Physical Therapy in Sport 58 (2022) 34–40

Contents lists available at ScienceDirect

Physical Therapy in Sport

journal homepage: www.elsevier.com/ptsp

Injury surveillance in English youth basketball: A 5-season cohort study to inform injury prevention strategies

Dr Craig Barden [a, b, *], Dr Peter K. Thain [c]

[a] Sports Science and Medicine Department, SGS Sport, South Gloucestershire and Stroud College, Bristol, UK
[b] School of Sport and Exercise, University of Gloucestershire, Gloucester, UK
[c] School of Health Sciences, Birmingham City University, Birmingham, UK

ARTICLE INFO

Article history:
Received 17 June 2022
Received in revised form
25 August 2022
Accepted 28 August 2022

Keywords:
Basketball
Youth
Injury
Epidemiology

ABSTRACT

Objectives: Describe the injury risk of English youth basketball, comparing game versus training injury incidence and burden.
Design: 5 season (2013/14-2018/19) prospective cohort study.
Setting: Basketball academy at an English sports college.
Participants: Male basketball players (n = 110, mean age; 17.3 ± 0.9 years).
Main outcomes measures: Descriptive data regarding game and training injury incidence (injuries per 1000 athlete-exposures (AE)) and burden (severity x incidence) are provided with 95% confidence intervals (CI). Rate ratios (RR; 95% CI) were used to compare outcome measures, with results statistically significant if the 95% CI did not pass 1.0.
Results: Fifty-four injuries were sustained during 13,350-AE (1666 games, 9684 training). Game injury incidence (12.0/1000-AE, 95% CI 6.7–17.3) was significantly greater than training injury incidence (2.4/1000-AE, 95% CI 1.4–3.3; RR = 5.1, 95% CI 2.8–9.2). Games had a significantly greater injury burden (216 days absence/1000-AE, 95% CI 121-311) than training (62 days absence/1000-AE, 95% CI 37-88; RR = 3.5, 95% CI 1.9–6.3). The ankle was the most injured body location (37%), whilst over 50% of injuries occurring through contact mechanisms.
Conclusion: This study is the most comprehensive description of injury epidemiology in English youth basketball to date. This information can inform evidence-based injury prevention strategies to mitigate risk in this population.

1. Introduction

Basketball is a multidirectional sport, requiring excellent agility, power and strength during intermittent bouts of high intensity activity (Ben Abdelkrim et al., 2010; Dick et al., 2007; Petway et al., 2020). In England, basketball has the second highest participation rate of any team-sport, second only to football, with nearly half a million young people (16–24 year olds) playing per year (Sport England, 2022). These figures are surprisingly high given the sport does not gain much national publicity in comparison to traditional sports such as football and rugby. Whilst all sports participation comes with a risk of injury, the risk in English youth basketball is largely unknown with a scarcity of research in this area.

Injuries can have a detrimental effect on a young athlete's physical and mental health (Maffulli et al., 2010; Putukian, 2016), impair academic achievement (Russell et al., 2019) and lead to cessation of sport and physical activity (Ardern, Taylor, Feller, & Webster, 2012). Describing the epidemiology of injury is the first stage of developing injury prevention strategies (Bolling, van Mechelen, Pasman, & Verhagen, 2018; Finch, 2006). To the authors knowledge, only one previous study has described the injury risk in English basketball (Barden, Quarrie, McKay, & Stokes, 2021), with much of the available literature coming from North American high-school and collegiate injury surveillance programmes (Kerr et al., 2018). A ten-season cohort study from these populations identified injuries to the lower-limb as the most common, predominantly occurring at the ankle (game incidence range: 0.33–1.64/1000-AE) and knee (game incidence range: 0.85–2.15/1000-AE) (Clifton et al., 2018). Interestingly, concussions were the

* Corresponding author. SGS Sports Academies, WISE Campus, New Road, Stoke Gifford, Bristol, BS34 8LP, UK.
E-mail address: Craig.Barden@sgscol.ac.uk (D.C. Barden).

https://doi.org/10.1016/j.ptsp.2022.08.005
1466-853X/

fourth most common pathology in collegiate basketball (Dick et al., 2007), with 84% occurring through player contact despite basketball being classed as a 'non-contact' sport (Chandran, Elmi, Young, & DiPietro, 2020). The high prevalence of contact related injuries is evident in the literature (Clifton et al., 2018; Dick et al., 2007), with over 50% of training and game injuries arising from player-contact in North American high-school and collegiate basketball (Clifton et al., 2018). These findings reinforce the need to conduct robust injury surveillance studies, describing the pathologies and injury aetiology occurring in various populations. However, most epidemiological data is currently from North American settings, where differences in laws, such as quarter length and the use of a shot clock, exist in comparison to English basketball. These subtle differences may result in large differences in game demands and styles of play, all subsequently influencing injury risk. Thus, there is a need to assess the injury risk in English youth basketball as the generalisability of existing literature may not be appropriate.

