



This is a peer-reviewed, post-print (final draft post-refereeing) version of the following published document:

James, David V ORCID logoORCID: <https://orcid.org/0000-0002-0805-7453>, Mills, Hayley, Crone, Diane ORCID logoORCID: <https://orcid.org/0000-0002-8798-2929>, Johnston, Lynne H, Morris, Clare and Gidlow, Christopher J (2009) Factors associated with physical activity referral completion and health outcomes. *Journal of Sports Sciences*, 27 (10). pp. 1007-1017. doi:10.1080/02640410903214248

Official URL: <http://www.tandfonline.com/toc/rjsp20/27/10#.U39WJ3jdXTo>

DOI: <http://dx.doi.org/10.1080/02640410903214248>

EPrint URI: <https://eprints.glos.ac.uk/id/eprint/386>

Disclaimer

The University of Gloucestershire has obtained warranties from all depositors as to their title in the material deposited and as to their right to deposit such material.

The University of Gloucestershire makes no representation or warranties of commercial utility, title, or fitness for a particular purpose or any other warranty, express or implied in respect of any material deposited.

The University of Gloucestershire makes no representation that the use of the materials will not infringe any patent, copyright, trademark or other property or proprietary rights.

The University of Gloucestershire accepts no liability for any infringement of intellectual property rights in any material deposited but will remove such material from public view pending investigation in the event of an allegation of any such infringement.

PLEASE SCROLL DOWN FOR TEXT.

This is a peer-reviewed, post-print (final draft post-refereeing) version of the following published document:

James, D., Mills, H., Crone, D., Johnston, L. H., Morris, C., & Gidlow, C. J. (2009). Factors associated with physical activity referral completion and health outcomes. *Journal of sports sciences*, 27(10), 1007-1017.

Published in the Journal of Sports Sciences, and available online at:

http://www.tandfonline.com/loi/VB_RoZRdXTo

We recommend you cite the published (post-print) version.

The URL for the published version is:

<http://dx.doi.org/10.1080/02640410903214248>

Disclaimer

The University of Gloucestershire has obtained warranties from all depositors as to their title in the material deposited and as to their right to deposit such material.

The University of Gloucestershire makes no representation or warranties of commercial utility, title, or fitness for a particular purpose or any other warranty, express or implied in respect of any material deposited.

The University of Gloucestershire makes no representation that the use of the materials will not infringe any patent, copyright, trademark or other property or proprietary rights.

The University of Gloucestershire accepts no liability for any infringement of intellectual property rights in any material deposited but will remove such material from public view pending investigation in the event of an allegation of any such infringement.

PLEASE SCROLL DOWN FOR TEXT.

Title:

Factors associated with physical activity referral completion and health outcomes

Running title:

Physical activity referral outcomes

Key words:

Primary care - exercise referral – attendance – ethnicity – body mass - blood pressure

ABSTRACT

Participant socio-demographic characteristics and referral reason were investigated in relation to completion and health outcomes in a Primary Care **Physical Activity Referral Scheme** using a prospective population-based longitudinal design. Participants (n=1735) were recruited over a two-year period. A three-stage binary logistic regression analysis identified the factors associated with the outcomes of completion (model 1), body mass reduction (model 2) and blood pressure reduction (model 3). Participant age, gender, ethnicity, occupation and referral reason were the independent variables for model 1, with the variables of completion added in model 2 and completion and body mass reduction added in model 3. Logistic regression analysis revealed that increasing age is associated with the likelihood of completion (**Odds Ratio**, OR = 1.019; **Confidence Interval**, CI = 1.008-1.030; p = 0.001). Participants with a pulmonary condition are less likely to complete (OR = 0.546; CI = 0.346-0.860; p < 0.01) compared to those referred for cardiovascular conditions. For ethnicity, in comparison to the white category, patients in the mixed category are significantly more likely to achieve a reduction in body mass (OR = 3.991; CI = 1.191-13.373; p < 0.05). Those who complete are more likely to achieve a reduction in body mass (OR = 3.541; CI = 2.721-4.608; p < 0.001). When compared to the unemployed category, the skilled manual category had an increased likelihood of achieving a reduction in blood pressure (OR = 1.875; CI = 1.044-3.227; p < 0.05). Participants who completed also demonstrated an increased likelihood of a reduction in blood pressure (OR = 1.680; CI = 1.250-2.003; p < 0.001). Furthermore, those participants who achieved a reduction in body mass had an increased likelihood of achieving a reduction in blood pressure (OR = 1.292; CI = 1.008-1.641; p < 0.05). Completion is associated with health outcomes of reduced body mass and blood pressure.

INTRODUCTION

The importance of regular physical activity has gained increasing prominence within public health policy in the UK and many other developed countries. For example, in response to the UK national trend in obesity, a range of initiatives that promote physical activity have been launched, including a national social marketing campaign (Change4Life) and the Healthy Communities Initiative (Department of Health, 2008). Now, more than ever, primary care is recognised as an important setting for changing physical activity behaviour in those in most need (Church & Blair, 2009; Gidlow & Murphy, 2009; Williams, 2009). Of the various physical activity interventions in primary care, **Physical Activity Referral Schemes** have arguably become one of the most prevalent physical activity interventions in the UK (Dugdill et al, 2005) and similar primary care based interventions also exist in other countries (e.g., Morgan, 2005).

An absence of evidence regarding the effectiveness of **Physical Activity Referral Schemes** at increasing physical activity levels is well documented (e.g., Williams 2009). The lack of evidence is even more acute when attempting to determine who **Physical Activity Referral Schemes** are most appropriate for (Gidlow et al, 2005), and answers to such questions are of great importance given the scarcity of resources. To date, limited randomised controlled trials into effectiveness have been completed (NICE, 2006), so these forms of evaluation will continue to provide important evidence in the future (Williams 2009). However, to better understand factors associated with attendance and completion of **Physical Activity Referral Schemes**, and related health outcomes, population-based longitudinal studies (also referred to as before and after studies) undoubtedly have an important role. To our knowledge, only three such studies have been published for UK data, all of which focused solely on attendance as the outcome (Harrison et al, 2005; Gidlow et al, 2007; James et al, 2008). Whilst attendance (including uptake and completion) is important, given the public health role of **Physical Activity Referral Schemes** it is also necessary to explore associations between attendance and other health related outcomes. In particular, changes in body mass and blood pressure, and the factors involved in such changes, are extremely important from a public health

perspective and have been highlighted as potentially modifiable through short-term exercise programmes (Taylor et al, 1998; Dugdill & Graham, 2004).

