AN AUDIT OF INJURIES IN SIX ENGLISH PROFESSIONAL SOCCER ACADEMIES

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Abstract

Regulations now state that professional academies in the United Kingdom are required to substantially increase the volume of soccer training. The purpose of this study was to assess the current injury occurrence, providing an update to reports published prior to the introduction of the Elite Player Performance Plan (EPPP). 608 elite male youth soccer players aged 11 – 18 years from the academies of six professional soccer clubs were prospectively monitored, recording injuries during the 2014-2015 soccer season. An injury rate of 1.32 injuries per player / season was indicated with a mean time loss of 21.9 days per injury. The greatest time loss per injury was in the U14s-U15s, and the highest rate of severe injuries in the U15s. Strains and sprains were the most common injury type, with the knee and ankle the most frequently injured anatomical sites. Seasonal variation indicated two peaks in injury incidence, occurring in September and January. In comparison to a published audit prior to the inception of the EPPP, this study indicates that academy soccer players are three-times more likely to experience an injury. Given that time loss and injury severity also increased during periods that typically follow rapid growth, these players should be considered an important focus group for training load monitoring and injury prevention strategies.

Key words

Youth, injury, risk, training volume

Introduction

Reducing injury occurrence in youth soccer players is of great importance due to their status as developmental athletes aiming to achieve professional contracts. In this cohort there is an inherent risk of injury to the immature skeleton in response to high training loads (Mafulli and Pintore, 1990). Furthermore, the frequency of overuse injuries increases in junior players who undertake high volume soccer training programmes (≥ 5 hours per week) (Schmikli et al., 2011). In the United Kingdom, previous injury surveillance data indicate a linear increase in the total number of injuries with each respective age group category for academy players (Price et al., 2004). An overall injury incidence rate (defined as the number of injuries divided by the total number of players in a given group) of 0.40 injuries per player, per season was reported (Price et al., 2004); however, the player incidence rate across a wide range of chronological age groups, reflective of the structure within a professional soccer academy was not examined.

Under new regulations introduced by the English Premier League, a substantial increase in the volume of soccer specific training has occurred in boys as young as eight years of age (EPPP, 2011). In the original UK soccer academy system set out in 1998, the number of required contact hours for coaching was approximately 3,760 (accumulated incrementally from age 8-21) (EPPP, 2011). Under the new regulations set out in the Elite Player Performance Plan (EPPP) which as introduced in 2011, this number has been increased to 8,500 on-pitch contact hours for clubs in the highest academy classification category. Of further concern, the EPPP adopts a linear approach to increases in training volume between 12-16 years of age, despite these developmental stages coinciding with rapid variations in growth rate and a heightened risk of injury (Rumpf and Cronin, 2012; van der Sluis et al., 2014). The impact of this substantial increase in training volume and its related injury risk for young athletes is currently unknown (Read et al., 2016).

When interpreting the existing evidence in elite male youth soccer players in the United Kingdom (Cloke et al., 2010; Moore et al., 2011; Price et al., 2004), it is apparent that each of these studies occurred prior to the implementation of the EPPP. The injury reporting period for the original audit by Price et al. (2004) was prospectively reported from July 1999 to May 2001. Current data are required to examine the injury occurrence since the EPPP enforced changes to provide a more accurate reflection of the existing trends in this cohort. Therefore, the purpose of this study was to evaluate the current injury trends using comparable analyses to a previous audit

(Price et al., 2004), providing an update of the player incidence rate, type, location, severity and seasonal variation of injuries sustained by a large group of elite male youth soccer players. Additionally, further analysis was included to examine the player incidence rate across different chronological age groups.

Methods

Experimental design

This study employed a prospective cohort design, tracking injury occurrence in elite male youth soccer players aged 11 – 18 years from the academies of six professional soccer clubs in the United Kingdom during the 2014-2015 competitive soccer season. Subject characteristics for each chronological age group are displayed in table 1. Of the six clubs that participated, two were category 3, three were category 2 and the remaining club was classified as category 1. The total sample of players included in the study was n = 608. All players were participating regularly in football training and competitions in accordance with the regulations set out by the Premier League's Elite Player Performance Plan. Club officials and parental consent and participant assent were collected prior to the commencement of the study. Ethical approval was granted by the institutional ethics committee.

