood,* **92** (11), 963-969.

Ridley, K., Olds, T.S. and Hill, A. (2006). The Multimedia Activity Recall for Children and Adolescents (MARCA): development and evaluation. *Intenational Journal of Behavioral Nutrition and Physical Activity*, **3**, 10.

Rifas-Shiman, S.L., Gillman, M.W., Field, A.E., Frazier, A.L., Berkey, C.S., Tomeo, C.A., Colditz, G.A. (2001). Comparing physical activity questionnaires for youth: seasonal vs annual format. *American Journal of Preventive Medicine,* **20** (4), 282-285.

Rippe, J. M. and Hess, S. (1998). The role of physical activity in the prevention and management of obesity. *Journal of the American Dietetic Association,* **98** (10) (suppl. 2), S31-S38.

Roberts, D., Foehr, U. and Rideout, V. (2006). Generation M: Media in the Lives of 8-18 year olds. Kaiser Family Foundation Report 7251.

Roberts, K. (1996). Young people, schools, sport and government policy. *Sport, Education and Society,* **1** (1), 47-57.

Rocchini, A. P. (2002). Childhood obesity and a diabetes epidemic. *New England Journal of Medicine,* **346** (11), 854-855.

Roman, B., Serra-Majem, L., Ribas-Barba, L., Pérez-Rodrigo, C. and Aranceta, J. (2008). How many children and adolescents in Spain comply with the recommendations on physical activity. *The Journal of Sports Medicine and Physical Fitness,* **48** (3), 380-387.

Rosenbloom, A. L., Joe, J. R., Young, R. S. and Winter, W. E. (1999). Emerging epidemic of type 2 diabetes in youth. *Diabetes Care,* **22** (2), 345-354.

Rothman, K. and Greenland, S. (2001). *Modern Epidemiology*. Philapdelphia: Lippincott-Raven Press.

Rowlands, A.V. (2007). Accelerometer assessment of physical activity in children: an update. *Pediatric Exercise Science,* **19** (3), 252-266.

Rowlands, A. V., Eston, R. G. and Ingledew, D. K. (1999). Relationship between activity levels, aerobic fitness, and body fat in 8- to 10-year old children. *Journal of Applied Physiology,* **86** (4), 1428-1435.

Rowlands, A.V. and Eston, R.G. (2007). The measurement and interpretation of children's physical activity. *Journal of Sports Science and Medicine,* **6** (3), 270-276.

Rowlands, A.V., Pilgrim, E.L. and Eston, R.G. (2009). Seasonal changes in children's physical activity: an examination of group changes, intra-individual variability and consistency in activity pattern across season. *Annals of Human Biology,* **36** (4), 363-378.

Royal College of Physicians, Royal College of Paediatrics and Child Health and Faculty of Public Health Medicine (2004). *Storing Up Problems: The Medical Case for a Slimmer Nation*. London: Royal College of Physicians, Royal College of Paediatrics and Child Health and Faculty of Public Health Medicine.

Royal Mail Group Ltd. (2008). Postcode finder. *Royal Mail [online],* [accessed 2008-2009]. Available from URL: http://postcode.royalmail.com/portal/rm/postcodefinder?catId=400145

Ruiz, J.R., Rizzo, N.S., Hurtig-Wennlof, A., Ortega, F.B., Warnberg, J. and Sjostrom, M. (2006). Relations of total physical activity and intensity to fitness and fatness in children: The European Youth Heart Study. *American Journal of Clinical Nutrition,* **84** (2), 299-303.

Sagatun, A., Søgaard, A. J., Bjertness, E., Selmer, R. and Heyerdahl, S. (2007). The association between weekly hours of physical activity and mental health: a three-year follow-up study of 15-16-year-old students in the city of Oslo, Norway. *BMC Public Health,* **7**, 155.

Sagatun, A., Kolle, E., Anderssen, S. A., Thoresen, M. and Sogaard, A. J. (2008). Three-year follow-up of physical activity in Norwegian youth from two ethnic groups: associations with socio-demographic factors. *BMC Public Health,* **8**, 419.

Sallis, J.F. (1991). Self-report measutes of children's physical activity. *Journal of School Health,* **61** (5), 215-219.

Sallis, J. F. (1993). Epidemiology of physical activity and fitness in children and adolescents. *Critical Reviews in Food Science and Nutrition,* **33** (415), 403-408.

Sallis, J. F. (2000). Age-related decline in physical activity: a synthesis of human and animal studies. *Medicine and Science in Sports and Exercise,* **32** (9), 1598-600.

Sallis, J. F., Simons-Morton, B. G., Stone, E. J., Corbin, C. B., Epstein, L. H., Faucette, N., Iannotti, R. J., Killen, J. D., Klesges, R. C., Petray, C. K., Rowland, T.W. and Taylor, W.C. (1992). Determinants of physical activity and interventions in youth. *Medicine and Science in Sports and Exercise,* **24** (6 suppl.), S248-S257.

Sallis, J. F., Condon, S. A., Goggin, K. J., Roby, J. J., Kolody, B. and Alcaraz, J. E. (1993). The development of self-administered physical activity surveys for 4th grade students. *Research Quarterly for Exercise and Sport,* **64** (1), 25-31.

Sallis, J.F. and Owen, N. (1999). *Physical Activity and Behavioral Medicine.* Thousand Oaks, CA: Sage Publications.

Sallis, J.F., Prochaska, J.J., Taylor, W.C., Hill, J.O. and Geraci, J.C. (1999). Correlates of physical activity in a national sample of girls and boys in grades 4 through 12. *Health Psychology,* **18** (4), 410-415.

Sallis, J. F. and Saelens, B. E. (2000). Assessment of physical activity by self-report: status, limitations, and future directions. *Research Quarterly for Exercise and Sport,* **71** (2 suppl.), S1-S14.

Sallis, J.F., Owen, N.O. and Fotheringham, M. (2000a). Behavioral epidemiology: a systematic framework to classify phases of research on health promotion and disease prevention. *Annals of Behavioral Medicine,* **22** (4), 294-298.

Sallis, J. F., Prochaska, J. J. and Taylor, W. C. (2000b). A review of correlates of physical activity of children and adolescents. *Medicine and Science in Sports and Exercise,* **32** (5), 963-975.

Sallis, J.F. and Owen, N. (2002). Ecological models of health behaviour. In: *Health Behaviour and Health Education: Theory, Research and Practice* (3rd edn.) (edited by K. Glanz, B.K. Rimer and F.M. Lewis), pp.462-484. San Francisco: Jossey-Bass.

Salmon, J., Booth, M.L., Phongsavan, P., Murphy, N. and Timperio, N. (2007). Promoting physical activity participation among children and adolescents. *Epidemiologic Reviews*, **29**, 144-159.

Salmon, J., Tremblay, M.S., Marshall, S.J. and Hume, C. (2011). Health risks, correlates, and interventions to reduce sedentary behavior in young people. *American Journal of Preventive Medicine*, **41** (2), 197-206.

Samdal, O., Tynjala, J., Roberts, C., Sallis, J. F., Villberg, J. and Wold, B. (2006). Trends in vigorous physical activity and TV watching of adolescents from 1986 to 2002 in seven European Countries. *European Journal of Public Health,* **17** (3), 242-248.

Sanchez, A., Norman, G. J., Sallis, J. F., Calfas, K. J., Cella, J. and Patrick, K. (2007). Patterns and correlates of physical activity and nutrition behaviors in adolescents. *American Journal of Preventive Medicine,* **32** (2), 124-130.

Santos, M. P., Esculcas, C. and Mota, J. (2004). The relationship between socioeconomic status and adolescents' organized and nonorganized physical activities. *Pediatric Exercise Science,* **16**, 210-218.

Santos, M. P., Gomes, H. and Mota, J. (2005). Physical activity and sedentary behaviors in adolescents. *Annals of Behavioral Medicine,* **30** (1), 21-24.

Sardinha, L. B., Andersen, L. B., Anderssen, S. A., Quiterio, A. L., Ornelas, R., Froberg, K., Riddoch, C. J. and Ekelund, U. (2008). Objectively measured time spent sedentary is associated with insulin resistance independent of overall and central body fat in 9- to 10-year-old Portuguese children. *Diabetes Care,* **31** (3), 569-575.

Saul, C. and Payner, N. (1999). How does the prevalence of specific morbidities compare with measures of socio-economic status at small area level. *Journal of Public Health Medicine,* **21** (3), 340-347.

Sawyer, M. G., Arney, F. M., Baghurst, P. A., Clark, J. J., Graetz, B. W., Kosky, R. J., Nurcombe, B., Patton, G. C., Prior, M. R., Raphael, B., Rey, J. M., Whaites, L. C. and Zubrick, S. R. (2001). The mental health of young people in Australia: key findings from the child and adolescent component of the national survey of mental health and well-being. *Australian and New Zealand Journal of Psychiatry,* **35** (6), 806-814.

Schmitz, K. H., Lytle, L. A., Phillips, G. A., Murray, D. M., Birnbaum, A. S. and Kubik, M. Y. (2002). Psychosocial correlates of physical activity and sedentary leisure habits in young adolescents: the teens eating for energy and nutrition at school study. *Preventive Medicine,* **34** (2), 266-278.

Scottish Executive (2003). *Let's Make Scotland More Active: A Strategy for Physical Activity.* Edinburgh: Scottish Government.

Scully, M., Dixon, H., White, V. and Beckmann, K. (2007). Dietary, physical activity and sedentary behaviour among Australian secondary students. *Health Promotion International,* **22** (3), 236-245.

Seabra, A. F., Mendonca, D. M., Thomis, M. A., Malina, R. M. and Maia, J. A. (2007). Sports participation among Portuguese youth 10 to 18 years. *Journal of Physical Activity and Health,* **4** (4), 370-380.

Sengupta, S. (2009). Determinants of Health. In: *Key Concepts in Public Health* (edited by F. Wilson and M. Mabhala), pp. 15-20. London; Sage Publications.

Seroczynski, A. D., Cole, D. A. and Maxwell, S. E. (1997). Cumulative and compensatory effects of competence and incompetence on depressive symptoms in children. *Journal of Abnormal Psychology,* **106** (4), 586-597.

Shavers, V. L. (2007). Measurement of socioeconomic status in health disparities research. *Journal of the National Medical Association,* **99** (9), 1013-1023.

Shaw, M., Galobardes, B., Lawlor, D. A., Lynch, J., Wheeler, B. and Davey Smith, G. (2007). Townsend Index of Deprivation. In: *The handbook of Inequality and Socioeconomic Position: Concepts and Measures* (edited by M. Shaw, B. Galobardes, D.A.. Lawlor, J. Lynch, B. Wheeler and Davey Smith, G), pp. 140-141. Bristol: The Policy Press.

Shephard, R. J. (2003). Limits to the measurement of habitual physical activity by questionnaires. *British Journal of Sports Medicine,* **37** (3), 197-206.

Sigfúsdóttir, I. D., Kristjánsson, A. L. and Allegrante, J. P. (2007). Health behaviour and academic achievement in Icelandic school children. *Health Education Research,* **22** (1), 70-80.

Silbereisen, R. K. (2001). Adolescents: leisure-time activities. *International Encyclopedia of the Social and Behavioral Sciences*, **1**, 122-125.

Silva, R. C. and Malina, R. M. (2000). Level of physical activity in adolescents from Niteroi, Rio de Janeiro, Brazil [in Portuguese]. *Cadernos de Saúde Pública,* **16** (4), 1091-1097.

Simon, C., Wagner, A., DiVita, C., Rauscher, E., Klein-Platat, C., Arveiler, D., Schweitzer, B. and Triby, E. (2004). Intervention centred on adolescents' physical activity and sedentary behaviour (ICAPS): concept and 6-month results. *International Journal of Obesity*, **28** (suppl. 3), S96-S103.

Sinha, R., Fisch, G., Teague, B., Tamborlane, W. V., Banyas, B., Allen, K., Savoye, M., Rieger, V. and Taksali, S. (2002). Prevalence of impaired glucose tolerance among children and adolescents with marked obesity. *New England Journal of Medicine,* **346** (11), 802-810.

Sisson, S.B. and Katzmarzyk, P.T. (2008). International prevalence of physical activity in youth and adults. *Obesity Reviews*, **9** (6), 606-614.

Sisson, S.B., Church, T.S., Martin, C.K., Tudor-Locke, C., Smith, S.R., Bouchard, C., Earnest, C.P., Rankinen, T., Newton, R.L. and Katmarzyk, P.T. (2009). Profiles of sedentary behavior in children and adolescents: the US National Health and Nutrition Examination Survey, 2001-2006. *International Journal of Pediatric Obesity*, **4** (4), 353-359.

Slootmaker, S.M., Chin A Paw, M.J., Schuit, A.J., Van Mechelen, W. and Koppes, L.L. (2009). Concurrent validfity of the PAM accelerometer relative to the MTI Actigraph using oxygen consumption as a reference. *Scandinavian Journal of Medicine and Science in Sports*, **19** (1), 36-43.

Smith, A., Green, K. and Roberts, K. (2004). Sports participation and the 'obesity/health crisis': reflections on the case of young people in England. *International Review for the Sociology of Sport,* **39** (4), 457-464.

Smith, A. and Green, K. (2005). The place of sport and physical activity in young people's lives and its implications for health: some sociological comments. *Journal of Youth Studies,* **8** (2), 241-253.

Smith, A., Thurston, M., Lamb, K. and Green, K. (2007). Young people's participation in National Curriculum Physical Education: a study of 15-16 year olds in North-West England and North-East Wales. *European Physical Education Review,* **13** (2), 165-194.

Smyth, J. and Stone, A. (2003). Ecological momentary assessment research in behavioral medicine. *Journal of Happiness Studies,* **4**, 35-52.

Speiser, P.W., Rudolf, M.C.J., Anhalt, H., Camacho-Hubner, C., Chiarelli, F., Eliakim, A., Freemark, M., Gruters, A., Hershkovitz, E., Lughetti, L., Krude, H., Latzer, Y., Lustig, R.H., Pescovitz, O.H., Pinhas-Hamiel, O., Rogol, A.D., Shalitin, S., Sultan, C., Stein, D., Vardi, P., Werther, G.A., Zadik, Z., Zuckerman-Levin, N., Hochberg, Z and on behalf of the Obesity Consensus Working Group (2005). Consensus statement: Childhood obesity. *Journal of Clinical Endocrinology and Metabolism*, **90** (3), 1871-1887.

Sport England (2006). *Sport England Active People Survey 2005-2006.* London: Sport England.

Sport England (2008). *Sport England Strategy 2008-2011.* London: Sport England.

Stamatakis, E., Primatesta, P., Chinn, S., Rona, R. and Falascheti, E. (2005). Overweight and obesity trends from 1974 to 2003 in English children: What is the role of socio-economic factors? *Archives of Disease in Childhood,* **90** (10), 999-1004.

Statistics Canada (2005). *Measured Obesity: Overweight Canadian Children and Adolescents. Nutrition: Findings from the Canadian Community Health Survey*. Ottawa, ON: Statistics Canada.

Steele, R.M., Van Sluijs, E.M.F., Cassidy, A., Griffin, S.J. and Ekelund, U. (2009). Testing sedentary time or moderate- and vigorous-intensity activity: Independent relations with adiposity in a population-based sample of 10-y-old British children. *American Journal of Clinical Nutrition*, **90**, 1185-1192.

Stensel, D. J., Lin, F. P., Ho, T. F. and Aw, T. C. (2001). Serum lipids, serum insulin, plasma fibrinogen and aerobic capacity in obese and non-obese Singaporean boys. *International Journal of Obesity and Related Metabolic Disorders,* **25** (7), 984-989.

Stensel, D.J., Gorely, T. and Biddle, S.J.H. (2008). Youth Health Outcomes. In: *Youth Physical Activity and Sedentary - Challenges and Solutions* (edited by A.L. Smith and S.J.H. Biddle), pp. 31-58. Champaign, IL: Human Kinetics.

Steptoe, A. and Butler, N. (1996) Sports participation and emotional wellbeing in adolescents. *Lancet,* **347** (9018), 1789-1792.

Stone, M.R., Rowlands, A.V. and Eston, R.G. (2009). Relationships between accelerometer-assessed physical activity and health in children: impact of the activity-intensity classification method. *Journal of Sports Science and Medicine*, **8**, 136-143.

Strasburger, V. C. (2004). Children, adolescents, and the media. *Current Problems in Pediatric and Adolescent Health Care,* **34** (2), 54-113.

Stratton, G. and Watson, P. (2009). Young people and physical activity. In: *Physical Activity and Health Promotion - Evidence-based Approaches to Practice* (edited by L. Dugdill, D. Crone and R. Murphy), pp. 150-173. Chichester: Wiley and Sons Ltd.

Strauss, R. S. and Pollack, H. A. (2001). Epidemic increase in childhood overweight, 1986-1998. *Journal of the American Medical Association,* **286** (22), 2845-2848.

Strong, M., Maheswaran, R. and Pearson, T. (2006). A comparison of methods for calculating general practice level socioeconomic deprivation. *International Journal of Health Geographics,* **5**, 29.

Strong, W. B., Malina, R. M., Blimkie, C. J., Daniels, S. R., Dishman, R. K., Gutin, B., Hergenroeder, A. C., Must, A., Nixon, P. A., Pivarnik, J. M., Rowland, T., Trost, S. and Trudeau, F. (2005). Evidence based physical activity for school-age youth. *Journal of Pediatrics,* **146** (6), 732-737.

Sulemana, H., Smolensky, M.H. and Lai, D. (2006). Relationship between physical activity and body mass index in adolescents. *Medicine and Science in Sports and Exercise*, **38** (6), 1182-1186.

Tabachnick, B. G. and Fidell, L. S. (1996). *Using Multivariate Statistics.* New York: Harper Collins.

Tammelin, T. (2005). A review of longitudinal studies on youth predictors of adulthood physical activity. *International Journal of Adolescent Medicine and Health*, **17** (1), 3-12.

Tammelin, T., Nayha, S., Hills, A. P. and Jarvelin, M. R. (2003). Adolescent participation in sports and adult physical activity. *American Journal of Preventive Medicine,* **24** (1), 22-28.

Tammelin, T., Ekelund, U., Remes, J. and Näyhä, S. (2007). Physical activity and sedentary behaviors among Finnish youth. *Medicine and Science in Sports and Exercise,* **39** (7), 1067-1074.

Taylor, H. L., Klepetar, E., Keys, A, Parlin, W., Blackburn, H. and Puchner, T. (1962). Death rates among physically active and sedentary employees of the railroad industry. *American Journal of Public Health,* **52**, 1697-1707.

Telama, R., Yang, X., Laakso, L. and Viikari, J. (1997). Physical activity in childhood and adolescence as a predictor of physical activity in young adulthood. *American Journal of Preventive Medicine,* **13** (4), 317-323.

Telama, R. and Yang, X. (2000). Decline of physical activity from youth to young adulthood in Finland. *Medicine and Science in Sports and Exercise,* **32** (9), 1617-1622.

Telama, R., Yang, X., Viikari, J., Valimaki, I., Wanne, O. and Raitakari, O. (2005). Physical activity from childhood to adulthood: a 21-year tracking study. *American Journal of Preventive Medicine,* **28** (3), 267-273.

Telford, A., Salmon, J., Jolley, D. and Crawford, D. (2004). Reliability and validity of physical activity questionnaires for children: the Childen's Leisure Activities Study Survey (CLASS). *Pediatric Exercise Science,* **16** (1), 64-78.

Tenorio, M.C.M., de Barros, M.V.G., Tassitano, R.M., Bezzera, J., Tenorio, J.M. and Hallal, P.C. (2010). Physical activity and sedentary behavior among adolescent high school students. *Revista Brasileira de Epidemiologia*, **13** (1), 105-117.

The Countryside Agency, Department for Environment, Food and Rural Affairs, Office of the Deputy Prime Minister, Office for National Statistics and Welsh Assembly Government (2004). *Rural and Urban Area Classification 2004: An Introductory Guide.* London: The Countryside Agency, Department for Environment, Food and Rural Affairs, Office of the Deputy Prime Minister, Office for National Statistics and Welsh Assembly Government.

The National Cholesterol Education Program Exprt Panel (2001). Executive Summary of the Third Report of The National Cholesterol Education Program Expert Panel on Detection, Evaluation, and Treatment of High Blood Cholesterol in Adults (Adult Treatment Panel III). *Journal of the American Medical Association*, **285** (19), 2486-2497.

The NHS Information Centre (2010). *Statistics on Obesity, Physical Activity and Diet: England, 2010.* London: The NHS Information Centre, Lifestyle Statistics.

The Sedentary Behaviour and Obesity Expert Working Group (2010a). *Working Paper - Sedentary Behaviour and Obesity: Review of the Current Scientific Evidence*. London: Department of Health and Department for Children, Schools and Families.

The Sedentary Behaviour and Obesity Expert Working Group (2010b). *Sedentary Behaviour and Obesity: Review of the Current Scientific Evidence*. London: Department of Health and Department for Children, Schools and Families.

The Sports Council (1985). *Active Lifestyles: Coventry City Council – Interim Report on the Results of the Pupils' Leisure Survey*. London: Sports Council.

The Sports Council (1991). *Active Life Styles. Post-school Sports Participation: A Case Study in Coventry - Participation Demonstration Projects.* London: The Sports Council Research Unit (NW).

Thibault, H., Contrand, B., Saubusse, E., Baine, M. and Maurice-Tison, S. (2010). Risk factors for overweight and obesity in French adolescents: physical activity, sedentary behavior and parental characteristics. *Nutrition,* **26** (2), 192-200.

Thompson, A. M., Baxter-Jones, A. D., Murwald, R. L. and Bailey, D. A. (2003). Comparison of physical activity in male and female children: does maturation matter? *Medicine and Science in Sports and Exercise,* **35** (10), 1684-1690.

Tittlbach, S.A., Sygusch, R., Brehm, W., Woll, A., Lampert, T., Abele, A.E. and Bos, K. (2011). Association between physical activity and health in German adolescents. *European Journal of Sport Science,* **11** (4), 283-291.

Tomson, L. M., Pangrazi, R. P., Friedman, G. and Hutchison, N. (2003). Childhood depressive symptoms, physical activity and health related fitness. *Journal of Sport and Exercise Psychology,* **25** (4), 419-439.

Toth, M. J. and Poehlman, E. T. (1995). Resting metabolic rate and cardiovasculsr disease risk in resistence and aerobic trained middle aged women. *International Journal of Obesity Related Metabolic Disorders,* **19** (10), 691-698.

Townsend, P., Phillimore, P. and Beattie, A. (1988). *Health and Deprivation: Inequality and the North.* Bristol: Croom Helm.

Tremblay, M.S., Colley, R.C., Saunders, T.J., Healy, G.N. and Owen, N. (2010). Physiological and health implications of a sedentary lifestyle. *Applied Physiology, Nutition and Metabolism,* **35** (6), 725-740.

Tremblay, M.S., LeBlanc, A.G., Janssen, A., Kho, M.E., Hicks, A., Murumets, K., Colley, R.C. and Duggan, M. (2011). Canadian sedentary behaviour guidelines for children and youth. *Applied Physiology, Nutrition and Metabolism,* **36** (1), 59-64.

Trost, S.G. (2007). State of the art reviews: measurement of physical activity in children and adolescents. *American Journal of Lifestyle Medicine,* **1**, 299.

Trost, S. G., Ward, D. S., Moorehead, S. M., Watson, P. D., Riner, W. and Burke, J. R. (1998). Validity of the computer science and applications (CSA) activity monitor in children. *Medicine and Science in Sports and Exercise,* **30** (4), 629-633.

Trost, S. G., Pate, R. R., Freedson, P. S., Sallis, J. F. and Taylor, W. C. (2000). Using objective physical activity measures with youth: how many days of monitoring are needed? *Medicine and Science in Sports and Exercise,* **32** (2), 426-431.

Trost, S. G., Owen, N., Bauman, A. E., Sallis, J. F. and Brown, W. (2002a). Correlates of adults' participation in physical activity: review and update. *Medicine and Science in Sports and Exercise,* **34** (12), 1996-2001.

