Females sustain more ankle injuries than males in youth football

ABSTRACT

This prospective study evaluated the incidence and pattern of acute injuries in youth (9- to 14-years old) football players. Ten football clubs [n=730 players (567 males, 163 females)] participated in the 20-week follow-up study (January - June 2015). Data was collected by sending standardized weekly SMS to players' parents/guardians with follow up interviews for injured players. During the study period, 278 players (38%) sustained 410 acute injuries. The overall injury incidence for males and females was 6.47 (95% CI, 5.84-7.09) injuries per 1000 hours of football exposure. Most injuries (40%) caused minimal absence from sports. Eighty-four percent of the injuries affected the lower extremities, ankle (30%), knee (17%) and thigh (16%) being the most commonly injured body sites. Females had significantly higher ankle injury rate (IRR) 1.85 (95% CI, 1.18-2.91, p=0.007) and non-contact ankle injury rate IRR 2.78 (95% CI, 1.91-4.02, p<0.001) than males. In conclusion, our results showed that the acute injury incidence among youth football is moderately high, females are at higher risk for ankle injuries. Injury prevention programme specified preventing ankle injuries should be considered in the future.

Keywords: football, epidemiology, acute injury, sports injury, youth

1 INTRODUCTION

Football is the most popular team sport in Finland. The Football Association of Finland has 917 registered clubs with about 140 000 licensed players. From these, the number of young players ≤14 years is approximately 98 000, 24 000 are females (Football Association of Finland 2018 [1].

Football is a high-intensity interval sport combining speed, agility, strength and endurance. Benefits of regular participation in football include increased physical activity and improved social skills in children [2-5]. However, playing football contains a moderate risk for an injury, the knee, ankle and thigh being the most commonly injured body parts [6-8].

Several studies have evaluated the injury profile in youth (players under 19 years old) football players [9-17]. However, the number of prospective studies on football injuries in youth is low [2], and to our knowledge only three studies have examined injuries in players under 14 years [6-8]. Furthermore, only two of these studies [6, 8] collected player exposure hours to describe incidence rates (IR) as the

number of injuries per 1000 hours. According to one of these earlier studies [6] the overall time-loss injury incidence in youth football was 2.2/1000 hours of exposure (95% confidence interval (CI), 1.8-2.6) in males and 2.0 (CI 1.4-2.5) in females. This study used monthly data collection, where all the injuries during the previous month were collected through physical therapist's telephone and/or email interview. In another study [8] collected injuries on a weekly basis through team coaches and reported an injury incidence of 0.61 injuries per 1000 practice hours (95% CI, 0.53-0.69) and 4.6 injuries (95% CI, 4.0-5.2) per 1000 game hours. Studies using injury collection based on team coaches' or medical staff's reports might underestimate overall injury incidence [18]. A player-based data collection has shown to increase the accuracy of reported injury incidence rates in team sports [18]. Previous studies have reported good response rates using a short message service (SMS) as a tool for injury surveillance [19-20]. Hence, studies with weekly data collection through players and their parents among youth football are needed.

Although football is one of the world's most popular sport among youth, there is a paucity of studies evaluating acute injuries in youth football. Prospective epidemiological data on incidence, severity and causes of acute injuries is needed when developing injury prevention strategies [21]. This study aimed to investigate the incidence rate and characteristics of acute (traumatic) injuries among youth female and male football players, and to compare lower extremity injury risk between sexes.

2 MATERIALS AND METHODS

2.1 Study design and participants

This was a prospective injury surveillance study conducted in Finland during 2015. The cohort of this study consisted of the control arm of a randomized controlled trial (RCT) to investigate the effect of neuromuscular training warm-up for prevention of lower extremity injuries in youth football (ISRCTN14046021). The study was carried out in Sami Hyypiä Academy (SHA), the national training and research centre of Finnish football. Every second year, the SHA selects youth clubs from Finland to participate in the player development monitoring programme in which 9-14-year-old talented males and females participate on a three-day player monitoring event twice a year. In August 2014 twenty SHA clubs were invited to take part in the RCT (January – June 2015). Ten clubs (48 teams, 737 players) of the control arm of the RCT not involved in prevention intervention were entered the current study (Figure 1). Players who were official members of the participating team and injury-free (able to participate team practices and games) at the onset of the study were eligible to participate. The final participation was based on an informed consent of each player and parent/guardian. The study was approved by the ethics committee of the Pirkanmaa Hospital District,

Tampere, Finland (ETL code R13110), and performed in agreement with the ethical guidelines of the International Journal of Sports Medicine [22].