Table 1 Mean (s) values for participant details per sub-group

Age Group	Age (yrs.)	Body Mass (kg)	Stature (cm)	Leg Length (cm)	Maturity Offset
U11	11.2 ± 0.6	37.8 ± 5.8	144.0 ± 6.7	75.9 ± 4.8	-2.6 ± 0.5
U12	12.1 ± 0.6	40.3 ± 5.7	149.2 ± 5.9	79.3 ± 4.7	-2.0 ± 0.6
U13	12.87 ± 0.6	44.7 ± 8.8	155.8 ± 9.1	83.8 ± 6.8	-1.2 ± 0.7
U14	14.0 ± 0.5	50.2 ± 9.2	162.8 ± 9.4	84.2 ± 13.0	-0.1 ± 0.9
U15	15.3 ± 0.6	60.97 ± 8.4	172.2 ± 7.6	91.6 ± 5.3	1.0 ± 0.6
U16	16.1 ± 0.6	65.3 ± 8.1	175.8 ± 7.0	92.1 ± 5.7	1.8 ± 0.6
U18	17.5 ± 0.8	72.0 ± 6.5	178.9 ± 5.9	93.2 ± 4.2	2.9 ± 0.7

Procedures

Anthropometry and biological maturity: Body mass (kg) was measured on a calibrated physician scale (Seca 786 Culta, Milan, Italy). Standing and sitting height (cm) were recorded on a measurement platform (Seca 274, Milan, Italy). Stage of maturation was calculated in a non-invasive manner utilizing a previously validated regression equation comprising measures of age, body mass, standing height and sitting height (Mirwald, 2002). Using this method, maturity offset (calculation of years from PHV) was completed. The equation has been used previously to predict maturational status in paediatric research with a standard error of approximately 6 months (Mirwald et al., 2002).

Injury Audit Details

To provide clear comparisons with research conducted prior to the implementation of the EPPP, the categories and types of injuries and procedures employed by Price et al. (2004) were replicated. Injuries experienced during the study period were diagnosed and prospectively recorded by medical personnel of each club. Injuries were documented if they occurred during soccer-related activities and if the player was subsequently unable to participate in training or competition for a minimum of 48 hours following the incident, not including the day of injury (Price et al., 2004). Players were classified as injured until the medical staff (chartered physiotherapists) of their respective clubs deemed they were fit to resume full training.

Player incidence rate was calculated by dividing the number of injuries sustained during the season by the total number of registered players. *Injury severity* was classified based on the number of days missed including: slight (2 - 3 days), minor (4 - 7 days), moderate (1 - 4 weeks) and severe (> 4 weeks). *Injury mechanism* was defined, whereby a contact or non-contact injury was indicated when an incident with clear contact or collision from another player, the ball or another object either did, or did not, occur respectively. An overuse injury was defined as a condition with a gradual onset associated with repetitive micro trauma and where no clearly identifiable acute incident was present. The *date of injury* was also recorded to examine the effects of seasonal variation on the number of injuries experienced during each calendar month.

Statistical analysis

Descriptive data are presented using frequencies and percentages. To investigate between-group differences for seasonal variation, number of injuries and the time loss per injury, Chi-squared (χ^2) and Kruskal-Wallis tests were used with statistical significance set at an alpha level of $p \leq 0.05$. Descriptive data were computed through Microsoft Excel® 2010 and Chi-squared and Kruskal-Wallis tests were calculated using SPSS® (V.21. Chicago Illinois).

Results

Total injuries and player injury rate: 804 injuries were recorded during the course of the season across all age groups, equating to an average injury rate of 1.32 injuries per player and a mean time loss of 21.9 days per injury. The number of injuries, mean time loss per injury and injury rates per player for each respective age group are shown in *table 2*. Significantly greater and fewer numbers of injuries were recorded in the U18s and U11s respectively ($p < 0.05$). The U14s and U15s experienced the longest time loss per injury and this was significantly greater than the U11s ($p < 0.001$).

