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Injury Incidence and Burden in a Youth Elite football (Soccer) Academy: A 4-Season Prospective Study of 551 players aged from under 9 to under 19 years.

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ABSTRACT

Objective

Investigate the incidence and burden of injuries by age-group in youth soccer academy players during four consecutive seasons.

Methods All injuries that caused time-loss or required medical attention (as per Consensus definitions) were prospectively recorded in 551 youth soccer players from under-9 years to under-19 years. Injury rate (IR) and burden (IB) were calculated as number of injuries per squad-season (s-s), as well as for type, location and age-groups.

Results A total of 2204 injuries were recorded. 40% (n=882) required medical attention and 60% (n=1322) caused time-loss. The total time-loss was 25,034 days. A squad of 25 players sustained an average of 30 time-loss injuries (TLI) per squad-season with an injury burden of 574 days lost per squad-season. Compared with the other age groups, U-16 players had the highest TLI rate per squad-season (95%CI lower-upper) [IR: 59 (7-8); IB: 992 (29-30) days] and U-18 players had the greatest burden per squad-season [IR: 42.1 (6-7); IB: 1408 (35-36) days]. Across the cohort of players, contusions (IR=7.7/s-s), sprains (IR=4.9/s-s) and growth-related injuries (IR=4.3/s-s) were the most common TLI. Meniscus/cartilage injuries had the greatest injury severity (95%CI lower-upper): [IR: 0.4 (0.3-0.7); IB: 73 (22-181) days]. The burden (95%CI lower-upper) of physeal fractures was double that of non-physeal fractures [IR: 0.8 (0.6-1.2); IB: 58 (33-78) days].

Summary: At this youth football academy, each squad of 25 players averaged 30 injuries per season which resulted in 574 days lost. The highest incidence of time-loss injuries occurred in Under-16 players, while the highest injury burden occurred in Under-18 players.

Key words: Epidemiology – Paediatric – growth plate injuries – Apophyseal injuries

What were the findings?

- The mean time-loss injury incidence (IR) was 30 injuries/squad-season, with an injury burden (IB) of 574 days lost/squad-season.
- While peak of time-loss injuries incidence (59 per squad-season) occurred in U-16 players, the peak of injury burden (1408 days lost/squad-season) occurred in U-18 players.
- Growth plate injuries were the second most prevalent time-loss injuries, accounting for 27% of the total lay-off time.
- Apophyseal injuries was the most prevalent diagnosis for the knee and the hip/pelvis.
- 50% of all fractures involved the physis, with a recovery period that was twice as long as mature bone fractures.

How might it impact on clinical practice in the future?

- The field of pediatric sports medicine should distinguish physeal injuries from mature bone injuries.
- Researchers should need not to only consider incidence when reporting injuries in youth sport and soccer academy. Express the injury burden by age-group and injury type will provide an enhanced understanding of the impact of injuries and will guide injury prevention.

INTRODUCTION

Elite youth soccer academies across the world exist to support young players becoming professional players.(1, 2) Talented children and adolescent athletes are a unique population and require a safe, adapted and developmental coaching program including appropriate illness and injury surveillance systems.(3) There is a lack of prospective epidemiology studies over consecutive seasons among youth elite football academies around the world including large cohorts.(4) In an English youth academy, Price et al.(4) found a rate of 0.8 injuries per player-season for a mean time-loss of 9 days per player-season, while Le Gall et al.(5) in elite youth French players observed a rate of 2.2 injuries per player-season for a mean time-loss of 32 days per player-season. Recently from different academies in Belgium, Brazil, England, Netherlands, Spain, and Uruguay, a rate between 0.7 to 1.3 injuries per player-season with a mean time-loss ranging from 16 to 29 days per player-season have been reported.(6-13) The limited depth jeopardises the scientific and clinical understanding of injury prevention, examination, rehabilitation, and long-term consequences of severe injuries and much could be learnt from other more experienced paediatric health care providers.(14-18) More detailed and precise prospective investigations are required using diagnoses that are specific to children and adolescents. This will allow clinicians to more accurately determine the pattern, incidence and burden of the type of injuries in these young players.(15) Understanding of injury risk, burden and precise aetiology will help to consistently optimise clinical management, injury prevention and optimise the development in elite youth soccer.(19) The objective of this study was to examine the extent of the different types of injuries and their respective incidence and burden, in all age-groups from U-9 to U-19 over four-consecutive seasons, in an elite youth soccer academy.

METHOD

Study design and subjects

A prospective cohort study of Qatari male youth elite soccer players was performed during four consecutive seasons in different age-groups from under 9 (U-9) to U-19, including a total of 551 players from childhood to late-adolescent. Players trained and played at the National training centre ASPIRE Academy in Doha, Qatar. All trained at a similar time of the day (between 10.00am to 12.00pm and between 4.00pm to 6.00pm), except when an international tournament or training camp were set overseas. Age-groups from U-13 to U-18 trained for approximately 14 $h \cdot wk^{-1}$ including combined soccer-specific training and competitive play, with a single rest day per week. This weekly load typically comprised 6–8 soccer training sessions, 1 strength training session, 1–2 conditioning sessions, and 1 domestic game per week. In addition, the players were engaged with the academy in two invited international games every three weeks. The younger age-groups, from U-9 to U-12, participated in an average of nine hours per week of combined soccer-specific training and competitive play. This typically comprised ~5 soccer training sessions including agility and coordination, and one domestic game per week. In addition, the younger players participated in a one-day tournament on a monthly basis. Signed parental and student consent for the screening was sought and obtained prior to any examination.

Data collection

All musculoskeletal injuries sustained were prospectively recorded by the academy medical staff in an electronic standardised format established on the consensus of Fuller et al.(20) Each squad had an experienced dedicated physiotherapist and all injuries were examined in cooperation with the Academy sports physician. Referral to a surgeon, specialist, or imaging was requested on a case by case basis if required/necessary to consolidate the diagnosis. Each team's physiotherapist submitted their injury

information of all discharged injured players to the senior physiotherapist who reviewed and consolidated all data on a weekly basis. Injuries not sustained in the context of the soccer programme, or any data related to sickness or other general medical conditions were excluded from this study.

Definition of injury

An injury was recorded as a result of any physical complaint resulting from a game or training, that required the attention of the medical staff. A visit to the physiotherapy department requiring a clinical examination without missing a full training session or game was termed "medical attention".(20) A visit resulting in a player being unable to fully take part in the training session or game the following day, was labelled "time-loss" injury. The lay-off (or player unavailability) was calculated by the number of days missed from the date of injury (day zero) until the day before the return to training participation and game selection availability.(19) The consensus statement from Fuller et al.(20) was not explicitly considering the physis. Therefore, aiming to collect prospectively and uniformly all physis injuries, the injury surveillance system was customized by adding "Growth related injuries" and "physeal fracture" as new injury types.(19) Similarly, other items have been added and muscle injuries were classified as per the Munich consensus statement (See supplementary Table 1 for all categories terminology details).(19, 21)

Anthropometric measurements

Anthropometry measure were taken in the morning three times during each season by an ISAK® (International Society for the Advancement of Kinanthropometry) practitioner. Measures included standing and sitting height (± 0.1 cm Holtain Limited, Crosswell, UK) and body mass (± 0.1 kg ADE Electronic Column Scales, Hamburg, Germany). The skinfold land marking and the Σ 7 skinfold measurements (± 0.1 mm

Harpenden skinfold calliper, Baty International, Burguess Hill, U.K.) were taken in accordance with international standards.(22) Maturity offset was obtained by a non-invasive method previously used in paediatric research comprising age and anthropometric measurements to predict maturational status (standard error of approximately 6 months).(23)

Data analysis

Descriptive statistics of variables were presented as mean ± standard deviation (SD) and percentage for categorical variables to compare the injury rate for all injury types and locations between age-groups. Poisson based 95% confidence intervals were calculated.(24) The injury burden (IB) was calculated using the following equation:

IB = Mean type injury incidence × Lay-off median per type of injury

Injury burden was expressed as the number of injury days lost per squad-season (Squad of 25 players) and 95% CI.(19) Because of the skewed distribution of time-loss injuries by types, we used the median to calculate the severity.

RESULTS

All age-groups from U-9 to U-18 were observed over four seasons, while the U-19 group over one season only. Demographic characteristics are described in Table-1.

Table 1. Demographic characteristics of the players by age group (Displayed anthropometric values are corresponding to the measurements taken at the beginning of each season).

Age Groups	Total Players-Seasons	Age (years)	Maturity off-set (Years)	Stature (cm)	Trunk Height (cm)	Leg length (cm)	Body Mass (kg)	Body mass index
	N	Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD
U-9	96	8.7 ± 0.2	-4.5 ± 0.8	131.0 ± 5.3	69.9 ± 4.3	61.4 ± 3.6	26.5 ± 2.9	15.2 ± 1.4
U-10	103	9.7 ± 0.3	-4.1 ± 0.5	135.5 ± 6.5	71.6 ± 3.7	65.3 ± 4.6	31.0 ± 6.1	16.8 ± 2.1
U-11	113	10.7 ± 0.2	-2.6 ± 0.2	142.2 ± 6.6	74.4 ± 5.1	69.5 ± 1.8	36.0 ± 7.3	17.8 ± 2.7
U-12	111	11.6 ± 0.3	-2.2 ± 0.8	147.0 ± 6.6	76.5 ± 3.0	72.3 ± 5.4	39.2 ± 5.8	21.2 ± 19.8
U-13	98	12.7 ± 0.3	-1.3 ± 0.6	154.1 ± 7.0	79.0 ± 3.8	75.1 ± 4.2	43.2 ± 6.8	18.1 ± 1.8
U-14	112	13.7 ± 0.3	-0.4 ± 0.7	160.1 ± 7.1	82.8 ± 4.2	77.3 ± 3.9	48.1 ± 7.7	18.7 ± 1.9
U-15	115	14.6 ± 0.3	0.4 ± 0.8	167.1 ± 7.3	86.5 ± 4.8	80.5 ± 3.9	54.7 ± 8.4	19.5 ± 2.1
U-16	112	15.6 ± 0.3	1.6 ± 0.6	171.8 ± 5.8	90.3 ± 3.6	81.5 ± 4.1	61.6 ± 6.7	20.9 ± 1.9
U-17	106	16.6 ± 0.3	2.3 ± 0.5	173.7 ± 5.4	91.8 ± 3.1	81.9 ± 4.3	64.1 ± 6.3	21.2 ± 1.7
U-18	108	17.6 ± 0.3	2.7 ± 0.5	173.5 ± 5.8	91.2 ± 3.0	82.3 ± 4.7	65.8 ± 8.0	21.8 ± 2.1
U-19	17	18.4 ± 0.3	3.9 ± 0.4	170.3 ± 8.0	89.1 ± 3.0	82.1 ± 5.1	69.8 ± 7.5	20.4 ± 0.5

A total of 2204 injuries were recorded, of which 40% (n=882) were medical attention (MA) and 60% (n=1322) were time-loss injuries (TLI), resulting in 25034 lay-off days absence from training or game participation. A mean incidence of 30.3 injuries per squad-season was sustained with an injury burden of 573.6 days lost per squad-season. The prevalence of time-loss recurrent injuries was 4.1% (n=55) and 3.5% (n=47) within the same season. Lay-off and severities of all type of injuries are displayed in Table-2. The distribution of injuries by location was as follows: Lower limbs 83.7% (n=1844), upper-limbs 8.4% (n=185) and trunk/head: 7.9% (n=175). Table 2 presents all type and location of TLI incurred across all age-groups during the four seasons. The burden of age-groups (Figure-1) and type of injuries (Figure-2) are illustrated by the risk matrix.