2.2 Data collection

The players completed baseline questionnaires and measurements (body mass and height, [Seca gmbh & co. kg. 22089 Hamburg, Germany]) during their team's monitoring event in fall 2014 (September 2014 to January 2015). The baseline questionnaire included questions about age, sex, starting age, and previous/current injuries. Exposure hours were recorded per training and games separately. The players kept training diaries (number and length of sessions) as a part of the SHA programme and the data was collected by the SHA monthly. If player's practice hours were missing, the values were replaced with the average of her/his teams' practice hours. The time of exposure to football games was calculated for entire teams. The Finnish competitive season 2015 started in March-April and the game data was achieved from SHA game diaries (for wintertime exposure) and from the Finnish Football Association archives (for on-season exposure). Only the number of played games were attained from the data and therefore game exposure in hours for each team was estimated using standard game durations (from 20 to 80 minutes) for each age group and number of players on the pitch (8 to 11).

Injury registration was carried out by SMS. During the follow-up the player's parent/legal guardian received a weekly SMS regarding new injuries: "Has your child had any musculoskeletal complaint or injuries during the previous seven days (yes/no)." After each reported injury, a study physiotherapist contacted the injured player and/or parent/legal guardian and collected details of the injury by a standardized phone interview.

Injury definitions and recording of injuries were done according to the established consensus article on football injury research [23]. An injury was determined as 'any physical complaint sustained by a player that results from a football match or training, irrespective of the need for medical attention or time loss from football activities.' A recurrent injury was defined 'an injury of the same type and at the same site as an index injury and which occurs after a player's return to full participation from the index injury'. The player was defined as injured until being able to train and play normally again. Location of injury, injury circumstances and mechanism, treatment and diagnosis (if available), time loss from sport, and whether the injury was a first-time or a recurrent injury were registered. The mechanisms of injury were reported as contact (direct contact to the injured body region) or non-contact (no direct contact to the injured body region) [24]. Only acute injuries that resulted from a

specific identifiable event or trauma [23] were included in the analysis. Overuse injuries have been reported elsewhere [25]. The severity of an injury was defined as time-loss from full participation in training and playing: slight (0 days), minimal (1-3 days), mild (4-7 days), moderate (8-28 days), severe (>28 days), and career ending injury (injury causing the player stop playing football totally or forcing the player to play at a lower level) [23].

2.3 Statistical analyses

Data was analysed using Stata (Stata Statistical Software: Release 15. College Station, TX: StataCorp LLC). Baseline characteristics (age, sex, height, weight and playing years) were described as means and standard deviations (SD) (Table 1). Injury incidence rates were expressed as the number of injuries per 1000 practice and game hours. Due to over dispersed data negative binomial regression was used instead of Poisson regression. In the model, the number of injuries was the outcome and the exposure hours per player were considered by adding the exposure option corresponding to the length of time a player was followed to adjust the negative binomial regression estimates. Sex was included as an explanatory variable into all models and, in multivariate models, it was adjusted for the potential factors (age, body mass, and height as continuous variables) associated with having acute injuries. Multicollinearity between explanatory variables was not detected. Intragroup correlation between players in same club was taken into account by calculating cluster-robust standard errors [26]. The results are expressed as incidence rate ratios (IRRs) with their 95% CIs and p-values.