Trost, S. G., Pate, R. R., Sallis, J. F., Freedson, P. S., Taylor, W. C., Dowda, M. and Sirard, J. (2002b). Age and gender differences in objectively measured physical activity in youth. *Medicine and Science in Sports and Exercise,* **34** (2), 350-355.

Trost, S.G., Sallis, J.F., Pate, R.R., Freedson, P.S., Taylor, W.C. and Dowda, M. (2003). Evaluating a model of parental influence on youth physical activity. *American Journal of Preventive Medicine,* **25** (4), 277-282.

Tunstall, H.V.Z., Shaw, M. and Dorling, D. (2004). Places and health. *Journal of Epidemiology and Community Health,* 58 (1), 6-10.

Twisk, J. W., Kemper, H. C. and Van Mechelen, W. (2002a). Prediction of cardiovascular disease risk factors later in life by physical activity and physical fitness in youth: general comments and conclusions. *International Journal of Sports Medicine,* **23** (suppl. 1), S44-S49.

Twisk, J. W., Kemper, H. C. and Van Mechelen, W. (2002b). The relationship between physical fitness and physical activity during adolescence and cardiovascular disease risk factors at adult age. The Amsterdam Growth and Health Longitudinal Study. *International Journal of Sports Medicine,* **23** (suppl. 1), S8-S14.

Uijtdewilligen, L., Nauta, J., Singh, A.S., Van Mechelen, W., Twisk, J.W.R., Van der Horst, K. and Chinapaw, M.J.M. (2011). Determinants of physical activity and sedentary behaviour in young people: a review and quality synthesis of prospective studies. *British Journal of Sports Medicine,* **45** (11), 896-905.

Ullrich-French, S.C., Power, T.G., Daratha, K.B., Bindler, R.C. and Steele, M.M. (2010). Examination of adolescents' screen time and physical fitness as independent correlates of weight status and blood pressure. *Journal of Sports Sciences,* **28** (11), 1189-1196.

University of Gloucestershire (2006). *Guidelines for Involving Children and Young People in Research.* Cheltenham: University of Gloucestershire.

U.S. Centers for Disease Control and Prevention. (2008). Youth risk behavior surveillance: United States, 2007. *Morbidity and Mortality Weekly Report,* **57** ss-4, 1-36.

U.S. Department of Agriculture (2005). *Dietary Guidelines for Americans 2005 Chapter 4 [Department of Health and Human Services Report].* Washington, DC: U.S. Government Printing Office.

U.S. Department of Health and Human Services and U.S. Department of Agriculture (2005). *Dietary Guidelines for Americans (6th edn.).* Washington, DC: U.S. Government Printing Office.

U.S. Department of Health and Human Services (2000). *Healthy People 2010: understanding and improving health (2nd edn.).* Washuington, DC: U.S. Government Printing Office.

U.S. Department of Health and Human Services (2008). *2008 Physical Activity Guidelines for Americans.* Washington, DC: U.S. Department of Health and Human Services.

Ussher, M. H., Owen, C. G., Cook, D. G. and Whincup, P. H. (2007). The relationship between physical activity, sedentary behaviour and psychological wellbeing among adolescents. *Social Psychiatry and Pyschiatric Epidemiology,* **42** (10), 851-856.

Utter, J., Neumark-Sztainer, D., Jeffery, R. and Story, M. (2003). Couch potatoes or french fries: are sedentary behaviors associated with body mass index, physical activity, and dietary behaviors among adolescents? *Journal of the American Dietetic Association,* **103** (10), 1298-305.

Van der Horst, K., Paw, M. J. C. A., Twisk, J. W. R. and Van Mechelen, W. (2007). A brief review on correlates of physical activity and sedentariness in youth. *Medicine and Science in Sports and Exercise,* **39** (8), 1241-1250.

Van Mechelen, W., Twisk, J. W., Post, G. B., Snel, J. and Kemper, H. C. (2000). Physical activity of young people: the Amsterdam Longitudinal Growth and Health Study. *Medicine and Science in Sports and Exercise,* **32** (9), 1610-1616.

Van Sluijs, E.M.F., Page, A., Ommundsen, Y. and Griffin, S.J. (2010). Behavioural and social correlates of sedentary time in young people. *British Journal of Sports Medicine*, **44** (10), 747-755.

Vandewater, E.A., Bickham, D.S. and Lee, J.H. (2006). Time well spent? Relating television use to children's free time activities. *Pediatrics,* **117** (2), 181-191.

Vicente-Rodríguez, G., Rey-López, J. P., Martin-Matillas, M., Moreno, L. A., Wärnberg, J., Redondo, C., Tercedor, P., Delgado, M., Marcos, A., Castillo, M. and Bueno, M. (2008). Television watching, videogames, and excess of body fat in Spanish adolescents: the AVENA study. *Nutrition,* **24** (7-8), 654-662.

Vilhjalmsson, R. and Thorlindsson, T. (1998). Factors related to physical activity: a study of adolescents. *Social Science and Medicine,* **47** (5), 665-675.

Vilhjalmsson, R. and Kristjansdottir, G. (2003). Gender differences in physical activity in older children and adolescents: the central role of oragnized sport. *Social Science and Medicine,* **56** (2), 363-374.

Viner, R. M. and Cole, T. J. (2005) .Television viewing in early childhood predicts adult body mass index. *Journal of Pediatrics,* **147** (4), 429-435.

Viner, R. M., Haines, M. M., Head, J. A., Bhui, K., Taylor, S. J. C., Stansfeld, S. A., Hillier, S. and Booy, R. (2006). Variations in associations of health risk behaviors among ethnic minority early adolescents. *Journal of Adolescent Health,* **38** (1), 55.

Wade, E. (1987). *'Bridging the Gap' Research Working Paper 22 - A Scheme to Stop School Leavers Dropping Out of Sport.* London: Sports Council.

Wang, Y. and Lobstein, T. (2006). Worldwide trends in childhood overweight and obesity. *International Journal of Pediatric Obesity*, **1** (1), 11-25.

Ward, D.S., Evenson, K.R., Vaughn, A., Rodgers, A.B. and Troiano, R.P. (2005). Accelerometer use in physical activity: best practices and research recommendations. *Medicine and Science in Sports and Exercise*, **37** (11 suppl.), S582-S588.

Wardle, J., Robb, K., Johnson, F. (2002). Assessing socioeconomic status in adolescents: The validity of a home affluence scale. *Journal of Epidemiology and Community Health,* **56** (8), 595-599.

Wareham, N. J., Van Sluijs, E. M. and Ekelund, U. (2005). Physical activity and obesity prevention: a review of the current evidence. *Proceedings of the Nutrition Society,* **64** (2), 229-47.

Warnecke, R. B., Johnson, T. P., Chavez, N., Sudman, S., O'Rourke, D. P., Lacey, L. and Horm, J. (1997). Improving question wording in surveys of culturally diverse populations. *Annals of Epidemiology,* **7** (5), 334-342.

Weiss, R., Dziura, J., Burgert, T.S., Tamborlane, W.V., Taksali, S.E., Yeckel, C.W., Allen, K., Lopes, M., Savoye, M., Morrison, J., Sherwin, R.S. and Caprio, S. (2004). Obesity and the metabolic syndrome in children and adolescents. *New England Journal of Medicine,* **350** (23), 2362-2374.

Welk, G. J. (2002). *Physical Activity Assessments for Health-related Research.* Leeds: Human Kinetics.

Welk, G. J., Corbin, C. B. and Dale, D. (2000). Measurement issues in the assessment of physical activity in children. *Research Quarterly for Exercise and Sport,* **71** (2 suppl.), S59-S73.

Wells, J.C., Hallal, P.C., Reichert, F.F., Menezes, A.M., Araujo, C.L. and Victora, C.G. (2008). Sleep patterns and television viewing in relation to obesity and blood pressure: evidence from an adolescent Brazilian cohort. *International Journal of Obesity*, **32** (7), 1042-1049.

Welsh Assembly Government (2006). *Climbing Higher: Creating an Active Wales: A 5 year strategic action plan.* Cardiff: Welsh Assembly Government.

Whitaker, R. C., Wright, J. A., Pepe, M. S., Seidel, K. D. and Dietz, W. H. (1997). Predicting obesity in young adulthood from childhood and parental obesity. *New England Journal of Medicine,* **337** (13), 869-873.

Willoughby, T. (2008). A short-term longitudinal study of internet and computer game use by adolescent boys and girls: prevalence, frequency of use, and psychosocial predictors. *Developmental Psychology*, **44** (1), 195-204.

Wilson, P. W. F., D'Agostino, R. B., Parise, H., Sullivan, L. and Meigs, J. B. (2005) .Metabolic syndrome as a precursor of cardiovascular disease and type 2 diabetes. *Circulation,* **112** (20), 3066-3072.

Yates, T., Wilmot, E.G., Khunti, K., Biddle, S., Gorely, T. and Davies, M. (2011). Stand up for your health: is it time to rethink the physical activity paradigm?. *Diabetes Research and Clinical Practice*, **93** (2), 292-294.

Zick, C. D., Smith, K. R., Brown, B. B., Fan, J. X. and Kowaleski-Jones, L. (2007). Physical activity during the transition from adolescence to adulthood. *Journal of Physical Activity and Health,* **4** (2), 125-137.

Zimmermann-Sloutskis, D., Wanner, M., Zimmermann, E. and Martin, B.W. (2010). Physical activity levels and determinants of change in young adults: a longitudinal panel study. *International Journal of Behavioral Nutrition and Physical Activity*, **7**, 2.

Appendix 1: Invitation letter to state/mainstream schools and reply slip

UNIVERSITY OF GLOUCESTERSHIRE
at Cheltenham and Gloucester

Address of school

University of Gloucestershire
Faculty of Sport, Health and Social Care
Oxstalls Campus
Oxstalls Lane
Gloucester
GL2 9HW
Mobile: [redacted]
Email: [redacted]

Monday 11th February 2008

Dear

I am a PhD research student in the Faculty of Sport, Health and Social Care at the University of Gloucestershire. I am contacting you in relation to a study I am undertaking into sport and physical activity participation and sedentarism among Year 11 pupils in Gloucestershire. This study will involve tracking a large cohort of Year 11 pupils during the important transition from completing compulsory education and entering tertiary studies, employment or unemployment. This will be at two time points over a 12 month period.

I have been working with Gloucestershire County Council and Active Gloucestershire (the County Sports Partnership) who are supporting the study. I understand that your school is currently participating in the pupil online survey with Year 10 pupils. However, the study I am conducting will involve Year 11 pupils completing a simple three page questionnaire. The questionnaire will only take about 10 minutes to complete and the intention is for it to be completed as part of a Year 11 assembly or in PSHE or citizenship lessons. I could come into the school and administer the questionnaire or if more convenient for the school, the questionnaire could be administered by teachers who could then send the batch of questionnaires in the internal mail, free of charge to the following recipient and address:

[redacted], Sport and Physical Activity Co-ordinator, Room 132, The Bridge, Shire Hall, Westgate Street, Gloucester, Gloucestershire, GL1 2TR.

An instruction sheet will be provided for teachers if they are administering the questionnaire and a copy of this is enclosed. I have a range of dates available when I could come into the school to administer the questionnaire and these are also enclosed with this letter.

As all Year 11 pupils will be under 18 at the time of completing the questionnaire and because of some confidential information that is required (name, home address and postcode), I have enclosed a letter that each Year 11 pupil will need to give to their parent(s)/guardian(s). For your information, the name, home address and postcode of each pupil will be completed separately from the questionnaire on a name and home address form to ensure anonymity and confidentiality. The purpose of the name and home address form is to ensure that all Year 11 pupils who do not remain in education that complete the questionnaire at the first time point, have the opportunity to complete it again at the second time point between September and December 2008 when they will be contacted via the post. Please note that pupils remaining in further education will be able to complete the questionnaire again within the sixth form at school or college. Ethical approval for this study has been granted by the University of Gloucestershire's Research Ethics Sub-Committee and criminal records bureau clearance has been obtained for the researcher.

I have enclosed a copy of the questionnaire, the information sheet for pupils and the name and home address form for your information. If you are interested in taking part, please could you return the enclosed reply slip to me by **Wednesday 27th February 2008** in the FREEPOST envelope provided. I will then contact you to arrange a convenient date when I could administer the questionnaire or make arrangements for sending out the batch of questionnaires, pupil information sheets, teacher instruction sheets and name and address forms to the school. It is anticipated that the questionnaires will be administered by **Friday 9th May 2008** at the latest.

Please do not hesitate to contact me if you have any questions.

Yours sincerely

Christopher Owens BSc (Hons) MSc
PhD Research Student
University of Gloucestershire

Reply slip

Name of school ....

Contact name of person to deal with ....

Phone number ....

Fax number ....

Email address ....

Would a Year 11 assembly or PSHE or citizenship lessons be more convenient? ....
....

Would it be more convenient for you for me to administer the questionnaire or for teachers to administer the questionnaire? ....

Convenient date(s) and time(s) for the school when I could administer the questionnaire........
....
....
....
....
....
....
....
....

Appendix 2: Invitation letter to private/independent schools and reply slip

Address of school

University of Gloucestershire
Faculty of Sport, Health and Social Care
Oxstalls Campus
Oxstalls Lane
Gloucester
GL2 9HW
Mobile: [redacted]
Email: [redacted]

Monday 11th February 2008

Dear

I am a PhD research student in the Faculty of Sport, Health and Social Care at the University of Gloucestershire. I am contacting you in relation to a study I am undertaking into sport and physical activity participation and sedentarism among Year 11 pupils in Gloucestershire. This study will involve tracking a large cohort of Year 11 pupils during the important transition from completing compulsory education and entering tertiary studies, employment or unemployment. This will be at two time points over a 12 month period.

I have been working with Gloucestershire County Council and Active Gloucestershire (the County Sports Partnership) who are supporting the study. The study I am conducting will involve Year 11 pupils completing a simple three page questionnaire. The questionnaire will only take about 10 minutes to complete and the intention is for it to be completed as part of a Year 11 assembly or in PSHE or citizenship lessons. I could come into the school and administer the questionnaire or if more convenient for the school, the questionnaire could be administered by teachers who could then send the batch of questionnaires in a FREEPOST envelope provided by the University of Gloucestershire. An instruction sheet will be provided for teachers to follow when administering the questionnaire and a copy of this is enclosed.

I have a range of dates available when I could come into the school to administer the questionnaire and these are enclosed with this letter.

As all Year 11 pupils will be under 18 at the time of completing the questionnaire and because of some confidential information that is required (name, home address and postcode), I have enclosed a letter that each Year 11 pupil will need to give to their parent(s)/guardian(s). For your information, the name, home address and postcode of each pupil will be completed separately from the questionnaire on a name and home address form to ensure anonymity and confidentiality. The purpose of the name and home address form is to ensure that all Year 11 pupils who do not remain in education that complete the questionnaire at the first time point, have the opportunity to complete it again at the second time point between September and December 2008 when they will be contacted via the post. Please note that pupils remaining in further education will be able to complete the questionnaire again within the sixth form at school or college. Ethical approval for this study has been granted by the University of Gloucestershire's Research Ethics Sub-Committee and criminal records bureau clearance has been obtained for the researcher.

I have enclosed a copy of the questionnaire, the information sheet for pupils and the name and home address form for your information. If you are interested in taking part, please could you return the enclosed reply slip to me by **Wednesday 27th February 2008** in the FREEPOST envelope provided. I will then contact you to arrange a convenient date when I could administer the questionnaire or make arrangements for sending out the batch of questionnaires, pupil information sheets, teacher instruction sheets and name and address forms to the school. It is anticipated that the questionnaires would be administered by **Friday 9th May 2008** at the latest.

Please do not hesitate to contact me if you have any questions.

Yours sincerely

Christopher Owens BSc (Hons) MSc
PhD Research Student
University of Gloucestershire

Reply slip

Name of school ....

Contact name of person to deal with ....

Phone number..

Fax number..

Email address..

Would a Year 11 assembly or PSHE or citizenship lessons be more convenient? ....
....

Would it be more convenient for you for me to administer the questionnaire or for teachers to administer the questionnaire?..

Convenient date(s) and time(s) for the school when I could administer the questionnaire......
....
....
....
....
....
....
....

Appendix 3: Pilot questionnaire at first school

UNIVERSITY OF GLOUCESTERSHIRE
at Cheltenham and Gloucester

Sport and Physical Activity Participation and Sedentarism
Questionnaire for Adolescents

Date.................................

School name..

College name/Workplace name ***(only answer if you have finished school)***.........
....
....

Home postcode...

1. Age (Please tick one option) **( ) 15** **( ) 16** **( ) 17**

2. Gender (Please circle) **Male/Female**

3. Do you have a disability? (Please circle) **Yes/No**

4. Do you have a medical condition? (Please circle) **Yes/No**

5. What is your ethnic origin? (Please circle one option below)

   White **Mixed** **Asian or Asian British**

   Black or Black British **Chinese or Other Ethnic Group**

6. Did you achieve 5 or more A* to C passes in your GCSEs? ***(only answer if you have finished Year 11)*** (Please circle)

   Yes/No

7. How many of the past 14 days have you done **at least 60 minutes (in a number of bouts or in total)** of sport or physical activity, which has made you breathe faster, your heart beat faster, made you feel warmer but did not make you feel exhausted or tired? (Sport or physical activity includes, for example, walking to and from school/college/work, organised sports and games (including time in physical education class), exercise classes, fast cycling, jogging and recreational activities such as dancing) (Please tick one option)

( ) None ( ) 1 to 2 days ( ) 3 to 5 days

( ) 6 to 8 days ( ) 9 to 11 days ( ) 12 to 14 days

8. Of these past 14 days when you have done **at least 60 minutes (in a number of bouts or in total),** how many times did you take part in **team or individual sports**? (Please tick one option)

( ) None ( ) 1 to 2 times ( ) 3 to 5 times

( ) 6 to 8 times ( ) 9 to 11 times ( ) 12 to 14 times

9. Of these past 14 days when you have done **at least 60 minutes (in a number of bouts or in total),** how many times did you take part in **physical activity on a social or fitness improving level**? (Please tick one option)

( ) None ( ) 1 to 2 times ( ) 3 to 5 times

( ) 6 to 8 times ( ) 9 to 11 times ( ) 12 to 14 times

10. During a normal week, how many **hours a day** do you watch television and DVDs, play computer or video games, or use a computer (for example, to go on the internet) before or after school/college/work? (Please tick one option)

( ) None ( ) 1 hour or less ( ) 2 to 3 hours

( ) 4 to 5 hours ( ) 6 or more hours

11. On a daily basis, how do you **normally** travel to and from school/college/work? (Please tick all that apply)

( ) Bus ( ) Train ( ) Car ( ) Bike

( ) Walk ( ) Other

12. On an average week, **how many sessions of 30 minutes** of sport and active recreation do you take part in? (Please tick one option)

( ) None ( ) One ( ) Two ( ) Three

( ) Four ( ) Five ( ) Six ( ) Seven

( ) More than 7 sessions

13. Is this sport and active recreation generally of a **high intensity**, **moderate intensity** or **low intensity**? (Please tick one option)

( ) High intensity (Hard and feel tired)

( ) Moderate intensity (Quite hard but don't feel tired and exhausted)

( ) Low intensity (Quite easy and not out of breath)

( ) Not applicable

Thank you for your time and help completing this questionnaire

Appendix 4: Pilot questionnaire at second school

ACTIVE GLOUCESTERSHIRE

Gloucestershire COUNTY COUNCIL

UNIVERSITY OF GLOUCESTERSHIRE
at Cheltenham and Gloucester

Sport and Physical Activity Participation and Sedentarism Questionnaire for Adolescents

Date..................................

School name..

College name/Workplace name ***(only answer if you have finished school)***............
....
....

Home Postcode...................................

1. Age (Please tick one option)   ( ) 15   ( ) 16   ( ) 17

2. Gender (Please circle)   Male/Female

3. Do you have an illness or disability which stops you playing sport or being physically active? (Please tick one option)

   ( ) Yes   ( ) No   ( ) Don't know

4. What is your ethnic origin? (Please tick one option below)

White
( ) British
( ) Irish
( ) Other

Mixed
( ) White and Black Caribbean
( ) White and Black African
( ) White and Asian
( ) Other Mixed

Asian or Asian British
( ) Indian
( ) Pakistani
( ) Bangladeshi
( ) Other Asian

Black or Black British
( ) Black Caribbean
( ) Black African
( ) Other Black

Chinese
( ) Chinese

Other Ethnic Group
( ) Other Ethnic Group
Please specify..............

5. Did you achieve 5 or more A* to C passes in your GCSEs? ***(only answer if you have finished Year 11)*** (Please circle)

Yes/No

6. On how many of the past 7 days have you done **at least 60 minutes (in a number of bouts or in total)** of sport or physical activity, which has made you slightly out of breath, made your heart beat faster, made you feel warmer **but did not necessarily** make you feel exhausted or tired? (Sport or physical activity includes, for example, walking to and from school/college/work, organised sports and games (including time in PE class), a newspaper delivery round, exercise classes, and recreational activities such as dancing) (Please tick one option)

( ) None ( ) 1 to 2 days ( ) 3 to 4 days ( ) 5 to 6 days

( ) 7 days

7. Of these past 7 days when you have done **at least 60 minutes (in a number of bouts or in total)**, how many times did you take part in **organised team or individual sports**? (Please tick one option)

( ) None ( ) 1 to 2 times ( ) 3 to 4 times ( ) 5 to 6 times

( ) 7 or more times

8. Of these past 7 days when you have done **at least 60 minutes (in a number of bouts or in total),** how many times did you take part in **physical activity that was not an organised team or individual sport**? (Please tick one option)

( ) None ( ) 1 to 2 times ( ) 3 to 4 times ( ) 5 to 6 times

( ) 7 or more times

9. Who did you **take part** in this/these sport(s) or physical activity(ies) with? (Please tick all that apply)

( ) One or both of my parents ( ) My sister(s) and/or brother(s)

( ) My classmate(s)/workmate(s) ( ) My teammate(s)/clubmate(s)

( ) My friend(s) ( ) My boy/girlfriend ( ) Nobody ( ) Not applicable

( ) Other Please specify…………………..

10. How many **hours a day** do you watch television and DVDs, play computer or video games, or use a computer **before or after** school/college/work **(you can also include lunchtime and break times at school/college/work)**? (Please tick one option)

( ) None ( ) 1 hour or less ( ) 2 to 3 hours ( ) 4 to 5 hours

( ) 6 or more hours

11. How many **hours a day** do you watch television and DVDs, play computer or video games, or use a computer **at the weekend**? (Please tick one option)

( ) None ( ) 1hour or less ( ) 2 to 3 hours ( ) 4 to 5 hours

( ) 6 or more hours

12. On a daily basis, how do you **normally** travel to and from school/college/ work? (Please tick all that apply)

( ) Bus ( ) Train ( ) Car ( ) Bike

( ) Walk ( ) Other Please specify...

13. During an average week, **how many sessions of 30 minutes (in a number of bouts or in total)** of sport and active recreation do you take part in? (Please tick one option)

( ) None ( ) 1 to 2 sessions ( ) 3 to 4 sessions ( ) 5 to 6 sessions

( ) 7 or more sessions

14. Is this sport and active recreation generally of a **vigorous intensity**, **moderate intensity** or **light intensity**? (Please tick one option)

( ) Vigorous intensity (Out of breath and sweating)

( ) Moderate intensity (Slightly out of breath and feel warm)

( ) Light intensity (Not out of breath and not sweating)

( ) Not applicable

Thank you for your time and help completing this questionnaire

Appendix 5: Information sheet (pilot one and pilot two)

ACTIVE GLOUCESTERSHIRE

UNIVERSITY OF GLOUCESTERSHIRE
at Cheltenham and Gloucester

Gloucestershire COUNTY COUNCIL

Information Sheet

Dear Pupil

Please take a few minutes to read through the information sheet.

First of all, please can you fill out the name and address form so that I can send you the questionnaire again between September and December 2008. Please make sure your contact details are correct. After you have done this, please could you fill out the questionnaire. The questionnaire is about the amount of sport and physical activity that you do in and out of school. There are also some general questions to answer.