Table 2 Number of injuries, player incidence rate and mean time loss per age group

Age Group	# registered players	# Injuries	Incidence rate	Time loss per injury (days)
U11	83	53*	0.64	15.9
U12	88	96	1.09	24.9
U13	83	102	1.23	16.9
U14	90	97	1.08	26.2***
U15	71	111	1.56	25.7***
U16	86	116	1.35	22.8
U18	107	229**	2.14	20.8

* significantly lower than all age groups ($p < 0.001$)

** significantly greater than the U11s, U12s, U13s, U14s, U16s ($p < 0.05$)

*** significantly greater than U11s ($p < 0.001$)

Injury location and type: In the whole sample of players, there was a greater proportion of non-contact injuries (62.1%) and this was consistent for each age group (55-68%), occurring predominantly in the lower extremity (78%). The anatomical location of all injuries sustained is displayed in *table 3*. The knee (20%) and ankle (18.3%) were the most frequent sites of injury, followed by the quadriceps (9.5%). The overall types of injury experienced are displayed in *table 4*. Muscle strains (20.9%) were the most frequently reported injury and there was a high proportion of ligament sprains (16.9%). The greatest number of muscle strains was present in the quadriceps (32%), with a relatively equal proportion occurring at the hamstrings, groin and hip (*figure 1*). The majority of ligament sprain injuries were sustained at the ankle (65%) and knee (32%). The knees were the most frequent site of tendinopathy (45%) and other overuse symptoms (61%). Growth-related injuries were less common, with the distribution by age group of sustained growth-related injuries displayed in *figure 2*.

Table 3 Anatomical location of injuries sustained

Injury location	#	%
Knee	161	20.0
Ankle	147	18.3
Quad	76	9.5
Foot	59	7.3
Groin	58	7.2
Head	55	6.8
Hamstring	49	6.1
Hip	44	5.5
Lower back	40	5.0
Calf	17	2.1
Hand	17	2.1
Shin	17	2.1
Shoulder	13	1.6
Arm	11	1.4
Pelvis	11	1.4
Other	11	1.4
Wrist	10	1.2
Abdomen	8	1.0

Table 4 Overall types of injury sustained

Injury Type	# Injuries	%
Muscle Strain	162	20.9
Ligament Sprain	131	16.9
Unknown Cause	126	16.3
Other diagnosis	83	10.7
Growth/Overuse	51	6.6
Tissue Bruising	38	4.9
Overuse	33	4.3
Tendinopathy	33	4.3
Low Back Pain	25	3.2
Fracture	23	3.0
Muscle Contusion	19	2.5
Cut	18	2.3
Inflammatory Synovitis	13	1.7
Meniscal Tear	7	0.9
Ligament Rupture	5	0.6
Periostitis	5	0.6
Dislocation	2	0.3