English youth basketball has high participation rates but there is a paucity of epidemiological data meaning the public health impact is unknown and evidence-based preventative strategies cannot be developed. Thus, the aims of this study were to 1) describe the injury risk (incidence and burden) of basketball within an English college (similar to high-school) population, 2) compare the injury risk between training and game injuries.

2. Materials and methods

2.1. Design and setting

This prospective cohort study of a single male basketball academy (16–19-year-old student athletes) was conducted over 5-seasons (2013/14-2018/19) at an English sports college. Over the course of the study the basketball academy had two teams, generally training twice per week (Monday and Friday), playing one fixture per week (Wednesday; or training if no game). The first team played in the national Elite Academy Basketball League (top national age-group competition), whilst the second team played in a regional league (Association of Colleges). Each season span from September/October to March/April depending on playoff success. Friendly games, included in this study, were played in pre-season (September/October) and throughout the season. Athletes provided written informed consent in pre-season for their injury data to be retained anonymously for the purposes of this injury surveillance study. Parental assent was obtained for individuals under-18 years old.

2.2. Injury surveillance and definitions

A 24-h time-loss injury definition was used as per the International Olympic Committee Consensus statement for recording epidemiological data (Bahr et al., 2020). Training attendance was compulsory and athletes attending training but unable to participate due to injury were instructed to attend the colleges sports injury clinic, where they could access free injury assessment and treatment. Injuries were captured on a bespoke paper report form detailing: date of injury, date of return, situation (training, game, overuse), injury mechanism (player contact, other contact, non-contact, overuse), general body region (upper-limb, lower-limb, head/neck, torso), specific body location (ankle, calf/achilles, foot, hand/wrist, hip, knee, low back, shoulder, thigh/groin, other), injury type (muscle/tendon, ligament, contusion/bruising, bone/fracture, other) and specific injury diagnosis (coded as per OSICS9) (Orchard et al., 2010). Overuse injuries were those classified as basketball related, occurring during or post-training/game, but with no mechanism identifiable at the time (Barden et al., 2021). Data was subsequently logged electronically in a database collated by the medical lead at the college (corresponding author). Due to the sample size, only the two most prevalent specific injury diagnosis are described in the results. Operationalised definitions can be found in supplementary file 1.

Training athlete-exposures (AE) were calculated via attendance registers completed by coaches for every basketball session (training and games). Training duration was not recorded and thus no time denominator was used for training injury risk. Game athlete-exposures were calculated from game statistics sheets generated for all games (5 a-side, 4 × 10-min quarters). Player game-hours (5 starting players x 40-min game duration/60 min) were calculated, with no additional exposure recorded for games which went to overtime.

2.3. Analysis

Training and game injury incidence is reported per 1000 athlete-exposures (/1000-AE), presented with 95% confidence intervals (CI). Game injury incidence is also reported per 1000 game player-hours (/1000 h) to allow comparisons with other studies using this denominator. Injury severity was calculated from the date of injury to the date the athlete was cleared to return to full participation. Injury burden (severity x incidence = days lost/1000-AE) was calculated to provide a measure of the total number of days lost over a time period. Prevalence is defined as the percentage of cases divided by the total population at risk. Further descriptive statistics [mean, range, 95% CI] are reported where applicable. Injuries which extended into the off-season were treated by the medical team two weeks into the off-season, after which the severity was marked as unknown (n = 3). Injuries with unknown severity, due to extending into the off-season (n = 2) or self-discharge (n = 1), were excluded from severity and burden analysis. Rate ratios (RR) were calculated to compare the overall incidence and burden between training and games. A RR > 1.0 suggests an increase in risk in games, whilst a RR < 1.0 suggests and increase in training risk. The same techniques were used to compare training and game injuries by mechanism, location and type. RR were deemed statistically significant if the 95% confidence intervals did not cross 1.0 (Knowles, Marshall, & Guskiewicz, 2006).