Elevated body mass and blood pressure are associated with a range of adverse health outcomes (Department of Health, 2004b), including an increased risk of cardiovascular disease (Kannel et al., 2002). Small decreases in body mass and blood pressure are known to be clinically important for long-term health outcomes. Based on the current trends in obesity it is predicted that, without concerted action, obesity prevalence will rise to 50% by 2050 (Department of Health, 2008). Prospective studies have shown that high levels of leisure-time physical activity are associated with lower risk of gains in body mass (Di Pietro, 1999; Fogelholm & Kukkonen-Harjula, 2000). There is also some evidence that more active adults tend to embrace other positive health behaviours, such as healthy eating (Blair et al., 1985). Experimental interventions to reduce body mass through increased physical activity have demonstrated a dose-response effect (Kasemiemi et al., 2001), and the most recent physical activity guidelines now recognise this (e.g., US Department of Health and Human Services, 2008). Given the prevalence of physical inactivity and obesity, it is important to evaluate the potential body mass reducing role of prevalent physical activity interventions such as **Physical Activity Referral Schemes**.

It is well recognised that small decreases in blood pressure in the population as a whole would dramatically reduce the incidence of cardiovascular disease (Cook et al, 1995). The resulting savings to the National Health Service would be considerable (National Institute for Health and Clinical Excellence, 2006b). Prospective cohort studies have revealed that those who are regularly more physically active are less likely to have elevated blood pressure (Wareham et al., 2000). Experimental interventions have confirmed that a reduction in blood pressure can be achieved through modest increases in physical activity (Kasemiemi et al., 2001), and such reductions have been observed in both hypertensive (Moreau et al., 2001; Ishikawa-Takata et al., 2003) and normotensive populations (Fortman et al., 1988). Given the prevalence of physical inactivity and hypertension, it is important to evaluate the potential blood pressure reducing role of prevalent physical activity interventions such as

Physical Activity Referral Schemes.

Ethnicity and socioeconomic factors have frequently been linked with physical activity and health outcomes (Burton et al, 2003; Department of Health, 2004a). Those from ethnic minority and low socioeconomic status groups, and particularly women, are known to be less active, and have an increased incidence of poor health (Department of Health, 2004a). Previous **Physical Activity Referral Schemes** studies employing a population-based longitudinal design (also known as a before and after design) have involved participant samples with somewhat limited diversity. Of the three existing UK studies, two involved a largely rural (~50%) and predominantly white British (>90%) population (Gidlow et al, 2007; James et al, 2008). The other study evaluated a scheme based in an urban, relatively deprived area, but, **due to the extremely limited ethnic diversity in the population**, ethnicity was not reported (Harrison et al, 2005). The present study reports findings from an evaluation of a collaborative **Physical Activity Referral Schemes** run by Greenwich Leisure Limited, Greenwich Teaching Primary Care Trust and Greenwich Council. The London Borough of Greenwich is ethnically diverse, with less than three-quarters of the population being white (74.9%) compared with 89.5% for the UK as a whole. The ethnic diversity is also confounded by a relatively large migrant population. Unemployment in Greenwich is also above the national average (5.4 versus 3.4%), and as high as 14.8% in some areas. In keeping with this relative deprivation, life expectancy in Greenwich is below average; 74.5 years for males and 80.1 years for females, compared with 76.5 years and 80.9 years, respectively, for the UK. The diversity within the Greenwich population provides an opportunity to explore known factors leading to health inequalities in relation to **Physical Activity Referral Schemes** outcomes.

Given the socio-demographic profile of the study sample and the proposed health-related outcomes, the present study, using a population-based longitudinal design, aims to investigate socio-demographic characteristics and referral reason in relation to: (i) attendance; (ii) reduction in body mass, and; (iii) reduction in blood pressure.

METHODS

Sample

All patients referred to a metropolitan **Physical Activity Referral Schemes** over a two-year period (April 2005 - March 2007) were invited to participate. Prior ethical approval was granted by the lead author's University Research Ethics Committee. The Bexley and Greenwich Research committee were also consulted. Patients were referred to the **Physical Activity Referral Schemes** if: (a) they had an existing condition that would benefit from regular exercise; (b) they were at increased risk of developing a condition that might be prevented by regular exercise; (c) they were a member of a community that would be less likely to access existing exercise opportunities. Out of 1735 potential participants, 420 were excluded because of incomplete data, leaving 1315 to be included in the analysis. Table 1 provides a description of those participants included in the analysis.

Physical activity referral scheme

All participants were referred by a primary care health professional to one of five leisure centres. After the exercise professional in the leisure centre made contact with the patient and assessed their needs, suitable (i.e., those meeting inclusion criteria) patients were offered a range of individual and group exercise sessions for a period up to 26 weeks. A programme of individual or group exercise was negotiated on a client-centred basis between participant and exercise professional. This process took into account the goals and capabilities of the referred patient. The exercise professional provided a consistent point of contact for participants. Regular (every 6 weeks) feedback on progress was provided by the exercise professional, allowing modification of participant's goals. The exercise environment included the gyms, studios, and swimming pools within the five leisure centres. Participants were able to access the facilities outside of the allocated sessions if they wished.

Assessment of participant completion outcome

Binary outcome categories were formed: completers, who attended the final

scheduled session; non-completers, who failed to attend the final scheduled session. This approach is consistent with previous research (Lord & Green, 1995; Hammond et al, 1997). Completion in the present study provides a proxy measure for attendance, since 90.1% of participants who were categorized as completers attended >80% of scheduled sessions (Gidlow et al, 2005).

Assessment of health outcomes

Exercise professionals conducted routine assessments of participant body mass and blood pressure. Body mass (kg) was determined using standard scales with a resolution of 0.1 kg. Blood pressure (mmHg) was determined through automated sphygmomanometry over the brachial artery at heart level after being seated for a period of five minutes. Diastolic and systolic measures were combined to obtain mean arterial pressure ($\text{Mean Arterial Pressure} = \text{Diastolic Blood Pressure} + [1/3(\text{Systolic Blood Pressure} - \text{Diastolic Blood Pressure})]$) (Tortora & Derrickson, 2006)), creating a single blood pressure value for entry into logistic regression analysis. Change in blood pressure was determined as the difference between initial mean arterial pressure and final mean arterial pressure recorded at the last scheduled session. Similarly, change in body mass was determined as the difference between initial mass and final mass recorded at the last scheduled session.

Assessment of socio-demographic characteristics

Data collected by health professionals at the point of referral included participant age, gender, ethnicity, occupation, primary referral reason (i.e., clinical condition). Age was retained as a continuous variable for regression models. Ethnicity was grouped into five broad categories (white, asian, black, chinese, mixed) to allow adequate group sizes for meaningful analysis. Categories were based on ethnic groupings provided by the primary care trusts, in accordance with the published guide for the collection and classification of ethnic data (Department of Health, 2003). As a measure of socioeconomic position, participants were placed into one of eight social classes based on occupation.