The name and address form and questionnaire will only take you about 10 minutes to do and you need to hand it back to your teacher when you have completed it.

Thank you for your help and for completing it.

Christopher Owens
University of Gloucestershire

Appendix 6: Name and address form for pilot stage one and two

ACTIVE GLOUCESTERSHIRE

UNIVERSITY OF GLOUCESTERSHIRE at Cheltenham and Gloucester

Gloucestershire COUNTY COUNCIL

Name and Home Address Form

Name……………………………………………………………………………………

Home Address……………………………………………………………………………

……………………………………………………………………………………………

……………………………………………………………………………………………

……………………………………………………………………………………………

……………………………………………………………………………………………

……………………………………………………………………………………………

……………………………………………………………………………………………

……………………………………………………………………………………………

Postcode………………………………

Appendix 7: Teacher instruction sheet at baseline

ACTIVE GLOUCESTERSHIRE

Gloucestershire COUNTY COUNCIL

UNIVERSITY OF GLOUCESTERSHIRE at Cheltenham and Gloucester

Sport and Physical Activity Questionnaire
Instructions for Teachers

- Please distribute the questionnaire to the pupils.

- Please then read out the following instructions to pupils:

- First of all, please could you all read the information sheet (page 1).

- Could you all then fill out the name and home address form (page 2).

- Once you have done this, please can you all start to fill out the questionnaire (pages 3, 4 & 5).

IMPORTANT!

Please then use the following *explanatory* notes (for certain sections/questions) in order to *guide* all the pupils through the questionnaire:

School/College Sixth Form name/Workplace name section
Explain to the pupils that they do not need to answer this section as they have not left school.

Question 5
Explain to the pupils that they do not need to answer this question as they have not finished their GCSEs.

Question 6
Explain to the pupils that a **"bout"** means a "chunk" or "period" of sport or physical activity **adding** up to 60 minutes. The "chunk" or "period" must always be at least 10 minutes. **Please use the examples of sport and physical activity given on the questionnaire if pupils are having difficulty in understanding the question.**

Question 7
Explain to the pupils that **"organised team or individual sports"** refers to specific activities practised through exercise and/or competitive sports run by sports organisations, sports clubs etc. They also include school club teams, out-of-school programmes etc.

Question 8
Explain to the pupils that **"physical activity that was not an organised team or individual sport"** refers to all physical activity that is not organised and/or competitive sport. For example, walking to and from school, a newspaper delivery round, cycling, swimming, jogging and dancing etc.

Question 10
Please emphasise to the pupils that they should include the amount they use a computer etc at lunchtime and in their break times.

Question 13a
Explain to the pupils that a **"bout"** means a "chunk" or "period" of sport or active recreation **adding** up to 30 minutes. The "chunk" or "period" must always be at least 10 minutes.

Explain that **"sport and active recreation"** includes all sport activities, and walking, cycling and swimming etc for recreational purposes.

Question 13b
Explain to the pupils that this question should be answered in relation to the previous question (Question 13a).

- Finally, please collect all the questionnaires together and send them in the **INTERNAL** mail, free of charge, to the following recipient and address:

[redacted], Sport and Physical Activity Co-ordinator, Room 132, The Bridge, Shire Hall, Westgate Street, Gloucester, Gloucestershire, GL1 2TR.

Thank you for assisting the pupils with the completion of the questionnaire

(Please note that pupils are under no obligation to fill out the name and home address form and questionnaire)

Kind regards

Christopher Owens
PhD Research Student
University of Gloucestershire

Appendix 8: Questionnaire at baseline

ACTIVE GLOUCESTERSHIRE

Gloucestershire COUNTY COUNCIL

UNIVERSITY OF GLOUCESTERSHIRE at Cheltenham and Gloucester

Sport and Physical Activity Questionnaire

Date..................................

School name/College name ***(only answer if you are in Year 11)***.........................
....

School/College Sixth Form name/Workplace name ***(only answer if you have finished Year 11)***..
....

Home Postcode..................................

1. Age (Please tick one option) ( ) 15 ( ) 16 ( ) 17

2. Gender (Please circle) Male/Female

3. Do you have an illness or disability which stops you playing sport or being physically active? (Please tick one option)

   ( ) Yes ( ) No ( ) Don't know

4. What is your ethnic origin? (Please tick one option below)

   White
   ( ) British
   ( ) Irish
   ( ) Other

   Mixed
   ( ) White and Black Caribbean
   ( ) White and Black African
   ( ) White and Asian
   ( ) Other Mixed

   Asian or Asian British
   ( ) Indian
   ( ) Pakistani
   ( ) Bangladeshi
   ( ) Other Asian

   Black or Black British
   ( ) Black Caribbean
   ( ) Black African
   ( ) Other Black

   Chinese
   ( ) Chinese

   Other Ethnic Group
   ( ) Other Ethnic Group
   Please specify...................

5. Did you achieve 5 or more A* to C passes in your GCSEs? ***(only answer if you have finished Year 11)*** (Please circle)

Yes/No

6. On how many of the past 7 days have you done **at least 60 minutes (in a number of bouts or in total)** of sport or physical activity, which has made you slightly out of breath, made your heart beat faster, made you feel warmer **but did not necessarily** make you feel exhausted or tired? (Sport or physical activity includes, for example, walking to and from school/college/work, organised sports and games [including time in PE class], a newspaper delivery round, exercise classes, and recreational activities such as dancing, which can also be included in this) (Please tick one option)

( ) None ( ) 1 to 2 days ( ) 3 to 4 days ( ) 5 to 6 days

( ) 7 days

7. Of these past 7 days when you have done **at least 60 minutes (in a number of bouts or in total)**, how many times did you take part in **organised team or individual sports**? (Please tick one option)

( ) None ( ) 1 to 2 times ( ) 3 to 4 times ( ) 5 to 6 times

( ) 7 or more times

8. Of these past 7 days when you have done **at least 60 minutes (in a number of bouts or in total),** how many times did you take part in **physical activity that was not an organised team or individual sport**? (Please tick one option)

( ) None ( ) 1 to 2 times ( ) 3 to 4 times ( ) 5 to 6 times

( ) 7 or more times

9. Who did you **take part** in this/these sport(s) or physical activity(ies) with? (Please tick all that apply)

( ) One or both of my parent(s)/guardian(s) ( ) My sister(s) and/or brother(s)

( ) My classmate(s)/workmate(s) ( ) My teammate(s)/clubmate(s)

( ) My friend(s) ( ) My boy/girlfriend

( ) Nobody ( ) Not applicable

( ) Other Please specify....................

10. How many **hours a day** do you watch television and DVDs, play computer or video games, or use a computer **before or after** school/college/work **(you can also include lunchtime and break times at school/college/work)**? (Please tick one option)

( ) None ( ) 1 hour or less ( ) 2 to 3 hours ( ) 4 to 5 hours

( ) 6 or more hours

11. How many **hours a day** do you watch television and DVDs, play computer or video games, or use a computer **at the weekend**? (Please tick one option)

( ) None ( ) 1hour or less ( ) 2 to 3 hours ( ) 4 to 5 hours

( ) 6 or more hours

12. On a daily basis, how do you **normally** travel to and from school/college/ work? (Please tick all that apply)

( ) Bus ( ) Train ( ) Car ( ) Bike

( ) Walk ( ) Other Please specify...

13a. During an average week, **how many sessions of 30 minutes (in a number of bouts or in total)** of sport and active recreation do you take part in? (Please tick one option)

( ) None ( ) 1 to 2 sessions ( ) 3 to 4 sessions ( ) 5 to 6 sessions

( ) 7 or more sessions

13b. Is this sport and active recreation generally of a **vigorous intensity**, **moderate intensity** or **light intensity**? (Please tick one option)

( ) Vigorous intensity (Out of breath and sweating)

( ) Moderate intensity (Slightly out of breath and feel warm)

( ) Light intensity (Not out of breath and not sweating)

( ) Not applicable

Thank you for your time and help completing this questionnaire

Appendix 9: Information sheet at baseline

ACTIVE GLOUCESTERSHIRE

Gloucestershire COUNTY COUNCIL

UNIVERSITY OF GLOUCESTERSHIRE at Cheltenham and Gloucester

Information Sheet

Dear Pupil

I am seeking your help with a research project looking at the amount of sport and physical activity that you do inside and outside of school. Please take a few moments to read through this information sheet before deciding whether to fill out the questionnaire.

When you have read through this information sheet, please can you fill out the name and home address form so that I can send you the questionnaire again between September and December 2008. Please make sure your contact details are correct. After you have done this, please could you fill out the questionnaire. Please be aware that you are under no obligation to fill out the name and home address form and questionnaire.

I would appreciate it if you could take the time to complete the name and home address form and questionnaire. Together they will only take you about 10 minutes to do and you need to return the completed sheets to your teacher or myself when they are finished. If you are happy to take part, please fill out the attached name and home address form and questionnaire.

Thank you for your help and for completing it.

Christopher S. Owens
PhD Research Student
University of Gloucestershire

Appendix 10: Name and address form at baseline and follow-up (stage one and two)

ACTIVE GLOUCESTERSHIRE

Gloucestershire COUNTY COUNCIL

UNIVERSITY OF GLOUCESTERSHIRE at Cheltenham and Gloucester

Name and Home Address Form

Name……………………………………………………………………………

Home Address…………………………………………………………………
……………………………………………………………………………………
……………………………………………………………………………………
……………………………………………………………………………………
……………………………………………………………………………………
……………………………………………………………………………………
……………………………………………………………………………………
……………………………………………………………………………………

Home Postcode………………………………

Appendix 11: Letter for missing responses at baseline

University of Gloucestershire
Faculty of Sport, Health and Social Care
Oxstalls Campus
Oxstalls Lane
Gloucester
GL2 9HW
Email: [redacted]

[date]

Dear [name of participant]

Thank you for filling out the questionnaire on sport and physical activity for my PhD study a few weeks ago at school. However, some questions have not been answered on the questionnaire. I have highlighted the questions you need to answer again in RED. Please can you tick the answer(s) missed out and send back to me in the FREEPOST envelope provided ASAP. Thank you very much.

Yours sincerely

Christopher Owens BSc (Hons) MSc
PhD Research Student
University of Gloucestershire

Appendix 12: Letter of thanks to schools who participated at baseline (no sixth form provision)

ACTIVE GLOUCESTERSHIRE

Gloucestershire COUNTY COUNCIL

UNIVERSITY OF GLOUCESTERSHIRE
at Cheltenham and Gloucester

[name of contact]
[address of school]

University of Gloucestershire
Faculty of Sport, Health and Social Care
Oxstalls Campus
Oxstalls Lane
Gloucester
GL2 9HW
Mobile: [redacted]
Email: [redacted]

[date]

Dear [name of contact]

I am writing to say thank you for allowing me to come into [name of school] recently to give out my questionnaire on sport and physical activity participation to Year 11 pupils. I have now collected all of my baseline data from Year 11s across Gloucestershire and will be busy inputting the data over the summer period.

Between September and December of this year, I will be attempting to follow up the same pupils that completed the questionnaire at baseline. The purpose of the follow up is to monitor any changes in activity levels during the important transition after completing compulsory education.

I really appreciate your co-operation and help. Please do not hesitate to contact me if you have any questions.

Yours sincerely

Christopher Owens BSc (Hons) MSc
PhD Research Student
University of Gloucestershire

Appendix 13: Letter of thanks to schools who participated at baseline (sixth form provision but no specific contact)

ACTIVE GLOUCESTERSHIRE

Gloucestershire COUNTY COUNCIL

UNIVERSITY OF GLOUCESTERSHIRE at Cheltenham and Gloucester

[contact at school]
[name of school]

University of Gloucestershire
Faculty of Sport, Health and Social Care
Oxstalls Campus
Oxstalls Lane
Gloucester
GL2 9HW
Mobile: [redacted]
Email: [redacted]

[date]

Dear [name of contact]

I am writing to say thank you for allowing me to come into [name of school] recently to give out my questionnaire on sport and physical activity participation to Year 11 pupils. I have now collected all of my baseline data from Year 11s across Gloucestershire and will be busy inputting the data over the summer period.

Between September and December of this year, I will be attempting to follow up the same pupils that completed the questionnaire at baseline. The purpose of the follow up is to monitor any changes in activity levels during the important transition after completing compulsory education.

I would really appreciate it if I could come back into [name of school] between September and December of this year when some of the pupils that completed the questionnaire are in sixth form. I could then give the same questionnaire out again, which will only take ten minutes to complete.

I will contact you by telephone or email in September to enquire about arranging a follow up visit to the school.

I really appreciate your co-operation and help. Please do not hesitate to contact me if you have any questions.

Yours sincerely

Christopher Owens BSc (Hons) MSc
PhD Research Student
University of Gloucestershire

Appendix 14: Letter of thanks to schools who participated at baseline (sixth form provision and contact)

ACTIVE GLOUCESTERSHIRE

Gloucestershire COUNTY COUNCIL

UNIVERSITY OF GLOUCESTERSHIRE
at Cheltenham and Gloucester

[contact at school]
[address of school]

University of Gloucestershire
Faculty of Sport, Health and Social Care
Oxstalls Campus
Oxstalls Lane
Gloucester
GL2 9HW
Mobile: [redacted]
Email: [redacted]

[date]

Dear [name of contact]

I am writing to say thank you for allowing me to come into [name of school] recently to give out my questionnaire on sport and physical activity participation to Year 11 pupils. I have now collected all of my baseline data from Year 11s across Gloucestershire and will be busy inputting the data over the summer period.

Between September and December of this year, I will be attempting to follow up the same pupils that completed the questionnaire at baseline. In relation to those pupils that will have continued into the sixth form at [name of school], I will contact [suggested contact name] as suggested in September to arrange a follow up visit to the school. I will mention that [contact who gave consent] agreed to this year's questionnaire and knew it was a 2-year study.

I really appreciate your co-operation and help. Please do not hesitate to contact me if you have any questions.

Yours sincerely

Christopher Owens BSc (Hons) MSc
PhD Research Student
University of Gloucestershire

Appendix 15: Teacher instruction sheet at follow-up (stage one)

ACTIVE GLOUCESTERSHIRE

Gloucestershire COUNTY COUNCIL

UNIVERSITY OF GLOUCESTERSHIRE
at Cheltenham and Gloucester

Sport and Physical Activity Questionnaire
Instructions for Teachers

- Please distribute the questionnaire to the pupils.
- Please then read out the following instructions to pupils:

- First of all, please could you all read the information sheet (page 1).

- Could you all then fill out the name and home address form (page 2).

- Once you have done this, please can you all start to fill out the questionnaire (pages 3, 4 & 5).

IMPORTANT!

Please then use the following *explanatory* notes (for certain sections/questions) in order to *guide* all the pupils through the questionnaire:

Question 6
Explain to the pupils that a **"bout"** means a "chunk" or "period" of sport or physical activity **adding** up to 60 minutes. The "chunk" or "period" must always be at least 10 minutes. **Please use the examples of sport and physical activity given on the questionnaire if pupils are having difficulty in understanding the question.**

Question 7
Explain to the pupils that **"organised team or individual sports"** refers to specific activities practised through exercise and/or

competitive sports run by sports organisations, sports clubs etc. They also include school club teams, out-of-school programmes etc.

Question 8
Explain to the pupils that **"physical activity that was not an organised team or individual sport"** refers to all physical activity that is not organised and/or competitive sport. For example, walking to and from school, a newspaper delivery round, cycling, swimming, jogging and dancing etc.

Question 10
Please emphasise to the pupils that they should include the amount they use a computer etc at lunchtime and in their break times.

Question 13a
Explain to the pupils that a **"bout"** means a "chunk" or "period" of sport or active recreation **adding** up to 30 minutes. The "chunk" or "period" must always be at least 10 minutes.

Explain that **"sport and active recreation"** includes all sport activities, and walking, cycling and swimming etc for recreational purposes.

Question 13b
Explain to the pupils that this question should be answered in relation to the previous question (Question 13a).

- Finally, please collect all the questionnaires together and return them to [contact person at school].

Thank you for assisting the pupils with the completion of the questionnaire

(Please note that pupils are under no obligation to fill out the name and home address form and questionnaire)

Kind regards

Christopher Owens
PhD Research Student
University of Gloucestershire

Appendix 16: Questionnaire at follow-up

ACTIVE GLOUCESTERSHIRE

Gloucestershire COUNTY COUNCIL

UNIVERSITY OF GLOUCESTERSHIRE at Cheltenham and Gloucester

Sport and Physical Activity Questionnaire

Date..................................

What are you doing now? (Please tick one option)

( ) Studying full-time in Sixth Form/College
( ) Working (including apprenticeship/trainee programme)
( ) Unemployed/not working or studying

Home Postcode..................................

1. Age (Please tick one option) ( ) 15 ( ) 16 ( ) 17 ( ) 18

2. Gender (Please circle) Male/Female

3. Do you have an illness or disability which stops you playing sport or being physically active? (Please tick one option)

( ) Yes ( ) No ( ) Don't know

4. What is your ethnic origin? (Please tick one option below)

White
( ) British
( ) Irish
( ) Other

Mixed
( ) White and Black Caribbean
( ) White and Black African
( ) White and Asian
( ) Other Mixed

Asian or Asian British
( ) Indian
( ) Pakistani
( ) Bangladeshi
( ) Other Asian

Black or Black British
( ) Black Caribbean
( ) Black African
( ) Other Black

Chinese
( ) Chinese

Other Ethnic Group
( ) Other Ethnic Group
Please specify.....................

5. Did you achieve 5 or more A* to C passes in your GCSEs? (Please circle)

Yes/No

6. On how many of the past 7 days have you done **at least 60 minutes (in a number of bouts or in total)** of sport or physical activity, which has made you slightly out of breath, made your heart beat faster, made you feel warmer **but did not necessarily** make you feel exhausted or tired? (Sport or physical activity includes, for example, walking to and from school/college/work, organised sports and games [including time in PE class], a newspaper delivery round, exercise classes, and recreational activities such as dancing, which can also be included in this) (Please tick one option)

( ) None ( ) 1 to 2 days ( ) 3 to 4 days ( ) 5 to 6 days

( ) 7 days

7. Of these past 7 days when you have done **at least 60 minutes (in a number of bouts or in total)**, how many times did you take part in **organised team or individual sports**? (Please tick one option)

( ) None ( ) 1 to 2 times ( ) 3 to 4 times ( ) 5 to 6 times

( ) 7 or more times

8. Of these past 7 days when you have done **at least 60 minutes (in a number of bouts or in total),** how many times did you take part in **physical activity that was not an organised team or individual sport**? (Please tick one option)

( ) None ( ) 1 to 2 times ( ) 3 to 4 times ( ) 5 to 6 times

( ) 7 or more times

9. Who did you **take part** in this/these sport(s) or physical activity(ies) with? (Please tick all that apply)

( ) One or both of my parent(s)/guardian(s) ( ) My sister(s) and/or brother(s)

( ) My classmate(s)/workmate(s) ( ) My teammate(s)/clubmate(s)

( ) My friend(s) ( ) My boy/girlfriend

( ) Nobody ( ) Not applicable

( ) Other Please specify………………..

10. How many **hours a day** do you watch television and DVDs, play computer or video games, or use a computer **before or after** school/college/work **(you can also include lunchtime and break times at school/college/work)**? (Please tick one option)

( ) None ( ) 1 hour or less ( ) 2 to 3 hours ( ) 4 to 5 hours

( ) 6 or more hours

11. How many **hours a day** do you watch television and DVDs, play computer or video games, or use a computer **at the weekend**? (Please tick one option)

( ) None ( ) 1hour or less ( ) 2 to 3 hours ( ) 4 to 5 hours

( ) 6 or more hours

12. On a daily basis, how do you **normally** travel to and from school/college/ work? (Please tick all that apply)

( ) Bus ( ) Train ( ) Car ( ) Bike

( ) Walk ( ) Other Please specify..

13a. During an average week, **how many sessions of 30 minutes (in a number of bouts or in total)** of sport and active recreation do you take part in? (Please tick one option)

( ) None ( ) 1 to 2 sessions ( ) 3 to 4 sessions ( ) 5 to 6 sessions

( ) 7 or more sessions

13b. Is this sport and active recreation generally of a **vigorous intensity**, **moderate intensity** or **light intensity**? (Please tick one option)

( ) Vigorous intensity (Out of breath and sweating)

( ) Moderate intensity (Slightly out of breath and feel warm)

( ) Light intensity (Not out of breath and not sweating)

( ) Not applicable

Thank you for your time and help completing this questionnaire

Appendix 17: Information sheet at follow-up (in school)

ACTIVE GLOUCESTERSHIRE

Gloucestershire COUNTY COUNCIL

UNIVERSITY OF GLOUCESTERSHIRE at Cheltenham and Gloucester

Information Sheet

Dear Pupil

I am a PhD research student in the Faculty of Sport, Health and Social Care at the University of Gloucestershire. I am contacting you in relation to a questionnaire that you completed earlier in the year at school. The questionnaire was interested in how much sport and physical activity you did inside and outside of school.

I am now attempting to contact everyone who completed the questionnaire before and would be very grateful if you could fill it out again. Please could you also fill out the name and home address form, making sure that your contact details are correct. Please make sure you answer each question. It will only take you about 10 minutes to do in total and you need to hand it back to your teacher or me when you have completed it. Please be aware that you are under no obligation to fill out the name and home address form and questionnaire.

All returned questionnaires will be entered into a free prize draw for the chance to **win £30 of Amazon vouchers**.

If you are happy to take part, please fill out the questionnaire.

Good luck!

Thank you for your help and for completing it.

Christopher Owens
PhD Research Student
University of Gloucestershire

Appendix 18: Letter for missing answers at follow-up (stage one and stage two)

ACTIVE GLOUCESTERSHIRE Gloucestershire COUNTY COUNCIL UNIVERSITY OF GLOUCESTERSHIRE at Cheltenham and Gloucester

University of Gloucestershire
Faculty of Sport, Health and Social Care
Oxstalls Campus
Oxstalls Lane
Gloucester
GL2 9HW
Email: [redacted]

[date]

Dear [name of participant]

Thank you for filling out the questionnaire again on sport and physical activity for my PhD. However, some questions have not been answered on the questionnaire. I have highlighted the questions you need to answer again in **RED**. Please can you tick/fill in the answer(s) missed out and send back to me in the **FREEPOST** envelope provided by [date for return]. Thank you very much.

(P.S. you don't need to pay for a stamp, it is free!)

Yours sincerely

Christopher Owens BSc (Hons) MSc
PhD Research Student
University of Gloucestershire

Appendix 19: Information sheet at follow-up (via post)

ACTIVE GLOUCESTERSHIRE

Gloucestershire COUNTY COUNCIL

UNIVERSITY OF GLOUCESTERSHIRE at Cheltenham and Gloucester

Dear [name of participant]

Thank you for completing my questionnaire earlier in the year at school. The questionnaire was interested in how much sport and physical activity you did inside and outside of school.

I am now contacting everyone who completed the questionnaire before and would be very grateful if you could fill it out again. This is so that I can measure changes in your physical activity levels since finishing Year 11. **Please make sure you answer each question.** Please could you also fill out the name and home address form, making sure that your contact details are correct. It will only take you about 10 minutes to do all of it in total.

When you have filled it all in, please send the name and home address form and questionnaire back to me in the **FREEPOST** envelope provided by **Friday 12th December 2008 at the latest.** You don't need to put a stamp on the envelope, it is free. All returned questionnaires will be entered into a free prize draw for the chance to **win £30 of Amazon vouchers**.

Good luck!

Thank you for your help and for completing it.