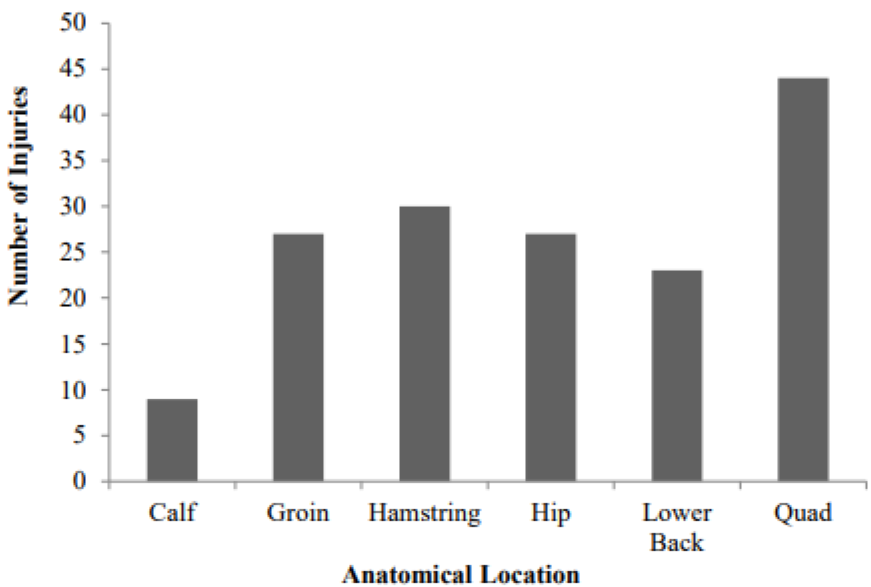

Figure 1 Anatomical location of muscle strain injuries

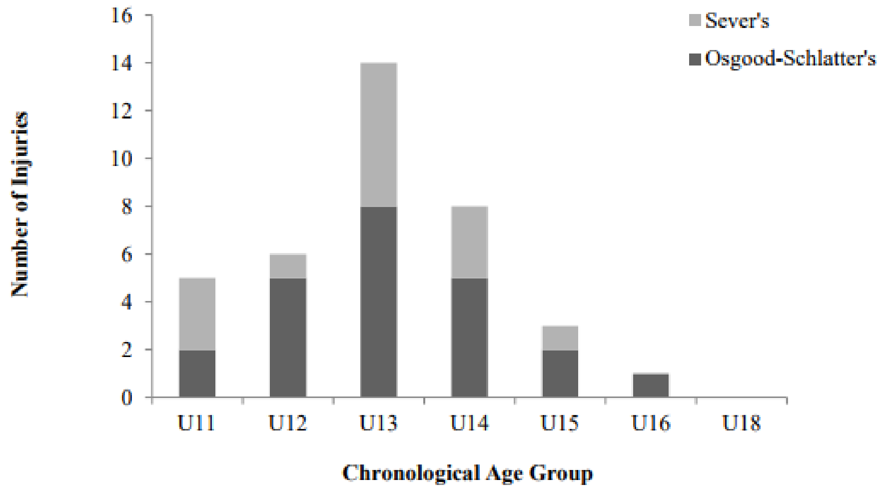

Figure 2 Number of growth overuse injuries due to Sever's disease and Osgood-Schlatter's disease per chronological age group

Injury severity: The most frequently reported injuries were classified as moderate in nature (42.9%). Severe injuries accounted for 22% of the total injuries, with minor and slight injuries occurring less frequently (20.4% and 14.7% respectively). Player incidence rates of severe injuries per age group are displayed in *figure 3*.

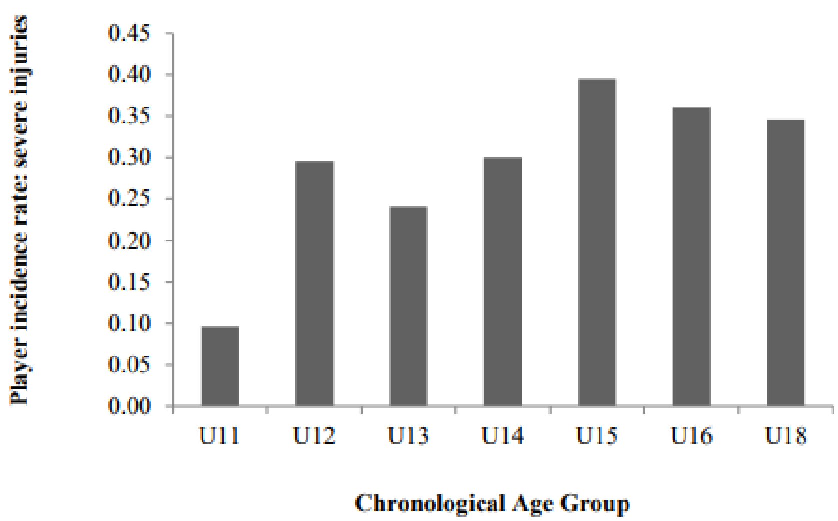

Figure 3 Player incidence rate for severe injuries in each chronological age group

Seasonal variation: The number of injuries sustained during each calendar month for all the age groups combined is displayed in *figure 4*. Two injury peaks were evident where the observed frequencies were greater than what might be expected by chance, specifically, in September and January (both $p < .001$). Significantly fewer numbers of injuries were shown in May and June ($p < .001$).