3 RESULTS

Follow-up data were obtained from 730 players, where the average response rate to the weekly survey was 95%. Altogether, 51 players (7%) dropped-out during the intervention period due to reasons specified in Figure 1. Data collected from drop outs were included from the time they participated. During the 20-week follow up, a total of 63405 hours of football exposure (8145 hours in games and 55260 hours in practices) were recorded. In total, 278 players sustained a total of 410 injuries: 22% (n=89) of these occurred in females and the remaining 78% (n=321) in males (Table 2). The overall injury incidence rate per 1000 hours of football exposure for both sexes was 6.47 (95% CI, 5.84-7.01) being 25.91 (95% CI, 22.41-29.40) in games and 3.60 (95% CI, 3.10-4.10) in practices. Females had an overall incidence rate of 7.20 (95% CI, 5.71-8.70) per 1000 hours of football exposure, whereas males had an overall incidence rate of 6.29 (95% CI, 5.60-6.98) per 1000 hours of football exposure. Altogether, 38% of the players had at least 1 injury during the 20-week follow-up. During the follow-up, 374 injuries (91%) were new and 35 (9%) were recurrent.

3.1 Injury location and mechanism

The majority of the acute injuries (84%) affected the lower extremity. Most commonly injured body regions in the players were the ankle (30%), knee (17%) and thigh (16%) (Table 2). Overall injury incidence in games and practices was 25.91 (95% CI 22.41-29.40) and 3.60 (95% 95 CI 3.10-4.10), respectively. Contact accounted for 63% (IR 4.05, 95% CI 3.56-4.55) of all injuries and 37% (IR 2.41, 95% CI 2.03-2.80) were non-contact injuries. By injury site, the highest injury rate occurred in non-contact injuries were ankle (50%, IR 0.66, 95% CI 0.46-0.82) and thigh (72%, IR 0.66, 95% CI 0.46-0.82) followed by hip/groin (86%, IR 0.39, 95% CI 0.24-0.55) and knee (36%, IR 0.28, 95% CI 0.15-0.42).

3.2 Injury severity

Severity of injuries is presented in Table 3. Lower extremity injuries were more severe than injuries at other sites. The majority of injuries (n=166, 40%) were of minimal severity and mean time-loss from full participation in football practice was 8 days (95% CI 6.49-8.99). Severe injuries affected most commonly knee and ankle. Seven percent of knee injuries (n=5) were severe and caused on average 50 days of time-loss (95% CI 28.0-71.6). Of all ankle injuries, 4% (n=5) were severe (mean time-loss 48 days, 95% CI 10.0-86.4).

3.3 Sex differences

Total of 277 players (38%), including 37% of the females and 38% of the males, had at least 1 injury during the 20-week follow-up. The most commonly injured body parts in both sexes were ankle, knee and thigh, but some sex differences were observed: hip/groin and hand/finger injuries were more prevalent in males (Table 2). Ten percent of females and twelve percent of males sustained recurrent injuries.

3.4 Injury risk factors

Females had significantly higher ankle injury rate (IRR 1.85, 95% CI 1.18-2.91, p=0.007) and non-contact ankle injury rate (IRR 2.78, 95% CI 1.91-4.02, p<0.001) compared to males (Table 4). No significant association was observed between age or body mass and lower extremity injuries. Per 1 cm increase in height was lead to a decrease of 3% in the rate for lower extremity injuries.

4 DISCUSSION

The aim of the study was to examine the occurrence and characteristics of acute injuries in young players aged 9-14 playing Finnish National programme. The key finding was the high rate of injuries in 9- to 14-year-old players in football, while game-injury incidence was 25.91 (95% CI 22.41-29.40) and training-injury incidence was 3.60 (95% CI 3.10-4.10). The overall injury incidence rate was 6.47 (CI 5.84-7.09) and 38% of the players had at least 1 acute injury during the 20-week follow-up. Moreover, a relatively high proportion of all injuries (37%, IR 2.41, 95% CI 2.03-2.80) were non-contact injuries.

According to our findings, the risk for overall injury incidence seems high when some previous studies evaluating injuries in children's football [6, 8] have reported much lower overall incidences of 2.12 and 1.06 per 1000 hours during 1 season and over 2 seasons follow-up, respectively. However, these results are not directly comparable to earlier studies [6, 8] because of differences on injury definitions and data collection methods. Furthermore, our study used weekly SMS where players' guardians were asked for possible injuries every week. This might have yielded in more complete reporting of injuries, such as slight injuries, when compared to monthly or more traditional approaches such as e-mail, injury diaries, self-driven proactive reporting or seeking for medical attention, where injuries causing the player to miss 1 day or more of game or training sessions were reported [6, 8].