Assessment of referral reason

The reasons for referral were grouped into eight broad categories which incorporated related conditions, similar to those chosen by James et al (2008) (cardiovascular, pulmonary, metabolic, orthopaedic, neuromuscular, sensory, mental health, miscellaneous). This categorisation was assisted by the International Classification of Disease (World Health Organisation, 2000), and was consistent with approaches in recent policy documents (Department of Health 2004b).

Statistical analysis

A three-stage binary logistic regression (Bagley et al, 2001; Kirkwood & Sterne, 2003) was used (referred to as three models) to identify participant socio-demographic characteristics and referral reasons associated with the three binary outcomes of completion, body mass reduction and blood pressure reduction (Table 2). Five common independent variables were entered into each regression model: age, gender, ethnicity, occupation and referral reason. In addition, completion was available for entry into model two, and completion and body mass reduction was available for entry into model three (Figure 1). There was a strong rationale for inclusion of all five potential independent variables in each regression model, regardless of whether or not they were subsequently found to be statistically important. The selection of each independent variable was based on evidence from prior research, and therefore all variables were entered simultaneously into each regression model.

*****Table 2: Binary outcome variables for logistic regression models*****

*****Figure 1: Variables included in the multiple-stage regression*****

All goodness of fit tests (Hosmer & Lemeshow; Cox & Snell; Nagelkerke) suggested that the three models were good fits of the data. The predicted outcomes agreed well with actual outcomes (56 – 68%) in every model. Residuals were examined in an attempt to isolate any points where the model may have fit the data poorly. No cases were seen to fall outside those values deemed to cause concern (Field, 2005).

Discriminant analysis was used to determine whether or not differences in group sizes for the binary outcome would influence the findings. The largest discrepancy in binary outcome group size in model 2 (group 0: n=877; group 1: n=438) had no influence on the findings; i.e., the results presented were the same regardless of whether group sizes were assumed to be equal or were accounted for in the analysis.

RESULTS

The majority of participants were women (65.4%) and 59% of participants were under the age of 50 years. The three most highly represented ethnic groups were white (69.4%), black (17.6%) and asian (11.2%). The three most highly represented occupations were unemployed (35.7%), retired (21.7%), and skilled non-manual (14.8%). The most prevalent primary referral reason was metabolic condition (36.3%), followed by orthopaedic (24.7%) and cardiovascular (17.5%). Out of the 1315 participants referred, 57% completed their exercise programme, 33.3% achieved a body mass reduction, and 49.2% reduced their blood pressure.

***** Table 3: Binary logistic regression analysis outcomes *****

Findings from the three-stage binary logistic regression analysis are provided in Table 3. The findings from model one revealed that increasing age was associated with the likelihood of patients completing (Odds Ratio, OR = 1.019; Confidence Interval, CI = 1.008- 1.030; p = 0.001); for every increase in decade of age there was a 19 % increase in the likelihood of completing. Ethnicity was associated with the likelihood of completion, with participants in the mixed category being more likely to complete (OR = 6.310; CI = 1.388-28.695; p < 0.05). Participants with a pulmonary condition were less likely to complete (OR = 0.546; CI = 0.346-0.860; p < 0.01) than those referred for cardiovascular conditions.

Model two revealed that, in comparison to the white category, participants in the

mixed category are significantly more likely to achieve a reduction in body mass (OR = 3.991; CI = 1.191-13.373; $p < 0.05$). Those who complete are more likely to achieve a reduction in body mass (OR = 3.541; CI = 2.721-4.608; $p < 0.001$).

Model three indicated that, compared those in the unemployed category, participants in skilled manual occupational category had an increased likelihood of achieving a reduction in blood pressure (OR = 1.875; CI = 1.044-3.227; $p < 0.05$). Participants who completed also demonstrated an increased likelihood of a reduction in blood pressure (OR = 1.680; CI = 1.250-2.003; $p < 0.001$), than non-completers. Those who achieved a reduction in body mass had an increased likelihood of blood pressure reductions (OR = 1.292; CI = 1.008-1.641; $p < 0.05$).

DISCUSSION

Physical Activity Referral Schemes operate across the majority of Primary Care Trusts in the UK (Gidlow & Murphy, 2009), but little is known about the factors associated with **Physical Activity Referral Schemes** completion and other outcomes. The findings from the present study, from a diverse metropolitan population, have revealed that completion of a course of scheduled sessions is associated with older age, ethnicity and referral reason. Furthermore, reductions in body mass and blood pressure are associated with completion, and reduction in blood pressure is associated with reduction in body mass.

Better adherence and increased rates of completion of scheduled exercise sessions with increasing age is consistent with existing **Physical Activity Referral Schemes** research (Dugdill et al, 2005; Gidlow et al, 2007; James et al, 2008), research examining other types of physical activity scheme (Anton et al, 2001; Martin & Sinden, 2001; Fox et al, 2007) and reviews on this subject (Ashworth et al, 2005; Stathi, 2009). An age-related reduction in time constraints provides a plausible explanation for this finding, which is consistent with time constraints being the most frequently cited physical activity barrier in

adults (Biddle & Mutrie, 2008). Younger and middle aged adults are likely to have a greater number of commitments that might be prioritised at the expense of physical activity, such as work and a young family. The social environment for scheduled exercise sessions may also be better received by older adults. Greater rates of referral and uptake of **Physical Activity Referral Schemes** opportunities by adults in middle- and early old-age (Harrison et al, 2005; Gidlow et al, 2007) may have created a social environment more suited to certain age profiles (Hardcastle & Taylor, 2001). Furthermore, the relative importance of physical activity as a means of social interaction in older people (Stathi et al., 2003; Stathi, 2009) not only supports this notion, but also represents a potentially important factor contributing to higher completion rates in older people whereby developing social networks increases their likelihood of continued attendance. The **Physical Activity Referral Schemes** in the present investigation specifically encouraged social interaction through group exercise, the proactive role of the facilitators, and organised coffee meetings. Although it is well documented that physical activity reduces with age (Trost et al, 2002; Taylor et al., 2004; Stathi, 2009), this same literature may offer an insight into the reasons for the apparent popularity of **Physical Activity Referral Schemes** for older adults. The safe and well supervised environment for exercise may offset reported barriers of fear of falling and fear of exacerbating existing medical conditions (Lim & Taylor, 2005). Furthermore, according to Resnick & Spellbringer (2000), this greater awareness of health issues can be a motivating factor for participating in preventative health programmes.