Insert Figure-1

Insert Figure-2

Training injuries accounted for 51.1% (n=1127) and 48.9% (n=1077) occurred in the games. A total of 920 records (41.7%) were the results of contact circumstances, while

1284 (58.3%) were non-contact. The top-5 diagnoses by location are displayed in Figure-3 with substantial differences if considered by age groups (Supplementary Figure 1). A detailed summary of diagnosis by body-regions is presented in supplementary Table-3.

Insert Figure-3

Table 2. Frequency (%), rates per squad-season*, lay-off (Mean ± SD, Sum) and severities of all type of medical attention and time-loss injuries. (*The rate per squad per season is established on a squad of 25 players).

Type of injuries	Frequency		Rate		Lay-off		Severity of injuries				
	Overall	Time-loss injuries	Overall	Time-loss injuries	Mean ± SD (Min-Max)	Sum	Medical attention (0 day)	Minor (1-3 days)	Moderate (4-7 days)	Major (8-28 days)	Severe (>28 days)
	N (%)	N (%)	per squad*/season		(Days)	N Days (%)	N (%)	N (% of Time-loss)			
Contusion/bruise/hematoma	778 (35.3%)	337 (25.5%)	17.8	7.7	4.6 ± 6.9 (1-67)	1567 (6.3%)	441 (56.7%)	210 (62.3%)	77 (22.8%)	46 (13.7%)	4 (1.2%)
Sprain/ligament injury	284 (12.9%)	215 (16.3%)	6.5	4.9	31.3 ± 54.3 (1-401)	6732 (26.9%)	69 (24.3%)	41 (19.1%)	40 (18.6%)	70 (32.5%)	64 (29.8%)
Growth related condition	269 (12.2%)	208 (15.7%)	6.2	4.8	19.1 ± 26.0 (1-241)	3973 (15.9%)	61 (22.7%)	35 (16.8%)	41 (15.7%)	92 (44.3%)	40 (19.2%)
Functional muscle disorder/neural irritation	385 (17.5%)	190 (14.4%)	8.8	4.4	4.2 ± 4.4 (1-27)	796 (3.2%)	195 (50.6%)	116 (61.0%)	45 (23.7%)	29 (15.3%)	-
Muscle strain/rupture	127 (5.8%)	126 (9.5%)	2.9	2.9	22.5 ± 17.8 (2-151)	2836 (11.3%)	1 (0.8%)	3 (2.4%)	10 (7.9%)	84 (66.7%)	29 (23.0%)
Overuse unspecific	115 (5.2%)	67 (5.1%)	2.6	1.5	6.7 ± 9.0 (1-56)	448 (1.8%)	48 (41.7%)	35 (52.2%)	16 (23.9%)	14 (20.9%)	2 (3.0%)
Physeal fracture	38 (1.7%)	37 (2.8%)	0.9	0.8	78.1 ± 73.9 (1-352)	2889 (11.5%)	1 (2.6%)	2 (5.4%)	-	9 (24.3%)	26 (70.3%)
Fracture (Non physeal)	38 (1.7%)	37 (2.8%)	0.9	0.8	43.8 ± 48.3 (1-286)	1621 (6.5%)	1 (2.6%)	5 (13.5%)	2 (5.4%)	5 (13.5%)	25 (67.6%)
Other bone injury	36 (1.6%)	29 (2.2%)	0.8	0.7	37.4 ± 38.1 (1-122)	1084 (4.3%)	7 (19.4%)	6 (20.7%)	1 (3.5%)	9 (31.0%)	13 (44.8%)
Other injury	47 (2.1%)	21 (1.6%)	1.1	0.5	13.7 ± 19.0 (1-83)	288 (1.2%)	26 (55.3%)	5 (23.8%)	6 (28.6%)	8 (38.1%)	2 (9.5%)
Lesion of meniscus and cartilage	19 (0.9%)	19 (1.4%)	0.4	0.4	128.8 ± 153.4 (3-655)	2448 (9.8%)	-	2 (10.5%)	-	3 (15.8%)	14 (73.7%)
Tendinopathy	28 (1.3%)	10 (0.8%)	0.6	0.2	17.6 ± 17.0 (1-54)	176 (0.7%)	18 (64.3%)	2 (20.0%)	2 (20.0%)	4 (40.0%)	2 (20.0%)
Concussion	14 (0.6%)	10 (0.8%)	0.3	0.2	3.1 ± 2.6 (1-9)	31 (0.1%)	4 (28.6%)	7 (70.0%)	2 (20.0%)	1 (10.0%)	-
Synovitis/effusion	16 (0.7%)	9 (0.7%)	0.4	0.2	5.7 ± 7.5 (1-25)	51 (0.2%)	7 (43.8%)	6 (66.7%)	2 (22.2%)	1 (11.1%)	-
Abrasion/laceration	7 (0.3%)	4 (0.3%)	0.2	0.1	7.5 ± 4.0 (2-11)	30 (0.1%)	3 (42.9%)	1 (25.0%)	1 (25.0%)	2 (50.0%)	-
Dislocation/Subluxation	3 (0.1%)	3 (0.2%)	0.1	0.1	21.3 ± 13.3 (6-29)	64 (0.3%)	-	-	1 (33.3%)	-	2 (66.7%)
Total	**2004 (100%)**	**1322 (100%)**	**50.5**	**30.3**	**18.9 ± 40.3 (1-655)**	**25034 (100%)**	**882 (40.0%)**	**476 (36.0%)**	**246 (18.6%)**	**377 (28.5%)**	**223 (16.9%)**

Table 3. Frequency (%), rates per squad-season* for type and location of time-loss injuries (*The rate per squad per season is established on a squad of 25 players).

	Age groups											
	U-9		U-10		U-11		U-12		U-13		U-14	
	n=96		n=103		n=114		n=111		n=98		n=112	
	Frequency (% of total)	Rate per squad*/season	Frequency (% of total)	Rate per squad*/season	Frequency (% of total)	Rate per squad*/season	Frequency (% of total)	Rate per squad*/season	Frequency (% of total)	Rate per squad*/season	Frequency (% of total)	Rate per squad*/season
Type of injuries												
Concussion	0 (0.0%)	0.0	0 (0.0%)	0.0	0 (0.0%)	0.0	0 (0.0%)	0.0	1 (0.9%)	0.3	0 (0.0%)	0.0
Lesion of meniscus and cartilage	0 (0.0%)	0.0	0 (0.0%)	0.0	0 (0.0%)	0.0	0 (0.0%)	0.0	0 (0.0%)	0.0	2 (1.1%)	0.4
Contusion/bruise/hematoma	7 (35.0%)	1.8	20 (69.0%)	4.9	22 (45.8%)	4.8	23 (48.9%)	5.2	32 (28.8%)	8.2	38 (21.3%)	8.5
Fracture (Non physeal)	2 (10.0%)	0.5	0 (0.0%)	0.0	1 (2.1%)	0.2	2 (4.3%)	0.5	1 (0.9%)	0.3	10 (5.6%)	2.2
Muscle strain/rupture	0 (0.0%)	0.0	0 (0.0%)	0.0	0 (0.0%)	0.0	1 (2.1%)	0.2	7 (6.3%)	1.8	12 (6.7%)	2.7
Abrasion/laceration	0 (0.0%)	0.0	0 (0.0%)	0.0	0 (0.0%)	0.0	0 (0.0%)	0.0	0 (0.0%)	0.0	2 (1.1%)	0.4
Other bone injury	1 (5.0%)	0.3	0 (0.0%)	0.0	0 (0.0%)	0.0	0 (0.0%)	0.0	1 (0.9%)	0.3	1 (0.6%)	0.2
Tendinopathy	0 (0.0%)	0.0	1 (3.4%)	0.2	0 (0.0%)	0.0	0 (0.0%)	0.0	1 (0.9%)	0.3	1 (0.6%)	0.2
Dislocation/Subluxation	0 (0.0%)	0.0	0 (0.0%)	0.0	0 (0.0%)	0.0	0 (0.0%)	0.0	0 (0.0%)	0.0	0 (0.0%)	0.0
Synovitis/effusion	1 (5.0%)	0.3	0 (0.0%)	0.0	0 (0.0%)	0.0	0 (0.0%)	0.0	0 (0.0%)	0.0	1 (0.6%)	0.2
Overuse unspecific	0 (0.0%)	0.0	1 (3.4%)	0.2	2 (4.2%)	0.4	2 (4.3%)	0.5	4 (3.6%)	1.0	11 (6.2%)	2.5
Other injury	2 (10.0%)	0.5	0 (0.0%)	0.0	3 (6.3%)	0.7	0 (0.0%)	0.0	0 (0.0%)	0.0	3 (1.7%)	0.7
Functional muscle disorder	0 (0.0%)	0.0	0 (0.0%)	0.0	3 (6.3%)	0.7	5 (10.6%)	1.1	14 (12.6%)	3.6	35 (19.7%)	7.8
Growth related condition	1 (5.0%)	0.3	4 (13.8%)	1.0	12 (25.0%)	2.6	12 (25.5%)	2.7	25 (22.5%)	6.4	44 (24.7%)	9.8
Physeal fracture	0 (0.0%)	0.0	1 (3.4%)	0.2	1 (2.1%)	0.2	2 (4.3%)	0.5	8 (7.2%)	2.0	4 (2.2%)	0.9
Sprain/ligament injury	6 (30.0%)	1.6	2 (6.9%)	0.5	4 (8.3%)	0.9	0 (0.0%)	0.0	17 (15.3%)	4.3	14 (7.9%)	3.1
Locations												
Head/face	0 (0.0%)	0.0	0 (0.0%)	0.0	0 (0.0%)	0.0	0 (0.0%)	0.0	1 (0.9%)	0.3	2 (1.1%)	0.4
Neck/cervical spine	0 (0.0%)	0.0	0 (0.0%)	0.0	0 (0.0%)	0.0	0 (0.0%)	0.0	0 (0.0%)	0.0	1 (0.6%)	0.2
Shoulder/Clavicula	2 (10.0%)	0.5	0 (0.0%)	0.0	1 (2.1%)	0.2	0 (0.0%)	0.0	0 (0.0%)	0.0	2 (1.1%)	0.4
Upper Arm	0 (0.0%)	0.0	0 (0.0%)	0.0	0 (0.0%)	0.0	0 (0.0%)	0.0	0 (0.0%)	0.0	0 (0.0%)	0.0
Elbow	0 (0.0%)	0.0	1 (3.4%)	0.2	0 (0.0%)	0.0	0 (0.0%)	0.0	0 (0.0%)	0.0	1 (0.6%)	0.2
Forearm/wrist	0 (0.0%)	0.0	0 (0.0%)	0.0	2 (4.2%)	0.4	4 (8.5%)	0.9	3 (2.7%)	0.8	3 (1.7%)	0.7
Hand/fingers	1 (5.0%)	0.3	2 (6.9%)	0.5	0 (0.0%)	0.0	1 (2.1%)	0.2	10 (9.0%)	2.6	5 (2.8%)	1.1
Ribs/thoracic spine	0 (0.0%)	0.0	0 (0.0%)	0.0	1 (2.1%)	0.2	1 (2.1%)	0.2	0 (0.0%)	0.0	1 (0.6%)	0.2
Abdomen/lumbar spine	0 (0.0%)	0.0	0 (0.0%)	0.0	0 (0.0%)	0.0	2 (4.3%)	0.5	6 (5.4%)	1.5	8 (4.5%)	1.8
Pelvis/hip/groin	0 (0.0%)	0.0	0 (0.0%)	0.0	3 (6.3%)	0.7	4 (8.5%)	0.9	7 (6.3%)	1.8	29 (16.3%)	6.5
Thigh	0 (0.0%)	0.0	0 (0.0%)	0.0	0 (0.0%)	0.0	0 (0.0%)	0.0	1 (0.9%)	0.3	0 (0.0%)	0.0
Quadriceps	0 (0.0%)	0.0	2 (6.9%)	0.5	3 (6.3%)	0.7	4 (8.5%)	0.9	11 (9.9%)	2.8	13 (7.3%)	2.9
Hamstring	0 (0.0%)	0.0	1 (3.4%)	0.2	2 (4.2%)	0.4	4 (8.5%)	0.9	5 (4.5%)	1.3	20 (11.2%)	4.5
Adductor	0 (0.0%)	0.0	1 (3.4%)	0.2	0 (0.0%)	0.0	1 (2.1%)	0.2	6 (5.4%)	1.5	13 (7.3%)	2.9