Christopher Owens
PhD Research Student
University of Gloucestershire

Appendix 20: Letter to parents at baseline

ACTIVE GLOUCESTERSHIRE

Gloucestershire COUNTY COUNCIL

UNIVERSITY OF GLOUCESTERSHIRE
at Cheltenham and Gloucester

University of Gloucestershire
Faculty of Sport, Health and Social Care
Oxstalls Campus
Oxstalls Lane
Gloucester
GL2 9HW
Email: [redacted]

[date sent]

Dear Parent(s)/Guardian(s)

I am a PhD research student in the Faculty of Sport, Health and Social Care at the University of Gloucestershire. I am contacting you in relation to a study I am undertaking into sport and physical activity participation and sedentarism among Year 11 pupils in Gloucestershire. This study will involve tracking a large population of Year 11 pupils during the transition from completing compulsory education and entering tertiary studies, employment or unemployment. This will be at two time points over a 12 month period through the completion of a simple three page questionnaire. This study is being funded jointly by the University of Gloucestershire and Active Gloucestershire (the County Sports Partnership). It is also being supported by Gloucestershire County Council.

Your son or daughter's school has agreed to take part in the study and I am contacting you to inform you that your son or daughter may be invited to complete a questionnaire on their physical activity and sport participation and sedentary activities inside and outside of school. The questionnaire will only take about 10 minutes to complete and the intention is for it to be completed as part of a Year 11 assembly or in PSHE or citizenship lessons. As this study is tracking the same pupils over a 12 month period, it is important that we have a record of your son or daughter's name, home address and postcode so that we can send them the questionnaire again between September and December 2008. Please feel assured that confidential information such as your son or daughter's name, home address and postcode will be respected at all times and will never be divulged to a third party. For your information, the name, home address and postcode of your son or daughter will be completed on a separate sheet from the questionnaire to ensure their anonymity and confidentiality.

Please feel free to contact me if you have any concerns regarding your son or daughter's involvement in this study. My contact details are at the top of this letter.

Yours faithfully

Christopher S. Owens BSc (Hons) MSc
PhD Research Student
University Of Gloucestershire

Appendix 21: 'Crib' sheet for calculation of screen time status

Coding system applied for Q10 response and Q11 response; 1 = None; 2 = 1 hour or less; 3 = 2 to 3 hours; 4 = 4 to 5 hours; 5 = 6 or more hours)

Q10 response code	**Q11 response code**	**Calculation**	**Total hours of screen time**	**Not meeting screen time guidelines (0) Meeting screen time guidelines (1)**
1	1	0 + 0	0	1
1	2	0 + 2	2	1
1	3	0 + 5	5	1
1	4	0 + 9	9	1
1	5	0 + 12	12	1
2	1	5 + 0	5	1
2	2	5 + 2	7	1
2	3	5 + 5	10	1
2	4	5 + 9	14	1
2	5	5 + 12	17	0
3	1	12.5 + 0	12.5	1
3	2	12.5 + 2	14.5	0
3	3	12.5 + 5	17.5	0
3	4	12.5 + 9	21.5	0
3	5	12.5 + 12	24.5	0
4	1	22.5 + 0	22.5	0
4	2	22.5 + 2	24.5	0
4	3	22.5 + 5	27.5	0
4	4	22.5 + 9	31.5	0
4	5	22.5 + 12	34.5	0
5	1	30 + 0	30	0
5	2	30 + 2	32	0
5	3	30 + 5	35	0
5	4	30 + 9	39	0
5	5	30 +12	42	0

Appendix 22: Calculation of Townsend score

Stage one – percentages of each Townsend component

% Overcrowding = UV 0590005 (Households with an occupancy rating of -1) + UV0590006 (Households with an occupancy rating of -2 or less) / UV0590001 (All households) x 100

% Unemployed = UV 0280012 (Unemployed) / UV 0280002 (Economically active) x 100

% Home ownership = 100 – UV 0630002 (Owned) / UV0630001 (All households) x 100

% Car ownership = UV 0620002 (No car or van) / UV 0620001 (All households) x 100

Stage two – creation of four variables

Var 1 = Log(%overcrowding + 1)

Var 2 = Log(%unemployed +1)

Var 3 = %not owner occupancy

Var 4 = %nocar

Stage three – resultant standardised Zscores

Zscore1 = (Var 1 – Mean(Var1)/S.D.(Var1)

Zscore2 = (Var2 – Mean(Var2)/S.D.(Var2)

Zscore3 = (Var3 – Mean(Var3/S.D.(Var3)

Zscore4 = (Var4 – Mean(Var4/S.D.(Var4)

Stage four – Townsend score produced

Sum(Zscore1 : Zscore4) = Townsend Index

Appendix 23: SPSS output for McNemar test and cross-tabulations for Research Question 1 (including preliminary cross-tabulations) (analysis one)

McNemar test (Research Question 1 – analysis one)

pabaselinefinaltown & pafollowupfinaltown

	Pafollowupfinaltown	
pabaselinefinaltown	not meeting guidelines	meeting guidelines
not meeting guidelines	537	33
meeting guidelines	67	26

Test Statistics[b]

	pabaselinefinaltown & pafollowupfinaltown
N	663
Chi-Square[a]	10.890
Asymp. Sig.	.001

a. Continuity Corrected

b. McNemar Test

Cross-tabulations (Research Question 1 – analysis one)

Case Processing Summary

	Cases					
	Valid		Missing		Total	
	N	Percent	N	Percent	N	Percent
pabaselinefinaltown * pafollowupfinaltown	663	79.5%	171	20.5%	834	100.0%

pabaselinefinaltown * pafollowupfinaltown Crosstabulation

			pafollowupfinaltown		
			not meeting guidelines	meeting guidelines	Total
pabaselinefinaltown	not meeting guidelines	Count	537	33	570
		% of Total	81.0%	5.0%	86.0%
	meeting guidelines	Count	67	26	93
		% of Total	10.1%	3.9%	14.0%
	Total	Count	604	59	663
		% of Total	91.1%	8.9%	100.0%

Cross-tabulations (preliminary analysis – Research Question 1 (analysis one))

Case Processing Summary

	Cases					
	Valid		Missing		Total	
	N	Percent	N	Percent	N	Percent
pabaselinefinaltown * pafollowupfinaltown	663	79.5%	171	20.5%	834	100.0%

pabaselinefinaltown * pafollowupfinaltown Crosstabulation

			Pafollowupfinaltown		
			not meeting guidelines	meeting guidelines	Total
pabaselinefinaltown	not meeting guidelines	Count	537	33	570
		Expected Count	519.3	50.7	570.0
		% within pabaselinefinaltown	94.2%	5.8%	100.0%
	meeting guidelines	Count	67	26	93
		Expected Count	84.7	8.3	93.0
		% within pabaselinefinaltown	72.0%	28.0%	100.0%
	Total	Count	604	59	663
		Expected Count	604.0	59.0	663.0
		% within pabaselinefinaltown	91.1%	8.9%	100.0%

Appendix 24: SPSS output for McNemar test and cross-tabulations for Research Question 1 (including preliminary cross-tabulations) (analysis two)

McNemar test (Research Question 1 – analysis two)

pabaselinefinalnontown & pafollowupfinalnontown

	pafollowupfinalnontown	
pabaselinefinalnontown	not meeting guidelines	meeting guidelines
not meeting guidelines	668	45
meeting guidlines	89	32

Test Statistics[b]

	pabaselinefinalnontown & pafollowupfinalnontown
N	834
Chi-Square[a]	13.799
Asymp. Sig.	.000

a. Continuity Corrected

b. McNemar Test

Cross-tabulations (Research Question 1 – analysis two)

Case Processing Summary

	Cases					
	Valid		Missing		Total	
	N	Percent	N	Percent	N	Percent
pabaselinefinalnontown * pafollowupfinalnontown	834	100.0%	0	.0%	834	100.0%

pabaselinefinalnontown * pafollowupfinalnontown Crosstabulation

			pafollowupfinalnontown		
			not meeting guidelines	meeting guidelines	Total
pabaselinefinalnontown	not meeting guidelines	Count	668	45	713
		% of Total	80.1%	5.4%	85.5%
	meeting guidlines	Count	89	32	121
		% of Total	10.7%	3.8%	14.5%
	Total	Count	757	77	834
		% of Total	90.8%	9.2%	100.0%

Cross-tabulations (preliminary analysis – Research Question 1 (analysis two))

Case Processing Summary

	Cases					
	Valid		Missing		Total	
	N	Percent	N	Percent	N	Percent
pabaselinefinalnontown * pafollowupfinalnontown	834	100.0%	0	.0%	834	100.0%

pabaselinefinalnontown * pafollowupfinalnontown Crosstabulation

			pafollowupfinalnontown		
			not meeting guidelines	meeting guidelines	Total
pabaselinefinalnontown	not meeting guidelines	Count	668	45	713
		Expected Count	647.2	65.8	713.0
		% within pabaselinefinalnontown	93.7%	6.3%	100.0%
	meeting guidlines	Count	89	32	121
		Expected Count	109.8	11.2	121.0
		% within pabaselinefinalnontown	73.6%	26.4%	100.0%
	Total	Count	757	77	834
		Expected Count	757.0	77.0	834.0
		% within pabaselinefinalnontown	90.8%	9.2%	100.0%

Appendix 25: SPSS outputs for sample size checks – prior to running BLR analysis for Research Question 2 (analysis one and analysis two) and Research Question 4 (analysis one and analysis two)

Model 1 (analysis one)

pafollowupbroad

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	not meeting guidelines	604	91.1	91.1	91.1
	meeting guidelines	59	8.9	8.9	100.0
	Total	663	100.0	100.0	

genderfin

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	male	362	54.6	54.6	54.6
	female	301	45.4	45.4	100.0
	Total	663	100.0	100.0	

ethnicityfin

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	white	625	94.3	94.3	94.3
	other	38	5.7	5.7	100.0
	Total	663	100.0	100.0	

gcsepassfin

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	no	54	8.1	8.1	8.1
	yes	609	91.9	91.9	100.0
	Total	663	100.0	100.0	

schooltypefin

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	state/mainstream	604	91.1	91.1	91.1
	private/independent	59	8.9	8.9	100.0
	Total	663	100.0	100.0	

ruralurbanfin

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	urban	462	69.7	69.7	69.7
	rural	201	30.3	30.3	100.0
	Total	663	100.0	100.0	

sesfin

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Q1 - least deprived	166	25.0	25.0	25.0
	Q2	167	25.2	25.2	50.2
	Q3	164	24.7	24.7	75.0
	Q4 - most deprived	166	25.0	25.0	100.0
	Total	663	100.0	100.0	

Model 2 (analysis two)

pafollowupbroad

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	not meeting guidelines	757	90.8	90.8	90.8
	meeting guidelines	77	9.2	9.2	100.0
	Total	834	100.0	100.0	

genderfin

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	male	447	53.6	53.6	53.6
	female	387	46.4	46.4	100.0
	Total	834	100.0	100.0	

ethnicityfin

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	white	792	95.0	95.0	95.0
	other	42	5.0	5.0	100.0
	Total	834	100.0	100.0	

gcsepassfin

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	no	66	7.9	7.9	7.9
	yes	768	92.1	92.1	100.0
	Total	834	100.0	100.0	

schooltypefin

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	state/mainstream	764	91.6	91.6	91.6
	private/independent	70	8.4	8.4	100.0
	Total	834	100.0	100.0	

Model 3 (analysis one)

screentimestatusfollowupbroad

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	not meeting guidelines	541	81.6	81.6	81.6
	meeting guidelines	122	18.4	18.4	100.0
	Total	663	100.0	100.0	

genderfin

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	male	362	54.6	54.6	54.6
	female	301	45.4	45.4	100.0
	Total	663	100.0	100.0	

ethnicityfin

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	white	625	94.3	94.3	94.3
	other	38	5.7	5.7	100.0
	Total	663	100.0	100.0	

gcsepassfin

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	no	54	8.1	8.1	8.1
	yes	609	91.9	91.9	100.0
	Total	663	100.0	100.0	

schooltypefin

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	state/mainstream	604	91.1	91.1	91.1
	private/independent	59	8.9	8.9	100.0
	Total	663	100.0	100.0	

ruralurbanfin

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	urban	462	69.7	69.7	69.7
	rural	201	30.3	30.3	100.0
	Total	663	100.0	100.0	

sesfin

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Q1 - least deprived	166	25.0	25.0	25.0
	Q2	167	25.2	25.2	50.2
	Q3	164	24.7	24.7	75.0
	Q4 - most deprived	166	25.0	25.0	100.0
	Total	663	100.0	100.0	

Model 4 (analysis two)

screentimestatusfollowupbroad

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	not meeting guidelines	670	80.3	80.3	80.3
	meeting guidelines	164	19.7	19.7	100.0
	Total	834	100.0	100.0	

genderfin

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	male	447	53.6	53.6	53.6
	female	387	46.4	46.4	100.0
	Total	834	100.0	100.0	

ethnicityfin

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	white	792	95.0	95.0	95.0
	other	42	5.0	5.0	100.0
	Total	834	100.0	100.0	

gcsepassfin

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	no	66	7.9	7.9	7.9
	yes	768	92.1	92.1	100.0
	Total	834	100.0	100.0	

schooltypefin

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	state/mainstream	764	91.6	91.6	91.6
	private/independent	70	8.4	8.4	100.0
	Total	834	100.0	100.0	

Appendix 26: SPSS outputs for multicollinearity checks – prior to running BLR analysis for Research Question 2 (analysis one and analysis two) and Research Question 4 (analysis one and analysis two)

Model 1 (analysis one)

Variables Entered/Removed[b]

Model	Variables Entered	Variables Removed	Method
1	sesfin, ruralurbanfin, genderfin, ethnicityfin, schooltypefin, gcsepassfin[a]	.	Enter

a. All requested variables entered.

b. Dependent Variable: pafollowupbroad

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Collinearity Statistics	
		B	Std. Error	Beta			Tolerance	VIF
1	(Constant)	.117	.046		2.515	.012		
	genderfin	-.054	.022	-.094	-2.407	.016	.992	1.008
	ethnicityfin	-.041	.048	-.034	-.862	.389	.976	1.024
	gcsepassfin	-.002	.041	-.002	-.045	.964	.959	1.042
	schooltypefin	-.056	.039	-.056	-1.413	.158	.972	1.029
	ruralurbanfin	-.005	.024	-.008	-.213	.832	.968	1.033
	sesfin	.005	.010	.018	.465	.642	.951	1.051

a. Dependent Variable: pafollowupbroad

Model 2 (analysis two)

Variables Entered/Removed[b]

Model	Variables Entered	Variables Removed	Method
1	schooltypefin, ethnicityfin, genderfin, gcsepassfin[a]	.	Enter

a. All requested variables entered.

b. Dependent Variable: pafollowupbroad

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Collinearity Statistics	
		B	Std. Error	Beta			Tolerance	VIF
1	(Constant)	.121	.037		3.254	.001		
	genderfin	-.051	.020	-.087	-2.528	.012	.997	1.003
	ethnicityfin	-.023	.046	-.017	-.506	.613	1.000	1.000
	gcsepassfin	.002	.037	.002	.051	.959	.995	1.005
	schooltypefin	-.067	.036	-.064	-1.848	.065	.996	1.004

a. Dependent Variable: pafollowupbroad

Model 3 (analysis one)

Variables Entered/Removed[b]

Model	Variables Entered	Variables Removed	Method
1	sesfin, ruralurbanfin, genderfin, ethnicityfin, schooltypefin, gcsepassfin[a]	.	Enter

a. All requested variables entered.

b. Dependent Variable: screentimestatusfollowupbroad

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Collinearity Statistics	
		B	Std. Error	Beta			Tolerance	VIF
1	(Constant)	.187	.064		2.949	.003		
	genderfin	-.003	.030	-.003	-.088	.930	.992	1.008
	ethnicityfin	.036	.066	.021	.543	.587	.976	1.024
	gcsepassfin	-.024	.056	-.017	-.430	.667	.959	1.042
	schooltypefin	.032	.054	.024	.596	.551	.972	1.029
	ruralurbanfin	.042	.033	.050	1.266	.206	.968	1.033
	sesfin	.002	.014	.005	.116	.907	.951	1.051

a. Dependent Variable: screentimestatusfollowupbroad

Model 4 (analysis two)

Variables Entered/Removed[b]

Model	Variables Entered	Variables Removed	Method
1	schooltypefin, ethnicityfin, genderfin, gcsepassfin[a]	.	Enter

a. All requested variables entered.

b. Dependent Variable: screentimestatusfollowupbroad

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Collinearity Statistics	
		B	Std. Error	Beta			Tolerance	VIF
1	(Constant)	.191	.051		3.734	.000		
	genderfin	.037	.028	.046	1.332	.183	.997	1.003
	ethnicityfin	-.006	.063	-.003	-.088	.930	1.000	1.000
	gcsepassfin	-.017	.051	-.012	-.332	.740	.995	1.005
	schooltypefin	.049	.050	.034	.992	.321	.996	1.004

a. Dependent Variable: screentimestatusfollowupbroad

Appendix 27: SPSS output for BLR for Research Question 2 (Model 1 – analysis one)

Dependent Variable Encoding

Original Value	Internal Value
not meeting guidelines	0
meeting guidelines	1

Categorical Variables Codings

		Frequency	Parameter coding		
			(1)	(2)	(3)
sesfin	Q1 - least deprived	166	.000	.000	.000
	Q2	167	1.000	.000	.000
	Q3	164	.000	1.000	.000
	Q4 - most deprived	166	.000	.000	1.000
ethnicityfin	white	625	.000		
	other	38	1.000		
gcsepassfin	no	54	.000		
	yes	609	1.000		
schooltypefin	state/mainstream	604	.000		
	private/independent	59	1.000		
ruralurbanfin	urban	462	.000		
	rural	201	1.000		
genderfin	male	362	.000		
	female	301	1.000		

Model Summary

Step	-2 Log likelihood	Cox & Snell R Square	Nagelkerke R Square
1	384.924[a]	.020	.043

a. Estimation terminated at iteration number 6 because parameter estimates changed by less than .001.

Hosmer and Lemeshow Test

Step	Chi-square	df	Sig.
1	5.660	8	.685

Classification Table[a]

Observed			Predicted: pafollowupbroad: not meeting guidelines	meeting guidelines	Percentage Correct
Step 1	pafollowupbroad	not meeting guidelines	604	0	100.0
		meeting guidelines	59	0	.0
		Overall Percentage			91.1

a. The cut value is .500

Variables in the Equation

		B	S.E.	Wald	df	Sig.	Exp(B)	95.0% C.I.for EXP(B) Lower	Upper
Step 1	genderfin(1)	-.741	.298	6.192	1	.013	.476	.266	.854
	ethnicityfin(1)	-.680	.751	.821	1	.365	.507	.116	2.206
	gcsepassfin(1)	-.093	.507	.034	1	.855	.911	.337	2.462
	schooltypefin(1)	-1.080	.741	2.123	1	.145	.340	.079	1.452
	ruralurbanfin(1)	-.054	.310	.031	1	.861	.947	.516	1.738
	sesfin			3.371	3	.338			
	sesfin(1)	.725	.401	3.267	1	.071	2.064	.941	4.530
	sesfin(2)	.366	.418	.769	1	.381	1.442	.636	3.270
	sesfin(3)	.348	.430	.654	1	.419	1.416	.609	3.293
	Constant	-2.226	.595	14.016	1	.000	.108		

Appendix 28: SPSS output for BLR for Research Question 2 (Model 2 – analysis two)

Dependent Variable Encoding

Original Value	Internal Value
not meeting guidelines	0
meeting guidelines	1

Categorical Variables Codings

		Frequency	Parameter coding (1)
schooltypefin	state/mainstream	764	.000
	private/independent	70	1.000
ethnicityfin	white	792	.000
	other	42	1.000
gcsepassfin	no	66	.000
	yes	768	1.000
genderfin	male	447	.000
	female	387	1.000

Model Summary

Step	-2 Log likelihood	Cox & Snell R Square	Nagelkerke R Square
1	501.890[a]	.014	.030

a. Estimation terminated at iteration number 6 because parameter estimates changed by less than .001.

Hosmer and Lemeshow Test

Step	Chi-square	df	Sig.
1	.432	3	.934

Classification Table[a]

Observed			Predicted: pafollowupbroad: not meeting guidelines	Predicted: pafollowupbroad: meeting guidelines	Percentage Correct
Step 1	pafollowupbroad	not meeting guidelines	757	0	100.0
		meeting guidelines	77	0	.0
		Overall Percentage			90.8

a. The cut value is .500

Variables in the Equation

		B	S.E.	Wald	df	Sig.	Exp(B)	95.0% C.I.for EXP(B) Lower	95.0% C.I.for EXP(B) Upper
Step 1	genderfin(1)	-.637	.255	6.243	1	.012	.529	.321	.872
	ethnicityfin(1)	-.321	.615	.273	1	.601	.725	.217	2.420
	gcsepassfin(1)	.021	.449	.002	1	.963	1.021	.424	2.462
	schooltypefin(1)	-1.283	.729	3.097	1	.078	.277	.066	1.157
	Constant	-1.970	.443	19.773	1	.000	.139		

Appendix 29: SPSS output for McNemar test and cross-tabulations for Research Question 3 (including preliminary cross-tabulations) (analysis one)

McNemar test (Research Question 3 – analysis one)

screentimestatusbaselinetown & screentimestatusfollowuptown

screentimestatusbaselinetown	screentimestatusfollowuptown: not meeting guidelines	screentimestatusfollowuptown: meeting guidelines
not meeting guidelines	468	67
meeting guidelines	73	55

Test Statistics[b]

	screentimestatusbaselinetown & screentimestatusfollowuptown
N	663
Chi-Square[a]	.179
Asymp. Sig.	.673

a. Continuity Corrected

b. McNemar Test

Cross-tabulations (Research Question 3 – analysis one)

screentimestatusbaselinetown * screentimestatusfollowuptown Crosstabulation

			screentimestatusfollowuptown		
			Not meeting guidelines	meeting guidelines	Total
screentimestatusbaselinetown	not meeting guidelines	Count	468	67	535
		% of Total	70.6%	10.1%	80.7%
	meeting guidelines	Count	73	55	128
		% of Total	11.0%	8.3%	19.3%
	Total	Count	541	122	663
		% of Total	81.6%	18.4%	100.0%

Cross-tabulations (preliminary analysis – Research Question 3 (analysis one))

Case Processing Summary

	Cases					
	Valid		Missing		Total	
	N	Percent	N	Percent	N	Percent
screentimestatusbaselinetown * screentimestatusfollowuptown	663	79.5%	171	20.5%	834	100.0%

screentimestatusbaselinetown * screentimestatusfollowuptown Crosstabulation

			screentimestatusfollowuptown		
			not meeting guidelines	meeting guidelines	Total
screentimestatusbaselinetown	not meeting guidelines	Count	468	67	535
		Expected Count	436.6	98.4	535.0
		% within screentimestatusbaselinetown	87.5%	12.5%	100.0%
	meeting guidelines	Count	73	55	128
		Expected Count	104.4	23.6	128.0
		% within screentimestatusbaselinetown	57.0%	43.0%	100.0%
	Total	Count	541	122	663
		Expected Count	541.0	122.0	663.0
		% within screentimestatusbaselinetown	81.6%	18.4%	100.0%

Appendix 30: SPSS output for McNemar test and cross-tabulations for Research Question 3 (including preliminary cross-tabulations) (analysis two)

McNemar test (Research Question 3 – analysis two)

screentimestatusbaselinenontown & screentimestatusfollowupnontown

screentimestatusbaselinenontown	screentimestatusfollowupnontown: not meeting guidelines	screentimestatusfollowupnontown: meeting guidelines
not meeting guidelines	575	90
meeting guidelines	95	74

Test Statistics[b]

	screentimestatusbaselinenontown & screentimestatusfollowupnontown
N	834
Chi-Square[a]	.086
Asymp. Sig.	.769

a. Continuity Corrected

b. McNemar Test

Cross-tabulations (Research Question 3 – analysis two)

screentimestatusbaselinenontown * screentimestatusfollowupnontown Crosstabulation

			screentimestatusfollowupnontown		
			not meeting guidelines	meeting guidelines	Total
screentimestatusbaselinenontown	not meeting guidelines	Count	575	90	665
		% of Total	68.9%	10.8%	79.7%
	meeting guidelines	Count	95	74	169
		% of Total	11.4%	8.9%	20.3%
	Total	Count	670	164	834
		% of Total	80.3%	19.7%	100.0%

Cross-tabulations (preliminary analysis – Research Question 3 (analysis two))

Case Processing Summary

	Cases					
	Valid		Missing		Total	
	N	Percent	N	Percent	N	Percent
screentimestatusbaselinenontown * screentimestatusfollowupnontown	834	100.0%	0	.0%	834	100.0%

screentimestatusbaselinenontown * screentimestatusfollowupnontown Crosstabulation

			screentimestatusfollowupnontown		
			not meeting guidelines	meeting guidelines	Total
screentimestatusbaselinenontown	not meeting guidelines	Count	575	90	665
		Expected Count	534.2	130.8	665.0
		% within screentimestatusbaselinenontown	86.5%	13.5%	100.0%
	meeting guidelines	Count	95	74	169
		Expected Count	135.8	33.2	169.0
		% within screentimestatusbaselinenontown	56.2%	43.8%	100.0%
	Total	Count	670	164	834
		Expected Count	670.0	164.0	834.0
		% within screentimestatusbaselinenontown	80.3%	19.7%	100.0%

Appendix 31: SPSS output for BLR for Research Question 4 (Model 3 – analysis one)

Dependent Variable Encoding

Original Value	Internal Value
not meeting guidelines	0
meeting guidelines	1

Categorical Variables Codings

		Frequency	Parameter coding		
			(1)	(2)	(3)
sesfin	Q1 - least deprived	166	.000	.000	.000
	Q2	167	1.000	.000	.000
	Q3	164	.000	1.000	.000
	Q4 - most deprived	166	.000	.000	1.000
ethnicityfin	white	625	.000		
	other	38	1.000		
gcsepassfin	no	54	.000		
	yes	609	1.000		
schooltypefin	state/mainstream	604	.000		
	private/independent	59	1.000		
ruralurbanfin	urban	462	.000		
	rural	201	1.000		
genderfin	male	362	.000		
	female	301	1.000		

Model Summary

Step	-2 Log likelihood	Cox & Snell R Square	Nagelkerke R Square
1	629.403[a]	.006	.009

a. Estimation terminated at iteration number 4 because parameter estimates changed by less than .001.