The greater likelihood of completion of scheduled exercise sessions in men reported elsewhere (Gidlow et al, 2007; James et al, 2008) was not evident in the present study. Whilst this may reflect a social environment for exercise where men and women feel equally supported, a number of other factors may have contributed to this finding. The greater proportion of recruited participants were women, and this finding is typical of exercise interventions in general, where men are known to be harder to recruit, with women accounting for approximately sixty per cent of participants (e.g., Gidlow et al, 2005; Harrison et al, 2005; James et al., 2008). The equal likelihood of completion of scheduled exercise sessions in the present study should be interpreted in light of a greater

proportion of women taking up the opportunity in the first place. Recruitment of men to **Physical Activity Referral Schemes** clearly remains a challenge for health professionals.

Traditionally, physical activity interventions tend to attract *white*, middle-aged, well-educated, and more affluent individuals (Godin & Shephard, 1983; Dunn, 1996; Hillsdon & Thorogood, 1996; Hillsdon et al, 1999; Simons-Morton et al., 2000; Adams & White, 2003; McKay et al., 2003; Hillsdon et al., 2005). A review concluded that interventions for ethnic minorities and those on low incomes could be successful, but that conditions necessary for success were not clear (Taylor et al, 1998). Indeed, when the influences on a given behaviour (such as physical activity) are so multi-factorial, it is difficult to tease out necessary conditions for success. In **Physical Activity Referral Schemes** research a consistent relationship is already evident between attendance and the correlates of age, gender, referral reason and socio-economic position (Taylor et al., 1998; Dugdill et al., 2005; Gidlow et al, 2007; Hardcastle et al, 2008; James et al, 2008). Perhaps due to limited ethnic variation in the study samples, or potential problems in targeting a diverse sample, the influence of ethnicity on **Physical Activity Referral Schemes** completion remains unclear. The **Physical Activity Referral Schemes** in the present study actively targeted ethnic groups from a diverse population, providing a facilitated pathway to promote access and minimise barriers. The support provided by the staff and the wide diversity of those attending the scheduled exercise sessions may have also encouraged members of different ethnic groups to attend. It should be noted that, although those in the 'mixed' ethnicity group were more likely to successfully attend (compared with the 'white' group), the small numbers of mixed ethnicity participants (n=14) is a limitation of the present study. However, given the diverse nature of the Greenwich borough population, the present findings offer new insight into the potential for using **Physical Activity Referral Schemes** in ethnically diverse populations, and provides a useful start point for further research.

Several researchers have investigated the association between referral reason and attendance at scheduled exercise sessions. Dugdill & Graham (2004)

reported lower attendance in those referred primarily for 'overweight'; individuals referred post myocardial infarction (i.e. cardiac rehabilitation) tended to attend more scheduled sessions. High compliance with exercise for such serious medical conditions has been reported elsewhere (Friedman et al, 1997). Similarly, James et al (2008) reported that the likelihood of taking up a **Physical Activity Referral Schemes** intervention opportunity was reduced in those referred for reasons of overweight or mental health. In the present study, compared with those referred for cardiovascular conditions, participants referred with pulmonary conditions were less likely to complete the scheduled exercise sessions. Pulmonary conditions such as bronchitis and emphysema are permanent and progressive, characterised by shortness of breath upon exertion, often with fatigue, coughing and wheezing (Reardon et al, 2005). Although physical training is considered crucial to increase exercise capacity, functional status and associated quality of life, such symptoms are likely to make exercise an uncomfortable experience. Where deterioration is evident, patients may perceive limited improvement from the exercise, especially compared with cardiac patients for whom noticeable improvements in function from exercise are much more attainable (Hillsdon et al, 2005). Pulmonary conditions are also unstable, can vary with seasonal changes (e.g., cold weather), and are aggravated by the flu and chest infections (Glezen et al, 1987). Consequential interruptions to regular attendance at scheduled sessions may reduce participant motivation. It should also not be overlooked that chronic respiratory disease is also associated with an increased risk of mental health conditions such as anxiety and depression (Dowson et al, 2004). Mental health conditions are already associated with poor uptake in the **Physical Activity Referral Schemes** literature (James et al., 2008). Future research might reasonably focus on the potential of exercise groups comprised of participants with similar conditions.

To our knowledge, this is the first **Physical Activity Referral Schemes** study of its type to explore factors associated with both completion and health related outcomes. Although it has been speculated that completion of the scheduled exercise sessions in previous studies would be likely to result in reductions in body mass and positive changes in other health related outcomes (e.g. blood

pressure), it was not possible to make such claims with any certainty (Gidlow et al, 2007; James et al, 2008). In the present study, completion is associated with body mass reduction and reduced blood pressure. It is well established at an individual level that increasing physical activity has the potential to cause body mass loss through increased total daily energy expenditure, and possibly through an improvement in other lifestyle choices that might reduce energy intake, such as healthier eating (Blair et al., 1985). Physical activity alone (rather than coupled with dietary intervention) has been linked with modest body mass loss of around 0.5-1 kg per month (US Department of Health and Human Services, 1996). Although substantial body mass reduction might not be a realistic target for a relatively short **Physical Activity Referral Schemes** intervention (up to 12 weeks), a meta-analysis reported a mean body mass reduction of between 15.0 and 7.5 kg over the study duration (8-30 weeks) in exercise only interventions, depending on the intensity of intervention (Anderson et al 2001). Within the present **Physical Activity Referral Schemes**, it is therefore not surprising to see that previous assumptions regarding the association between completion and health related outcomes has been confirmed for reduction of body mass and blood pressure.

An association between body mass reduction and blood pressure reduction has been observed previously (Stevens et al, 2001). The blood pressure lowering effect of modest loss of body mass (5-10 %) in both hypertensive and normotensive patients has been reported (Mertens & Van Gaal, 2000). Even modest exercise interventions have been shown to reduce blood pressure (Wilmore, 2001; Ishikawa-Takata et al, 2003; Cornelissen & Fagard, 2005), however the addition of a programme targeting energy intake has been shown to further enhance this effect (Blumenthal et al., 2000). Moreover, such reductions in blood pressure are seen both in those who are overweight and those who are normal weight (Whelton et al., 2002). In the present study, completion of scheduled exercise sessions was positively associated with reduced body mass, and mass loss was positively associated with reduced blood pressure. To our knowledge, this is the first time such an association has been reported for a **Physical Activity Referral Schemes** when using a prospective population-based longitudinal design. Other research exploring

physical activity interventions has found a noticeable decrease in blood pressure (Grant et al., 2004; Taylor & Fox, 2005; Isaacs et al., 2007). The extent to which the findings of the present study reflect the effect of the scheduled exercise sessions as opposed to other lifestyle changes is unknown. However, given the prominence of overweight and hypertension as risk factors for cardiovascular disease, any intervention that reduces the prevalence of these risk factors has important public health benefits.