Knee	4 (20.0%)	1.0	9 (31.0%)	2.2	9 (18.8%)	2.0	6 (12.8%)	1.4	16 (14.4%)	4.1	15 (8.4%)	3.3
Lower leg	1 (5.0%)	0.3	3 (10.3%)	0.7	3 (6.3%)	0.7	9 (19.1%)	2.0	15 (13.5%)	3.8	26 (14.6%)	5.8
Calf/Achilles tendon	2 (10.0%)	0.5	1 (3.4%)	0.2	2 (4.2%)	0.4	1 (2.1%)	0.2	5 (4.5%)	1.3	4 (2.2%)	0.9
Ankle	7 (35.0%)	1.8	3 (10.3%)	0.7	6 (12.5%)	1.3	0 (0.0%)	0.0	15 (13.5%)	3.8	15 (8.4%)	3.3
Foot/toes	3 (15.0%)	0.8	6 (20.7%)	1.5	16 (33.3%)	3.5	10 (21.3%)	2.3	10 (9.0%)	2.6	20 (11.2%)	4.5
Total	20 (100.0%)	5.2	29 (100.0%)	7.0	48 (100.0%)	10.5	47 (100.0%)	10.6	111 (100.0%)	28.3	178 (100.0%)	39.7

Age groups										
U-15		**U-16**		**U-17**		**U-18**		**U-19**	
n=115		n=112		n=106		n=108		n=17	
Frequency (% of total)	Rate per squad*/season	Frequency (% of total)	Rate per squad*/season	Frequency (% of total)	Rate per squad*/season	Frequency (% of total)	Rate per squad*/season	Frequency (% of total)	Rate per squad*/season
2 (0.9%)	0.4	3 (1.1%)	0.7	4 (2.0%)	0.9	0 (0.0%)	0.0	0 (0.0%)	0.0
1 (0.5%)	0.2	5 (1.9%)	1.1	5 (2.5%)	1.2	5 (2.7%)	1.2	1 (4.0%)	1.5
50 (23.4%)	10.9	77 (29.2%)	17.2	41 (20.1%)	9.7	26 (14.3%)	6.0	1 (4.0%)	1.5
9 (4.2%)	2.0	1 (0.4%)	0.2	2 (1.0%)	0.5	9 (4.9%)	2.1	0 (0.0%)	0.0
22 (10.3%)	4.8	22 (8.3%)	4.9	25 (12.3%)	5.9	31 (17.0%)	7.2	6 (24.0%)	8.8
1 (0.5%)	0.2	1 (0.4%)	0.2	0 (0.0%)	0.0	0 (0.0%)	0.0	0 (0.0%)	0.0
2 (0.9%)	0.4	7 (2.7%)	1.6	2 (1.0%)	0.5	8 (4.4%)	1.9	7 (28.0%)	10.3
1 (0.5%)	0.2	1 (0.4%)	0.2	2 (1.0%)	0.5	3 (1.6%)	0.7	0 (0.0%)	0.0
0 (0.0%)	0.0	0 (0.0%)	0.0	2 (1.0%)	0.5	1 (0.5%)	0.2	0 (0.0%)	0.0
1 (0.5%)	0.2	4 (1.5%)	0.9	1 (0.5%)	0.2	1 (0.5%)	0.2	0 (0.0%)	0.0
8 (3.7%)	1.7	16 (6.1%)	3.6	11 (5.4%)	2.6	11 (6.0%)	2.5	1 (4.0%)	1.5
4 (1.9%)	0.9	2 (0.8%)	0.4	5 (2.5%)	1.2	2 (1.1%)	0.5	0 (0.0%)	0.0
41 (19.2%)	8.9	38 (14.4%)	8.5	29 (14.2%)	6.8	21 (11.5%)	4.9	4 (16.0%)	5.9
32 (15.0%)	7.0	35 (13.3%)	7.8	28 (13.7%)	6.6	13 (7.1%)	3.0	2 (8.0%)	2.9
7 (3.3%)	1.5	10 (3.8%)	2.2	3 (1.5%)	0.7	1 (0.5%)	0.2	0 (0.0%)	0.0
33 (15.4%)	7.2	42 (15.9%)	9.4	44 (21.6%)	10.4	50 (27.5%)	11.6	3 (12.0%)	4.4
4 (1.9%)	0.9	4 (1.5%)	0.9	4 (2.0%)	0.9	0 (0.0%)	0.0	0 (0.0%)	0.0
3 (1.4%)	0.7	1 (0.4%)	0.2	0 (0.0%)	0.0	0 (0.0%)	0.0	0 (0.0%)	0.0
4 (1.9%)	0.9	0 (0.0%)	0.0	1 (0.5%)	0.2	3 (1.6%)	0.7	0 (0.0%)	0.0
0 (0.0%)	0.0	0 (0.0%)	0.0	0 (0.0%)	0.0	0 (0.0%)	0.0	0 (0.0%)	0.0
0 (0.0%)	0.0	1 (0.4%)	0.2	1 (0.5%)	0.2	1 (0.5%)	0.2	0 (0.0%)	0.0
4 (1.9%)	0.9	2 (0.8%)	0.4	4 (2.0%)	0.9	2 (1.1%)	0.5	0 (0.0%)	0.0
5 (2.3%)	1.1	3 (1.1%)	0.7	2 (1.0%)	0.5	6 (3.3%)	1.4	0 (0.0%)	0.0
2 (0.9%)	0.4	1 (0.4%)	0.2	1 (0.5%)	0.2	2 (1.1%)	0.5	1 (4.0%)	1.5
16 (7.5%)	3.5	16 (6.1%)	3.6	5 (2.5%)	1.2	5 (2.7%)	1.2	0 (0.0%)	0.0
32 (15.0%)	7.0	37 (14.0%)	8.3	37 (18.1%)	8.7	18 (9.9%)	4.2	4 (16.0%)	5.9
0 (0.0%)	0.0	3 (1.1%)	0.7	3 (1.5%)	0.7	2 (1.1%)	0.5	1 (4.0%)	1.5
19 (8.9%)	4.1	24 (9.1%)	5.4	22 (10.8%)	5.2	22 (12.1%)	5.1	1 (4.0%)	1.5

20 (9.3%)	4.3	25 (9.5%)	5.6	22 (10.8%)	5.2	22 (12.1%)	5.1	5 (20.0%)	7.4
12 (5.6%)	2.6	12 (4.5%)	2.7	12 (5.9%)	2.8	13 (7.1%)	3.0	2 (8.0%)	2.9
16 (7.5%)	3.5	34 (12.9%)	7.6	26 (12.7%)	6.1	31 (17.0%)	7.2	2 (8.0%)	2.9
20 (9.3%)	4.3	21 (8.0%)	4.7	4 (2.0%)	0.9	8 (4.4%)	1.9	3 (12.0%)	4.4
5 (2.3%)	1.1	10 (3.8%)	2.2	7 (3.4%)	1.7	4 (2.2%)	0.9	1 (4.0%)	1.5
37 (17.3%)	8.0	41 (15.5%)	9.2	42 (20.6%)	9.9	35 (19.2%)	8.1	4 (16.0%)	5.9
15 (7.0%)	3.3	29 (11.0%)	6.5	11 (5.4%)	2.6	8 (4.4%)	1.9	1 (4.0%)	1.5
214 (100.0%)	46.5	264 (100.0%)	58.9	204 (100.0%)	48.1	182 (100.0%)	42.1	25 (100.0%)	36.8

DISCUSSION

This is the first prospective study investigating injury epidemiology in elite youth soccer players from the Middle East with the largest cohort from a single academy. We found a mean incidence of 30 injuries per squad-season were sustained, with an injury burden of 574 days lost per squad-season. U-16 players had the highest injury incidence (59 injuries per squad-season) while U-18 had the worst burden (1408 days per squad-season). After ligament/sprain, growth plate injuries (growth related conditions plus physeal fractures) were the most prevalent time-loss injuries accounting for 27% (6862 days) of the entire lay-off in our study.