3. Results

In total, 110 athletes (mean age = 17.3 ± 0.9 years), completing 175 player-seasons, were enrolled in a basketball academy over the 5-seasons. Fifty-four injuries were recorded (20 games, 23 training, 11 overuse), sustained by 46 athletes, in 11,350 athlete-exposures (1666 games, 9684 training; Table 1). A total of 161 games (537 player-hours) were played, across both teams, throughout the study period (see Table 2).

3.1. Injury incidence

Over the 5-seasons, game injury incidence (12.0/1000-AE, 95% CI 6.7–17.3) was significantly greater than training incidence (2.4/1000-AE, 95% CI 1.4–3.3; RR = 5.1, 95% CI 2.8–9.2). Overuse injuries had an incidence of 1.0/1000-AE (95% CI 0.4–1.5) (Fig. 1). Using a player-hour denominator, game incidence was 37.3/1000 h (95% CI 20.9–53.6).

3.2. Injury severity

Injury severity ranged from 1 to 85 days, with mean game severity 18 days missed (95% CI 10-26) and mean training severity of 26 days missed (95% CI 15-37). Overuse injuries had a mean

Table 1
Descriptive overview by situation.

Measure	Overall	Training	Game	Overuse
Athlete-Exposure (AE)	11350	9684	1666	11350
Injuries (n)	54	23	20	11
Incidence/1000-AE (95% CI)	4.8 (3.5–6.0)	2.4 (1.4–3.3)	12.0 (6.7–17.3)	1.0 (0.4–1.5)
Mean Severity (95% CI)	24 (18-31)	26 (15-37)	18 (10-26)	31 (13-49)
Burden/1000-AE (95% CI)	115 (84-145)	62 (37-88)	216 (121-311)	30 (12-48)

Table 2
Descriptive statistics (incidence, severity, burden) with 95% confidence intervals for game and training injuries.

Nature of Injury	Game				Training			
	n (%)	Incidence /1000-AE	Severity	Burden /1000-AE	n (%)	Incidence /1000-AE	Severity	Burden /1000-AE
Mechanism								
- Player contact	11 (55%)	6.6 (2.7–10.5)	16 (10-23)	106 (43-169)	12 (52%)	1.2 (0.5–1.9)	34 (27-41)	42 (18-66)
- Non-contact	7 (35%)	4.2 (1.1–7.3)	24 (19-29)	101 (26-176)	11 (48%)	1.1 (0.5–1.8)	19 (12-25)	21 (9-34)
General Location								
- Lower limb	17 (85%)	10.2 (5.4–15.1)	20 (12-28)	205 (107-302)	20 (87%)	2.0 (1.2–3.0)	25 (16-34)	51 (29-74)
Body Location								
- Ankle	9 (45%)	5.4 (1.9–8.9)	28 (23-34)	154 (53-254)	11 (48%)	1.1 (0.5–1.8)	36 (30-42)	37 (14-60)
- Knee	2 (10%)	1.2 (0.0–2.9)	5 (2-8)	6 (0-14)	6 (26%)	0.6 (0.1–1.1)	15 (10-20)	9 (2-17)
Type								
- Muscle/tendon	5 (25%)	3.0 (0.4–5.6)	5 (1-9)	15 (2-28)	5 (22%)	0.5 (0.1–1)	12 (8-17)	6 (1-12)
- Ligament (non-bone)	12 (60%)	7.2 (3.1–11.3)	25 (18-32)	181 (79-284)	15 (65%)	1.5 (0.8–2.3)	30 (23-38)	47 (23-71)

Note: Data not provided for variables where overall n < 5 due to the wide range in confidence intervals.

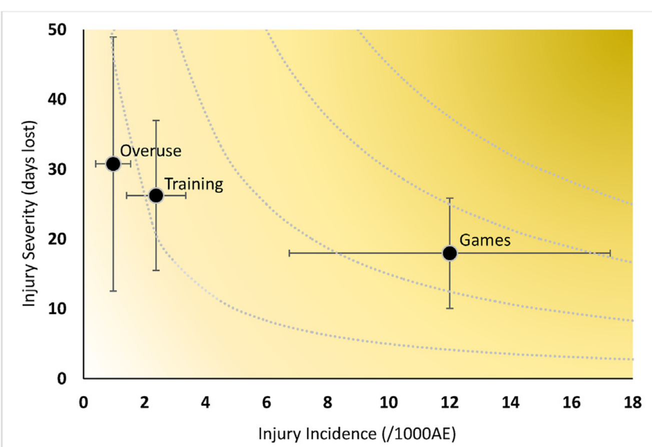

Fig. 1. Injury Risk Matrix (injury incidence x severity) by situational breakdown, presented with 95% CI.

severity of 31 days lost (95% CI 13-49).