There are well known socioeconomic position gradients for various health outcomes, such as blood pressure (e.g. Shaper et al 1981; Ebrahim et al. 2004), and for physical activity itself (Health Education Authority, 1995; Gidlow, 2006). A small decrease in the average population blood pressure level could dramatically reduce the incidence of cardiovascular disease in the population (Cook et al, 1995), leading to significant savings to the NHS (National Institute for Health and Clinical Excellence, 2006b). Therefore, the potential for **Physical Activity Referral Schemes** to reduce blood pressure, especially within lower socioeconomic groups, is worth considering. It is worth noting that socioeconomic position has been associated with uptake and attendance of **Physical Activity Referral Schemes** (Gidlow et al, 2007). In the present study, skilled manual employment was associated with reduced blood pressure. It is possible that the supplementation of work based physical activity with scheduled exercise sessions was more likely to lead to a reduction in blood pressure.

Although strong associations have been reported in the present study, and in many cases these confirm previous findings, the design of the present study does not permit any conclusions about causality. For example, although completion was associated with body mass reduction, and both completion and body mass reduction were associated with blood pressure reduction, we cannot be sure about the factors that caused a reduction in either body mass or blood pressure. Study designs employing a control group are better suited to determining the extent to which increases in physical activity as part of **Physical Activity Referral Schemes** cause the improvements in health indices. A particular limitation of the present study is that measurements of body mass

and blood pressure were made by a range of exercise practitioners in the 'field' setting, and, despite rigorous training, the reliability of the measurements were likely to be poorer than those made by a trained researcher. However, the large number of participants in the present study provides good statistical power, even in the presence of poorer measurement reliability. It should also be emphasised that the study design benefits from good ecological validity, which is extremely important when attempting to determine key factors involved in the success of the **Physical Activity Referral Schemes** process.

CONCLUSIONS

The present research demonstrates the value of prospective population-based longitudinal studies of **Physical Activity Referral Schemes**. The findings from this and similar studies (Harrison et al., 2005; Gidlow et al., 2007; James et al., 2008) make an important contribution to the area by addressing a gap in knowledge. The present study revealed that, within a diverse metropolitan population, the likelihood of scheme completion increased with age, was lower in those referred with a pulmonary condition, and the possible ethnic association requires further study. Completion was also associated with body mass and blood pressure reductions, and body mass reduction is associated with blood pressure reduction. Interestingly, those in the skilled manual occupational group were more likely to demonstrate a blood pressure reduction. These findings support and build on previous findings and further emphasise that programme completion must remain a priority for **Physical Activity Referral Schemes**. Strategies to better accommodate patients referred with pulmonary conditions should be explored. Given the importance of completion for body mass and blood pressure reduction, health and exercise professionals need to develop strategies to improve completion rates during referral and uptake phases of **Physical Activity Referral Schemes**.

ACKNOWLEDGEMENT

This study was supported by funding from the Healthwise consortium which included: Greenwich Leisure Limited (GLL); Greenwich Teaching Primary Care Trust (GTPCT); and Greenwich Council.

REFERENCES

- Adams, J. & White, M. (2003). Are activity promotion interventions based on the transtheoretical model effective? A critical review. *British Journal of Sports Medicine*, 37, 106-114
- Anderson, J.W., Konz, E.C., Frederich, R.C. & Wood, C.L. (2001). Long-term weight-loss maintenance: a meta-analysis of US studies. *American Journal of Clinical Nutrition*, 74(5), 579-584
- Anton, S.D., Perri, M.G., Riley, J.R., Kanasky, W.F., Rodrigue, J.R. & Sears, S.F. (2001). Differential predictors of adherence in exercise programmes with moderate versus higher levels of intensity and frequency. *Journal of Sport and Exercise Psychology*, 27, 171-187
- Ashworth, N.L., Chad, K.E., Harrison, E.L., Reeder, B.A. & Marshall, S.C. (2005). Home versus centre based physical activity programmes in older adults. *Cochrane Database of Systematic Reviews*, 1, CD004017
- Bagley, S.C., White, H. & Golomb, B.A. (2001). Logistic regression in the medical literature: Standards for use and reporting, with particular attention to one medical domain. *Journal of Clinical Epidemiology*, 54, 979-985
- Biddle S. & Mutrie N. (2008). *Psychology of physical activity*. (Second edition) London: Routledge
- Blair, S.N., Jacobs, D.R. & Powell, K.E. (1985). Relationships between exercise or physical activity and other health behaviours. *Public Health*, 100, 172-180
- Blumenthal, J.A., Sherwood, A., Gullette, E.C., Babyak, M., Waugh, R. & Georgiades, A. (2000). Exercise and weight loss reduced blood pressure in men and women with mild hypertension. *Archives of Internal Medicine*, 160, 1947-1958
- Burton, N.W., Turrell, G. & Oldenburg, B. (2003). Participation in recreational

physical activity: why do socio-economic groups differ? *Health Education and Behaviour*, 30, 225-244

Church, T.S. & Blair, S.N. (2009). When will we treat physical activity as a legitimate medical therapy ... even though it does not come in a pill? *Br J Sports Medicine*, 43(2), 80-81

Cook, N.R., Cohen, J., Hebert, P.R., Taylor, J.O., & Hennekens, C.H. (1995). Implications of small reductions in diastolic blood pressure for primary prevention. *Archives of Internal Medicine*, 155, 701-709

Cornelissen, V.A., & Fagard, R.H. (2005). Effect of resistance training on resting blood pressure: a meta-analysis of randomised controlled trials. *Journal of Hypertension*, 23, 251-259

Department of Health (2003). *Ethnic group statistics: A guide for the collection and classification of ethnicity data*. National Statistics Publication

Department of Health (2004a). *Choosing health? Choosing activity: a consultation on how to increase physical activity*. London: The Stationery Office

Department of Health (2004b). *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: Crown copyright

Department of Health (2008). *Healthy Weight, Healthy Lives: A Cross Government Strategy for England*. London: The Stationery Office

DiPietro, L. (1995). Physical activity, body weight and adiposity: an epidemiologic perspective. *Exercise and Sport Science Reviews*, 23, 275-303

Dowson, C.A., Cuijter, R.G., & Mulder, R.T. (2004). Anxiety and self management behaviour in chronic pulmonary disease: what has been learned? *Chronic Respiratory Disease*, 1, 213-220

Dugdill L. & Graham R.C. (2004). Promoting physical activity: building sustainable interventions. In *Exercise therapy: prevention and treatment of disease* (Eds. J. Gormley & J. Hussey) pp. 240-255. Oxford: Blackwell Science Publishing