Injury characteristics

The lower limb was the most commonly injured location as described in previous studies.(5, 25-27) Consistent with a recent systematic review,(17) the ankle in combination with foot/toes had the highest prevalence (23%). The knee (11%) and pelvis-hip-groin (11%) were also prevalent and within the range. Although not being reported in all studies,(4-7, 10) the proportion of medical attention seems similar to other studies that have reported this.(26-28) The prevalence of severe injuries in our study was 17%, which is very close to the median of 18% found in a systematic review.(17) Similarly to some investigations from English and Dutch professional soccer academies, the rate of 30 time-loss injuries per squad-season indicates that the Academy is in the middle-range of the reported incidence from other studies (ranging from 10 to 50 injuries per squad-season), involving a wide variety of different age-groups.(4, 6, 7, 9, 10, 12) The differences with previous studies may be due to the evolution in youth soccer as the game has developed over time.(2, 4) The apparent discrepency between results, may also arise from different methodological issues. The rates of medical attention and/or minor injuries can be affected by clinicians invested in research relying on the data collection.(29) Also, some authors have differing injury definitions where some consider only

non-contact injuries or define injuries as not able to participate at 48h post-injury onset.(4, 5, 9, 10)

Injuries incidence and age-groups

Similar to other youth soccer epidemiology reports, the incidence of injuries increases with the age.(4, 6, 7, 10) In recent years, in elite youth soccer, the under 15-y age-group was found to have the highest probability of suffering a time-loss injury, which is slightly different from recent audits and the present study, where the highest injury incidence was found in U-16.(8, 17) The U-15 had the third (after U-17) highest incidence of time-loss injuries in our study. The contextual difference among studies is important to consider, as almost all investigations were performed in professional club academy settings and only a few in National team settings.(17) In Asia, U-16 is the first age-group to be involved in official Asian Football Confederation competition (AFC U-16 Championship qualifiers) which requires a dedicated international preparation including training camps and friendly tournaments, which is very different compared to club footballers playing matches once a week. Interestingly, the rate in the youth players (30 injuries/squad-season) was higher than the 23.6 injuries/squad-season reported in the adult's first division football league of Qatar.(30) The youth's higher injury incidence compared to senior players is not unusual and is in-line with a previous study from English professional football.(31) The youth high-level football players are more likely to suffer time-loss injuries than adults in the domestic professional league.(17, 32, 33)

Age-groups injury burden

When the injury data of our study is further compared, the findings indicate a low injury burden in the childhood age-groups (U-9 to U-12), increasing substantially through early- and middle- (U-13 to U-17) to reach the highest values in late-adolescence (U-18 and U-19) (Figure 1). Injury burden has not been extensively investigated in youth soccer and the results of the present study are not in line with the trend found in a Dutch cohort, where the peak overall

injury burden was 357 days lost/squad-season in U-16.(6, 17) The findings were aligned with Belgian's Professional academies, reporting a greater injury burden in older- (U13-15) in comparison with the youngest age-groups (U9-12).(11) The latter study' injury burden (652 days/squad-season in U13-15) is similar to the 627 days found in the present study for equivalent age-groups. However, the injury burden of their youngest age-group (275 days/squad-season) was three-fold greater than ours (83 days/squad-season). The increased burden of injuries across the age-group potentially hinder the optimal developmental processes. The burden of each age-group is an important consideration as it might have detrimental consequences on the individual development and long-term performance by missing certain optimal ''window of trainability'' of physical and technical characteristics.(34)

Injury types prevalence and age-groups

The most prevalent time-loss injuries obtained from this study, differs from most of the literature on elite youth soccer players, apart from the work of Kemper et al. with comparable outcomes.(12, 17) The growth related injuries accounted for 19% of all severe injuries (> 4 weeks) and is within the prevalence range (11% and 29%) of two other youth elite academy studies.(5, 35) Growth related injuries are recognised to be undereported and mistakenly diagnosed as muscle injuries.(36, 37) In youth soccer, they have not been well categorised and reported underneath overuse injuries.(6, 7, 11, 17) From U-10 to U-13, the growth related injuries were the second most frequent type of time-loss injury and in U-14 they were the leading cause. In Elite French players,(5) the U-14 had the most osteochondral disorders and a recent study in youth elite soccer players from different countries observed similar overall trend.(8) Sprains have been observed to be very common in youth soccer.(25) In this cohort, sprain was the leading diagnois in U-17 and U-18. Another unusual result in our study, is the low rate of muscle tear (6%) and the large amount of functional muscle disorders (14%). Muscular tears in youth elite male soccer has been found to be the most common type of

injuries in English soccer academy,(4, 10) and accounted for 15% to 46% of injuries.(8, 13, 25) A Swedish study reported similar frequency of muscle tear,(38) while a Brazilian study found muscle tears had the highest incidence in the oldest age-groups (U-18 and U-19).(7) Several interacting factors might play a role in this soft tissues outcome. Direct access to imaging (ultrasonography and magnetic resonance imaging) probably played a significant role in the accuracy and consistency of clinical investiguation and diagnosis, where actual tears were ruled out and then classified as functional muscle disorders.(21, 39) During the study period, all teams had a systematic individualised injury prevention plan alongside the football program. Such a framework was perhaps different from past research when injury prevention was not as popular and poorly implemented.(4, 5)

Type of injuries burden

The impact of injuries can be considered in relation to its burden using a risk matrix.(19) The overall two most burdensome type of injuries were sprain/ligament (Median lay-off: 14 days; Rate: 4.9 injury per squad-season) and growth-related condition (Median lay-off: 12 days; Rate: 4.8 injury per squad-season). Growth-related injuries were more common and burdensome than in previous studies,(17, 25) where they were reported to have a prevalence between 5% to 7% and a rate per squad/season between 0.8 to 2.1.(4, 5, 10) The overall higher rate and burden of growth related condition in this current youth elite population, in comparison to the literature, might reflect an increase of weekly soccer practice participation and higher intensity.(40) Meniscus-cartilage injuries had the longest lay-off. While meniscus injuries did occur in different age-groups, U-18 was the most impacted and it plays an important role in the total burden of this age-group. Meniscal tear incidence in adolescents has increased in recent years because of increased sports participation and more widespread use of MRI as a diagnostic tool.(41) Loss of meniscus integrity in young players leads to a greater prevalence of osteoarthritis development.(42) Looking after the knee in paediatric sports medicine is of prime

importance, longer lay-offs and a more conservative approach to promote healing is required.(41, 43) Fractures accounted for 3% of all injuries similar to what is usually found in youth soccer (2-9%).(17) Half of the fractures were physeal fractures (1.7%), accounting for 12% of all severe injuires. There are no epidemiological studies from soccer academies reporting on physeal fractures, but they are accounting in peadiatric medicine for 15% to 30% of all fractures in children and for 30% in a soccer tournament.(44, 45) Interestingly, the burden of physeal fractures (2889 days; 12% of the total lay-off) was double that of mature bone fractures. This is not surprising, as the return to sport of young skeletally immature players from severe injuries involving the physis is considerably longer than adults.(46)

Common diagnosis

The most common diagnosis for the upper limb, was non-physeal fractures, with an important number of physeal fractures of the forearm and wrist. In the trunk, spondylolysis accounted for the most significant burden. A comparable trend of diagnosis for the spine and upper limb was found in a general paediatric sports population.(18) Sprain and tendinopathy were the most frequent knee diagnosis reported in a English youth academy.(47) In the present study, apophyseal osteochondroses were the primary diagnosis for the knee and the hip-pelvis. However, sprain, Osgood-Schlatter and meniscus tear were the three most prevalent diagnosis of severe injuries. In line with a previous study, the three foremost diagnosis of the foot/ankle were: sprain/ligament, contusion/bruise and apophyseal osteochondroses.(48) In the calf/lower leg, contusions were the most common, the physeal fractures were only ranked as the fifth most prevalent diagnosis, but accounted for the greatest burden. Growth plate injury was in the top five diagnosis of all location, except the head/face and the thigh locations. The outcomes highlight the difference of injury pattern between age groups, youth and adult soccer players, emphasising the importance for clinicians to be acquainted with and suspicious of growth plate

injuries in youth elite soccer whenever an injury is located around a physis.(45) Injury patterns were different than the current litterature from other regions in the world.

Strengths and limitations

We note at least one limitation, individual exposure time is missing from this work and therefore the incidence of injury in relation to exposure time are not presented. However, as suggested by latest international Olympic committee consensus statement, expressing the rates of injury per number of players per period of the concerned sports has been used.(19) The inclusion of specific additional items related to paediatric injuries in the injury surveillance system, provides a more accurate and consistent record, probably leading to a greater clinical contribution as previously recommended.(19, 49)

Summary

The mean incidence of time-loss injuries was 30 per squad-season, with an injury burden of 574 days lost/squad-season. The highest injury incidence was found in U-16 and the greatest injury burden in U-18, emphasising that although the peak injury incidence occurred earlier during middle-adolescence, the injury burden seems to increase throughout the academy period to reach its peak in late-adolescence. Growth plate injuries were prevalent, accounting for almost one third of the total lay-off. A high proportion of fractures involved the physis, highlighting the need for specific consideration in future prospective studies. We emphasise the necessity for more dedicated epidemiology studies in youth Asian elite soccer players.

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Compliance with Ethical standards

Ethical Approval

All procedures performed in this original study involving human participants were in accordance with the ethical standards. This research was approved by the scientific boards of ASPETAR and ASPIRE Academy and the ethics was granted by Qatar Anti-Doping Laboratory Ethics-Committee (SCH-ADL-070), conforming to the recommendations of the 1964 Helsinki-Declaration and its later amendments or comparable ethical standards.

Informed consent

Written informed consent to use regularly collected injury data for research purposes was obtained from all individual participant's guardian included in this original study.

Disclosure statement

Olivier Materne, Karim Chamari, Abdulaziz Farooq, Adam Weir, Per Holmich, Roald Bahr, Matt Greig and Lars R. McNaughton declare that they have no conflict of interest in the production of this research.

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Figure 1. Risk matrix based on the duration of time-loss illustrating the burden for all age-groups. Severity (mean of days lost) and incidence of injury per squad-season (25 players). The curved grey lines represent point with equal burden (days per squad-season). The vertical and horizontal error bars represent 95% CI (all dataset is available in Supplementary Table 2).

Figure 2. Risk matrix based on the duration of time-loss illustrating the burden for all type of injuries. Severity (median of days lost) and incidence of injury per squad-season (25 players). The curved grey lines represent point with equal burden (days per squad-season). The vertical and horizontal error bars represent 95% CI. The 95% CI upper bound for the Median of meniscus/cartilage injuries is 181 days (all dataset is available in Supplementary Table 2).

Figure 3. The five most prevalent time-loss injuries for each main location with their corresponding proportion of days lost during the 4 seasons (Prevalence % - % lay-off). The values are in relation to each specific location (100%).

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Dear Editor,

We would like to thank the reviewers and editor for their constructive feed-back on the manuscript and positive recommendation for publication in your well-respected scientific Journal.

We have outlined below our responses for the two minor issues that have been raised and highlighted in red in the marked copy.

We hope that it will complete all information that you need.

Many thanks and Best Wishes

Olivier Materne (on behalf of all authors)

1. "Please check that all author names are correctly entered as this will be the name displayed in any PubMed search."

Yes, all author names have been checked.

2. Reviewer: 1

Comments to the Author

The authors have addressed all points and reviewed the manuscript accordingly.

The addition of supplementary material is appropriate.

Congratulations again for an excellent work!

Thank you

3. Reviewer: 2

Comments to the Author

Thank you for revising the manuscript.

Thank you

4. Reviewer: 3

Comments to the Author

a. In your response to R1 point 2. You have said that you do not want to add specific diagnoses of injury types as there is also a wider project using the same data. Unfortunately, this is not a good enough reason to withhold important information on this paper and should be included as a minimum in the appendix as suggested by the reviewer 1.

We have designed an additional Table for the appendix including 52 different diagnosis organised by body-regions and ranked by their impact on the burden.

The table displays for each diagnosis: the Frequency (%); Rate per squad/season (95% CI); Total time loss; Median of time loss (Interquartile 25th - 75th); Burden (95% CI) Time loss per season (See the table on the bottom of the responses).

In the manuscript, we have added the below sentence at the end of the "RESULTS".

Read now: "A detailed summary of diagnosis by body-regions is presented in supplementary Table-3."

b. It is also not clear about the ethical approval of this study? Was ethics required? If not why not?

Yes, ethics was required. As part of the initial on-line submission process the information in the box of compliance with ethical standards.

For more precision, we have added the name of the institutions.

Read now:

Ethical Approval

All procedures performed in this original study involving human participants were in accordance with the ethical standards. This research was approved by the scientific board of the the scientific boards of ASPETAR and ASPIRE Academy and the ethics was granted by Qatar Anti-Doping Laboratory Ethics-Committee (SCH-ADL-070), conforming to the recommendations of the 1964 Helsinki-Declaration and its later amendments or comparable ethical standards.