3.3. Injury burden

Games had a significantly greater injury burden (216 days absence/1000-AE, 95% CI 121-311) than training (62 days absence/1000-AE, 95% CI 37-88; RR = 3.5, 95% CI 1.9–6.3). Using a time denominator, games had an injury burden of 671 days absence/1000 h (95% CI 377-965). The burden of overuse injuries was 30 days absence/1000-AE (95% CI 12-48).

3.4. Injury location

Lower limb injuries were most prevalent in games (85.0%, 10.2/1000 A-E, 95% CI 5.4–15.1) and training (87.0%, 2.1/1000-AE, 95% CI 1.2–3.0; RR = 4.9, 95% CI 2.6–9.4), with only 4 trunk and 3 upper limb injuries recorded overall (Fig. 2). Of specific body locations, the ankle (37.0%, 1.8/1000-AE, 95% CI 1.0–2.5) was the most injured overall, followed by the knee (31.5%, 1.5/1000-AE, 95% CI 0.8–2.2). No other specific body location sustained more than four injuries. The incidence of ankle injuries was significantly greater in games than training (5.4/1000-AE, 95% CI 1.9–8.9 and 1.1/1000-AE, 95% CI 0.5–1.8, respectively; RR = 4.8, 95% CI 2.0–11.5).

3.5. Injury mechanism

The most common mechanism of injury in both games and training was via player contact (55%, 6.6/1000-AE, 95% CI 2.7–10.5 and 52%, 1.2/1000-AE, 95% CI 0.5–1.9, respectively; RR = 5.3, 95% CI 2.4–12.1). There was a significantly greater incidence of non-contact injuries in games compared to training (RR = 3.7, 95% CI 1.4–9.5). Overall, 20% (1.0/1000-AE, 95% CI 0.4–1.5) of all injuries were categorised as overuse.

3.6. Injury type

Ligament sprains were the most common injury type for games and training (60%, 7.2/1000-AE, 95% CI 3.1–11.3 and 65%, 1.5/1000-AE, 95% CI 0.8–2.3, respectively) followed by muscle/tendon injuries (25%, 3.0/1000-AE, 95% CI 0.4–5.6 and 22%, 0.5/1000-AE, 95% CI 0.1–1.0, respectively). The incidence of ligament sprains and muscle/tendon strains was significantly greater in games than training (RR = 4.7, 95% CI 2.2–9.9 and RR = 5.8, 95% CI 1.7–20.1, respectively). Lateral ankle sprains were the most common specific injury diagnosis (n = 19; 35% of all injuries), mostly occurring in training (53%; game 47%), with player contact the most frequent mechanism (74%). Patellar tendinopathy was the second most common specific injury diagnosis (n = 9), accounting for 73% of all overuse injuries.

4. Discussion

This study provides the most comprehensive description of the

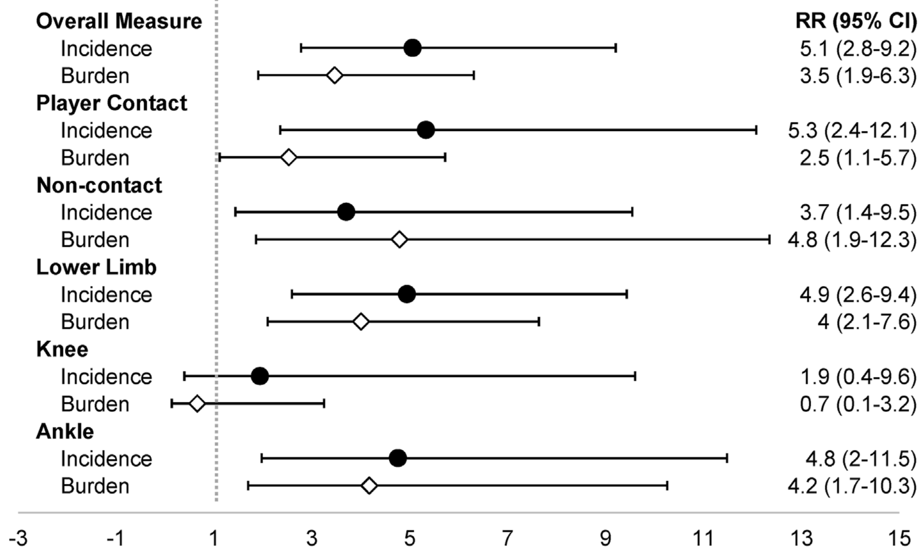

Fig. 2. Rate Ratios (with 95% CI) for game versus training injuries. Rate ratio>1 suggests greater injury risk in games than training.