Dugdill L., Graham R.C. & McNair F. (2005). Exercise referral: the public health panacea for physical activity promotion? A critical perspective of exercise referral schemes; their development and evaluation. *Ergonomics*, 48, 1390-1410

Dunn, A.L. (1996). Getting started - a review of physical activity adoption studies. *British Journal of Sports Medicine*, 30, 193-9

Ebrahim, S., Montaner, D. & Lawlor, D.A. (2004). Clustering of risk factors and social class in childhood and adulthood in British women's heart and health study: cross sectional analysis. *British Medical Journal*, 328(7444), 861

Field, A. (2005). *Discovering Statistics Using SPSS*. London: Sage

Fogelholm, M., & Kukkonen-Harjula, K. (2000). Does physical activity prevent weight gain - a systematic review. *Obesity Reviews*, 1, 95-111

Fortmann, S.P., Haskell, W.L. & Wood, P.D. (1988). Effects of weight loss on clinic and ambulatory blood pressure in normotensive men. *American Journal of Cardiology*, 62, 89–93

Fox, K.R., Stathi, A., McKenna, J. & Davis, M. (2007). Physical activity and mental well-being in older people participating in the Better Ageing Project. *Eur Journal of Applied Physiology*, 100(5), 591-602

Freidman, D.B., Williams, A.N. & Levine, B.D. (1997). Compliance and efficacy of cardiac rehabilitation and risk factor modification in the medically indigent. *American Journal of Cardiology*, 79, 281–285

Gidlow C., Johnston L.H., Crone D. & James D.V.B. (2005). Attendance of exercise referral schemes in the UK: a systematic review. *Health Education Journal*, 64(2), 168-186

Gidlow, C., Johnston, L.H., Crone, D., Ellis, N. & James, D.V.B. (2006). A systematic review of evidence of the relationship between socio-economic position and physical activity. *Health Education Journal*, 65, 338-367

Gidlow C., Johnston L., Crone D., Morris C., Smith A., Foster C. & James, D.V.B. (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. & James, D.V.B. (2008) Methods of evaluation: issues and implications for Physical Activity Referral Schemes. *American Journal of Lifestyle Medicine*, 2(1), 46-50

Gidlow, C. & Murphy, R. (2009). Physical activity promotion in primary health care. In *Physical Activity and Health Promotion: Evidence-based Approaches to Practice* (Eds. L. Dugdill, D. Crone & R. Murphy) pp. 87–102. Oxford: Wiley Blackwell.

Glezen, W.P., Decker, M., & Perrotta, D.M. (1987). Survey of underlying conditions of persons hospitalised with acute respiratory disease during influenza epidemics in Houston 1978-1981. *American Review of Respiratory Disease*, 136, 550-555

Godin, G. & Shephard, R.J. (1983). Physical fitness promotion programmes: effectiveness in modifying exercise behaviour. *Canadian Journal of Applied Sports Science*, 8, 2

Grant, S., Todd, K., Aitchison, T.C., Kelly, P. & Stoddart, D. (2004). The effects of a 12-week group exercise programme on physiological and psychological variables and function in overweight women. *Public Health*, 118, 31-42

Hammond J., Brodie D. & Bundred P. (1997). Exercise on prescription: guidelines for health professionals. *Health Promotion International*, 12, 33-41

Hardcastle S. & Taylor A.H. (2001). Looking for more than weight loss and fitness gain: psycho-social dimensions among older women in a primary health care exercise referral scheme. *Journal of Aging and Physical Activity*, 9, 313–328

Hardcastle, S., Taylor, A., Bailey, M. & Castle, R. (2008). A randomised controlled trial on the effectiveness of a primary health care based counselling intervention on physical activity, diet and CHD risk factors. *Patient Education and Counseling*, 70, 31-39

Harrison R.A., McNair F. & Dugdill L. (2005). Access to exercise referral schemes - a population based analysis. *Journal of Public Health Medicine*, 27(4), 326-330

Health Education Authority (1995). *Physical activity matters across England: variations by region*. London: Health Education Authority

Hillsdon, M., Foster, C. & Thorogood, M. (2005). Interventions for promoting physical activity. *Cochrane Database of Systematic Reviews* Art. No.: CD003180.pub2

Hillsdon, M. & Thorogood, M. (1996). A systematic review of physical activity promotion strategies. *British Journal of Sports Medicine*, 30, 84-89

Hillsdon, M., Thorogood, M. & Foster, C. (1999). A systematic review of strategies to promote physical activity. In *Benefits and hazards of exercise* (Ed. D. McAuley) pp. 25-46. London: BMJ Publishing

Ishikawa-Takata, K., Ohta, T. & Tanaka, H. (2003). How much exercise is required to reduce blood pressure in essential hypertensives: A dose response study. *American Journal of Hypertension*, 16, 629-633

Issacs, A., Critchley, J., See Tai, S., Buckingham, K., Westley, D. & Harridge, S. (2007). Exercise Evaluation Randomised Trial (EXERT): a randomised trial comparing GP referral for leisure centre-based exercise, community-based walking and advice only. *Health Technology Assessment*, 11(10), 1-184

James, D., Johnston, L. H., Crone, D., Sidford, A. H., Gidlow, C., & Morris, C. (2008). Factors associated with physical activity referral uptake and participation. *Journal of Sports Sciences*, 26(2), 217-224

Kannel, W.B., Wilson, P.W., Nam, B.H. & D'Agostino, R.B. (2002). Risk stratification of obesity as a coronary risk factor. *American Journal of Cardiology*, 90(7), 697-701

Kasaniemi, Y.A., Danforth, E., Yensen, M., Kopelman, P.G., Lefebvre, P. & Reeder, B.A. (2001). Dose–response issues concerning physical activity and health: an evidence-based symposium. *Medicine and Science in Sports and Exercise*, 33(6), S351-S358

Kirkwood, B.R., & Sterne, J.A.C. (2003). *Essential medical statistics* (2nd edition) Oxford: Blackwell Publishing Ltd

Lim, K. & Taylor, L. (2005). Factors associated with physical activity among older people - a population based study. *Preventative Medicine*, 40(1), 33-40

Lord J. & Green F. (1995). Exercise on prescription: does it work? *Health Education Journal*, 54, 453–464

Martin, K.S. & Sinden, A.R. (2001). Who will stay and who will go? A review of older adults' adherence to randomised controlled trials of exercise. *Journal of Aging Physical Activity*, 9(2), 91-114