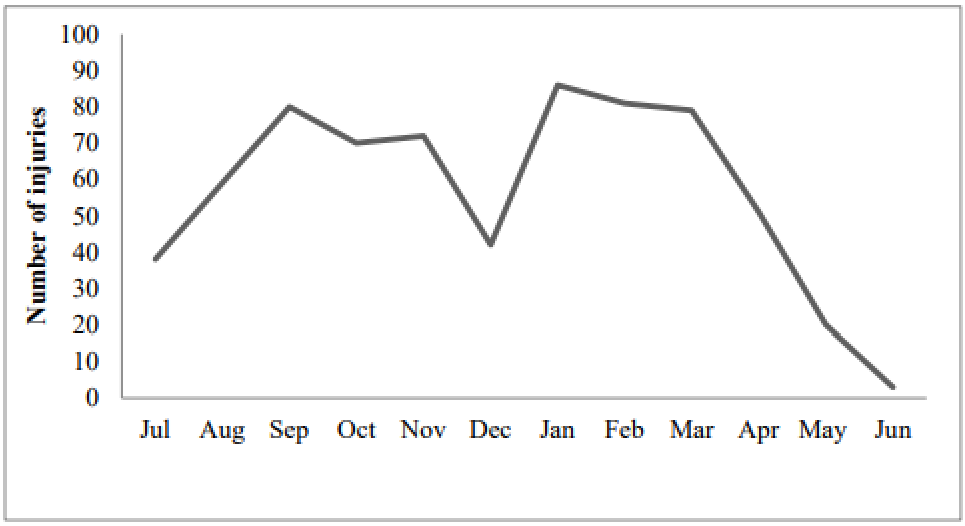

Figure 4 Seasonal variation of injuries sustained

Discussion

With the recent inception of the EPPP and subsequent increase in the required training hours, the current study aimed to examine the injury occurrence in elite male youth soccer players. With all players combined, an incidence rate of 1.32 injuries per player over the course of the season was shown and this was even higher in some age groups, peaking in the U18s at 2.14 injuries per player/season. The lowest number of injuries was reported in the U11s with a significant increase in the older age groups. A further significant increase was present in the U18s. However, in-spite of a high player incidence rate in the U18s, the time loss experienced for each injury was comparable to the other age groups. Severe injuries were more frequent for players in the older age groups, peaking in the U15s, while the time loss for each injury was greatest in the U14s and U15s. The most frequent anatomical sites of injury were the knee and ankle, with muscle strains accounting for the greatest percentage of all injuries, followed by ligament sprains. Seasonal variation indicated two peaks in incidence, specifically in September and January.

Incidence rate was higher in older players, with peak values recorded in the U15s and U18s. The main purpose of the current study was to compare the injury occurrence to an audit completed prior to the inception of the EPPP (Price et al., 2004), while adopting the same analytical approach. Previously, a mean player incidence rate of 0.40 injuries per player, per season was reported (Price et al., 2004). Therefore, the findings of the current study and that of Price et al. (2004) indicate that during the 13 years between the respective studies there has been a three-fold increase in the player injury incidence rate. A plausible explanation could be the dramatic increase in the recommended on-pitch player exposure hours (3,760 vs. 6,600 and 8,500 accumulated incrementally from age 9-21) for clubs in the highest academy classification categories (category 1 and category 2 clubs respectively) (EPPP, 2011). While anecdotally, the impact of such a significant increase in training volume for these young athletes was of concern to practitioners; this study provides empirical evidence that highlights the potentially deleterious effects of the EPPP on injury risk in male youth soccer players (Read et al., 2016). Based on the cumulative hours required before and after the inception of the EPPP, contact time has more than doubled, while injury rates have more than trebled. These data indicate that the heightened volume of exposures at least in part accounts for the increase in injury. Also, a high proportion of injuries were non-contact in nature when the sample was analysed as a whole and across the different chronological age groups. Arguably these injuries are preventable with appropriate management of training loads and the inclusion of individualised training programmes that target deficits in neuromuscular control (Read et al., 2016).

Significantly fewer injuries were recorded in the U11s than all other age groups. It should be acknowledged that these players compete in a 9 vs. 9 format, whereas, all the other age groups in this study play 11 vs. 11. A further point to consider is that a rise in the on-pitch contact time (from 8 to 12; 5 to 6; and 3 to 6 hours per week for category 1, 2 and 3 clubs respectively) is indicated in the EPPP (EPPP, 2011). Furthermore, during the period of the U12-U16 development phase, a further increase up to 16 hours per week of soccer specific activity is specified. In other sports, increased exposure has been identified as the most important risk factor for injury in young athletes (Rose et al., 2008). Also, youths who completed more hours of sport per week than their age in years, or whose ratio of organised sports versus free play time was > 2:1, were at a greater risk of serious overuse injury (Jayanthi et al., 2015). This provides a plausible explanation for the linear increase in the number of injuries shown in the current study with each respective age group category. The greater frequency of injuries in the U18s may also be due to heightened intensities of play and increased exposure, reflective of their status as full time academy players; increasing the likelihood of slight and minor incidences.