Hosmer and Lemeshow Test

Step	Chi-square	df	Sig.
1	3.936	8	.863

Classification Table[a]

Observed			Predicted: screentimestatusfollowupbroad: not meeting guidelines	meeting guidelines	Percentage Correct
Step 1	screentimestatusfollowupbroad	not meeting guidelines	541	0	100.0
		meeting guidelines	122	0	.0
		Overall Percentage			81.6

a. The cut value is .500

Variables in the Equation

		B	S.E.	Wald	df	Sig.	Exp(B)	95.0% C.I.for EXP(B) Lower	Upper
Step 1	genderfin(1)	-.013	.204	.004	1	.949	.987	.662	1.472
	ethnicityfin(1)	.262	.420	.390	1	.532	1.300	.571	2.961
	gcsepassfin(1)	-.182	.364	.251	1	.617	.833	.408	1.701
	schooltypefin(1)	.196	.339	.333	1	.564	1.216	.626	2.362
	ruralurbanfin(1)	.242	.219	1.222	1	.269	1.273	.830	1.955
	sesfin			1.152	3	.764			
	sesfin(1)	.098	.290	.113	1	.737	1.102	.625	1.946
	sesfin(2)	.248	.284	.762	1	.383	1.282	.734	2.238
	sesfin(3)	-.026	.302	.007	1	.932	.975	.539	1.762
	Constant	-1.512	.422	12.852	1	.000	.220		

Appendix 32: SPSS output for BLR for Research Question 4 (Model 4 – analysis two)

Dependent Variable Encoding

Original Value	Internal Value
not meeting guidelines	0
meeting guidelines	1

Categorical Variables Codings

		Frequency	Parameter coding (1)
schooltypefin	state/mainstream	764	.000
	private/independent	70	1.000
ethnicityfin	white	792	.000
	other	42	1.000
gcsepassfin	no	66	.000
	yes	768	1.000
genderfin	male	447	.000
	female	387	1.000

Model Summary

Step	-2 Log likelihood	Cox & Snell R Square	Nagelkerke R Square
1	823.927[a]	.003	.006

a. Estimation terminated at iteration number 4 because parameter estimates changed by less than .001.

Hosmer and Lemeshow Test

Step	Chi-square	df	Sig.
1	.748	3	.862

Classification Table[a]

Observed			Predicted: screentimestatusfollowupbroad not meeting guidelines	Predicted: screentimestatusfollowupbroad meeting guidelines	Percentage Correct
Step 1	screentimestatusfollowupbroad	not meeting guidelines	670	0	100.0
		meeting guidelines	164	0	.0
		Overall Percentage			80.3

a. The cut value is .500

Variables in the Equation

		B	S.E.	Wald	df	Sig.	Exp(B)	95.0% C.I.for EXP(B) Lower	95.0% C.I.for EXP(B) Upper
Step 1	genderfin(1)	.233	.175	1.776	1	.183	1.262	.896	1.778
	ethnicityfin(1)	-.037	.404	.008	1	.927	.964	.437	2.127
	gcsepassfin(1)	-.106	.316	.112	1	.738	.900	.484	1.671
	schooltypefin(1)	.292	.295	.980	1	.322	1.339	.751	2.385
	Constant	-1.447	.318	20.739	1	.000	.235		

Appendix 33: SPSS outputs for sample size checks – prior to running BLR analysis for all further BLR analysis (Model F1 to Model F10)

Model F1 (analysis one)

pachangefinaldv

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	other combinations	596	89.9	89.9	89.9
	meeting to not meeting guidelines	67	10.1	10.1	100.0
	Total	663	100.0	100.0	

genderfin

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	male	362	54.6	54.6	54.6
	female	301	45.4	45.4	100.0
	Total	663	100.0	100.0	

ethnicityfin

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	white	625	94.3	94.3	94.3
	other	38	5.7	5.7	100.0
	Total	663	100.0	100.0	

gcsepassfin

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	no	54	8.1	8.1	8.1
	yes	609	91.9	91.9	100.0
	Total	663	100.0	100.0	

schooltypefin

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	state/mainstream	604	91.1	91.1	91.1
	private/independent	59	8.9	8.9	100.0
	Total	663	100.0	100.0	

ruralurbanfin

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	urban	462	69.7	69.7	69.7
	rural	201	30.3	30.3	100.0
	Total	663	100.0	100.0	

sesfin

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Q1 - least deprived	166	25.0	25.0	25.0
	Q2	167	25.2	25.2	50.2
	Q3	164	24.7	24.7	75.0
	Q4 - most deprived	166	25.0	25.0	100.0
	Total	663	100.0	100.0	

Model F2 (analysis two)

pachangefinaldv

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	other combinations	745	89.3	89.3	89.3
	meeting to not meeting guidelines	89	10.7	10.7	100.0
	Total	834	100.0	100.0	

genderfin

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	male	447	53.6	53.6	53.6
	female	387	46.4	46.4	100.0
	Total	834	100.0	100.0	

ethnicityfin

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	white	792	95.0	95.0	95.0
	other	42	5.0	5.0	100.0
	Total	834	100.0	100.0	

gcsepassfin

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	no	66	7.9	7.9	7.9
	yes	768	92.1	92.1	100.0
	Total	834	100.0	100.0	

schooltypefin

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	state/mainstream	764	91.6	91.6	91.6
	private/independent	70	8.4	8.4	100.0
	Total	834	100.0	100.0	

Model F3 (analysis one)

pafollowupbroad

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	not meeting guidelines	604	91.1	91.1	91.1
	meeting guidelines	59	8.9	8.9	100.0
	Total	663	100.0	100.0	

genderfin

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	male	362	54.6	54.6	54.6
	female	301	45.4	45.4	100.0
	Total	663	100.0	100.0	

ethnicityfin

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	white	625	94.3	94.3	94.3
	other	38	5.7	5.7	100.0
	Total	663	100.0	100.0	

gcsepassfin

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	no	54	8.1	8.1	8.1
	yes	609	91.9	91.9	100.0
	Total	663	100.0	100.0	

statusfin

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	education	641	96.7	96.7	96.7
	employment or unemployment	22	3.3	3.3	100.0
	Total	663	100.0	100.0	

ruralurbanfin

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	urban	462	69.7	69.7	69.7
	rural	201	30.3	30.3	100.0
	Total	663	100.0	100.0	

sesfin

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Q1 - least deprived	166	25.0	25.0	25.0
	Q2	167	25.2	25.2	50.2
	Q3	164	24.7	24.7	75.0
	Q4 - most deprived	166	25.0	25.0	100.0
	Total	663	100.0	100.0	

Model F4 (analysis two)

pafollowupbroad

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	not meeting guidelines	757	90.8	90.8	90.8
	meeting guidelines	77	9.2	9.2	100.0
	Total	834	100.0	100.0	

genderfin

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	male	447	53.6	53.6	53.6
	female	387	46.4	46.4	100.0
	Total	834	100.0	100.0	

ethnicityfin

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	white	792	95.0	95.0	95.0
	other	42	5.0	5.0	100.0
	Total	834	100.0	100.0	

gcsepassfin

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	no	66	7.9	7.9	7.9
	yes	768	92.1	92.1	100.0
	Total	834	100.0	100.0	

statusfin

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	education	806	96.6	96.6	96.6
	employment or unemployment	28	3.4	3.4	100.0
	Total	834	100.0	100.0	

Model F5 (analysis one)

screentimestatusfollowupbroad

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	not meeting guidelines	541	81.6	81.6	81.6
	meeting guidelines	122	18.4	18.4	100.0
	Total	663	100.0	100.0	

genderfin

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	male	362	54.6	54.6	54.6
	female	301	45.4	45.4	100.0
	Total	663	100.0	100.0	

ethnicityfin

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	white	625	94.3	94.3	94.3
	other	38	5.7	5.7	100.0
	Total	663	100.0	100.0	

gcsepassfin

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	no	54	8.1	8.1	8.1
	yes	609	91.9	91.9	100.0
	Total	663	100.0	100.0	

statusfin

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	education	641	96.7	96.7	96.7
	employment or unemployment	22	3.3	3.3	100.0
	Total	663	100.0	100.0	

ruralurbanfin

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	urban	462	69.7	69.7	69.7
	rural	201	30.3	30.3	100.0
	Total	663	100.0	100.0	

sesfin

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Q1 - least deprived	166	25.0	25.0	25.0
	Q2	167	25.2	25.2	50.2
	Q3	164	24.7	24.7	75.0
	Q4 - most deprived	166	25.0	25.0	100.0
	Total	663	100.0	100.0	

Model F6 (analysis two)

screentimestatusfollowupbroad

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	not meeting guidelines	670	80.3	80.3	80.3
	meeting guidelines	164	19.7	19.7	100.0
	Total	834	100.0	100.0	

genderfin

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	male	447	53.6	53.6	53.6
	female	387	46.4	46.4	100.0
	Total	834	100.0	100.0	

ethnicityfin

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	white	792	95.0	95.0	95.0
	other	42	5.0	5.0	100.0
	Total	834	100.0	100.0	

gcsepassfin

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	no	66	7.9	7.9	7.9
	yes	768	92.1	92.1	100.0
	Total	834	100.0	100.0	

statusfin

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	education	806	96.6	96.6	96.6
	employment or unemployment	28	3.4	3.4	100.0
	Total	834	100.0	100.0	

Model F7 (analysis one)

pafollowupbroad

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	not meeting guidelines	604	91.1	91.1	91.1
	meeting guidelines	59	8.9	8.9	100.0
	Total	663	100.0	100.0	

genderfin

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	male	362	54.6	54.6	54.6
	female	301	45.4	45.4	100.0
	Total	663	100.0	100.0	

ethnicityfin

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	white	625	94.3	94.3	94.3
	other	38	5.7	5.7	100.0
	Total	663	100.0	100.0	

pabaselinefin

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	not meeting guidelines	570	86.0	86.0	86.0
	meeting guidelines	93	14.0	14.0	100.0
	Total	663	100.0	100.0	

Model F8 (analysis two)

pafollowupbroad

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	not meeting guidelines	757	90.8	90.8	90.8
	meeting guidelines	77	9.2	9.2	100.0
	Total	834	100.0	100.0	

genderfin

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	male	447	53.6	53.6	53.6
	female	387	46.4	46.4	100.0
	Total	834	100.0	100.0	

ethnicityfin

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	white	792	95.0	95.0	95.0
	other	42	5.0	5.0	100.0
	Total	834	100.0	100.0	

pabaselinefin

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	not meeting guidelines	713	85.5	85.5	85.5
	meeting guidelines	121	14.5	14.5	100.0
	Total	834	100.0	100.0	

schooltypefin

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	state/mainstream	764	91.6	91.6	91.6
	private/independent	70	8.4	8.4	100.0
	Total	834	100.0	100.0	

Model F9 (analysis one)

screentimestatusfollowupbroad

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	not meeting guidelines	541	81.6	81.6	81.6
	meeting guidelines	122	18.4	18.4	100.0
	Total	663	100.0	100.0	

genderfin

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	male	362	54.6	54.6	54.6
	female	301	45.4	45.4	100.0
	Total	663	100.0	100.0	

ethnicityfin

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	white	625	94.3	94.3	94.3
	other	38	5.7	5.7	100.0
	Total	663	100.0	100.0	

screentimestatusbaselinefin

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	not meeting guidelines	535	80.7	80.7	80.7
	meeting guidelines	128	19.3	19.3	100.0
	Total	663	100.0	100.0	

schooltypefin

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	state/mainstream	604	91.1	91.1	91.1
	private/independent	59	8.9	8.9	100.0
	Total	663	100.0	100.0	

ruralurbanfin

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	urban	462	69.7	69.7	69.7
	rural	201	30.3	30.3	100.0
	Total	663	100.0	100.0	

sesfin

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Q1 - least deprived	166	25.0	25.0	25.0
	Q2	167	25.2	25.2	50.2
	Q3	164	24.7	24.7	75.0
	Q4 - most deprived	166	25.0	25.0	100.0
	Total	663	100.0	100.0	

Model F10 (analysis two)

screentimestatusfollowupbroad

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	not meeting guidelines	670	80.3	80.3	80.3
	meeting guidelines	164	19.7	19.7	100.0
	Total	834	100.0	100.0	

genderfin

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	male	447	53.6	53.6	53.6
	female	387	46.4	46.4	100.0
	Total	834	100.0	100.0	

ethnicityfin

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	white	792	95.0	95.0	95.0
	other	42	5.0	5.0	100.0
	Total	834	100.0	100.0	

screentimestatusbaselinefin

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	not meeting guidelines	665	79.7	79.7	79.7
	meeting guidelines	169	20.3	20.3	100.0
	Total	834	100.0	100.0	

schooltypefin

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	state/mainstream	764	91.6	91.6	91.6
	private/independent	70	8.4	8.4	100.0
	Total	834	100.0	100.0	

Appendix 34: SPSS outputs for multicollinearity checks – prior to running BLR analysis for all further BLR analysis (Model F1 to Model F10)

Model F1 (analysis one)

Variables Entered/Removed[b]

Model	Variables Entered	Variables Removed	Method
1	sesfin, ruralurbanfin, genderfin, ethnicityfin, schooltypefin, gcsepassfin[a]	.	Enter

a. All requested variables entered.

b. Dependent Variable: pachangefinaldv

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Collinearity Statistics	
		B	Std. Error	Beta			Tolerance	VIF
1	(Constant)	.165	.049		3.360	.001		
	genderfin	-.051	.024	-.084	-2.171	.030	.992	1.008
	ethnicityfin	-.081	.051	-.063	-1.596	.111	.976	1.024
	gcsepassfin	-.017	.044	-.015	-.383	.702	.959	1.042
	schooltypefin	-.046	.042	-.044	-1.113	.266	.972	1.029
	ruralurbanfin	-.026	.026	-.039	-.992	.322	.968	1.033
	sesfin	-.006	.011	-.022	-.560	.575	.951	1.051

a. Dependent Variable: pachangefinaldv

Model F2 (analysis two)

Variables Entered/Removed[b]

Model	Variables Entered	Variables Removed	Method
1	schooltypefin, ethnicityfin, genderfin, gcsepassfin[a]	.	Enter

a. All requested variables entered.

b. Dependent Variable: pachangefinaldv

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Collinearity Statistics	
		B	Std. Error	Beta			Tolerance	VIF
1	(Constant)	.140	.040		3.545	.000		
	genderfin	-.059	.021	-.095	-2.744	.006	.997	1.003
	ethnicityfin	-.039	.049	-.027	-.795	.427	1.000	1.000
	gcsepassfin	.000	.040	.000	-.009	.993	.995	1.005
	schooltypefin	-.051	.039	-.045	-1.313	.190	.996	1.004

a. Dependent Variable: pachangefinaldv

Model F3 (analysis one)

Variables Entered/Removed[b]

Model	Variables Entered	Variables Removed	Method
1	sesfin, ruralurbanfin, genderfin, statusfin, ethnicityfin, gcsepassfin[a]	.	Enter

a. All requested variables entered.

b. Dependent Variable: pafollowupbroad

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Collinearity Statistics	
		B	Std. Error	Beta			Tolerance	VIF
1	(Constant)	.117	.048		2.445	.015		
	genderfin	-.055	.022	-.096	-2.454	.014	.993	1.007
	ethnicityfin	-.044	.048	-.036	-.910	.363	.975	1.026
	gcsepassfin	-.006	.043	-.006	-.147	.883	.893	1.119
	statusfin	-.004	.065	-.002	-.056	.955	.913	1.095
	ruralurbanfin	-.010	.024	-.016	-.415	.678	.987	1.013
	sesfin	.005	.010	.021	.523	.601	.949	1.053

a. Dependent Variable: pafollowupbroad

Model F4 (analysis two)

Variables Entered/Removed[b]

Model	Variables Entered	Variables Removed	Method
1	statusfin, genderfin, ethnicityfin, gcsepassfin[a]	.	Enter

a. All requested variables entered.

b. Dependent Variable: pafollowupbroad

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Collinearity Statistics	
		B	Std. Error	Beta			Tolerance	VIF
1	(Constant)	.126	.040		3.158	.002		
	genderfin	-.052	.020	-.090	-2.592	.010	.998	1.002
	ethnicityfin	-.025	.046	-.019	-.542	.588	.998	1.002
	gcsepassfin	-.008	.039	-.008	-.208	.835	.883	1.133
	statusfin	-.027	.059	-.017	-.458	.647	.883	1.133

a. Dependent Variable: pafollowupbroad

Model F5 (analysis one)

Variables Entered/Removed[b]

Model	Variables Entered	Variables Removed	Method
1	sesfin, ruralurbanfin, genderfin, statusfin, ethnicityfin, gcsepassfin[a]	.	Enter

a. All requested variables entered.

b. Dependent Variable: screentimestatusfollowupbroad

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Collinearity Statistics	
		B	Std. Error	Beta			Tolerance	VIF
1	(Constant)	.190	.066		2.900	.004		
	genderfin	-.002	.030	-.003	-.068	.946	.993	1.007
	ethnicityfin	.036	.066	.022	.554	.580	.975	1.026
	gcsepassfin	-.025	.058	-.017	-.421	.674	.893	1.119
	statusfin	-.014	.088	-.007	-.164	.870	.913	1.095
	ruralurbanfin	.045	.033	.054	1.368	.172	.987	1.013
	sesfin	.001	.014	.004	.103	.918	.949	1.053

a. Dependent Variable: screentimestatusfollowupbroad

Model F6 (analysis two)

Variables Entered/Removed[b]

Model	Variables Entered	Variables Removed	Method
1	statusfin, genderfin, ethnicityfin, gcsepassfin[a]	.	Enter

a. All requested variables entered.

b. Dependent Variable: screentimestatusfollowupbroad

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Collinearity Statistics	
		B	Std. Error	Beta			Tolerance	VIF
1	(Constant)	.189	.055		3.439	.001		
	genderfin	.038	.028	.047	1.366	.172	.998	1.002
	ethnicityfin	-.005	.063	-.003	-.072	.942	.998	1.002
	gcsepassfin	-.011	.054	-.008	-.208	.836	.883	1.133
	statusfin	.012	.081	.006	.150	.880	.883	1.133

a. Dependent Variable: screentimestatusfollowupbroad

Model F7 (analysis one)

Variables Entered/Removed[b]

Model	Variables Entered	Variables Removed	Method
1	sesfin, pabaselinefin, ruralurbanfin, genderfin, schooltypefin, ethnicityfin[a]	.	Enter

a. All requested variables entered.

b. Dependent Variable: pafollowupbroad

Coefficients[a]

Model		Unstandardized Coefficients B	Unstandardized Coefficients Std. Error	Standardized Coefficients Beta	t	Sig.	Collinearity Statistics Tolerance	Collinearity Statistics VIF
1	(Constant)	.074	.022		3.322	.001		
	genderfin	-.036	.022	-.063	-1.674	.095	.981	1.019
	ethnicityfin	-.014	.047	-.011	-.295	.768	.969	1.032
	pabaselinefin	.213	.031	.259	6.835	.000	.974	1.027
	schooltypefin	-.042	.038	-.042	-1.097	.273	.973	1.027
	ruralurbanfin	.002	.024	.003	.082	.935	.966	1.035
	sesfin	.003	.010	.014	.363	.717	.982	1.018

a. Dependent Variable: pafollowupbroad

Model F8 (analysis two)

Variables Entered/Removed[b]

Model	Variables Entered	Variables Removed	Method
1	schooltypefin, ethnicityfin, genderfin, pabaselinefin[a]	.	Enter

a. All requested variables entered.

b. Dependent Variable: pafollowupbroad

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Collinearity Statistics	
		B	Std. Error	Beta			Tolerance	VIF
1	(Constant)	.085	.015		5.733	.000		
	genderfin	-.033	.020	-.057	-1.687	.092	.982	1.018
	ethnicityfin	-.013	.044	-.009	-.282	.778	.998	1.002
	pabaselinefin	.192	.028	.234	6.895	.000	.978	1.022
	schooltypefin	-.052	.035	-.050	-1.487	.137	.995	1.005

a. Dependent Variable: pafollowupbroad

Model F9 (analysis one)

Variables Entered/Removed[b]

Model	Variables Entered	Variables Removed	Method
1	sesfin, ruralurbanfin, genderfin, screentimestatus baselinefin, schooltypefin, ethnicityfin[a]	.	Enter

a. All requested variables entered.

b. Dependent Variable: screentimestatusfollowupbroad

Coefficients[a]

Model		Unstandardized Coefficients B	Unstandardized Coefficients Std. Error	Standardized Coefficients Beta	t	Sig.	Collinearity Statistics Tolerance	Collinearity Statistics VIF
1	(Constant)	.123	.029		4.185	.000		
	genderfin	-.003	.029	-.004	-.105	.916	.995	1.006
	ethnicityfin	.021	.063	.013	.335	.738	.976	1.025
	screentimestatusbaselinefin	.303	.037	.308	8.271	.000	.989	1.011
	schooltypefin	.024	.051	.018	.478	.633	.976	1.025
	ruralurbanfin	.024	.032	.028	.753	.452	.963	1.038
	sesfin	-.005	.013	-.013	-.353	.724	.978	1.022

a. Dependent Variable: screentimestatusfollowupbroad

Model F10 (analysis two)

Variables Entered/Removed[b]

Model	Variables Entered	Variables Removed	Method
1	schooltypefin, ethnicityfin, screentimestatusbaselinefin, genderfin[a]	.	Enter

a. All requested variables entered.

b. Dependent Variable: screentimestatusfollowupbroad

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Collinearity Statistics	
		B	Std. Error	Beta			Tolerance	VIF
1	(Constant)	.122	.019		6.289	.000		
	genderfin	.024	.026	.030	.892	.373	.996	1.004
	ethnicityfin	-.010	.060	-.005	-.162	.871	1.000	1.000
	screentimestatusbaselinefin	.300	.033	.304	9.169	.000	.996	1.004
	schooltypefin	.036	.047	.025	.761	.447	.998	1.002

a. Dependent Variable: screentimestatusfollowupbroad

Appendix 35: SPSS output for BLR for further analysis (Model F1 – analysis one)

Dependent Variable Encoding

Original Value	Internal Value
other combinations	0
meeting to not meeting guidelines	1

Categorical Variables Codings

		Frequency	Parameter coding		
			(1)	(2)	(3)
sesfin	Q1 - least deprived	166	.000	.000	.000
	Q2	167	1.000	.000	.000
	Q3	164	.000	1.000	.000
	Q4 - most deprived	166	.000	.000	1.000
ethnicityfin	white	625	.000		
	other	38	1.000		
gcsepassfin	no	54	.000		
	yes	609	1.000		
schooltypefin	state/mainstream	604	.000		
	private/independent	59	1.000		
ruralurbanfin	urban	462	.000		
	rural	201	1.000		
genderfin	male	362	.000		
	female	301	1.000		

Model Summary

Step	-2 Log likelihood	Cox & Snell R Square	Nagelkerke R Square
1	417.512[a]	.025	.052

a. Estimation terminated at iteration number 6 because parameter estimates changed by less than .001.