However, if the editor wishes so, we can add it within the manuscript in the methodology part?

c. What does the 'parental consent to screening' relate to? What about the use of this data? Are the players and their guardians aware? This needs to be clarified.

Yes, a written informed consent to use regularly collected screening and injury data was obtained at the beginning of the season for each participant.

We agree that the sentence was not clear. We have now modified as:

Before: Informed consent

Signed parental- and student-consent for the screening was obtained prior to examination for all individual participants included in this original study. Participation in the screening was voluntary, and assurances were given that their status in the academy would not be affected if they did not wish to undergo any aspects of the screening.

Read now: Informed consent

Written informed consent to use regularly collected injury data for research purposes was obtained from all individual participant's guardian included in this original study.

Currently this information was at the end of the manuscript under "compliance with ethical standards". However, if the editor wishes so, we can add it within the manuscript in the methodology part?

5. Associate Editor

Comments to the Author:

Dear authors, the manuscript has been revised according to the reviewer's comments, and the proposed supplementary material is appropriate. Just two points should be addressed:

1) It is not clear about the ethical approval of this study? Was ethics required? If not why not? What does the 'parental consent to screening' relate to? What about the use of this data? Are the players and their

guardians aware? This needs to be clarified.

2) In your response to R1 point 2. You have said that you do not want to add specific diagnoses of injury types as there is also a wider project using the same data. Unfortunately, this is not a good enough reason to withhold important information on this

paper and should be included as a minimum in the appendix as suggested by the reviewer 1.

We have addressed the points raised by the reviewers (see above).

Additional table

Supplementary Table 3 Summary of time loss injuries diagnosis by body-regions during the four consecutive seasons displayed as: Frequency (%), Rates (per player-season and per squad-season*), Total time loss (days), Median time loss (Interquartile 25th – 75th) and burden by season (95% CI).

Body-regions *Diagnosis*	Frequency (%)	Rate per squad*/season (95% CI)	Total time loss Days	Median time loss (Interquartile 25th - 75th) Days	Burden (95% CI) Time loss per season Days
Head & neck	**20 (1.5%)**	**0.46 (0.28 - 0.71)**	**86**	**3 (1 - 6)**	**21.5 (17.2 - 26.6)**
Concussion	10 (0.8%)	0.23 (0.11 - 0.42)	31	3 (1 - 5)	7.8 (5.3 - 11.0)
Nose fracture (Non physeal)	1 (0.1%)	0.02 (0.00 - 0.13)	20	20 (20 - 20)	5.0 (3.1 - 7.7)
Functional muscle disorder	5 (0.4%)	0.11 (0.04 - 0.27)	19	3 (2 - 6)	4.8 (2.9 - 7.4)
Upper limb	**77 (5.8%)**	1.76 (1.39 - 2.21)	**1557**	**7 (2 - 27)**	**389.3 (370.2 - 409.1)**
Clavicular Fracture (Non physeal)	5 (0.4%)	0.11 (0.04 - 0.27)	584	80 (58 - 116)	146.0 (134.4 - 158.3)
Forearm physeal fracture	9 (0.7%)	0.21 (0.09 - 0.39)	218	26 (21 - 31)	54.5 (47.5 - 62.2)
Hand/finger fracture (Non physeal)	10 (0.8%)	0.23 (0.11 - 0.42)	175	11 (2 - 31)	43.8 (37.5 - 50.7)
Forearm fracture (Non physeal)	6 (0.5%)	0.14 (0.05 - 0.30)	150	27 (6 - 33)	37.5 (31.7 - 44.0)
Hand/finger physeal fracture	5 (0.4%)	0.11 (0.04 - 0.27)	84	22 (9 - 25)	21.0 (16.8 - 26.0)
Arm physis injury (avulsion/osteochondrosis)	2 (0.2%)	0.05 (0.01 - 0.17)	45	23 (7 - 38)	11.3 (8.2 - 15.1)
Elbow physis injury (avulsion/osteochondrosis)	1 (0.1%)	0.02 (0.00 - 0.13)	44	44 (44 - 44)	11.0 (8.0 - 14.8)
Hand/fingers sprain/ligament	11 (0.8%)	0.25 (0.13 - 0.45)	43	4 (1 - 6)	10.8 (7.8 - 14.5)
Shoulder dislocation/Subluxation	2 (0.2%)	0.05 (0.01 - 0.17)	35	18 (6 - 29)	8.8 (6.1 - 12.2)
Elbow fracture (Non physeal)	1 (0.1%)	0.02 (0.00 - 0.13)	33	33 (33 - 33)	8.3 (5.7 - 11.6)
Trunk	**68 (5.1%)**	1.56 (1.21 - 1.98)	**1866**	**7 (2 - 25)**	**466.5 (445.6 - 488.2)**
Spondylolysis & spondylolisthesis	11 (0.8%)	0.25 (0.13 - 0.45)	1358	115 (78 - 160)	339.5 (321.7 - 358.0)
Overuse unspecific pathology	23 (1.7%)	0.53 (0.33 - 0.79)	175	6 (2 - 10)	43.8 (37.5 - 50.7)
Bone and pars stress reaction	4 (0.3%)	0.09 (0.02 - 0.23)	168	43 (32 - 52)	42.0 (35.9 - 48.9)
Functional muscle disorder	10 (0.8%)	0.23 (0.11 - 0.42)	56	3 (1 - 8)	14.0 (10.6 - 18.2)
Ribs contusion	4 (0.3%)	0.09 (0.02 - 0.23)	17	5 (2 - 7)	4.3 (2.5 - 6.8)
Hip & pelvis	**171 (12.9%)**	3.92 (3.35 - 4.55)	**3042**	**12 (4 - 25)**	**760.5 (733.7 - 788.0)**
Physis injury (avulsion/osteochondrosis)	110 (8.3%)	2.52 (2.07 - 3.04)	1978	13 (5 - 25)	494.5 (472.8 - 516.7)
Ilio-psoas and gluteus strain	16 (1.2%)	0.37 (0.21 - 0.60)	388	24 (18 - 31)	97.0 (87.6 - 107.1)
Bone stress reaction	7 (0.5%)	0.16 (0.06 - 0.33)	248	18 (3 - 83)	62.0 (54.5 - 70.2)
Contusion	14 (1.1%)	0.32 (0.18 - 0.54)	83	1 (1 - 3)	20.8 (16.5 - 25.7)
Overuse unspecific pathology	8 (0.6%)	0.18 (0.08 - 0.36)	64	6 (3 - 11)	16.0 (12.3 - 20.4)

Thigh	**329 (24.9%)**	7.54 (6.75 - 8.40)	**3356**	**4 (2 - 14)**	**839.0 (810.9 - 867.9)**
Hamstring strain	53 (4.0%)	1.21 (0.91 - 1.59)	1375	20 (13 - 29)	343.8 (325.8 - 362.4)
Quadriceps strain	28 (2.1%)	0.64 (0.43 - 0.93)	560	19 (11 - 22)	140.0 (128.6 - 152.1)
Adductor strain	20 (1.5%)	0.46 (0.28 - 0.71)	367	17 (13 - 24)	91.8 (82.6 - 101.6)
Quadriceps contusion	64 (4.8%)	1.47 (1.13 - 1.87)	367	3 (1 - 6)	91.8 (82.6 - 101.6)
Hamstring functional muscle disorder	64 (4.8%)	1.47 (1.13 - 1.87)	225	2 (1 - 4)	56.3 (49.1 - 64.1)
Adductor functional muscle disorder	49 (3.7%)	1.12 (0.83 - 1.48)	195	3 (1 - 5)	48.8 (42.1 - 56.1)
Quadriceps functional muscle disorder	27 (2.0%)	0.62 (0.41 - 0.90)	151	4 (2 - 6)	37.8 (32.0 - 44.3)
Knee	**218 (16.5%)**	5.00 (4.35 - 5.70)	**7705**	**11 (3 - 29)**	**1926.3 (1883.5 - 1969.7)**
Sprain/ligament	50 (3.8%)	1.15 (0.85 - 1.51)	2949	24 (10 - 42)	737.3 (710.9 - 764.3)
Meniscus (tear, discoid) & cartilage damage	16 (1.2%)	0.37 (0.21 - 0.60)	2100	80 (21 - 170)	525.0 (502.8 - 547.9)
Knee physis injury (avulsion/osteochondrosis)	66 (5.0%)	1.51 (1.17 - 1.92)	1358	10 (6 - 22)	339.5 (321.7 - 358.0)
Physeal fracture	6 (0.5%)	0.14 (0.05 - 0.30)	512	75 (58 - 86)	128.0 (117.2 - 139.6)
Knee contusion	39 (3.0%)	0.89 (0.64 - 1.22)	257	3 (2 - 10)	64.3 (56.6 - 72.6)
Overuse unspecific pathology	17 (1.3%)	0.39 (0.23 - 0.62)	106	2 (1 to 7)	26.5 (21.7 - 32.1)
Lower leg & calf	**105 (7.9%)**	2.41 (1.97 - 2.91)	**1360**	**4 (1 - 9)**	**340.0 (322.2 - 358.6)**
Lower leg physeal fracture	5 (0.4%)	0.11 (0.04 - 0.27)	529	43 (40 - 58)	132.3 (121.2 - 144.0)
Lower leg fracture (Non physeal)	3 (0.2%)	0.07 (0.01 - 0.20)	197	61 (55 - 81)	49.3 (42.6 - 56.6)
Lower leg bone stress injury	6 (0.5%)	0.14 (0.05 - 0.30)	176	14 (4 - 55)	44.0 (37.7 - 51.0)
Calf muscles strain	9 (0.7%)	0.21 (0.09 - 0.39)	146	17 (11 - 18)	36.5 (30.8 - 42.9)
Lower leg contusion	42 (3.2%)	0.96 (0.69 - 1.30)	142	2 (1 - 5)	35.5 (29.9 - 41.8)
Calf muscles functional muscle disorder	15 (1.1%)	0.34 (0.19 - 0.57)	78	5 (1 - 7)	19.5 (15.4 - 24.3)
Calf contusion	17 (1.3%)	0.39 (0.23 - 0.62)	56	2 (1 - 5)	14.0 (10.6 - 18.2)
Foot & ankle	**334 (25.3%)**	7.65 (6.85 - 8.52)	**6062**	**7 (2 - 21)**	**1515.5 (1477.6 - 1554.1)**
Ankle sprain/ligament	142 (10.7%)	3.25 (2.74 - 3.84)	3662	15 (4 - 34)	915.5 (886.1 - 945.6)
Foot/toes physis injury (avulsion/osteochondrosis)	27 (2.0%)	0.62 (0.41 - 0.90)	522	9 (4 - 23)	130.5 (119.5 - 142.2)
Ankle cartilage injury	3 (0.2%)	0.07 (0.01 - 0.20)	348	60 (29 - 259)	87.0 (78.1 - 96.6)
Foot/toes fracture (Non physeal)	9 (0.7%)	0.21 (0.09 - 0.39)	334	34 (30 - 44)	83.5 (74.8 - 93.0)
Foot/toes contusion	74 (5.6%)	1.70 (1.33 - 2.13)	274	3 (1 - 5)	68.5 (60.6 - 77.1)
Ankle contusion	42 (3.2%)	0.96 (0.69 - 1.30)	214	3 (1 - 7)	53.5 (46.6 - 61.2)
Ankle impingement, os trigonum	6 (0.5%)	0.14 (0.05 - 0.30)	143	6 (1 - 46)	35.8 (30.1 - 42.1)
Foot/toes bone stress reaction	2 (0.2%)	0.05 (0.01 - 0.17)	141	71 (29 - 112)	35.3 (29.7 - 41.6)
Foot/toes sprain/ligament	6 (0.5%)	0.14 (0.05 - 0.30)	36	7 (2 - 7)	9.0 (6.3 - 12.5)

Injury Incidence and Burden in a Youth Elite football (Soccer) Academy: A 4-Season Prospective Study of 551 players aged from under 9 to under 19 years.