The injuries in this study affected mostly the lower extremities, more specifically the ankle (30%), knee (17%) and thigh (16%) being in concordance with earlier studies [6-8] evaluating injuries in children's football. Most injuries (40%) were minimal causing 1-3 days of time loss from games or practices. This is in line with earlier studies in which the majority of injuries have caused less than one-week time loss from football [6-8]. In our study, only 6% of the injuries were severe resulting in absence of over 28 days, which is in agreement with the earlier results of children's football [6]. However, it is difficult to compare the injury rates to earlier studies because of the differences in injury definitions, data collection methods, and the duration and timing (on-season/off-season) of follow-up period. In our study, the injury severity was classified into 6 different categories according to the consensus for injury reporting in football [23], when another study [6] has used 3 different injury severity categories (minor 1-7 days, moderate 8-21 days and major >21 days).

One previous study [8] has reported that 21% (IR 0.22 95% CI 0.17-0.27) of the injuries were non-contact injuries. In our study, even larger percentage (37%, 2.41, 95% CI 2.03-2.80) of injuries occurred without contact. By injury site, the highest relative number of non-contact injuries occurred the ankle (50%, IR 0.66, 95% CI 0.46-0.82) and thigh (72%, IR 0.66, 95% CI 0.46-0.82) followed by hip/groin (86%, IR 0.39, 95% CI 0.24-0.55) and knee (36%, IR 0.28, 95% CI 0.15-0.42). Neuromuscular training has been found to be effective reducing the risk for non-contact lower extremity injuries in different sports [27-33] and also in children's football [28, 34] Based on our results, large scale implementation of neuromuscular training in youth football is needed. In addition, as the number of non-contact ankle injuries was high, ankle specific prevention programmes should be considered in the future studies.

There were some differences in injury incidences and characteristics between females and males. Females were 42% more likely to have ankle injuries compared to males corresponding to one previous study of injury differences in male and female football players [35] and high rate of ankle injuries in young female football players in general [34-36]. According to our study, females showed higher overall injury likelihood being in agreement with some earlier studies, where female sex has also been associated with higher likelihood of having football injuries in general [37] and during training [38]. Neither age or body mass were associated on the likelihood of lower extremity injuries in females and males. Increasing height per 1 cm was associated with 3% decreased likelihood of having lower extremity injuries, while some previous studies [8, 34] have found, that the probability of sustaining an injury tended to increase with age and height [38]. However, our results showed that the difference in likelihood is minimal and further research about risk factors for football injuries in young players is needed.

This study had several strengths. This was a prospective cohort study with 5-month follow-up. The sample size was considerably large and representative both geographically (players all over Finland) and by sex (22% girls). Furthermore, we had a very low drop-out rate (7%). The response rate of weekly reporting was high (95%). The use of SMS data collection might have lowered the threshold for reporting injuries and consequently might have led to higher and more reliable injury incidences. We recommend the extended use of these data collection methods in future research.

The main limitation of the study is missing individual game exposure data. The game exposure (number of games per each team, length of games, number of players on the field) was achieved from the SHA and the Finnish Football Association and was calculated for entire teams. A second limitation was that we did not perform a clinical examination of the injured players to assure

diagnoses. Most of the injuries (74%) were treated at home. After each reported injury, a study physiotherapist contacted the injured player and/or parent/legal guardian and registered details of the injury by a standardized phone interview. Third, our study was carried out during the spring season from January to June when players are mainly playing and practicing either on artificial turf or on different indoor playing surfaces. Different playing surfaces and the timing of the study period (early in Finnish football season) might have influenced on the injury incidence.

In contrast to earlier studies [8, 39-40], we almost missed to see concussions during follow-up as only one concussion was reported. The amount of head injuries that we reported (2% of all injuries) is lower than the results achieved in some earlier studies [8, 39], where head injury frequencies of 6% and 15% of all injuries were observed, respectively. It is possible that players' guardians did not report injuries affected to the head area as the weekly SMS implied specifically to "musculoskeletal complaint or injuries". Hence, the low rate of head injuries in our study should be interpreted with caution.