Hosmer and Lemeshow Test

Step	Chi-square	df	Sig.
1	5.555	8	.697

Classification Table[a]

Observed			Predicted: pachangefinaldv: other combinations	Predicted: pachangefinaldv: meeting to not meeting guidelines	Predicted: Percentage Correct
Step 1	pachangefinaldv	other combinations	596	0	100.0
		meeting to not meeting guidelines	67	0	.0
		Overall Percentage			89.9

a. The cut value is .500

Variables in the Equation

		B	S.E.	Wald	df	Sig.	Exp(B)	95.0% C.I.for EXP(B) Lower	95.0% C.I.for EXP(B) Upper
Step 1	genderfin(1)	-.552	.276	3.996	1	.046	.576	.335	.989
	ethnicityfin(1)	-1.417	1.030	1.894	1	.169	.242	.032	1.824
	gcsepassfin(1)	-.179	.470	.146	1	.703	.836	.333	2.099
	schooltypefin(1)	-.690	.615	1.259	1	.262	.501	.150	1.674
	ruralurbanfin(1)	-.370	.303	1.497	1	.221	.691	.382	1.250
	sesfin			5.046	3	.168			
	sesfin(1)	-.621	.393	2.498	1	.114	.537	.249	1.161
	sesfin(2)	.111	.332	.112	1	.738	1.118	.583	2.143
	sesfin(3)	-.475	.383	1.542	1	.214	.622	.294	1.316
	Constant	-1.400	.523	7.151	1	.007	.247		

Appendix 36: SPSS output for BLR for further analysis (Model F2 – analysis two)

Dependent Variable Encoding

Original Value	Internal Value
other combinations	0
meeting to not meeting guidelines	1

Categorical Variables Codings

		Frequency	Parameter coding (1)
schooltypefin	state/mainstream	764	.000
	private/independent	70	1.000
ethnicityfin	white	792	.000
	other	42	1.000
gcsepassfin	no	66	.000
	yes	768	1.000
genderfin	male	447	.000
	female	387	1.000

Model Summary

Step	-2 Log likelihood	Cox & Snell R Square	Nagelkerke R Square
1	555.797[a]	.013	.026

a. Estimation terminated at iteration number 5 because parameter estimates changed by less than .001.

Hosmer and Lemeshow Test

Step	Chi-square	df	Sig.
1	.905	3	.824

Classification Table[a]

Observed			Predicted: pachangefinaldv: other combinations	Predicted: pachangefinaldv: meeting to not meeting guidelines	Predicted: Percentage Correct
Step 1	pachangefinaldv	other combinations	745	0	100.0
		meeting to not meeting guidelines	89	0	.0
		Overall Percentage			89.3

a. The cut value is .500

Variables in the Equation

		B	S.E.	Wald	df	Sig.	Exp(B)	95.0% C.I.for EXP(B) Lower	95.0% C.I.for EXP(B) Upper
Step 1	genderfin(1)	-.646	.238	7.341	1	.007	.524	.329	.836
	ethnicityfin(1)	-.489	.613	.636	1	.425	.613	.185	2.038
	gcsepassfin(1)	-.004	.420	.000	1	.992	.996	.438	2.267
	schooltypefin(1)	-.697	.530	1.732	1	.188	.498	.176	1.407
	Constant	-1.796	.414	18.831	1	.000	.166		

Appendix 37: SPSS output for BLR for further analysis (Model F3 – analysis one)

Dependent Variable Encoding

Original Value	Internal Value
not meeting guidelines	0
meeting guidelines	1

Categorical Variables Codings

		Frequency	Parameter coding		
			(1)	(2)	(3)
sesfin	Q1 - least deprived	166	.000	.000	.000
	Q2	167	1.000	.000	.000
	Q3	164	.000	1.000	.000
	Q4 - most deprived	166	.000	.000	1.000
ethnicityfin	white	625	.000		
	other	38	1.000		
gcsepassfin	no	54	.000		
	yes	609	1.000		
statusfin	education	641	.000		
	employment or unemployment	22	1.000		
ruralurbanfin	urban	462	.000		
	rural	201	1.000		
genderfin	male	362	.000		
	female	301	1.000		

Model Summary

Step	-2 Log likelihood	Cox & Snell R Square	Nagelkerke R Square
1	387.794[a]	.015	.034

a. Estimation terminated at iteration number 6 because parameter estimates changed by less than .001.

Hosmer and Lemeshow Test

Step	Chi-square	df	Sig.
1	4.445	8	.815

Classification Table[a]

Observed			Predicted: pafollowupbroad: not meeting guidelines	Predicted: pafollowupbroad: meeting guidelines	Percentage Correct
Step 1	pafollowupbroad	not meeting guidelines	604	0	100.0
		meeting guidelines	59	0	.0
		Overall Percentage			91.1

a. The cut value is .500

Variables in the Equation

		B	S.E.	Wald	df	Sig.	Exp(B)	95.0% C.I.for EXP(B) Lower	95.0% C.I.for EXP(B) Upper
Step 1	genderfin(1)	-.752	.297	6.397	1	.011	.471	.263	.844
	ethnicityfin(1)	-.690	.749	.848	1	.357	.501	.115	2.178
	gcsepassfin(1)	-.140	.523	.072	1	.789	.869	.312	2.424
	statusfin(1)	-.021	.792	.001	1	.979	.979	.207	4.627
	ruralurbanfin(1)	-.128	.307	.174	1	.676	.880	.481	1.607
	sesfin			3.205	3	.361			
	sesfin(1)	.710	.400	3.149	1	.076	2.034	.928	4.456
	sesfin(2)	.383	.417	.844	1	.358	1.467	.648	3.325
	sesfin(3)	.365	.430	.720	1	.396	1.440	.620	3.346
	Constant	-2.224	.608	13.401	1	.000	.108		

Appendix 38: SPSS output for BLR for further analysis (Model F4 – analysis two)

Dependent Variable Encoding

Original Value	Internal Value
not meeting guidelines	0
meeting guidelines	1

Categorical Variables Codings

		Frequency	Parameter coding (1)
statusfin	education	806	.000
	employment or unemployment	28	1.000
ethnicityfin	white	792	.000
	other	42	1.000
gcsepassfin	no	66	.000
	yes	768	1.000
genderfin	male	447	.000
	female	387	1.000

Model Summary

Step	-2 Log likelihood	Cox & Snell R Square	Nagelkerke R Square
1	506.252[a]	.009	.019

a. Estimation terminated at iteration number 5 because parameter estimates changed by less than .001.

Hosmer and Lemeshow Test

Step	Chi-square	df	Sig.
1	2.422	2	.298

Classification Table[a]

Observed			Predicted: pafollowupbroad: not meeting guidelines	Predicted: pafollowupbroad: meeting guidelines	Predicted: Percentage Correct
Step 1	pafollowupbroad	not meeting guidelines	757	0	100.0
		meeting guidelines	77	0	.0
		Overall Percentage			90.8

a. The cut value is .500

Variables in the Equation

		B	S.E.	Wald	df	Sig.	Exp(B)	95.0% C.I.for EXP(B) Lower	95.0% C.I.for EXP(B) Upper
Step 1	genderfin(1)	-.649	.254	6.522	1	.011	.522	.317	.860
	ethnicityfin(1)	-.328	.614	.285	1	.594	.721	.216	2.400
	gcsepassfin(1)	-.095	.470	.041	1	.840	.909	.362	2.285
	statusfin(1)	-.352	.782	.202	1	.653	.703	.152	3.258
	Constant	-1.913	.468	16.704	1	.000	.148		

Appendix 39: SPSS output for BLR for further analysis (Model F5 – analysis one)

Dependent Variable Encoding

Original Value	Internal Value
not meeting guidelines	0
meeting guidelines	1

Categorical Variables Codings

		Frequency	Parameter coding (1)	(2)	(3)
sesfin	Q1 - least deprived	166	.000	.000	.000
	Q2	167	1.000	.000	.000
	Q3	164	.000	1.000	.000
	Q4 - most deprived	166	.000	.000	1.000
ethnicityfin	white	625	.000		
	other	38	1.000		
gcsepassfin	no	54	.000		
	yes	609	1.000		
statusfin	education	641	.000		
	employment or unemployment	22	1.000		
ruralurbanfin	urban	462	.000		
	rural	201	1.000		
genderfin	male	362	.000		
	female	301	1.000		

Model Summary

Step	-2 Log likelihood	Cox & Snell R Square	Nagelkerke R Square
1	629.717[a]	.005	.008

a. Estimation terminated at iteration number 4 because parameter estimates changed by less than .001.

Hosmer and Lemeshow Test

Step	Chi-square	df	Sig.
1	7.256	8	.509

Classification Table[a]

Observed			Predicted: screentimestatusfollowupbroad: not meeting guidelines	meeting guidelines	Percentage Correct
Step 1	screentimestatusfollow upbroad	not meeting guidelines	541	0	100.0
		meeting guidelines	122	0	.0
		Overall Percentage			81.6

a. The cut value is .500

Variables in the Equation

		B	S.E.	Wald	df	Sig.	Exp(B)	95.0% C.I.for EXP(B) Lower	Upper
Step 1	genderfin(1)	-.009	.204	.002	1	.964	.991	.665	1.477
	ethnicityfin(1)	.269	.420	.410	1	.522	1.309	.574	2.982
	gcsepassfin(1)	-.178	.378	.223	1	.637	.837	.399	1.755
	statusfin(1)	-.059	.593	.010	1	.921	.943	.295	3.016
	ruralurbanfin(1)	.261	.216	1.462	1	.227	1.299	.850	1.983
	sesfin			1.144	3	.766			
	sesfin(1)	.103	.290	.127	1	.721	1.109	.629	1.956
	sesfin(2)	.246	.284	.747	1	.388	1.278	.732	2.232
	sesfin(3)	-.028	.303	.009	1	.926	.972	.537	1.760
	Constant	-1.504	.436	11.878	1	.001	.222		

Appendix 40: SPSS output for BLR for further analysis (Model F6 – analysis two)

Dependent Variable Encoding

Original Value	Internal Value
not meeting guidelines	0
meeting guidelines	1

Categorical Variables Codings

		Frequency	Parameter coding
			(1)
statusfin	education	806	.000
	employment or unemployment	28	1.000
ethnicityfin	white	792	.000
	other	42	1.000
gcsepassfin	no	66	.000
	yes	768	1.000
genderfin	male	447	.000
	female	387	1.000

Model Summary

Step	-2 Log likelihood	Cox & Snell R Square	Nagelkerke R Square
1	824.846[a]	.002	.004

a. Estimation terminated at iteration number 4 because parameter estimates changed by less than .001.

Hosmer and Lemeshow Test

Step	Chi-square	df	Sig.
1	.473	2	.789

Classification Table[a]

Observed			Predicted: screentimestatusfollowupbroad: not meeting guidelines	Predicted: screentimestatusfollowupbroad: meeting guidelines	Percentage Correct
Step 1	screentimestatusfollowupbroad	not meeting guidelines	670	0	100.0
		meeting guidelines	164	0	.0
		Overall Percentage			80.3

a. The cut value is .500

Variables in the Equation

		B	S.E.	Wald	df	Sig.	Exp(B)	95.0% C.I.for EXP(B) Lower	95.0% C.I.for EXP(B) Upper
Step 1	genderfin(1)	.239	.175	1.869	1	.172	1.270	.902	1.788
	ethnicityfin(1)	-.029	.404	.005	1	.942	.971	.440	2.143
	gcsepassfin(1)	-.069	.337	.042	1	.837	.933	.482	1.805
	statusfin(1)	.075	.502	.022	1	.882	1.078	.403	2.883
	Constant	-1.460	.343	18.133	1	.000	.232		

Appendix 41: SPSS output for BLR for further analysis (Model F7 – analysis one)

Dependent Variable Encoding

Original Value	Internal Value
not meeting guidelines	0
meeting guidelines	1

Categorical Variables Codings

		Frequency	Parameter coding		
			(1)	(2)	(3)
sesfin	Q1 - least deprived	166	.000	.000	.000
	Q2	167	1.000	.000	.000
	Q3	164	.000	1.000	.000
	Q4 - most deprived	166	.000	.000	1.000
ethnicityfin	white	625	.000		
	other	38	1.000		
pabaselinefin	not meeting guidelines	570	.000		
	meeting guidelines	93	1.000		
schooltypefin	state/mainstream	604	.000		
	private/independent	59	1.000		
ruralurbanfin	urban	462	.000		
	rural	201	1.000		
genderfin	male	362	.000		
	female	301	1.000		

Model Summary

Step	-2 Log likelihood	Cox & Snell R Square	Nagelkerke R Square
1	353.478[a]	.065	.144

a. Estimation terminated at iteration number 6 because parameter estimates changed by less than .001.

Hosmer and Lemeshow Test

Step	Chi-square	df	Sig.
1	5.597	8	.692

Classification Table[a]

Observed			Predicted: pafollowupbroad not meeting guidelines	meeting guidelines	Percentage Correct
Step 1	pafollowupbroad	not meeting guidelines	604	0	100.0
		meeting guidelines	59	0	.0
		Overall Percentage			91.1

a. The cut value is .500

Variables in the Equation

		B	S.E.	Wald	df	Sig.	Exp(B)	95.0% C.I.for EXP(B) Lower	Upper
Step 1	genderfin(1)	-.555	.308	3.254	1	.071	.574	.314	1.049
	ethnicityfin(1)	-.314	.765	.169	1	.681	.730	.163	3.269
	pabaselinefin(1)	1.766	.303	34.062	1	.000	5.847	3.231	10.581
	schooltypefin(1)	-.896	.747	1.437	1	.231	.408	.094	1.766
	ruralurbanfin(1)	.027	.322	.007	1	.934	1.027	.546	1.931
	sesfin			3.946	3	.267			
	sesfin(1)	.793	.416	3.639	1	.056	2.210	.978	4.991
	sesfin(2)	.297	.431	.476	1	.490	1.346	.579	3.133
	sesfin(3)	.356	.439	.656	1	.418	1.427	.604	3.374
	Constant	-2.880	.377	58.410	1	.000	.056		

Appendix 42: SPSS output for BLR for further analysis (Model F8 – analysis two)

Dependent Variable Encoding

Original Value	Internal Value
not meeting guidelines	0
meeting guidelines	1

Categorical Variables Codings

		Frequency	Parameter coding (1)
schooltypefin	state/mainstream	764	.000
	private/independent	70	1.000
ethnicityfin	white	792	.000
	other	42	1.000
pabaselinefin	not meeting guidelines	713	.000
	meeting guidelines	121	1.000
genderfin	male	447	.000
	female	387	1.000

Model Summary

Step	-2 Log likelihood	Cox & Snell R Square	Nagelkerke R Square
1	469.048[a]	.052	.113

a. Estimation terminated at iteration number 6 because parameter estimates changed by less than .001.

Hosmer and Lemeshow Test

Step	Chi-square	df	Sig.
1	.865	3	.834

Classification Table[a]

Observed			Predicted: pafollowupbroad not meeting guidelines	Predicted: pafollowupbroad meeting guidelines	Percentage Correct
Step 1	pafollowupbroad	not meeting guidelines	757	0	100.0
		meeting guidelines	77	0	.0
		Overall Percentage			90.8

a. The cut value is .500

Variables in the Equation

		B	S.E.	Wald	df	Sig.	Exp(B)	95.0% C.I.for EXP(B) Lower	Upper
Step 1	genderfin(1)	-.455	.263	2.996	1	.083	.634	.379	1.062
	ethnicityfin(1)	-.199	.628	.100	1	.751	.819	.239	2.808
	pabaselinefin(1)	1.569	.261	36.084	1	.000	4.803	2.878	8.015
	schooltypefin(1)	-1.137	.736	2.383	1	.123	.321	.076	1.359
	Constant	-2.421	.190	162.622	1	.000	.089		

Appendix 43: SPSS output for BLR for further analysis (Model F9– analysis one)

Dependent Variable Encoding

Original Value	Internal Value
not meeting guidelines	0
meeting guidelines	1

Categorical Variables Codings

		Frequency	Parameter coding (1)	(2)	(3)
sesfin	Q1 - least deprived	166	.000	.000	.000
	Q2	167	1.000	.000	.000
	Q3	164	.000	1.000	.000
	Q4 - most deprived	166	.000	.000	1.000
ethnicityfin	white	625	.000		
	other	38	1.000		
screentimestatusbaselinefin	not meeting guidelines	535	.000		
	meeting guidelines	128	1.000		
schooltypefin	state/mainstream	604	.000		
	private/independent	59	1.000		
ruralurbanfin	urban	462	.000		
	rural	201	1.000		
genderfin	male	362	.000		
	female	301	1.000		

Model Summary

Step	-2 Log likelihood	Cox & Snell R Square	Nagelkerke R Square
1	577.007[a]	.081	.132

a. Estimation terminated at iteration number 5 because parameter estimates changed by less than .001.

Hosmer and Lemeshow Test

Step	Chi-square	df	Sig.
1	7.580	8	.475

Classification Table[a]

Observed			Predicted: screentimestatusfollowupbroad: not meeting guidelines	Predicted: screentimestatusfollowupbroad: meeting guidelines	Predicted: Percentage Correct
Step 1	screentimestatusfollowupbroad	not meeting guidelines	539	2	99.6
		meeting guidelines	121	1	.8
		Overall Percentage			81.4

a. The cut value is .500

Variables in the Equation

		B	S.E.	Wald	df	Sig.	Exp(B)	95.0% C.I.for EXP(B) Lower	95.0% C.I.for EXP(B) Upper
Step 1	genderfin(1)	-.014	.214	.004	1	.947	.986	.648	1.500
	ethnicityfin(1)	.174	.442	.155	1	.693	1.191	.500	2.834
	screentimestatusbaselinefin(1)	1.645	.223	54.256	1	.000	5.181	3.344	8.025
	schooltypefin(1)	.156	.358	.189	1	.664	1.168	.579	2.357
	ruralurbanfin(1)	.149	.231	.416	1	.519	1.161	.738	1.827
	sesfin			.559	3	.906			
	sesfin(1)	.040	.304	.017	1	.896	1.040	.574	1.886
	sesfin(2)	.084	.299	.078	1	.780	1.087	.605	1.954
	sesfin(3)	-.133	.313	.182	1	.670	.875	.474	1.616
	Constant	-2.006	.251	64.005	1	.000	.135		

Appendix 44: SPSS output for BLR for further analysis (Model F10– analysis two)

Dependent Variable Encoding

Original Value	Internal Value
not meeting guidelines	0
meeting guidelines	1

Categorical Variables Codings

		Frequency	Parameter coding (1)
schooltypefin	state/mainstream	764	.000
	private/independent	70	1.000
ethnicityfin	white	792	.000
	other	42	1.000
screentimestatusbaselinefin	not meeting guidelines	665	.000
	meeting guidelines	169	1.000
genderfin	male	447	.000
	female	387	1.000

Model Summary

Step	-2 Log likelihood	Cox & Snell R Square	Nagelkerke R Square
1	757.446[a]	.080	.127

a. Estimation terminated at iteration number 5 because parameter estimates changed by less than .001.

Hosmer and Lemeshow Test

Step	Chi-square	df	Sig.
1	.915	5	.969

Classification Table[a]

Observed			Predicted: screentimestatusfollowupbroad: not meeting guidelines	Predicted: screentimestatusfollowupbroad: meeting guidelines	Predicted: Percentage Correct
Step 1	screentimestatusfollowupbroad	not meeting guidelines	669	1	99.9
		meeting guidelines	159	5	3.0
		Overall Percentage			80.8

a. The cut value is .500

Variables in the Equation

		B	S.E.	Wald	df	Sig.	Exp(B)	95.0% C.I.for EXP(B) Lower	95.0% C.I.for EXP(B) Upper
Step 1	genderfin(1)	.168	.183	.835	1	.361	1.182	.825	1.694
	ethnicityfin(1)	-.072	.424	.029	1	.866	.931	.405	2.138
	screentimestatusbaselinefin(1)	1.592	.192	68.399	1	.000	4.913	3.369	7.165
	schooltypefin(1)	.239	.310	.596	1	.440	1.270	.692	2.330
	Constant	-1.950	.148	173.546	1	.000	.142		

Appendix 45: SPSS output for physical activity and screen time status 'hybrid' (cross-tabulations – analysis one)

Cross-tabulations for physical activity and screen time status at baseline (analysis one)

pabaselinefinal * screentimestatusbaselinefinal Crosstabulation

			screentimestatusbaselinefinal		
			not meeting guidelines	meeting guidelines	Total
pabaselinefinal	not meeting guidelines	Count	468	102	570
		% of Total	70.6%	15.4%	86.0%
	meeting guidelines	Count	67	26	93
		% of Total	10.1%	3.9%	14.0%
	Total	Count	535	128	663
		% of Total	80.7%	19.3%	100.0%

Cross-tabulations for physical activity and screen time status at follow-up (analysis one)

pafollowupfinal * screentimestatusfollowupfinal Crosstabulation

			screentimestatusfollowupfinal		
			not meeting guidelines	meeting guidelines	Total
pafollowupfinal	not meeting guidelines	Count	496	108	604
		% of Total	74.8%	16.3%	91.1%
	meeting guidelines	Count	45	14	59
		% of Total	6.8%	2.1%	8.9%
	Total	Count	541	122	663
		% of Total	81.6%	18.4%	100.0%

Appendix 46: SPSS output for physical activity and screen time status 'hybrid' (cross-tabulations – analysis two)

Cross-tabulations for physical activity and screen time status at baseline (analysis two)

pabaselinefinal * screentimestatusbaselinefinal Crosstabulation

			screentimestatusbaselinefinal		
			not meeting guidelines	meeting guidelines	Total
pabaselinefinal	not meeting guidelines	Count	576	137	713
		% of Total	69.1%	16.4%	85.5%
	meeting guidelines	Count	89	32	121
		% of Total	10.7%	3.8%	14.5%
	Total	Count	665	169	834
		% of Total	79.7%	20.3%	100.0%

Cross-tabulations for physical activity and screen time status at follow-up (analysis two)

pafollowupfinal * screentimestatusfollowupfinal Crosstabulation

			screentimestatusfollowupfinal		
			not meeting guidelines	meeting guidelines	Total
pafollowupfinal	not meeting guidelines	Count	609	148	757
		% of Total	73.0%	17.7%	90.8%
	meeting guidelines	Count	61	16	77
		% of Total	7.3%	1.9%	9.2%
	Total	Count	670	164	834
		% of Total	80.3%	19.7%	100.0%

Appendix 47: SPSS outputs for travel data at baseline and follow-up (analysis one)