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ABSTRACT

Objective

Investigate the incidence and burden of injuries by age-group in youth soccer academy players during four consecutive seasons.

Methods All injuries that caused time-loss or required medical attention (as per Consensus definitions) were prospectively recorded in 551 youth soccer players from under-9 years to under-19 years. Injury rate (IR) and burden (IB) were calculated as number of injuries per squad-season (s-s), as well as for type, location and age-groups.

Results A total of 2204 injuries were recorded. 40% (n=882) required medical attention and 60% (n=1322) caused time-loss. The total time-loss was 25,034 days. A squad of 25 players sustained an average of 30 time-loss injuries (TLI) per squad-season with an injury burden of 574 days lost per squad-season. Compared with the other age groups, U-16 players had the highest TLI rate per squad-season (95%CI lower-upper) [IR: 59 (7-8); IB: 992 (29-30) days] and U-18 players had the greatest burden per squad-season [IR: 42.1 (6-7); IB: 1408 (35-36) days]. Across the cohort of players, contusions (IR=7.7/s-s), sprains (IR=4.9/s-s) and growth-related injuries (IR=4.3/s-s) were the most common TLI. Meniscus/cartilage injuries had the greatest injury severity (95%CI lower-upper): [IR: 0.4 (0.3-0.7); IB: 73 (22-181) days]. The burden (95%CI lower-upper) of physeal fractures was double that of non-physeal fractures [IR: 0.8 (0.6-1.2); IB: 58 (33-78) days].

Summary: At this youth football academy, each squad of 25 players averaged 30 injuries per season which resulted in 574 days lost. The highest incidence of time-loss injuries occurred in Under-16 players, while the highest injury burden occurred in Under-18 players.

Key words: Epidemiology – Paediatric – growth plate injuries – Apophyseal injuries

What were the findings?

- The mean time-loss injury incidence (IR) was 30 injuries/squad-season, with an injury burden (IB) of 574 days lost/squad-season.
- While peak of time-loss injuries incidence (59 per squad-season) occurred in U-16 players, the peak of injury burden (1408 days lost/squad-season) occurred in U-18 players.
- Growth plate injuries were the second most prevalent time-loss injuries, accounting for 27% of the total lay-off time.
- Apophyseal injuries was the most prevalent diagnosis for the knee and the hip/pelvis.
- 50% of all fractures involved the physis, with a recovery period that was twice as long as mature bone fractures.

How might it impact on clinical practice in the future?

- The field of pediatric sports medicine should distinguish physeal injuries from mature bone injuries.
- Researchers should need not to only consider incidence when reporting injuries in youth sport and soccer academy. Express the injury burden by age-group and injury type will provide an enhanced understanding of the impact of injuries and will guide injury prevention.

INTRODUCTION

Elite youth soccer academies across the world exist to support young players becoming professional players.(1, 2) Talented children and adolescent athletes are a unique population and require a safe, adapted and developmental coaching program including appropriate illness and injury surveillance systems.(3) There is a lack of prospective epidemiology studies over consecutive seasons among youth elite football academies around the world including large cohorts.(4) In an English youth academy, Price et al.(4) found a rate of 0.8 injuries per player-season for a mean time-loss of 9 days per player-season, while Le Gall et al.(5) in elite youth French players observed a rate of 2.2 injuries per player-season for a mean time-loss of 32 days per player-season. Recently from different academies in Belgium, Brazil, England, Netherlands, Spain, and Uruguay, a rate between 0.7 to 1.3 injuries per player-season with a mean time-loss ranging from 16 to 29 days per player-season have been reported.(6-13) The limited depth jeopardises the scientific and clinical understanding of injury prevention, examination, rehabilitation, and long-term consequences of severe injuries and much could be learnt from other more experienced paediatric health care providers.(14-18) More detailed and precise prospective investigations are required using diagnoses that are specific to children and adolescents. This will allow clinicians to more accurately determine the pattern, incidence and burden of the type of injuries in these young players.(15) Understanding of injury risk, burden and precise aetiology will help to consistently optimise clinical management, injury prevention and optimise the development in elite youth soccer.(19) The objective of this study was to examine the extent of the different types of injuries and their respective incidence and burden, in all age-groups from U-9 to U-19 over four-consecutive seasons, in an elite youth soccer academy.

METHOD

Study design and subjects

A prospective cohort study of Qatari male youth elite soccer players was performed during four consecutive seasons in different age-groups from under 9 (U-9) to U-19, including a total of 551 players from childhood to late-adolescent. Players trained and played at the National training centre ASPIRE Academy in Doha, Qatar. All trained at a similar time of the day (between 10.00am to 12.00pm and between 4.00pm to 6.00pm), except when an international tournament or training camp were set overseas. Age-groups from U-13 to U-18 trained for approximately 14 $h \cdot wk^{-1}$ including combined soccer-specific training and competitive play, with a single rest day per week. This weekly load typically comprised 6–8 soccer training sessions, 1 strength training session, 1–2 conditioning sessions, and 1 domestic game per week. In addition, the players were engaged with the academy in two invited international games every three weeks. The younger age-groups, from U-9 to U-12, participated in an average of nine hours per week of combined soccer-specific training and competitive play. This typically comprised ~5 soccer training sessions including agility and coordination, and one domestic game per week. In addition, the younger players participated in a one-day tournament on a monthly basis. Signed parental and student consent for the screening was sought and obtained prior to any examination.

Data collection

All musculoskeletal injuries sustained were prospectively recorded by the academy medical staff in an electronic standardised format established on the consensus of Fuller et al.(20) Each squad had an experienced dedicated physiotherapist and all injuries were examined in cooperation with the Academy sports physician. Referral to a surgeon, specialist, or imaging was requested on a case by case basis if required/necessary to consolidate the diagnosis. Each team's physiotherapist submitted their injury

information of all discharged injured players to the senior physiotherapist who reviewed and consolidated all data on a weekly basis. Injuries not sustained in the context of the soccer programme, or any data related to sickness or other general medical conditions were excluded from this study.

Definition of injury

An injury was recorded as a result of any physical complaint resulting from a game or training, that required the attention of the medical staff. A visit to the physiotherapy department requiring a clinical examination without missing a full training session or game was termed "medical attention".(20) A visit resulting in a player being unable to fully take part in the training session or game the following day, was labelled "time-loss" injury. The lay-off (or player unavailability) was calculated by the number of days missed from the date of injury (day zero) until the day before the return to training participation and game selection availability.(19) The consensus statement from Fuller et al.(20) was not explicitly considering the physis. Therefore, aiming to collect prospectively and uniformly all physis injuries, the injury surveillance system was customized by adding "Growth related injuries" and "physeal fracture" as new injury types.(19) Similarly, other items have been added and muscle injuries were classified as per the Munich consensus statement (See supplementary Table 1 for all categories terminology details).(19, 21)

Anthropometric measurements

Anthropometry measure were taken in the morning three times during each season by an ISAK® (International Society for the Advancement of Kinanthropometry) practitioner. Measures included standing and sitting height (± 0.1 cm Holtain Limited, Crosswell, UK) and body mass (± 0.1 kg ADE Electronic Column Scales, Hamburg, Germany). The skinfold land marking and the Σ 7 skinfold measurements (± 0.1 mm

Harpenden skinfold calliper, Baty International, Burguess Hill, U.K.) were taken in accordance with international standards.(22) Maturity offset was obtained by a non-invasive method previously used in paediatric research comprising age and anthropometric measurements to predict maturational status (standard error of approximately 6 months).(23)

Data analysis

Descriptive statistics of variables were presented as mean ± standard deviation (SD) and percentage for categorical variables to compare the injury rate for all injury types and locations between age-groups. Poisson based 95% confidence intervals were calculated.(24) The injury burden (IB) was calculated using the following equation:

IB = Mean type injury incidence × Lay-off median per type of injury

Injury burden was expressed as the number of injury days lost per squad-season (Squad of 25 players) and 95% CI.(19) Because of the skewed distribution of time-loss injuries by types, we used the median to calculate the severity.

RESULTS

All age-groups from U-9 to U-18 were observed over four seasons, while the U-19 group over one season only. Demographic characteristics are described in Table-1.

Table 1. Demographic characteristics of the players by age group (Displayed anthropometric values are corresponding to the measurements taken at the beginning of each season).

Age Groups	Total Players-Seasons	Age (years)	Maturity off-set (Years)	Stature (cm)	Trunk Height (cm)	Leg length (cm)	Body Mass (kg)	Body mass index
	N	Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD
U-9	96	8.7 ± 0.2	-4.5 ± 0.8	131.0 ± 5.3	69.9 ± 4.3	61.4 ± 3.6	26.5 ± 2.9	15.2 ± 1.4
U-10	103	9.7 ± 0.3	-4.1 ± 0.5	135.5 ± 6.5	71.6 ± 3.7	65.3 ± 4.6	31.0 ± 6.1	16.8 ± 2.1
U-11	113	10.7 ± 0.2	-2.6 ± 0.2	142.2 ± 6.6	74.4 ± 5.1	69.5 ± 1.8	36.0 ± 7.3	17.8 ± 2.7
U-12	111	11.6 ± 0.3	-2.2 ± 0.8	147.0 ± 6.6	76.5 ± 3.0	72.3 ± 5.4	39.2 ± 5.8	21.2 ± 19.8
U-13	98	12.7 ± 0.3	-1.3 ± 0.6	154.1 ± 7.0	79.0 ± 3.8	75.1 ± 4.2	43.2 ± 6.8	18.1 ± 1.8
U-14	112	13.7 ± 0.3	-0.4 ± 0.7	160.1 ± 7.1	82.8 ± 4.2	77.3 ± 3.9	48.1 ± 7.7	18.7 ± 1.9
U-15	115	14.6 ± 0.3	0.4 ± 0.8	167.1 ± 7.3	86.5 ± 4.8	80.5 ± 3.9	54.7 ± 8.4	19.5 ± 2.1
U-16	112	15.6 ± 0.3	1.6 ± 0.6	171.8 ± 5.8	90.3 ± 3.6	81.5 ± 4.1	61.6 ± 6.7	20.9 ± 1.9
U-17	106	16.6 ± 0.3	2.3 ± 0.5	173.7 ± 5.4	91.8 ± 3.1	81.9 ± 4.3	64.1 ± 6.3	21.2 ± 1.7
U-18	108	17.6 ± 0.3	2.7 ± 0.5	173.5 ± 5.8	91.2 ± 3.0	82.3 ± 4.7	65.8 ± 8.0	21.8 ± 2.1
U-19	17	18.4 ± 0.3	3.9 ± 0.4	170.3 ± 8.0	89.1 ± 3.0	82.1 ± 5.1	69.8 ± 7.5	20.4 ± 0.5

A total of 2204 injuries were recorded, of which 40% (n=882) were medical attention (MA) and 60% (n=1322) were time-loss injuries (TLI), resulting in 25034 lay-off days absence from training or game participation. A mean incidence of 30.3 injuries per squad-season was sustained with an injury burden of 573.6 days lost per squad-season. The prevalence of time-loss recurrent injuries was 4.1% (n=55) and 3.5% (n=47) within the same season. Lay-off and severities of all type of injuries are displayed in Table-2. The distribution of injuries by location was as follows: Lower limbs 83.7% (n=1844), upper-limbs 8.4% (n=185) and trunk/head: 7.9% (n=175). Table 2 presents all type and location of TLI incurred across all age-groups during the four seasons. The burden of age-groups (Figure-1) and type of injuries (Figure-2) are illustrated by the risk matrix.