The highest player incidence rate was reported in the U18s; however, the time loss experienced for each injury was comparable to those in other age groups. The incidence rate of severe injuries peaked in the U15s, while the longest time loss per injury was indicated in the U14s and U15s. This period coincides with a stage of rapid growth and increased injury risk (van der Sluis et al., 2014), whereby 'adolescent awkwardness' reflects temporary disruptions in motor control strategies (Philippaerts et al., 2006). This time-frame also corresponds with the onset of peak weight velocity which occurs approximately 12-18 months after peak height velocity (Beunen and Malina, 1998). At this time player will experience relative increases in muscle and overall mass due to heightened androgen concentrations (Viru et al., 1999) and this could increase ground reaction forces and loads experienced by soft tissue structures. Also, recent data signify the importance of the rate of change in anthropometric factors (Kemper et al., 2015). In elite male youth soccer players, rapid growth in stature ≥ 0.6 cm and an increased BMI $\geq 0.3 kg/m^2$ per month were significant predictors of injury (Kemper et al., 2015). Cumulatively, the results of the present study suggest that these age groups should be targeted for screening and prevention strategies. However, despite the apparent need for focused attention on those players around or just after peak height velocity, practitioners should be cognisant that interventions applied during the pre-pubertal years are deemed critical due to the accelerated periods of neural plasticity associated with pre-pubescence (Borms, 1996; Gallahue, 1982; Hirtz and Starosta, 2002, Myer et al., 2013).

The most frequent anatomical sites of injury were the knee and ankle, followed by the quadriceps. A high proportion of knee and ankle injuries are consistent with previous literature (Junge et al., 2000; Le Gall et al., 2006; Price et al., 2004;); however, the upper thigh was cited as the most common anatomical injury location in a previous audit of English academy soccer players (Price et al., 2004). A plausible explanation for the findings in the current study could be the heightened exposure to soccer-specific practice required following new EPPP regulations.

Increased training volumes will raise the frequency of jumping and rapid change of direction actions that may amplify injury risk (Daniel et al., 1994). Also a greater proportion (6.6% vs. 5%) of growth-related injuries (in particular Osgood-Schlatter's) and overuse injuries were reported in the present study compared to the previous audit (Price et al., 2004). Thus, it could be inferred from these data that the knee and ankle present the greatest risk of injury for elite male youth soccer players, which may be exacerbated by higher training volumes and periods of rapid growth.

Muscle strains were the most commonly recorded type of injury, which corresponds with previous research in this cohort that showed a propensity for hamstring strain injuries (Price et al., 2004). Specifically, 43% and 57% of all thigh muscle strains were sustained in the quadriceps and hamstrings respectively (Price et al., 2004). However, in the current study, the quadriceps was the most frequent site of muscle strain injury. This disparity could once again be attributed to the greater volume of soccer practice that is now required under new EPPP regulations. Increased exposures to repetitive actions such as kicking (requiring hip flexion and knee extension) and rapid eccentric loading of the quadriceps to control knee flexion and hip extension may subsequently increase injury risk (Kary, 2010). Elite male youth soccer players are required to assign the majority of their time to competitions or on-field conditioning, with proportionally less time allocated to strength training (Wrigley et al., 2012); thus, players may be physically underprepared to meet the demands of these high soccer training loads.