(1) Descriptive frequencies for each mode of travel at baseline and follow-up (analysis one)

busbaseline

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	yes	218	32.9	32.9	32.9
	no	445	67.1	67.1	100.0
	Total	663	100.0	100.0	

busfollowup

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	yes	301	45.4	45.4	45.4
	no	362	54.6	54.6	100.0
	Total	663	100.0	100.0	

trainbaseline

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	no	663	100.0	100.0	100.0

trainfollowup

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	yes	7	1.1	1.1	1.1
	no	656	98.9	98.9	100.0
	Total	663	100.0	100.0	

carbaseline

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	yes	244	36.8	36.8	36.8
	no	419	63.2	63.2	100.0
	Total	663	100.0	100.0	

carfollowup

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	yes	231	34.8	34.8	34.8
	no	432	65.2	65.2	100.0
	Total	663	100.0	100.0	

bikebaseline

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	yes	51	7.7	7.7	7.7
	no	612	92.3	92.3	100.0
	Total	663	100.0	100.0	

bikefollowup

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	yes	57	8.6	8.6	8.6
	no	606	91.4	91.4	100.0
	Total	663	100.0	100.0	

walkbaseline

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	yes	294	44.3	44.3	44.3
	no	369	55.7	55.7	100.0
	Total	663	100.0	100.0	

walkfollowup

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	yes	281	42.4	42.4	42.4
	no	382	57.6	57.6	100.0
	Total	663	100.0	100.0	

otherbaseline

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	yes	7	1.1	1.1	1.1
	no	656	98.9	98.9	100.0
	Total	663	100.0	100.0	

otherfollowup

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	yes	11	1.7	1.7	1.7
	no	652	98.3	98.3	100.0
	Total	663	100.0	100.0	

(2) Cross-tabulations for active modes of transport at baseline and follow-up (analysis one)

bikebaseline * bikefollowup Crosstabulation

			bikefollowup		
			yes	no	Total
bikebaseline	yes	Count	34	17	51
		% of Total	5.1%	2.6%	7.7%
	no	Count	23	589	612
		% of Total	3.5%	88.8%	92.3%
	Total	Count	57	606	663
		% of Total	8.6%	91.4%	100.0%

walkbaseline * walkfollowup Crosstabulation

			walkfollowup		
			yes	no	Total
walkbaseline	yes	Count	219	75	294
		% of Total	33.0%	11.3%	44.3%
	no	Count	62	307	369
		% of Total	9.4%	46.3%	55.7%
	Total	Count	281	382	663
		% of Total	42.4%	57.6%	100.0%

(3) Cross-tabulations for passive modes of transport at baseline and follow-up (analysis one)

busbaseline * busfollowup Crosstabulation

			busfollowup		
			yes	no	Total
busbaseline	yes	Count	187	31	218
		% of Total	28.2%	4.7%	32.9%
	no	Count	114	331	445
		% of Total	17.2%	49.9%	67.1%
	Total	Count	301	362	663
		% of Total	45.4%	54.6%	100.0%

trainbaseline * trainfollowup Crosstabulation

			trainfollowup		
			yes	no	Total
trainbaseline	no	Count	7	656	663
		% of Total	1.1%	98.9%	100.0%
	Total	Count	7	656	663
		% of Total	1.1%	98.9%	100.0%

carbaseline * carfollowup Crosstabulation

			carfollowup		
			yes	no	Total
carbaseline	yes	Count	175	69	244
		% of Total	26.4%	10.4%	36.8%
	no	Count	56	363	419
		% of Total	8.4%	54.8%	63.2%
	Total	Count	231	432	663
		% of Total	34.8%	65.2%	100.0%

Appendix 48: SPSS outputs for travel data at baseline and follow-up (analysis two)

(1) Descriptive frequencies for each mode of travel at baseline and follow-up (analysis two)

busbaseline

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	yes	321	38.5	38.5	38.5
	no	513	61.5	61.5	100.0
	Total	834	100.0	100.0	

busfollowup

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	yes	393	47.1	47.1	47.1
	no	441	52.9	52.9	100.0
	Total	834	100.0	100.0	

trainbaseline

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	yes	1	.1	.1	.1
	no	833	99.9	99.9	100.0
	Total	834	100.0	100.0	

trainfollowup

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	yes	9	1.1	1.1	1.1
	no	825	98.9	98.9	100.0
	Total	834	100.0	100.0	

carbaseline

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	yes	303	36.3	36.3	36.3
	no	531	63.7	63.7	100.0
	Total	834	100.0	100.0	

carfollowup

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	yes	318	38.1	38.1	38.1
	no	516	61.9	61.9	100.0
	Total	834	100.0	100.0	

bikebaseline

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	yes	55	6.6	6.6	6.6
	no	779	93.4	93.4	100.0
	Total	834	100.0	100.0	

bikefollowup

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	yes	62	7.4	7.4	7.4
	no	772	92.6	92.6	100.0
	Total	834	100.0	100.0	

walkbaseline

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	yes	340	40.8	40.8	40.8
	no	494	59.2	59.2	100.0
	Total	834	100.0	100.0	

walkfollowup

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	yes	328	39.3	39.3	39.3
	no	506	60.7	60.7	100.0
	Total	834	100.0	100.0	

otherbaseline

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	yes	8	1.0	1.0	1.0
	no	826	99.0	99.0	100.0
	Total	834	100.0	100.0	

otherfollowup

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	yes	16	1.9	1.9	1.9
	no	818	98.1	98.1	100.0
	Total	834	100.0	100.0	

(2) Cross-tabulations for active modes of transport at baseline and follow-up (analysis two)

bikebaseline * bikefollowup Crosstabulation

			bikefollowup		
			yes	no	Total
bikebaseline	yes	Count	36	19	55
		% of Total	4.3%	2.3%	6.6%
	no	Count	26	753	779
		% of Total	3.1%	90.3%	93.4%
	Total	Count	62	772	834
		% of Total	7.4%	92.6%	100.0%

walkbaseline * walkfollowup Crosstabulation

			walkfollowup		
			yes	no	Total
walkbaseline	yes	Count	251	89	340
		% of Total	30.1%	10.7%	40.8%
	no	Count	77	417	494
		% of Total	9.2%	50.0%	59.2%
	Total	Count	328	506	834
		% of Total	39.3%	60.7%	100.0%

(3) Cross-tabulations for passive modes of transport at baseline and follow-up (analysis two)

busbaseline * busfollowup Crosstabulation

			busfollowup		
			yes	no	Total
busbaseline	yes	Count	266	55	321
		% of Total	31.9%	6.6%	38.5%
	no	Count	127	386	513
		% of Total	15.2%	46.3%	61.5%
	Total	Count	393	441	834
		% of Total	47.1%	52.9%	100.0%

trainbaseline * trainfollowup Crosstabulation

			trainfollowup		
			yes	no	Total
trainbaseline	yes	Count	1	0	1
		% of Total	.1%	.0%	.1%
	no	Count	8	825	833
		% of Total	1.0%	98.9%	99.9%
	Total	Count	9	825	834
		% of Total	1.1%	98.9%	100.0%

carbaseline * carfollowup Crosstabulation

			carfollowup		
			yes	no	Total
carbaseline	yes	Count	223	80	303
		% of Total	26.7%	9.6%	36.3%
	no	Count	95	436	531
		% of Total	11.4%	52.3%	63.7%
	Total	Count	318	516	834
		% of Total	38.1%	61.9%	100.0%

Appendix 49: SPSS outputs for 'other' physical activity data collected at baseline and follow-up (analysis one)

(1) Descriptive frequencies for each physical activity question at baseline and follow-up (analysis one)

Number of times participated in organised team or individual sports in the previous seven days (when having participated in at least 60 minutes of sport or physical activity)

organisedteamorindivsportsbaseline

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	none	171	25.8	25.8	25.8
	1 to 2 times	296	44.6	44.6	70.4
	3 to 4 times	135	20.4	20.4	90.8
	5 to 6 times	39	5.9	5.9	96.7
	7 or more times	22	3.3	3.3	100.0
	Total	663	100.0	100.0	

organisedteamorindivsportsfollowup

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	none	231	34.8	34.8	34.8
	1 to 2 times	243	36.7	36.7	71.5
	3 to 4 times	139	21.0	21.0	92.5
	5 to 6 times	35	5.3	5.3	97.7
	7 or more times	15	2.3	2.3	100.0
	Total	663	100.0	100.0	

Number of times participated in physical activity that was not an organised team or individual sport in the previous seven days (when having participated in at least 60 minutes of sport or physical activity)

nonorganisedteamorindivsportsbaseline

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	none	102	15.4	15.4	15.4
	1 to 2 times	309	46.6	46.6	62.0
	3 to 4 times	154	23.2	23.2	85.2
	5 to 6 times	60	9.0	9.0	94.3
	7 or more times	38	5.7	5.7	100.0
	Total	663	100.0	100.0	

nonorganisedteamorindivsportsfollowup

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	none	132	19.9	19.9	19.9
	1 to 2 times	308	46.5	46.5	66.4
	3 to 4 times	144	21.7	21.7	88.1
	5 to 6 times	53	8.0	8.0	96.1
	7 or more times	26	3.9	3.9	100.0
	Total	663	100.0	100.0	

Number of sessions of 30 minutes of sport and active recreation participated in during an average week

sessionsof30minutesbaseline

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	none	41	6.2	6.2	6.2
	1 to 2 sessions	177	26.7	26.7	32.9
	3 to 4 sessions	193	29.1	29.1	62.0
	5 to 6 sessions	123	18.6	18.6	80.5
	7 or more sessions	129	19.5	19.5	100.0
	Total	663	100.0	100.0	

sessionsof30minutesfollowup

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	none	67	10.1	10.1	10.1
	1 to 2 sessions	181	27.3	27.3	37.4
	3 to 4 sessions	199	30.0	30.0	67.4
	5 to 6 sessions	112	16.9	16.9	84.3
	7 or more sessions	104	15.7	15.7	100.0
	Total	663	100.0	100.0	

The general intensity of the sport and active recreation undertaken during an average week

sportandactiverecintensitybaseline

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	vigorous intensity	221	33.3	33.3	33.3
	moderate intensity	364	54.9	54.9	88.2
	light intensity	45	6.8	6.8	95.0
	not applicable	33	5.0	5.0	100.0
	Total	663	100.0	100.0	

sportandactiverecintensityfollowup

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	vigorous intensity	234	35.3	35.3	35.3
	moderate intensity	326	49.2	49.2	84.5
	light intensity	53	8.0	8.0	92.5
	not applicable	50	7.5	7.5	100.0
	Total	663	100.0	100.0	

(2) Cross-tabulations for each question at baseline and follow-up (analysis one)

Number of times participated in organised team or individual sports in the previous seven days (when having participated in at least 60 minutes of sport or physical activity)

organisedteamorindivsportsbaseline * organisedteamorindivsportsfollowup Crosstabulation

			organisedteamorindivsportsfollowup					
			none	1 to 2 times	3 to 4 times	5 to 6 times	7 or more times	Total
organisedteamorindivsportsbaseline	none	Count	107	50	11	1	2	171
		% of Total	16.1%	7.5%	1.7%	.2%	.3%	25.8%
	1 to 2 times	Count	93	137	60	4	2	296
		% of Total	14.0%	20.7%	9.0%	.6%	.3%	44.6%
	3 to 4 times	Count	24	44	49	14	4	135
		% of Total	3.6%	6.6%	7.4%	2.1%	.6%	20.4%
	5 to 6 times	Count	1	8	13	13	4	39
		% of Total	.2%	1.2%	2.0%	2.0%	.6%	5.9%
	7 or more times	Count	6	4	6	3	3	22
		% of Total	.9%	.6%	.9%	.5%	.5%	3.3%
	Total	Count	231	243	139	35	15	663
		% of Total	34.8%	36.7%	21.0%	5.3%	2.3%	100.0%

Number of times participated in physical activity that was not an organised team or individual sport in the previous seven days (when having participated in at least 60 minutes of sport or physical activity)

nonorganisedteamorindivsportsbaseline * nonorganisedteamorindivsportsfollowup Crosstabulation

			nonorganisedteamorindivsportsfollowup					
			none	1 to 2 times	3 to 4 times	5 to 6 times	7 or more times	Total
nonorganisedteamorindivsportsbaseline	none	Count	36	52	10	1	3	102
		% of Total	5.4%	7.8%	1.5%	.2%	.5%	15.4%
	1 to 2 times	Count	61	158	61	22	7	309
		% of Total	9.2%	23.8%	9.2%	3.3%	1.1%	46.6%
	3 to 4 times	Count	22	71	41	12	8	154
		% of Total	3.3%	10.7%	6.2%	1.8%	1.2%	23.2%
	5 to 6 times	Count	8	18	21	10	3	60
		% of Total	1.2%	2.7%	3.2%	1.5%	.5%	9.0%
	7 or more times	Count	5	9	11	8	5	38
		% of Total	.8%	1.4%	1.7%	1.2%	.8%	5.7%
	Total	Count	132	308	144	53	26	663
		% of Total	19.9%	46.5%	21.7%	8.0%	3.9%	100.0%

Number of sessions of 30 minutes of sport and active recreation participated in during an average week

sessionsof30minutesbaseline * sessionsof30minutesfollowup Crosstabulation

			sessionsof30minutesfollowup					
			none	1 to 2 sessions	3 to 4 sessions	5 to 6 sessions	7 or more sessions	Total
sessionsof30minutesbaseline	none	Count	15	17	8	1	0	41
		% of Total	2.3%	2.6%	1.2%	.2%	.0%	6.2%
	1 to 2 sessions	Count	27	82	49	16	3	177
		% of Total	4.1%	12.4%	7.4%	2.4%	.5%	26.7%
	3 to 4 sessions	Count	17	47	72	36	21	193
		% of Total	2.6%	7.1%	10.9%	5.4%	3.2%	29.1%
	5 to 6 sessions	Count	4	23	41	26	29	123
		% of Total	.6%	3.5%	6.2%	3.9%	4.4%	18.6%
	7 or more sessions	Count	4	12	29	33	51	129
		% of Total	.6%	1.8%	4.4%	5.0%	7.7%	19.5%
	Total	Count	67	181	199	112	104	663
		% of Total	10.1%	27.3%	30.0%	16.9%	15.7%	100.0%

The general intensity of the sport and active recreation undertaken during an average week

sportandactiverecintensitybaseline * sportandactiverecintensityfollowup Crosstabulation

			sportandactiverecintensityfollowup				
			vigorous intensity	moderate intensity	light intensity	not applicable	Total
sportandactiverecintensitybaseline	vigorous intensity	Count	133	71	5	12	221
		% of Total	20.1%	10.7%	.8%	1.8%	33.3%
	moderate intensity	Count	88	214	36	26	364
		% of Total	13.3%	32.3%	5.4%	3.9%	54.9%
	light intensity	Count	8	27	4	6	45
		% of Total	1.2%	4.1%	.6%	.9%	6.8%
	not applicable	Count	5	14	8	6	33
		% of Total	.8%	2.1%	1.2%	.9%	5.0%
	Total	Count	234	326	53	50	663
		% of Total	35.3%	49.2%	8.0%	7.5%	100.0%

Appendix 50: SPSS outputs for 'other' physical activity data collected at baseline and follow-up (analysis two)

(1) Descriptive frequencies for each physical activity question at baseline and follow-up (analysis two)

Number of times participated in organised team or individual sports in the previous seven days (when having participated in at least 60 minutes of sport or physical activity)

organisedteamorindivsportsbaseline

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	None	198	23.7	23.7	23.7
	1 to 2 times	377	45.2	45.2	68.9
	3 to 4 times	181	21.7	21.7	90.6
	5 to 6 times	51	6.1	6.1	96.8
	7 or more times	27	3.2	3.2	100.0
	Total	834	100.0	100.0	

organisedteamorindivsportsfollowup

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	None	282	33.8	33.8	33.8
	1 to 2 times	311	37.3	37.3	71.1
	3 to 4 times	171	20.5	20.5	91.6
	5 to 6 times	45	5.4	5.4	97.0
	7 or more times	25	3.0	3.0	100.0
	Total	834	100.0	100.0	

Number of times participated in physical activity that was not an organised team or individual sport in the previous seven days (when having participated in at least 60 minutes of sport or physical activity)

nonorganisedteamorindivsportsbaseline

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	None	129	15.5	15.5	15.5
	1 to 2 times	390	46.8	46.8	62.2
	3 to 4 times	191	22.9	22.9	85.1
	5 to 6 times	77	9.2	9.2	94.4
	7 or more times	47	5.6	5.6	100.0
	Total	834	100.0	100.0	

nonorganisedteamorindivsportsfollowup

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	None	165	19.8	19.8	19.8
	1 to 2 times	393	47.1	47.1	66.9
	3 to 4 times	178	21.3	21.3	88.2
	5 to 6 times	62	7.4	7.4	95.7
	7 or more times	36	4.3	4.3	100.0
	Total	834	100.0	100.0	

Number of sessions of 30 minutes of sport and active recreation participated in during an average week

sessionsof30minutesbaseline

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	none	46	5.5	5.5	5.5
	1 to 2 sessions	221	26.5	26.5	32.0
	3 to 4 sessions	233	27.9	27.9	60.0
	5 to 6 sessions	170	20.4	20.4	80.3
	7 or more sessions	164	19.7	19.7	100.0
	Total	834	100.0	100.0	

sessionsof30minutesfollowup

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	none	80	9.6	9.6	9.6
	1 to 2 sessions	223	26.7	26.7	36.3
	3 to 4 sessions	253	30.3	30.3	66.7
	5 to 6 sessions	138	16.5	16.5	83.2
	7 or more sessions	140	16.8	16.8	100.0
	Total	834	100.0	100.0	

The general intensity of the sport and active recreation undertaken during an average week

sportandactiverecintensitybaseline

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	vigorous intensity	273	32.7	32.7	32.7
	moderate intensity	467	56.0	56.0	88.7
	light intensity	56	6.7	6.7	95.4
	not applicable	38	4.6	4.6	100.0
	Total	834	100.0	100.0	

sportandactiverecintensityfollowup

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	vigorous intensity	293	35.1	35.1	35.1
	moderate intensity	419	50.2	50.2	85.4
	light intensity	63	7.6	7.6	92.9
	not applicable	59	7.1	7.1	100.0
	Total	834	100.0	100.0	

(2) Cross-tabulations for each question at baseline and follow-up (analysis two)

Number of times participated in organised team or individual sports in the previous seven days (when having participated in at least 60 minutes of sport or physical activity)

organisedteamorindivsportsbaseline * organisedteamorindivsportsfollowup Crosstabulation

			organisedteamorindivsportsfollowup					
			None	1 to 2 times	3 to 4 times	5 to 6 times	7 or more times	Total
organisedteamorindivsportsbaseline	None	Count	124	58	12	2	2	198
		% of Total	14.9%	7.0%	1.4%	.2%	.2%	23.7%
	1 to 2 times	Count	120	172	73	6	6	377
		% of Total	14.4%	20.6%	8.8%	.7%	.7%	45.2%
	3 to 4 times	Count	30	65	61	17	8	181
		% of Total	3.6%	7.8%	7.3%	2.0%	1.0%	21.7%
	5 to 6 times	Count	2	12	17	15	5	51
		% of Total	.2%	1.4%	2.0%	1.8%	.6%	6.1%
	7 or more times	Count	6	4	8	5	4	27
		% of Total	.7%	.5%	1.0%	.6%	.5%	3.2%
	Total	Count	282	311	171	45	25	834
		% of Total	33.8%	37.3%	20.5%	5.4%	3.0%	100.0%

Number of times participated in physical activity that was not an organised team or individual sport in the previous seven days (when having participated in at least 60 minutes of sport or physical activity)

nonorganisedteamorindivsportsbaseline * nonorganisedteamorindivsportsfollowup Crosstabulation

			nonorganisedteamorindivsportsfollowup					
			None	1 to 2 times	3 to 4 times	5 to 6 times	7 or more times	Total
nonorganisedteamorindivsportsbaseline	None	Count	50	61	14	1	3	129
		% of Total	6.0%	7.3%	1.7%	.1%	.4%	15.5%
	1 to 2 times	Count	76	209	70	26	9	390
		% of Total	9.1%	25.1%	8.4%	3.1%	1.1%	46.8%
	3 to 4 times	Count	24	89	52	14	12	191
		% of Total	2.9%	10.7%	6.2%	1.7%	1.4%	22.9%
	5 to 6 times	Count	9	24	28	11	5	77
		% of Total	1.1%	2.9%	3.4%	1.3%	.6%	9.2%
	7 or more times	Count	6	10	14	10	7	47
		% of Total	.7%	1.2%	1.7%	1.2%	.8%	5.6%
	Total	Count	165	393	178	62	36	834
		% of Total	19.8%	47.1%	21.3%	7.4%	4.3%	100.0%

Number of sessions of 30 minutes of sport and active recreation participated in during an average week

sessionsof30minutesbaseline * sessionsof30minutesfollowup Crosstabulation

			sessionsof30minutesfollowup					
			none	1 to 2 sessions	3 to 4 sessions	5 to 6 sessions	7 or more sessions	Total
sessionsof30minutesbaseline	none	Count	19	18	8	1	0	46
		% of Total	2.3%	2.2%	1.0%	.1%	.0%	5.5%
	1 to 2 sessions	Count	34	101	60	18	8	221
		% of Total	4.1%	12.1%	7.2%	2.2%	1.0%	26.5%
	3 to 4 sessions	Count	19	57	88	41	28	233
		% of Total	2.3%	6.8%	10.6%	4.9%	3.4%	27.9%
	5 to 6 sessions	Count	4	31	60	37	38	170
		% of Total	.5%	3.7%	7.2%	4.4%	4.6%	20.4%
	7 or more sessions	Count	4	16	37	41	66	164
		% of Total	.5%	1.9%	4.4%	4.9%	7.9%	19.7%
	Total	Count	80	223	253	138	140	834
		% of Total	9.6%	26.7%	30.3%	16.5%	16.8%	100.0%

The general intensity of the sport and active recreation undertaken during an average week

sportandactiverecintensitybaseline * sportandactiverecintensityfollowup Crosstabulation

			sportandactiverecintensityfollowup				
			vigorous intensity	moderate intensity	light intensity	not applicable	Total
sportandactiverecintensitybaseline	vigorous intensity	Count	168	85	6	14	273
		% of Total	20.1%	10.2%	.7%	1.7%	32.7%
	moderate intensity	Count	111	286	42	28	467
		% of Total	13.3%	34.3%	5.0%	3.4%	56.0%
	light intensity	Count	9	32	7	8	56
		% of Total	1.1%	3.8%	.8%	1.0%	6.7%
	not applicable	Count	5	16	8	9	38
		% of Total	.6%	1.9%	1.0%	1.1%	4.6%
	Total	Count	293	419	63	59	834
		% of Total	35.1%	50.2%	7.6%	7.1%	100.0%

Appendix 51: SPSS output for sample size of independent variables at baseline, follow-up (analysis one) and follow-up (analysis two)

(a) Baseline

genderfin

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	male	1191	54.0	54.1	54.1
	female	1009	45.8	45.9	100.0
	Total	2200	99.8	100.0	
Missing	System	4	.2		
Total		2204	100.0		

ethnicityfin

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	white	2059	93.4	93.7	93.7
	other	138	6.3	6.3	100.0
	Total	2197	99.7	100.0	
Missing	System	7	.3		
Total		2204	100.0		

schooltypefin

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	state/mainstream	2068	93.8	93.8	93.8
	private/independent	136	6.2	6.2	100.0
	Total	2204	100.0	100.0	

ruralurbanfin

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	urban	1090	49.5	72.4	72.4
	rural	415	18.8	27.6	100.0
	Total	1505	68.3	100.0	
Missing	System	699	31.7		
Total		2204	100.0		

sesfin

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Q1 - least deprived	376	17.1	25.0	25.0
	Q2	376	17.1	25.0	50.0
	Q3	376	17.1	25.0	75.0
	Q4 - most deprived	375	17.0	25.0	100.0
	Total	1503	68.2	100.0	
Missing	System	701	31.8		
Total		2204	100.0		

pastatusbaselinefin

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	not meeting guidelines	1881	85.3	86.5	86.5
	meeting guidelines	294	13.3	13.5	100.0
	Total	2175	98.7	100.0	
Missing	System	29	1.3		
Total		2204	100.0		

screentimestatusatbaselinefin

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	not meeting guidelines	1746	79.2	80.2	80.2
	meeting guidelines	430	19.5	19.8	100.0
	Total	2176	98.7	100.0	
Missing	System	28	1.3		
Total		2204	100.0		