Insert Figure-1

Insert Figure-2

Training injuries accounted for 51.1% (n=1127) and 48.9% (n=1077) occurred in the games. A total of 920 records (41.7%) were the results of contact circumstances, while

1284 (58.3%) were non-contact. The top-5 diagnoses by location are displayed in Figure-3 with substantial differences if considered by age groups (Supplementary Figure 1). A detailed summary of diagnosis by body-regions is presented in supplementary Table-3.

Insert Figure-3

Table 2. Frequency (%), rates per squad-season*, lay-off (Mean ± SD, Sum) and severities of all type of medical attention and time-loss injuries. (*The rate per squad per season is established on a squad of 25 players).

Type of injuries	Frequency		Rate		Lay-off		Severity of injuries				
	Overall	Time-loss injuries	Overall	Time-loss injuries	Mean ± SD (Min-Max)	Sum	Medical attention (0 day)	Minor (1-3 days)	Moderate (4-7 days)	Major (8-28 days)	Severe (>28 days)
	N (%)	N (%)	per squad*/season		(Days)	N Days (%)	N (%)	N (% of Time-loss)			
Contusion/bruise/hematoma	778 (35.3%)	337 (25.5%)	17.8	7.7	4.6 ± 6.9 (1-67)	1567 (6.3%)	441 (56.7%)	210 (62.3%)	77 (22.8%)	46 (13.7%)	4 (1.2%)
Sprain/ligament injury	284 (12.9%)	215 (16.3%)	6.5	4.9	31.3 ± 54.3 (1-401)	6732 (26.9%)	69 (24.3%)	41 (19.1%)	40 (18.6%)	70 (32.5%)	64 (29.8%)
Growth related condition	269 (12.2%)	208 (15.7%)	6.2	4.8	19.1 ± 26.0 (1-241)	3973 (15.9%)	61 (22.7%)	35 (16.8%)	41 (15.7%)	92 (44.3%)	40 (19.2%)
Functional muscle disorder/neural irritation	385 (17.5%)	190 (14.4%)	8.8	4.4	4.2 ± 4.4 (1-27)	796 (3.2%)	195 (50.6%)	116 (61.0%)	45 (23.7%)	29 (15.3%)	-
Muscle strain/rupture	127 (5.8%)	126 (9.5%)	2.9	2.9	22.5 ± 17.8 (2-151)	2836 (11.3%)	1 (0.8%)	3 (2.4%)	10 (7.9%)	84 (66.7%)	29 (23.0%)
Overuse unspecific	115 (5.2%)	67 (5.1%)	2.6	1.5	6.7 ± 9.0 (1-56)	448 (1.8%)	48 (41.7%)	35 (52.2%)	16 (23.9%)	14 (20.9%)	2 (3.0%)
Physeal fracture	38 (1.7%)	37 (2.8%)	0.9	0.8	78.1 ± 73.9 (1-352)	2889 (11.5%)	1 (2.6%)	2 (5.4%)	-	9 (24.3%)	26 (70.3%)
Fracture (Non physeal)	38 (1.7%)	37 (2.8%)	0.9	0.8	43.8 ± 48.3 (1-286)	1621 (6.5%)	1 (2.6%)	5 (13.5%)	2 (5.4%)	5 (13.5%)	25 (67.6%)
Other bone injury	36 (1.6%)	29 (2.2%)	0.8	0.7	37.4 ± 38.1 (1-122)	1084 (4.3%)	7 (19.4%)	6 (20.7%)	1 (3.5%)	9 (31.0%)	13 (44.8%)
Other injury	47 (2.1%)	21 (1.6%)	1.1	0.5	13.7 ± 19.0 (1-83)	288 (1.2%)	26 (55.3%)	5 (23.8%)	6 (28.6%)	8 (38.1%)	2 (9.5%)
Lesion of meniscus and cartilage	19 (0.9%)	19 (1.4%)	0.4	0.4	128.8 ± 153.4 (3-655)	2448 (9.8%)	-	2 (10.5%)	-	3 (15.8%)	14 (73.7%)
Tendinopathy	28 (1.3%)	10 (0.8%)	0.6	0.2	17.6 ± 17.0 (1-54)	176 (0.7%)	18 (64.3%)	2 (20.0%)	2 (20.0%)	4 (40.0%)	2 (20.0%)
Concussion	14 (0.6%)	10 (0.8%)	0.3	0.2	3.1 ± 2.6 (1-9)	31 (0.1%)	4 (28.6%)	7 (70.0%)	2 (20.0%)	1 (10.0%)	-
Synovitis/effusion	16 (0.7%)	9 (0.7%)	0.4	0.2	5.7 ± 7.5 (1-25)	51 (0.2%)	7 (43.8%)	6 (66.7%)	2 (22.2%)	1 (11.1%)	-
Abrasion/laceration	7 (0.3%)	4 (0.3%)	0.2	0.1	7.5 ± 4.0 (2-11)	30 (0.1%)	3 (42.9%)	1 (25.0%)	1 (25.0%)	2 (50.0%)	-
Dislocation/Subluxation	3 (0.1%)	3 (0.2%)	0.1	0.1	21.3 ± 13.3 (6-29)	64 (0.3%)	-	-	1 (33.3%)	-	2 (66.7%)
Total	**2004 (100%)**	**1322 (100%)**	**50.5**	**30.3**	**18.9 ± 40.3 (1-655)**	**25034 (100%)**	**882 (40.0%)**	**476 (36.0%)**	**246 (18.6%)**	**377 (28.5%)**	**223 (16.9%)**

Table 3. Frequency (%), rates per squad-season* for type and location of time-loss injuries (*The rate per squad per season is established on a squad of 25 players).

	Age groups											
	U-9		U-10		U-11		U-12		U-13		U-14	
	n=96		n=103		n=114		n=111		n=98		n=112	
	Frequency (% of total)	Rate per squad*/season	Frequency (% of total)	Rate per squad*/season	Frequency (% of total)	Rate per squad*/season	Frequency (% of total)	Rate per squad*/season	Frequency (% of total)	Rate per squad*/season	Frequency (% of total)	Rate per squad*/season
Type of injuries												
Concussion	0 (0.0%)	0.0	0 (0.0%)	0.0	0 (0.0%)	0.0	0 (0.0%)	0.0	1 (0.9%)	0.3	0 (0.0%)	0.0
Lesion of meniscus and cartilage	0 (0.0%)	0.0	0 (0.0%)	0.0	0 (0.0%)	0.0	0 (0.0%)	0.0	0 (0.0%)	0.0	2 (1.1%)	0.4
Contusion/bruise/hematoma	7 (35.0%)	1.8	20 (69.0%)	4.9	22 (45.8%)	4.8	23 (48.9%)	5.2	32 (28.8%)	8.2	38 (21.3%)	8.5
Fracture (Non physeal)	2 (10.0%)	0.5	0 (0.0%)	0.0	1 (2.1%)	0.2	2 (4.3%)	0.5	1 (0.9%)	0.3	10 (5.6%)	2.2
Muscle strain/rupture	0 (0.0%)	0.0	0 (0.0%)	0.0	0 (0.0%)	0.0	1 (2.1%)	0.2	7 (6.3%)	1.8	12 (6.7%)	2.7
Abrasion/laceration	0 (0.0%)	0.0	0 (0.0%)	0.0	0 (0.0%)	0.0	0 (0.0%)	0.0	0 (0.0%)	0.0	2 (1.1%)	0.4
Other bone injury	1 (5.0%)	0.3	0 (0.0%)	0.0	0 (0.0%)	0.0	0 (0.0%)	0.0	1 (0.9%)	0.3	1 (0.6%)	0.2
Tendinopathy	0 (0.0%)	0.0	1 (3.4%)	0.2	0 (0.0%)	0.0	0 (0.0%)	0.0	1 (0.9%)	0.3	1 (0.6%)	0.2
Dislocation/Subluxation	0 (0.0%)	0.0	0 (0.0%)	0.0	0 (0.0%)	0.0	0 (0.0%)	0.0	0 (0.0%)	0.0	0 (0.0%)	0.0
Synovitis/effusion	1 (5.0%)	0.3	0 (0.0%)	0.0	0 (0.0%)	0.0	0 (0.0%)	0.0	0 (0.0%)	0.0	1 (0.6%)	0.2
Overuse unspecific	0 (0.0%)	0.0	1 (3.4%)	0.2	2 (4.2%)	0.4	2 (4.3%)	0.5	4 (3.6%)	1.0	11 (6.2%)	2.5
Other injury	2 (10.0%)	0.5	0 (0.0%)	0.0	3 (6.3%)	0.7	0 (0.0%)	0.0	0 (0.0%)	0.0	3 (1.7%)	0.7
Functional muscle disorder	0 (0.0%)	0.0	0 (0.0%)	0.0	3 (6.3%)	0.7	5 (10.6%)	1.1	14 (12.6%)	3.6	35 (19.7%)	7.8
Growth related condition	1 (5.0%)	0.3	4 (13.8%)	1.0	12 (25.0%)	2.6	12 (25.5%)	2.7	25 (22.5%)	6.4	44 (24.7%)	9.8
Physeal fracture	0 (0.0%)	0.0	1 (3.4%)	0.2	1 (2.1%)	0.2	2 (4.3%)	0.5	8 (7.2%)	2.0	4 (2.2%)	0.9
Sprain/ligament injury	6 (30.0%)	1.6	2 (6.9%)	0.5	4 (8.3%)	0.9	0 (0.0%)	0.0	17 (15.3%)	4.3	14 (7.9%)	3.1
Locations												
Head/face	0 (0.0%)	0.0	0 (0.0%)	0.0	0 (0.0%)	0.0	0 (0.0%)	0.0	1 (0.9%)	0.3	2 (1.1%)	0.4
Neck/cervical spine	0 (0.0%)	0.0	0 (0.0%)	0.0	0 (0.0%)	0.0	0 (0.0%)	0.0	0 (0.0%)	0.0	1 (0.6%)	0.2
Shoulder/Clavicula	2 (10.0%)	0.5	0 (0.0%)	0.0	1 (2.1%)	0.2	0 (0.0%)	0.0	0 (0.0%)	0.0	2 (1.1%)	0.4
Upper Arm	0 (0.0%)	0.0	0 (0.0%)	0.0	0 (0.0%)	0.0	0 (0.0%)	0.0	0 (0.0%)	0.0	0 (0.0%)	0.0
Elbow	0 (0.0%)	0.0	1 (3.4%)	0.2	0 (0.0%)	0.0	0 (0.0%)	0.0	0 (0.0%)	0.0	1 (0.6%)	0.2
Forearm/wrist	0 (0.0%)	0.0	0 (0.0%)	0.0	2 (4.2%)	0.4	4 (8.5%)	0.9	3 (2.7%)	0.8	3 (1.7%)	0.7
Hand/fingers	1 (5.0%)	0.3	2 (6.9%)	0.5	0 (0.0%)	0.0	1 (2.1%)	0.2	10 (9.0%)	2.6	5 (2.8%)	1.1
Ribs/thoracic spine	0 (0.0%)	0.0	0 (0.0%)	0.0	1 (2.1%)	0.2	1 (2.1%)	0.2	0 (0.0%)	0.0	1 (0.6%)	0.2
Abdomen/lumbar spine	0 (0.0%)	0.0	0 (0.0%)	0.0	0 (0.0%)	0.0	2 (4.3%)	0.5	6 (5.4%)	1.5	8 (4.5%)	1.8
Pelvis/hip/groin	0 (0.0%)	0.0	0 (0.0%)	0.0	3 (6.3%)	0.7	4 (8.5%)	0.9	7 (6.3%)	1.8	29 (16.3%)	6.5
Thigh	0 (0.0%)	0.0	0 (0.0%)	0.0	0 (0.0%)	0.0	0 (0.0%)	0.0	1 (0.9%)	0.3	0 (0.0%)	0.0
Quadriceps	0 (0.0%)	0.0	2 (6.9%)	0.5	3 (6.3%)	0.7	4 (8.5%)	0.9	11 (9.9%)	2.8	13 (7.3%)	2.9
Hamstring	0 (0.0%)	0.0	1 (3.4%)	0.2	2 (4.2%)	0.4	4 (8.5%)	0.9	5 (4.5%)	1.3	20 (11.2%)	4.5
Adductor	0 (0.0%)	0.0	1 (3.4%)	0.2	0 (0.0%)	0.0	1 (2.1%)	0.2	6 (5.4%)	1.5	13 (7.3%)	2.9