Seasonal variation of injury incidence showed an initial peak in the number of injuries following the completion of pre-season (September), which corresponds with previous research (Le Gall et al., 2006; Price et al., 2004). The linear injury increase shown from July to September in the present study is likely due to the accumulation of fatigue following intensive periods of soccer-specific training and the start of the competitive season. Heightened training loads have been associated with greater injury risk (Gabbett and Shahid, 2012; Rose et al., 2008) and physical stress has also demonstrated relationships with injury in elite male youth soccer players (Brink et al., 2010). This risk is further increased in youth athletes undertaking specialised sports practice (Jayanthi et al., 2015). A second peak in the number of injuries recorded in the current study occurred immediately after the mid-winter break (January). Increased incidence of injury following the mid-winter break could be a result of decreased levels of conditioning, and/or inappropriate training loads following a period of reduced activity (Price et al., 2004). Recent research in other sports has shown that spikes in acute workload increase injury risk (Hulin et al., 2014), whereby rapid escalations in training load are a key contributor to non-contact soft tissue injuries (Gabbett, 2015). This pattern was not observed in other investigations that tracked injuries in a French academy (Le Gall et al., 2006). Shorter but more frequent restitution periods allowed players to rest and recuperate while avoiding a rapid decline in their conditioning levels, reducing injury risk when returning to play (le Gall et al., 2006). It may be advisable for governing bodies to organise the competitive season with the inclusion of more regular breaks, allowing for a greater focus on recovery and a more gradual accumulation of the required training volume.

When interpreting the results of the current study, practitioners should be cognisant of the inherent limitations. While previous research has utilised a similar sample size to the current study (Brito et al., 2012; Cloke et al., 2009; Junge et al., 2000), it should be noted that fewer players were included in comparison to Price et al. (2004). Also, injury data were recorded over a single season and while this has been indicated as the minimum reporting period required (Fuller et al., 2006), seasonal comparison and the identification of longitudinal trends is not possible. Nonetheless, due to the paucity of research since the EPPP, the current experimental design was deemed appropriate and can be supported by longitudinal investigations in the future.

Finally, the present study did not account for player exposures as the aim of this research was to provide an update on data published prior to the EPPP. This information provides an indication of which chronological age groups are most susceptible to injury, accounting for their relative exposure to training and competition (Price et al., 2004). However, these data were not reported by Price et al. (2004) and thus, it is not possible to make comparisons or updates to historical data here. Furthermore, reporting incidence per exposures requires accurate quantification of the number and duration of each match and training session participated in by all the players in the cohort (Junge and Dvorak, 2000). In the current study, due to the variation in exposure reporting procedures between clubs and subsequent inaccuracies in measurement, this approach was deemed impractical. Also, solely reporting exposures based on the hours of participation does not account for the nature of the activities performed and disparity between activity patterns, training types, surface interaction, content and volume / intensity of the sessions, or grading of internal or external workloads performed between the different clubs. For example, a training philosophy focusing on small-sided games will increase the frequency of utility movements (Jones and Drust, 2007) and thus; likely the number of rapid accelerations, decelerations and changes of direction. Conversely, soccer practices that include higher frequencies of phase of play and technical work as opposed to small sided games will bestow different demands. In this study, player incidence rates were measured based on the number of registered players and the number of injuries sustained as this is not affected by the aforementioned variables and provides an indication of injury frequency in each age group. Future investigations should consider using wearable technologies to account for training time, grouping players by maturation to examine effects on injury incidence and quantify the demands of the training and competition activities undertaken using both internal and external workloads to more accurately identify injury incidence and contextualize the exposure data in this cohort.

Conclusions

The current study showed heightened player injury incidence rates compared to previously reported research on comparable populations (Price et al., 2004). These data indicate that the greater training volumes associated with the EPPP may have increased the number of injuries sustained per player during the course of a season. Injury risk increases from the U12s onwards, growth-related injuries peak in the U13s, the U14s and U15s are at a greater risk of severe injuries and the U18s are more likely to sustain multiple injuries. These players should be considered an important focus group for training load monitoring and injury prevention strategies targeting potential neuromuscular deficits. Specifically, for the U12s and U18s, more effective control should be applied in the progression of training and competition loads, and for the U13s-U15s, improved management of the interaction of growth, maturation, training load and quality of provision. The most frequent anatomical sites of injury were the knee and ankle, followed by the quadriceps.

Examination of age, maturation and growth-related risk factors, appropriate screening techniques and targeted injury prevention strategies with a specific focus on these anatomical locations is warranted. Practitioners should also consider stages within the season where players may be at greater risk, specifically at the end of the pre-season period (September) and following the mid-winter break (January).

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