(b) Follow-up (analysis one)

genderfin

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	male	362	54.6	54.6	54.6
	female	301	45.4	45.4	100.0
	Total	663	100.0	100.0	

ethnicityfin

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	white	625	94.3	94.3	94.3
	other	38	5.7	5.7	100.0
	Total	663	100.0	100.0	

gcsepassfin

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	no	54	8.1	8.1	8.1
	yes	609	91.9	91.9	100.0
	Total	663	100.0	100.0	

schooltypefin

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	state/mainstream	604	91.1	91.1	91.1
	private/independent	59	8.9	8.9	100.0
	Total	663	100.0	100.0	

ruralurbanfin

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	urban	462	69.7	69.7	69.7
	rural	201	30.3	30.3	100.0
	Total	663	100.0	100.0	

sesfin

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Q1 - least deprived	166	25.0	25.0	25.0
	Q2	167	25.2	25.2	50.2
	Q3	164	24.7	24.7	75.0
	Q4 - most deprived	166	25.0	25.0	100.0
	Total	663	100.0	100.0	

pabaselinefin

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	not meeting guidelines	570	86.0	86.0	86.0
	meeting guidelines	93	14.0	14.0	100.0
	Total	663	100.0	100.0	

screentimestatusbaselinefin

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	not meeting guidelines	535	80.7	80.7	80.7
	meeting guidelines	128	19.3	19.3	100.0
	Total	663	100.0	100.0	

Status at follow-up (analysis one)

statusfin

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	education	641	96.7	96.7	96.7
	employment or unemployment	22	3.3	3.3	100.0
	Total	663	100.0	100.0	

(c) Follow-up (analysis two)

genderfin

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	male	447	53.6	53.6	53.6
	female	387	46.4	46.4	100.0
	Total	834	100.0	100.0	

ethnicityfin

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	white	792	95.0	95.0	95.0
	other	42	5.0	5.0	100.0
	Total	834	100.0	100.0	

gcsepassfin

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	no	66	7.9	7.9	7.9
	yes	768	92.1	92.1	100.0
	Total	834	100.0	100.0	

schooltypefin

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	state/mainstream	764	91.6	91.6	91.6
	private/independent	70	8.4	8.4	100.0
	Total	834	100.0	100.0	

pabaselinefin

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	not meeting guidelines	713	85.5	85.5	85.5
	meeting guidelines	121	14.5	14.5	100.0
	Total	834	100.0	100.0	

screentimestatusbaselinefin

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	not meeting guidelines	665	79.7	79.7	79.7
	meeting guidelines	169	20.3	20.3	100.0
	Total	834	100.0	100.0	

Status at follow-up (analysis two)

statusfin

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	education	806	96.6	96.6	96.6
	employment or unemployment	28	3.4	3.4	100.0
	Total	834	100.0	100.0	

Appendix 52: Summary of main findings

Table A1
Summary of main findings

Research question number / specific further analysis	Summary of finding(s)
Research Question 1 Is there a change in physical activity in the transition between Year 11 and the period post compulsory education?	**Analysis one** - Significant change from meeting guidelines for physical activity at baseline but not meeting guidelines at follow-up. **Cross-tabulation analysis (analysis one and two)** **Outcomes: meeting guidelines at baseline and follow-up; meeting guidelines at baseline but not meeting guidelines at follow-up; not meeting guidelines at baseline but meeting guidelines at follow-up; and not meeting guidelines at either baseline or follow-up)** 3.9% meeting guidelines at baseline and follow-up. 10.1% meeting guidelines at baseline but not meeting guidelines at follow-up. 5.0% not meeting guidelines at baseline but meeting guidelines at follow-up. 81.0% not meeting guidelines at either baseline or follow-up. **Analysis two** - Significant change from meeting guidelines for physical activity at baseline but not meeting guidelines at follow-up. 3.8% meeting guidelines at baseline and follow-up. 10.7% meeting guidelines at baseline but not meeting guidelines at follow-up. 5.4% not meeting guidelines at baseline but meeting guidelines at follow-up. 80.1% not meeting guidelines at either baseline or follow-up.
Research Question 2 How is physical activity post compulsory education completion associated with a range of independent variables?	**Model 1 (analysis one)** - Greater likelihood of not meeting guidelines for physical activity at follow-up in females. When compared to males, females were 52.4% less likely to meet recommended guidelines for physical activity at follow-up. **Model 2 (analysis two)** – Greater likelihood of not meeting guidelines for physical activity participation at follow-up in females. When compared to males, females were 47.1% less likely to meet recommended guidelines for physical activity at follow-up.
Research Question 3 Is there a change in screen time status in the transition between Year 11 and the period post compulsory education?	**Analysis one** - No significant change in screen time status between baseline and follow-up. **Cross-tabulation analysis (analysis one and two)** **Outcomes: meeting guidelines at baseline and follow-up; meeting guidelines at baseline but not meeting guidelines at follow-up; not meeting guidelines at baseline but meeting guidelines at follow-up; and not meeting guidelines at either baseline or follow-up)**

	8.3% meeting guidelines at baseline and follow-up. 11.0% meeting guidelines at baseline but not meeting guidelines at follow-up. 10.1% not meeting guidelines at baseline but meeting guidelines at follow-up. 70.6% not meeting guidelines at baseline or follow-up. **Analysis two** - No significant change in screen time status between baseline and follow-up. 8.9% were meeting guidelines at baseline and follow-up. 11.4% were meeting guidelines at baseline but were not meeting guidelines at follow-up. 10.8% were not meeting guidelines at baseline but were meeting guidelines at follow-up. 68.9% were not meeting guidelines at baseline or follow-up.
Research Question 4 How is screen time status post compulsory education completion associated with a range of independent variables?	**Model 3 (analysis one)** - None of the independent variables made a statistically significant contribution to the model. **Model 4 (analysis two)** - None of the independent variables made a statistically significant contribution to the model.
First further analysis Due to the outcome of Research Question 1 (i.e., the significant decline in physical activity through the transition period from 'meeting guidelines at baseline' to 'not meeting guidelines at follow-up'), the impact of the same independent variables as previous was examined on the likelihood that participants would move from meeting guidelines for physical activity at baseline to not meeting guidelines at follow-up.	**Model F1 (analysis one)** - Lower likelihood of moving from meeting guidelines for physical activity at baseline to not meeting guidelines at follow-up in females. When compared to males, females were 42.4% less likely to move from meeting guidelines for physical activity at baseline to not meeting guidelines at follow-up. **Model F2 (analysis two)** - Lower likelihood of moving from meeting guidelines for physical activity at baseline to not meeting guidelines at follow-up in females. When compared to males, females were 47.6% less likely to move from meeting guidelines for physical activity at baseline to not meeting guidelines at follow-up.

Second further analysis Inclusion of 'status at follow-up' and removal of 'school type' as an independent variable in relation to:	
(1) Research Question 2 (i.e., How is physical activity post compulsory education completion associated with a range of independent variables?)	**Model F3 (analysis one)** – Greater likelihood of not meeting guidelines for physical activity at follow-up in females. When compared to males, females were 52.9% less likely to meet recommended guidelines for physical activity at follow-up. **Model F4 (analysis two)** – Greater likelihood of not meeting guidelines for physical activity at follow-up in females. When compared to males, females were 47.8% less likely to meet recommended guidelines for physical activity at follow-up.
(2) Research Question 4 (i.e., How is screen time status post compulsory education completion associated with a range of independent variables?).	**Model F5 (analysis one)** - none of the independent variables made a statistically significant contribution to the model. **Model F6 (analysis two)** - none of the independent variables made a statistically significant contribution to the model.
Third further analysis Inclusion of 'baseline physical activity' and removal of 'educational attainment' as an independent variable in relation to:	
Research Question 2 (i.e., How is physical activity post compulsory education completion associated with a range of independent variables?)	**Model F7 (analysis one)** – Meeting guidelines for physical activity at baseline increased the likelihood of meeting guidelines at follow-up. When compared to participants not meeting guidelines for physical activity at baseline, participants meeting guidelines for physical activity at baseline were 5.8 times more likely to meet recommended guidelines at follow-up. **Model F8 (analysis two)** – Meeting guidelines for physical activity at baseline increased the likelihood of meeting guidelines at follow-up. When compared to participants not meeting guidelines for physical activity at baseline, participants meeting guidelines for physical activity at baseline were 4.8 times more likely to meet recommended guidelines follow-up.

Inclusion of 'baseline screen time status' and removal of 'educational attainment' as an independent variable in relation to: Research Question 4 (i.e., How is screen time status post compulsory education completion associated with a range of independent variables?).	**Model F9 (analysis one)** – Meeting guidelines for screen time at baseline increased the likelihood of meeting guidelines at follow-up. When compared to participants not meeting guidelines for screen time at baseline, participants meeting guidelines for screen time at baseline were 5.2 times more likely to meet recommended guidelines at follow-up. **Model F10 (analysis two)** – Meeting guidelines for screen time at baseline increased the likelihood of meeting guidelines at follow-up. When compared to participants not meeting guidelines for screen time at baseline, participants meeting guidelines for screen time at baseline were 4.9 times more likely to meet recommended guidelines at follow-up.
Fourth further analysis Cross-tabulation analysis investigating a possible link between physical activity and screen time status of participants at baseline and follow-up. Cross-tabulations were performed for analysis one and two in the form of a 'hybrid'. The hybrid classified participants into four groups at baseline and follow-up respectively: (1) not meeting guidelines for physical activity and meeting screen time guidelines; (2) not meeting guidelines for physical activity and not meeting screen time guidelines; (3) meeting guidelines for physical activity and meeting screen time	<u>Cross-tabulation analysis</u> **<u>Outcomes:</u> not meeting guidelines for physical activity or screen time; were not meeting guidelines for physical activity but were meeting guidelines for screen time; were meeting guidelines for physical activity but were not meeting guidelines for screen time; and were meeting guidelines for physical activity and were also meeting guidelines for screen time** **Analysis one (baseline)** 70.6% were not meeting guidelines for physical activity or screen time. 15.4% were not meeting guidelines for physical activity but were meeting guidelines for screen time. 10.1% were meeting guidelines for physical activity but were not meeting guidelines for screen time. Only 3.9% were meeting guidelines for physical activity and were also meeting guidelines for screen time. **Analysis two (baseline)** 69.1% were not meeting guidelines for physical activity and were not meeting guidelines for screen time. 16.4% were not meeting guidelines for physical activity and were meeting guidelines for screen time. 10.7% were meeting guidelines for physical activity but were not meeting guidelines for screen time. Only 3.8% were meeting guidelines for physical activity and were also meeting guidelines for screen time. **Analysis one (follow-up)** 74.8% were not meeting guidelines for physical activity or screen time. 16.3% were not meeting guidelines for physical activity but were meeting guidelines for screen time. 6.8% were meeting guidelines for physical activity but were not meeting guidelines for screen time.

guidelines; and (4) meeting guidelines for physical activity and not meeting screen time guidelines.	Only 2.1% were meeting guidelines for physical activity and were also meeting guidelines for screen time. **Analysis two (follow-up)** 73.0% were not meeting guidelines for physical activity and were not meeting guidelines for screen time. 17.7% were not meeting guidelines for physical activity but were meeting guidelines for screen time. 7.3% were meeting guidelines for physical activity but were not meeting guidelines for screen time at. Only 1.9% were meeting guidelines for physical activity and were also meeting guidelines for screen time.
Analysis of travel data (fifth further analysis) Descriptive frequency analysis and cross-tabulation analysis of the travel data collected.	**Descriptive analysis** **Analysis one (baseline)** Most popular modes of transport at baseline were walking (44.3% of participants), car (36.8% of participants) and bus (32.9% of participants). Least popular modes of transport were train (0% of participants), 'other' modes (1.1% of participants) and bike (7.7% of participants). **Analysis one (follow-up)** Most popular modes of transport were bus (45.4% of participants), walking (42.4% of participants) and car (34.8% of participants). Least popular modes of transport were train (1.1% of participants), 'other' modes (1.7% of participants) and bike (8.6% of participants). **Analysis two (baseline)** Most popular modes of transport were walking (40.8% of participants), bus (38.5% of participants) and car (36.3% of participants). Least popular modes of transport were train (0.1% of participants), 'other' modes (1.0% of participants) and bike (6.6% of participants). **Analysis two (follow-up)** Most popular modes of transport were bus (47.1% of participants), walking (39.3% of participants) and car (38.1% of participants). Least popular modes of transport were train (1.1% of participants), 'other' modes (1.9% of participants) and bike (7.4% of participants). **Cross-tabulation analysis** **Outcomes: active modes of transport (analysis one and two) included: bike at baseline and follow-up; and walk at baseline and follow-up**. **Analysis one (baseline and follow-up) – Active transport** 88.8% did not bike to school/college/work at both baseline and follow-up and only 5.1% biked at both baseline and follow-up. 33.0% actively travelled to school/college/work at both baseline and follow-up by walking although 46.3% did not walk at either baseline or follow-up. Further, 9.4% moved from not walking at baseline to walking at follow-up although 11.3% who walked at baseline did not walk at follow-up.

	<u>Outcomes:</u> passive modes of transport (analysis one and two) included: car at baseline and follow-up; bus at baseline and follow-up; and train at baseline and follow-up. **Analysis one (baseline and follow-up) – Passive transport** 26.4% travelled to school/college/work by car at baseline and follow-up and 54.8% did not travel by car at either baseline or follow-up. In addition, 10.4% moved from travelling by car at baseline to not travelling by car at follow-up. 28.2% used the bus at both baseline and follow-up and 49.9% not using a bus at either baseline or follow-up. No participants used a train at baseline, with only 1.1% using a train at follow-up. In total, 98.9% did not use a train at either baseline or follow-up. **Analysis two (baseline and follow-up) – Active transport** 90.3% did not bike to school/college/work at both baseline and follow-up and only 4.3% biked at both baseline and follow-up. 30.1% actively travelled to school/college/work at both baseline and follow-up by walking although 50.0% did not walk at either baseline or follow-up. 9.2% moved from not walking at baseline to walking at follow-up. 10.7% who walked at baseline did not at follow-up. **Analysis two (baseline and follow-up) – Passive transport** 26.7% travelled to school/college/work by car at baseline and follow-up and 52.3% did not travel by car at either baseline or follow-up. 11.4% travelled by car at follow-up but did not at baseline whereas 9.6% who travelled by car did not at follow-up. 31.9% used the bus at both baseline and follow-up and 46.3% not using a bus at either baseline or follow-up. 15.2% who travelled by bus at follow-up did not at baseline. 98.9% did not use a train at either baseline or follow-up.
Analysis of physical activity data (Sixth further analysis) Descriptive analysis undertaken on the other measures of physical activity collected. These included data from the following questions asked: (1) number of times participated in organised team or individual sports in the previous seven days (when having participated in at least 60 minutes of sport or physical activity); (2) number of times participated in physical	**(1) - Analysis one and Analysis two: descriptive frequency** Largest proportion of participants at both baseline (44.6%) and follow-up (36.7%) took part in organised team or individual sports 1 to 2 times in the previous seven days. The second largest proportion of participants at both baseline (25.8%) and follow-up (34.8%) took part in no organised team or individual sports in the previous seven days. Further, the third largest proportion of participants at both baseline (20.4%) and follow-up (21.0%) took part in organised team or individual sports 3 to 4 times in the previous seven days. The lowest proportion of participants at both baseline (3.3%) and follow-up (2.3%) were those part those participating in organised team or individual sports 5 to 6 times in the previous seven days. The same pattern of findings is reflected for analysis two. **(1) – Analysis one and Analysis two: <u>Cross-tabulations analysis</u> (<u>Outcomes:</u> organised team or individual sports (analysis one and two) included: none at baseline and follow-up; 1 to 2 times at baseline and follow-up; 3 to 4 times at baseline and follow-up; 5 to 6 times at baseline and follow-up; and 7 or more times at baseline and follow-up)** 20.7% took part in organised team or individual sports 1 to 2 times in the previous seven days at baseline and follow-up. 16.1% took part in no organised team or individual sports in the previous seven days at baseline and follow-up. Only 3 participants (0.5% of all participants) took part in organised team or individual sports 7 or more times in the previous seven days at baseline and follow-up. The

activity that was not an organised team or individual sport in the previous seven days (when having participated in at least 60 minutes of sport or physical activity); (3) number of sessions of 30 minutes of sport and active recreation participated in during an average week; (4) and the general intensity of the sport and active recreation undertaken during an average week. For each of these questions, descriptive frequency analysis was undertaken to demonstrate the proportions of participants within the categories of each question at baseline and follow-up, in addition to cross-tabulations, which investigated the numbers of participants in each category at both baseline and follow-up. More specifically, the cross-tabulations consisted of: (1) organised team or individual sports at baseline and follow-up; (2) physical activity that was not an organised team or individual sport at baseline and follow-up; (3) sessions of 30 minutes of sport and active recreation at baseline and follow-up; and (4) intensity of	same pattern of findings was evident for analysis two. **(2) – Analysis one and Analysis two: descriptive frequency** Largest proportion of participants at both baseline (46.6%) and follow-up (46.5%) were those undertaking physical activity that was not an organised team or individual sport 1 to 2 times in the previous seven days. The second largest proportion of participants at both baseline (23.2%) and follow-up (21.7%) were those participants who undertook physical activity that was not an organised team or individual sport 3 to 4 times. Additionally, the third largest proportion were those participants reporting 'none' at both baseline (15.4%) and follow-up (19.9%). The lowest proportion of participants at both baseline (5.7%) and follow-up (3.9%) were those participating in physical activity that was not an organised team or individual sport 5 to 6 times in the previous seven days. The same pattern of findings is reflected in analysis two. **(2) – Analysis one and Analysis two: <u>Cross-tabulations analysis</u> (<u>Outcomes:</u> physical activity that was not an organised team or individual sport (analysis one and two) included: none at baseline and follow-up; 1 to 2 times at baseline and follow-up; 3 to 4 times at baseline and follow-up; 5 to 6 times at baseline and follow-up; and 7 or more times at baseline and follow-up)** 23.8% took part in physical activity that was not an organised team or individual sport 1 to 2 times in the previous seven days at baseline and follow-up. 10.7% took part 3 to 4 times whereas 9.2% moved from undertaking physical activity that was not an organised team or individual sport 1 to 2 times at baseline to 3 to 4 times at follow-up in the previous seven days. Only 5 participants (0.8% of all participants) participated in 7 or more times at baseline and follow-up. The same pattern of findings was evident for analysis two. **(3) – Analysis one and Analysis two: descriptive frequency** At both baseline (29.1%) and follow-up (30.0%) the largest proportion of participants participated in 3 to 4 sessions of 30 minutes of sport and active recreation during an average week. This was closely followed by the proportion of participants participating in 1 to 2 sessions at baseline (26.7%) and follow-up (27.3%). 5 to 6 sessions were participated in by 18.6% of participants at baseline and 16.9% of participants at follow-up whereas 7 or more sessions were participated in by 19.5% of participants at baseline and 15.7% of participants at follow-up. A similar pattern is shown for analysis two with the exception that slightly more participants participated in 5 to 6 sessions or than 7 or more sessions at baseline (20.4%). In addition, more participants participated in 7 or more sessions than 5 to 6 sessions at follow-up (16.8%). **(3) – Analysis one and Analysis two: <u>Cross-tabulations analysis</u> (<u>Outcomes</u>: sessions of 30 minutes of sport and active recreation during an average week (analysis one and two) included: none sessions at baseline and follow-up; 1 to 2 sessions at baseline and follow-up; 3 to 4 sessions at baseline and follow-up; 5 to 6 sessions at baseline and follow-up; and 7 or more sessions at baseline and follow-up)** 12.4% took part in 1 to 2 sessions of 30 minutes of sport and active recreation during an average week, closely followed by 10.9% participating in 3 to 4 sessions at both baseline and follow-up. 3.8% participated in 5 to 6 sessions at both baseline and follow-up. 7.7% participated in 7 or more sessions at both baseline and follow-up. The same pattern of findings was evident for analysis two.

sport and active recreation at baseline and follow-up. Each cross-tabulation was undertaken for analysis one and analysis two.	**(4) - Analysis one and Analysis two: descriptive frequency** Greatest proportion of participants undertook sport and active recreation of a moderate intensity at baseline (54.9%) and follow-up (49.2%). The second greatest proportion of participants participated in sport and active recreation of a vigorous intensity at baseline (33.3%) and follow-up (35.3%). Analysis two shows the same pattern of proportions as analysis one. **(4) – Analysis one and Analysis two: <u>Cross-tabulation analysis</u> (<u>Outcomes</u>: intensity of sport and active recreation (analysis one and two) included: vigorous intensity at baseline and follow-up; moderate intensity at baseline and follow-up; light intensity at baseline and follow-up; and not applicable at baseline and follow-up)** 32.3% took part in moderate intensity sport and active recreation at baseline and follow-up, in contrast to 20.1% who indicated that they undertook vigorous intensity sport and active recreation at baseline and follow-up. 13.3% moved from undertaking moderate intensity sport and active recreation at baseline to undertaking vigorous intensity sport and active recreation at follow-up. The same pattern of findings was evident for analysis two.
Seventh further analysis Final piece of further analysis attempted to investigate whether the (much larger) sample at baseline was similar to the sub-sample used for the longitudinal analysis (i.e., baseline and follow-up – analysis one and analysis two). Therefore, were those participants included in the longitudinal analysis representative of the broader sample at baseline in relation to the key independent variables.	Among the independent variables of interest in the present study, no bias was introduced at follow-up.

Note:
Analysis one = Final sample of participants who all had an associated OA code to include in statistical analyses (for socioeconomic status (i.e., Townsend score) and area of residence (urban or rural) determination).
Analysis two = Final sample of participants who did not have an associated OA code included in statistical analyses.

Appendix 53: Further exploration of a 'floor effect' in physical activity data at baseline

Table A2
Frequency and proportion (within gender type and whole sample) of males and females meeting and not meeting guidelines for physical activity at baseline (analysis one)

	Physical activity at baseline	
Gender	***Meeting guidelines (number and percentage - within (1) gender type and (2) whole sample)***	***Not meeting guidelines (number and percentage – within (1) gender type and (2) whole sample)***
Male	64 (17.7% / 9.7%)	298 (82.3% / 44.9%)
Female	29 (9.6% / 4.4%)	272 (90.4% / 41.0%)

SPSS output for cross-tabulations showing the frequency and proportion (within gender type and whole sample) of males and females meeting and not meeting guidelines for physical activity at baseline (analysis one)

genderfin * baselinepa Crosstabulation

			baselinepa		
			meeting guidelines	not meeting guidelines	Total
genderfin	male	Count	64	298	362
		% within genderfin	17.7%	82.3%	100.0%
		% of Total	9.7%	44.9%	54.6%
	female	Count	29	272	301
		% within genderfin	9.6%	90.4%	100.0%
		% of Total	4.4%	41.0%	45.4%
Total		Count	93	570	663
		% within genderfin	14.0%	86.0%	100.0%
		% of Total	14.0%	86.0%	100.0%

Table A3
Frequency and proportion (within gender type and whole sample) of males and females meeting and not meeting guidelines for physical activity at baseline (analysis two)

	Physical activity at baseline	
Gender	*Meeting guidelines (number and percentage – within (1) gender type and (2) whole sample)*	*Not meeting guidelines (number and percentage – within (1) gender type and (2) whole sample)*
Male	52 (11.6% / 6.2%)	395 (88.4% / 47.4%)
Female	25 (6.5% / 3.0%)	362 (93.5% / 43.4%)

SPSS output for cross-tabulations showing the frequency and proportion (within gender type and whole sample) of males and females meeting and not meeting guidelines for physical activity at baseline (analysis two)

genderfin * baselinepa Crosstabulation

			baselinepa		
			meeting guidelines	not meeting guidelines	Total
genderfin	male	Count	52	395	447
		% within genderfin	11.6%	88.4%	100.0%
		% of Total	6.2%	47.4%	53.6%
	female	Count	25	362	387
		% within genderfin	6.5%	93.5%	100.0%
		% of Total	3.0%	43.4%	46.4%
Total		Count	77	757	834
		% within genderfin	9.2%	90.8%	100.0%
		% of Total	9.2%	90.8%	100.0%