In conclusion, this prospective study showed that the overall acute injury incidence is high and ankle injuries are the most common injuries in 9- to 14-year-old football players. Females were almost twice as likely to have ankle injuries compared with males. The high injury incidence observed in this study warrants for more focus on injury prevention in children's football.

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Figure 1. The study population included the control arm of a RCT

Table 1. Baseline characteristics of the players (n=730) organised by age group classification (yr, Mean±SD).

Table 2. Number and incidence (per 1000 hours of football exposure) of acute injuries and incidence rate ratio (IRR) with 95% confidence interval (CI) and exposure time (h) for male and female football players

Table 3. Injury severity, number and incidence per 1000 hours of football exposure in female and male football players

Table 4. Incidence rate ratios with their 95% confidence intervals from negative binomial regression models

Table 1. Baseline characteristics of the players (n=730) organised by age group classification (yr, Mean±SD).

Age group	n	Age (yr), SD	Height (cm), SD	Body mass (kg), SD	Starting age (yr), SD
Males	567	12.3 (1.1)	151.7 (10.0)	41.2 (8.7)	5.4 (1.3)
9-10	94	10.6 (0.3)	142.3 (6.3)	34.2 (4.9)	5.3 (1.2)
11	146	11.6 (0.3)	147.5 (6.3)	37.8 (5.4)	5.3 (1.2)
12	156	12.6 (0.3)	153.5 (7.9)	41.9 (6.5)	5.6 (1.4)
13-14	171	13.6 (0.3)	160.6 (8.5)	48.7 (9.2)	5.4 (1.2)
Females	163	12.4 (1.1)	151.6 (9.2)	41.6 (7.7)	6.7 (1.5)
9-10	21	10.6 (0.3)	140.3 (3.9)	33.2 (4.0)	6.0 (1.4)
11	39	11.6 (0.3)	146.9 (6.2)	37.8 (5.2)	6.5 (1.1)
12	50	12.5 (0.3)	156.3 (6.1)	45.1 (6.8)	6.8 (1.5)
13-14	53	13.6 (0.3)	159.7 (5.3)	47.9 (5.0)	7.1 (1.7)

Table 2. Number and incidence (per 1000 hours of football exposure) of acute injuries and incidence rate ratio (IRR) with 95% confidence interval (CI) and exposure time (h) for male and female football players

	All players (n=730) Injuries n (incidence)‘	Male (n=567) Injuries n (incidence)‘	Female (n=163) Injuries n (incidence)‘	Males vs. Females IRR (95% CI)	p-value
All injuries	410 (6.47)	321 (6.29)	89 (7.20)	0.86 (0.64-1.17)	0.34
Game injuries	211 (25.91)	159 (24.67)	52 (30.59)	0.73 (0.51-1.05)	0.90
Training injuries	199 (3.60)	162 (3.63)	37 (3.47)	1.05 (0.63-1.74)	0.86
Injury location					
Ankle	121 (1.91)	86 (1.68)	35 (2.83)	0.58 (0.35-0.96)	0.033
Knee	70 (1.10)	55 (1.08)	15 (1.21)	0.89 (0.55-1.44)	0.63
Thigh	65 (1.03)	52 (1.02)	13 (1.05)	0.97 (0.30-3.09)	0.95
Foot/ toe	31 (0.49)	26 (0.51)	5 (0.40)	1.25 (0.60-2.61)	0.55
Lower leg/achilles	30 (0.47)	24 (0.47)	6 (0.49)	0.97 (0.42-2.24)	0.94
Hip/groin	29 (0.46)	26 (0.51)	3 (0.24)	2.09 (0.51-8.65)	0.31
Lower back/pelvis/sacrum	24 (0.38)	19 (0.37)	5 (0.40)	0.92 (0.57-1.47)	0.72
Hand/finger	12 (0.19)	11 (0.22)	1 (0.08)	2.64 (0.34-20.6)	0.35
Upper back/neck	8 (0.13)	6 (0.12)	2 (0.16)	0.73 (0.11-4.67)	0.74
Wrist	7 (0.11)	6 (0.12)	1 (0.08)	1.44 (0.15-13.8)	0.75
Shoulder/clavicula	4 (0.06)	2 (0.04)	2 (0.16)	0.24 (0.09-0.65)	0.005
Upper extremity	4 (0.06)	4 (0.08)	0	NA	NA
Chest/rib	3 (0.05)	3 (0.06)	0	NA	NA
Head/face	2 (0.03)	1 (0.02)	1 (0.08)	0.24 (0.01-4.57)	0.34
Exposure, h					
Overall exposure	63404.46	51050.42	12354.03		
Game exposure	8144.76	6444.96	1699.80		
Training exposure	55259.70	44605.46	10654.23		