McKay, H.A., Macdonald, H., Reed, K.E. & Khan, K.M. (2003). Exercise interventions for health: time to focus on dimension, delivery, and dollars. *British Journal of Sports Medicine*, 37, 98-99

Mertens, I.L. & Van Gaal, L.F. (2000). Overweight, Obesity, and Blood Pressure: The Effects of Modest Weight Reduction - a review. *Obesity Research*, 8, 270-278

Moreau, K.L., Degarmo, R., Langley, J., McMahon, C., Howley, E.T., Bassett, D.R. & Thompson, D.L. (2001). Increasing daily walking lowers blood pressure in postmenopausal women. *Medicine and Science in Sports and Exercise*, 33(11), 1825-1831

Morgan O. (2005). Approaches to increase physical activity: reviewing the evidence for exercise-referral schemes. *Public Health*, 119, 361-370

National Institute for Health and Clinical Excellence (2006a). *Four commonly used methods to increase physical activity: brief interventions in primary care, exercise referral schemes, pedometers and community-based exercise programmes for walking and cycling: Public Health Intervention Guidance no. 2*. London: NICE

National Institute for Health and Clinical Excellence (2006b). *Management of hypertension in adults in primary care: partial update*. London: NICE

Reardon, J., Casaburi, R., Morgan, M., Nici, L. & Rochester, C. (2005).

Pulmonary rehabilitation for COPD. *Respiratory Medicine*, 99, 19-27

Resnick, B. & Spellbringer, A.M. (2000). Understanding what motivates older adults to exercise. *Journal of Gerontology Nursing*, 26, 34-42

Shaper, A.G., Pocock, S.J., Walker, M., Cohen, N.M., Wale, C.J. & Thomson, A.G. (1981). British Regional Heart Study: cardiovascular risk factors in middle-aged men in 24 towns. *British Medical Journal (Clin Res Ed)*, 283(6285), 179–186

Simons-Morton, D.G., Hogan, P., Dunn, A.L., Pruitt, L., King, A.C., Levine, B. D. & Miller, S.T. (2000). Characteristics of inactive primary care patients: baseline data from the Activity Counseling Trial. *Preventive Medicine*, 31, 513-521

Stathi A., McKenna J. & Fox K. (2003). The experiences of older people participating in exercise referral schemes. *Journal of the Royal Society for Promotion of Health*, 124, 18–23

Stathi, A. (2009). Populations: Older People and Physical Activity. In *Physical Activity and Health Promotion: Evidence-based Approaches to Practice* (Eds. L. Dugdill, D. Crone & R. Murphy) pp. 174-189. Oxford: Wiley Blackwell

Stevens, V., Obarzanek, E. & Cook, N. (2001). Long-term weight loss and changes in blood pressure: Results of the trials of hypertension prevention, phase II. *Annals of Internal Medicine*, 134, 1-11

Taylor A.H., Doust J.H. & Webborn N. (1998). Randomised controlled trial to examine the effects of a GP exercise referral programme in Hailsham, East Sussex, on modifiable coronary heart disease risk factors. *Journal of Epidemiology and Community Health*, 52, 595-601

Taylor, A.H., Cable, N.T., Faulkner, G., Hillsdon, M., Narici, M.V. & Van Der Bij, A.K. (2004). Physical activity and older adults: a review of health benefits and the effectiveness of interventions. *Journal of Sports Sciences*, 22, 703-725

Taylor, W.C., Baranowski, T. & Young, D. (1998). Physical activity interventions in low-income, ethnic minority, and populations with disability. *Am J Preventative Medicine*, 15(4), 334-343

Taylor, A.H. & Fox, K.R. (2005). Changes in physical self-perceptions: findings from a randomised controlled study of a GP exercise referral scheme. *Health Psychology*, 24(11), 11-21

Totora, G.J. & Derrickson, B. (2006). *Principles of anatomy and physiology*. Chichester: Wiley

Trost S.G., Owen N., Bauman A.E., Sallis J.F. & Brown W. (2002). Correlates of adults participation in physical activity: Review and update. *Medicine and Science in Sports and Exercise*, 34, 1996-2001

US Department of Health and Human Services (1996). *Physical activity and health: a report of the Surgeon General*. Pittsburgh, USA: Department of Health and Human Services

US Department of Health and Human Services (2008) *2008 Physical Activity Guidelines for Americans*. Pittsburgh, USA: ODPHP Publication

Wareham, N.J., van Sluijs, E.M.F. & Ekelund, U. (2005) Physical activity and obesity prevention: a review of the current evidence. *Proceedings of the Nutrition Society*, 64, 229-247

Whelton, S., Chin, A., Xin, X. & He, J. (2002). Effect of aerobic exercise on blood pressure: a meta analysis of randomised, controlled trials. *Annals of Internal Medicine*, 136, 493-503

Williams, N.H. (2009). "The wise, for cure, on exercise depend": Physical activity interventions in primary care in Wales. *British Journal of Sports Medicine*, 43, 106-108

Wilmore, J.H. (2001). Dose-response: variation with age, sex and health status. *Medicine and Science in Sports and Exercise*, 33(6), S622-S634

World Health Organisation (2000). *International Classification of Disease*. Available at www.who.int/msa/mnh/ems/icd10/icd10.htm March 2005