injury risk in English youth basketball to date. Basketball is one of the most popular sports amongst adolescents in England and, due to its perceived 'non-contact' nature, it could be expected that basketball injuries are not a public health concern. However, the results from this study suggest that the injury risk is similar to other popular sports such as rugby. Describing the aetiology and pathology of basketball injuries is the first step to developing evidence-based preventative strategies specific to this population, making the sport as safe as possible for all participating.

The overall injury incidence (games and training combined) in this study was 4.8/1000-AE. However, games had a significantly greater injury risk than training (RR = 5.1), a finding consistent with basketball studies across a variety of youth settings (Borowski, Yard, Fields, & Comstock, 2008; Owoeye et al., 2020; Pasanen et al., 2017). Whilst research comparing training and game demands is sparse, a cohort study of a professional Spanish basketball team reported peak and maximum heart rate was greater in games than training (Torres-Ronda, Ric, Llabres-Torres, de Las Heras, & Schelling, 2016). Training sessions may include shooting drills, often controlled, non-contact and low intensity, considerably different than the fast, explosive, unpredictable nature of game play. Describing the risk and aetiology of injuries arising from games and training separately may influence the adoption of injury prevention strategies such as neuromuscular training programmes (Bonato, Benis, & La Torre, 2018; Owoeye, Palacios-Derflingher, & Emery, 2018), load management strategies (Weiss, Allen, McGuigan, & Whatman, 2017) or protective equipment (McGuine, Brooks, & Hetzel, 2011).

The game injury incidence rate reported in this present study (12.0/1000-AE) is notably greater than studies using the same time-loss definition in North American high-school (2.61–2.93/1000-AE) (Borowski et al., 2008; Clifton et al., 2018) and collegiate settings (8.85–9.99/1000-AE) (Clifton et al., 2018; Dick et al., 2007). Using a time-exposure denominator, the game injury incidence (37.3/1000 h) is comparable to Finnish (36.8/1000 h) (Pasanen et al., 2017) and English (43.0/1000 h) (Barden et al., 2021) male youth basketball cohorts. These incidence rates are greater than those reported in under-18 English rugby union (30.1/1000 h) (England Rugby, 2021), a sport which has come under intense scrutiny due to its high injury risk (Tucker, Raftery, & Verhagen, 2016). With the reported basketball injury risk in this study, combined with large participation numbers, preventative strategies and policies need to be developed to mitigate injury risk in English basketball, especially given both the physical and psychological impact sports injuries have on an athlete (Maffulli et al., 2010; Wiese-bjornstal et al., 1998).

The lower-limb was the most commonly injured body location in games (85%) and training (87%). Lateral ankle sprains were the most common pathology, accounting for 35% of all injuries within this study. This finding is consistent with studies in youth male basketball players in Finland (Pasanen et al., 2017), North American collegiate (Dick et al., 2007; Meeuwisse, Sellmer, & Hagel, 2003) and professional basketball players (Deitch, Starkey, Walters, & Moseley, 2006; Drakos, Domb, Starkey, Callahan, & Allen, 2010). Player contact was responsible for most lateral ankle sprains, a common trend amongst the basketball literature (Dick et al., 2007). The most common mechanism of injury to the lateral ankle ligaments is excessive loading during inversion, plantarflexion and internal rotation (Kristianslund et al., 2011). Within basketball this is frequently achieved when landing from a jump and mounting a player's foot (Cumps et al., 2007b). Given their prevalence and burden, with each sprain resulting in over a month lost, implementing preventative strategies to target ankle injuries is critical. The use of balance and proprioception training has been shown to reduce the incidence of ankle injuries in basketball (Cumps et al., 2007a; Eils, Schroter, Schroder, Gerss, & Rosenbaum, 2010), whilst screening athletes to highlight those at a predisposed risk (Plisky, Rauh, Kaminski, & Underwood, 2006) has been recommended. Taping or bracing to restrict excessive inversion is a common strategy used to prevent primary or secondary ankle injuries (McGuine et al., 2011). However, there is evidence that reducing the range of movement at the ankle joint alters the kinematics at the knee and subsequently increases injury risk further at this joint (Williams, Ng, Stephens, Klem, & Wild, 2018). Whilst this area needs further research, medical professionals should be mindful of this and use prophylactic taping and bracing based on an individualised approach.