*Upper extremity consisted upper arm, elbow and forearm

‘Absolute number of injuries (incidence: number of injuries per 1000 hours of football exposure)

‘NA= Not available

Table 3. Injury severity, number and incidence per 1000 hours of football exposure in female and male football players

Body region	Slight (0-d)		Minimal (1-3d)		Mild (4-7d)		Moderate (8-28d)		Severe (>28d)		All injuries		All
	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	
Head/neck	-	-	2 (0.16)	3 (0.06)	1 (0.08)	-	-	-	-	-	3 (0.24)	3 (0.06)	6 (0.09)
Upper extremity	2 (0.16)	5 (0.10)	1 (0.08)	8 (0.16)	1 (0.08)	1 (0.02)	-	4 (0.08)	-	5 (0.10)	4 (0.32)	23 (0.45)	27 (0.43)
Spine/trunk	-	4 (0.08)	2 (0.16)	7 (0.14)	-	2 (0.04)	1 (0. 08)	4 (0.08)	-	3 (0.06)	3 (0.24)	20 (0.39)	23 (0.36)
Lower extremity	13 (1.05)	20 (0.39)	24 (1.94)	119 (2.33)	18 (1.46)	58 (1.14)	12 (0.97)	73 (1.14)	1 (0.08)	16 (0.31)	68 (5.50)	286 (5.60)	354 (5.58)
Ankle	7 (0.57)	9 (0.18)	10 (0.81)	31 (0.61)	9 (0.73)	18 (0.35)	8 (0.65)	24 (0.47)	1 (0.08)	4 (0.08)	35 (2.83)	86 (1.68)	121 (1.91)
Knee	3 (0.24)	3 (0.06)	6 (0.49)	25 (0.49)	3 (0.24)	11 (0.22)	2 (0.16)	12 (0.24)	1 (0.08)	4 (0.08)	15 (1.21)	55 (1.08)	70 (1.10)
All injuries	15 (1.21)	29 (0.57)	29 (2.35)	137 (2.68)	20 (1.62)	61 (1.19)	13 (1.05)	81 (1.59)	1 (0.08)	24 (0.47)	89 (7.20)	321 (6.29)	410 (6.47)

‘Absolute number of injuries (incidence: number of injuries per 1000 hours of football exposure)

Table 4. Incidence rate ratios with their 95% confidence intervals from negative binomial regression models

	Lower extremity injuries				Knee injuries				Ankle injuries			
	All	*p*	Non-contact	*p*	All	*p*	Non-contact	*p*	All	*p*	Non-contact	*p*
Age, per yr	0.99 (0.81-1.22)	0.95	0.96 (0.80-1.15)	0.66	0.99 (0.70-1.38)	0.94	1.11 (0.65-1.91)	0.71	0.78 (0.56-1.08)	0.14	0.78 (0.57-1.06)	0.11
Sex, (ref=male)	1.20 (0.84-1.71)	0.32	1.42 (0.91-2.22)	0.12	1.02 (0.52-2.00)	0.96	1.14 (0.72-1.79)	0.58	1.85 (1.18-2.91)	0.007	2.78 (1.91-4.02)	<0.001
Body mass (kg)	1.03 (1.00-1.06)	0.059	1.03 (0.99-1.06)	0.12	1.03 (0.98-1.09)	0.20	1.01 (0.93-1.08)	0.88	1.04 (0.99-1.09)	0.14	1.05 (0.98-1.12)	0.15
Height (cm)	0.97 (0.95-1.00)	0.046	0.98 (0.94-1.02)	0.32	0.98 (0.95-1.01)	0.25	1.01 (0.91-1.11)	0.89	0.99 (0.94-1.03)	0.33	0.99 (0.93-1.05)	0.78

* P-value < 0.05