Independent Variables

Dependent Variables

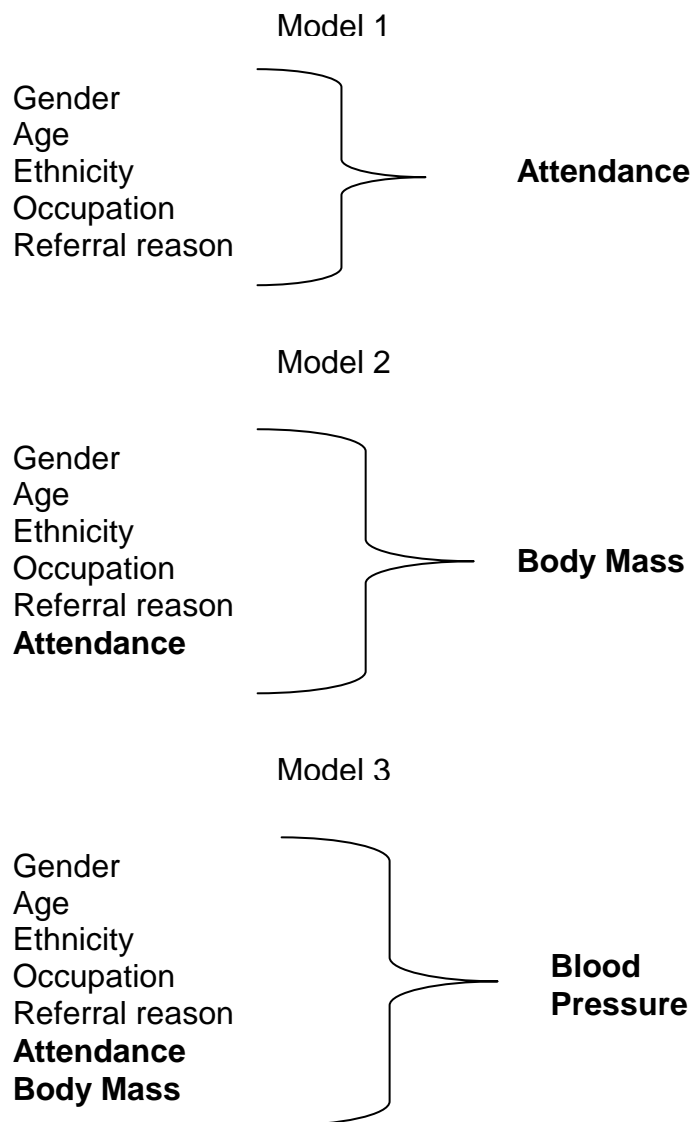


Figure 1: Variables included in the multiple-stage regression

Table 1: Descriptive characteristics of participants

	n	%
Gender		
Female	860	65.4
Male	455	34.6
Age		
Over 50	539	41.0
Under 50	776	59.0
Ethnicity		
White Background	913	69.4
Asian Background	147	11.2
Black Background	231	17.6
Chinese Background	10	0.8
Mixed Background	14	1.1
Occupation		
Unemployed	470	35.7
Retired	286	21.7
Unskilled	75	5.7
Partly skilled	97	7.4
Skilled manual	63	4.7
Skilled non manual	194	14.8
Managerial	70	5.3
Referral reason		
Cardiovascular heart disease	230	17.5
Pulmonary Diseases	130	9.9
Metabolic Diseases	478	36.3
Orthopaedic Diseases	325	24.7
Neuromuscular Disorders	14	1.1
Mental Health	123	9.4
Miscellaneous	15	1.1

Table 2: Binary outcome variables for logistic regression models

LR Model	Binary outcome 0		Binary outcome 1
1	Non-completion (n = 565)	vs.	Completion (n = 750)
2	Non reduction in body mass (n = 877)	vs.	Reduction in body mass (n = 438)
3	Non reduction in blood pressure (n = 668)	vs.	Reduction in blood pressure (n = 647)

Table 3: Binary logistic regression outcomes

	Model 1 OR (95%CI)	<i>p</i>	Model 2 OR (95%CI)	<i>p</i>	Model 3 OR (95%CI)	<i>p</i>
Gender						
Male	1.000 (ref)		1.000 (ref)		1.000 (ref)	
Female	0.923 (0.721 to 1.182)	0.526	1.075 (0.825 to 1.401)	0.593	0.923 (0.724 to 1.176)	0.515
Age (continuous)	1.019 (1.008 to 1.030)	0.001	0.998 (0.986 to 1.009)	0.670	0.999 (0.989 to 1.009)	0.698
Ethnicity		0.038		0.111		0.539
White	1.000 (ref)		1.000 (ref)		1.000 (ref)	
Asian	1.383 (0.946 to 2.202)	0.094	1.330 (0.904 to 1.955)	0.148	1.080 (0.750 to 1.558)	0.677
Black	0.866 (0.640 to 1.172)	0.352	1.185 (0.855 to 1.641)	0.307	0.987 (0.724 to 1.321)	0.884
Chinese	0.795 (0.224 to 2.825)	0.723	1.555 (0.395 to 6.121)	0.528	2.458 (0.602 to 9.792)	0.212
Mixed	6.310 (1.388 to 28.695)	0.017	3.991 (1.191 to 13.373)	0.025	2.214 (0.624 to 6.709)	0.237
Occupation		0.408		0.451		0.166
Unemployed	1.000		1.000 (ref)		1.00 (ref)	
Retired	1.300 (0.889 to 1.901)	0.176	0.811 (0.541 to 1.216)	0.311	0.832 (0.576 to 1.211)	0.343
Unskilled	0.874 (0.529 to 1.444)	0.600	0.900 (0.514 to 1.575)	0.712	0.734 (0.441 to 1.217)	0.239
Partly skilled	1.238 (0.786 to 1.952)	0.375	0.648 (0.387 to 1.085)	0.099	0.892 (0.577 to 1.422)	0.667
Skilled manual	1.018 (0.591 to 1.725)	0.950	1.373 (0.770 to 2.449)	0.282	1.875 (1.044 to 3.227)	0.035
Skilled non-manual	1.324 (0.935 to 1.875)	0.114	0.930 (0.641 to 1.350)	0.704	1.228 (0.868 to 1.732)	0.248
Managerial	1.610 (0.950 to 2.729)	0.077	0.661 (0.371 to 1.732)	0.160	0.884 (0.536 to 1.501)	0.679
Professional	1.328 (0.762 to 2.317)	0.317	0.963 (0.535 to 1.732)	0.899	1.046 (0.603 to 1.800)	0.884
Referral reason		0.065		0.587		0.698
Cardiovascular	1.000 (ref)		1.000 (ref)		1.000 (ref)	
Pulmonary	0.546 (0.346 to 0.860)	0.009	0.951 (0.580 to 1.558)	0.842	0.863 (0.552 to 1.353)	0.523
Metabolic	0.755 (0.537 to 1.061)	0.106	1.146 (0.803 to 1.637)	0.453	1.156 (0.829 to 1.604)	0.396
Orthopaedic	0.724 (0.505 to 1.040)	0.081	0.892 (0.609 to 1.307)	0.558	0.918 (0.650 to 1.310)	0.653
Neuromuscular	2.670 (0.709 to 10.055)	0.147	0.622 (0.183 to 2.110)	0.446	0.918 (0.315 to 2.807)	0.912
Mental	0.919 (0.571 to 1.479)	0.728	0.835 (0.499 to 1.397)	0.492	0.879 (0.555 to 1.412)	0.609
Miscellaneous	0.635 (0.217 to 1.854)	0.406	1.550 (0.504 to 4.772)	0.445	0.945 (0.318 to 2.671)	0.880
Completion						
Non-completion	N/I		1.000 (ref)		1.000 (ref)	
Completion	N/I	N/I	3.541 (2.721 to 4.608)	<0.001	1.680 (1.250 to 2.003)	<0.001
Body mass						
Non-reduction	N/I		N/I		1.000 (ref)	
Reduction	N/I	N/I	N/I	N/I	1.292 (1.008 to 1.641)	0.043

Note: N/I indicates that data were not included; OR is Odds Ratio; CI is Confidence Interval