Patellar tendinopathy was the second most common specific injury diagnosis, accounting for 73% of all overuse injuries. These injuries are notoriously difficult to manage but the use of isometric contractions may provide analgesic relief (Rio et al., 2017). Recently, much attention has focused on load management (Bourdon et al., 2017), aimed at minimising overuse injuries whilst maximising performance and reducing fatigue. Subsequently, the National Basketball Association (2016) have published load management guidelines for youth athletes, with recommendations around maximum training duration and minimum number of rest days per week. A further consideration for young athletes is that they may be playing multiple sports at one time or throughout a year. Evidence suggests that high-school athletes playing sport for 12 months of the year had a 42% increase in overuse injuries versus those who have an off season (Cuff, Loud, & O'Riordan, 2010). Therefore, it may be necessary to quantify load external to basketball for youth athletes if attempting to use load management to mitigate overuse injuries.

Neuromuscular training programmes are one strategy showing promise at reducing injury risk across multiple contexts. A meta-analysis found these programmes, often used as a warm-up, can reduce lower-limb injuries by 36% in youth sports including basketball (Emery, Roy, Whittaker, Nettel-Aguirre, & van Mechelen, 2015), whilst also improving physical performance (Faude et al., 2017). A greater dose-response effect of these programmes is seen when completed two or three times per week (Steib et al., 2017), whilst it is possible they may also provide a benefit when completed after a session (Whalan, Lovell, Steele, & Sampson, 2019). However, such interventions have been blighted by poor adherence and inadequate exercise fidelity (performing exercises competently) in youth basketball teams (Owoeye, Emery, Befus, Palacios-Derflingher, & Pasanen, 2020). Successful implementation is complex, but is influenced by end-users (coaches, medical professionals and athletes) perceptions, behaviour determinants and perceived contextual barriers (Munoz-Plaza et al., 2021; Raisanen et al., 2021; Verhagen et al., 2010). These remain unexplored in English youth basketball and a unique opportunity exists to investigate these behavioural determinants prior to engaging end-users to develop context-specific injury prevention strategies. This may expedite the uptake of research into practice, improving implementation and subsequently intervention effectiveness (Finch, 2006).

4.1. Limitations

This study used a time-loss injury definition to ensure consistency in the data collection. However, this approach fails to capture the impact that non-time loss injuries may have on an athlete and their performance (Clarsen, Ronsen, Myklebust, Florenes, & Bahr, 2014). A medical-attention definition may be more appropriate for basketball, given the prevalence of overuse injuries such as patellar tendinopathy. The Oslo Sports Trauma Research Centre Overuse Questionnaire may be of help to medical practitioners in the identification and management of these pathologies (Clarsen et al., 2020), and should be a consideration for future studies in this population.

This study was conducted prior to the publication of the International Olympic Committee's consensus statement for injury surveillance studies (Bahr et al., 2020). As such, the injury definitions adopted in this study do not precisely follow those recommended, although they are similar given they follow previously published sport-specific consensus statements (Fuller et al., 2006; Fuller et al., 2007). However, to progress the sports injury epidemiology field forward, it is recommended that injury surveillance studies use the consensus statement definitions and methodologies to allow for valid comparisons between studies (Bahr et al., 2020).

5. Conclusion

Basketball games have a significantly greater injury incidence than training, with most injuries occurring at the ankle and knee. The injury risk described in this study is comparable to contact sports, such as rugby, and when combined with high participation rates may mean they are affecting more young athletes than perhaps suspected. Describing injury risk, common mechanisms and specific pathologies occurring in English youth basketball is the first step developing evidence-based preventative strategies specific to this population. Given no such interventions currently exist, there is a unique opportunity to assess end-users' perceptions towards injury risk and prevention, alongside establishing contextual barriers towards preventative strategies. Once these have been established, it is recommended end-users are included in the development of such strategies to expedite the lag between research and practice, reducing the risk of injury in this population.

Ethical approval

All participants provided written informed consent, whilst parental consent was provided for those under-18 years old. It was not possible to obtain institutional ethical approval. Injury data was retained anonymously and individuals are not identifiable in the study.

Funding

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

Declaration of competing interest

The primary author is the Head of Strength, Conditioning and Sports Therapy at the college where this data was collected.

Acknowledgements

The authors wish to thank the medical professionals at the college for collecting injury data throughout the study period.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.ptsp.2022.08.005.

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