Knee	4 (20.0%)	1.0	9 (31.0%)	2.2	9 (18.8%)	2.0	6 (12.8%)	1.4	16 (14.4%)	4.1	15 (8.4%)	3.3
Lower leg	1 (5.0%)	0.3	3 (10.3%)	0.7	3 (6.3%)	0.7	9 (19.1%)	2.0	15 (13.5%)	3.8	26 (14.6%)	5.8
Calf/Achilles tendon	2 (10.0%)	0.5	1 (3.4%)	0.2	2 (4.2%)	0.4	1 (2.1%)	0.2	5 (4.5%)	1.3	4 (2.2%)	0.9
Ankle	7 (35.0%)	1.8	3 (10.3%)	0.7	6 (12.5%)	1.3	0 (0.0%)	0.0	15 (13.5%)	3.8	15 (8.4%)	3.3
Foot/toes	3 (15.0%)	0.8	6 (20.7%)	1.5	16 (33.3%)	3.5	10 (21.3%)	2.3	10 (9.0%)	2.6	20 (11.2%)	4.5
Total	20 (100.0%)	5.2	29 (100.0%)	7.0	48 (100.0%)	10.5	47 (100.0%)	10.6	111 (100.0%)	28.3	178 (100.0%)	39.7

Age groups										
U-15		**U-16**		**U-17**		**U-18**		**U-19**	
n=115		n=112		n=106		n=108		n=17	
Frequency (% of total)	Rate per squad*/season	Frequency (% of total)	Rate per squad*/season	Frequency (% of total)	Rate per squad*/season	Frequency (% of total)	Rate per squad*/season	Frequency (% of total)	Rate per squad*/season
2 (0.9%)	0.4	3 (1.1%)	0.7	4 (2.0%)	0.9	0 (0.0%)	0.0	0 (0.0%)	0.0
1 (0.5%)	0.2	5 (1.9%)	1.1	5 (2.5%)	1.2	5 (2.7%)	1.2	1 (4.0%)	1.5
50 (23.4%)	10.9	77 (29.2%)	17.2	41 (20.1%)	9.7	26 (14.3%)	6.0	1 (4.0%)	1.5
9 (4.2%)	2.0	1 (0.4%)	0.2	2 (1.0%)	0.5	9 (4.9%)	2.1	0 (0.0%)	0.0
22 (10.3%)	4.8	22 (8.3%)	4.9	25 (12.3%)	5.9	31 (17.0%)	7.2	6 (24.0%)	8.8
1 (0.5%)	0.2	1 (0.4%)	0.2	0 (0.0%)	0.0	0 (0.0%)	0.0	0 (0.0%)	0.0
2 (0.9%)	0.4	7 (2.7%)	1.6	2 (1.0%)	0.5	8 (4.4%)	1.9	7 (28.0%)	10.3
1 (0.5%)	0.2	1 (0.4%)	0.2	2 (1.0%)	0.5	3 (1.6%)	0.7	0 (0.0%)	0.0
0 (0.0%)	0.0	0 (0.0%)	0.0	2 (1.0%)	0.5	1 (0.5%)	0.2	0 (0.0%)	0.0
1 (0.5%)	0.2	4 (1.5%)	0.9	1 (0.5%)	0.2	1 (0.5%)	0.2	0 (0.0%)	0.0
8 (3.7%)	1.7	16 (6.1%)	3.6	11 (5.4%)	2.6	11 (6.0%)	2.5	1 (4.0%)	1.5
4 (1.9%)	0.9	2 (0.8%)	0.4	5 (2.5%)	1.2	2 (1.1%)	0.5	0 (0.0%)	0.0
41 (19.2%)	8.9	38 (14.4%)	8.5	29 (14.2%)	6.8	21 (11.5%)	4.9	4 (16.0%)	5.9
32 (15.0%)	7.0	35 (13.3%)	7.8	28 (13.7%)	6.6	13 (7.1%)	3.0	2 (8.0%)	2.9
7 (3.3%)	1.5	10 (3.8%)	2.2	3 (1.5%)	0.7	1 (0.5%)	0.2	0 (0.0%)	0.0
33 (15.4%)	7.2	42 (15.9%)	9.4	44 (21.6%)	10.4	50 (27.5%)	11.6	3 (12.0%)	4.4
4 (1.9%)	0.9	4 (1.5%)	0.9	4 (2.0%)	0.9	0 (0.0%)	0.0	0 (0.0%)	0.0
3 (1.4%)	0.7	1 (0.4%)	0.2	0 (0.0%)	0.0	0 (0.0%)	0.0	0 (0.0%)	0.0
4 (1.9%)	0.9	0 (0.0%)	0.0	1 (0.5%)	0.2	3 (1.6%)	0.7	0 (0.0%)	0.0
0 (0.0%)	0.0	0 (0.0%)	0.0	0 (0.0%)	0.0	0 (0.0%)	0.0	0 (0.0%)	0.0
0 (0.0%)	0.0	1 (0.4%)	0.2	1 (0.5%)	0.2	1 (0.5%)	0.2	0 (0.0%)	0.0
4 (1.9%)	0.9	2 (0.8%)	0.4	4 (2.0%)	0.9	2 (1.1%)	0.5	0 (0.0%)	0.0
5 (2.3%)	1.1	3 (1.1%)	0.7	2 (1.0%)	0.5	6 (3.3%)	1.4	0 (0.0%)	0.0
2 (0.9%)	0.4	1 (0.4%)	0.2	1 (0.5%)	0.2	2 (1.1%)	0.5	1 (4.0%)	1.5
16 (7.5%)	3.5	16 (6.1%)	3.6	5 (2.5%)	1.2	5 (2.7%)	1.2	0 (0.0%)	0.0
32 (15.0%)	7.0	37 (14.0%)	8.3	37 (18.1%)	8.7	18 (9.9%)	4.2	4 (16.0%)	5.9
0 (0.0%)	0.0	3 (1.1%)	0.7	3 (1.5%)	0.7	2 (1.1%)	0.5	1 (4.0%)	1.5
19 (8.9%)	4.1	24 (9.1%)	5.4	22 (10.8%)	5.2	22 (12.1%)	5.1	1 (4.0%)	1.5

20 (9.3%)	4.3	25 (9.5%)	5.6	22 (10.8%)	5.2	22 (12.1%)	5.1	5 (20.0%)	7.4
12 (5.6%)	2.6	12 (4.5%)	2.7	12 (5.9%)	2.8	13 (7.1%)	3.0	2 (8.0%)	2.9
16 (7.5%)	3.5	34 (12.9%)	7.6	26 (12.7%)	6.1	31 (17.0%)	7.2	2 (8.0%)	2.9
20 (9.3%)	4.3	21 (8.0%)	4.7	4 (2.0%)	0.9	8 (4.4%)	1.9	3 (12.0%)	4.4
5 (2.3%)	1.1	10 (3.8%)	2.2	7 (3.4%)	1.7	4 (2.2%)	0.9	1 (4.0%)	1.5
37 (17.3%)	8.0	41 (15.5%)	9.2	42 (20.6%)	9.9	35 (19.2%)	8.1	4 (16.0%)	5.9
15 (7.0%)	3.3	29 (11.0%)	6.5	11 (5.4%)	2.6	8 (4.4%)	1.9	1 (4.0%)	1.5
214 (100.0%)	46.5	264 (100.0%)	58.9	204 (100.0%)	48.1	182 (100.0%)	42.1	25 (100.0%)	36.8

DISCUSSION

This is the first prospective study investigating injury epidemiology in elite youth soccer players from the Middle East with the largest cohort from a single academy. We found a mean incidence of 30 injuries per squad-season were sustained, with an injury burden of 574 days lost per squad-season. U-16 players had the highest injury incidence (59 injuries per squad-season) while U-18 had the worst burden (1408 days per squad-season). After ligament/sprain, growth plate injuries (growth related conditions plus physeal fractures) were the most prevalent time-loss injuries accounting for 27% (6862 days) of the entire lay-off in our study.

Injury characteristics

The lower limb was the most commonly injured location as described in previous studies.(5, 25-27) Consistent with a recent systematic review,(17) the ankle in combination with foot/toes had the highest prevalence (23%). The knee (11%) and pelvis-hip-groin (11%) were also prevalent and within the range. Although not being reported in all studies,(4-7, 10) the proportion of medical attention seems similar to other studies that have reported this.(26-28) The prevalence of severe injuries in our study was 17%, which is very close to the median of 18% found in a systematic review.(17) Similarly to some investigations from English and Dutch professional soccer academies, the rate of 30 time-loss injuries per squad-season indicates that the Academy is in the middle-range of the reported incidence from other studies (ranging from 10 to 50 injuries per squad-season), involving a wide variety of different age-groups.(4, 6, 7, 9, 10, 12) The differences with previous studies may be due to the evolution in youth soccer as the game has developed over time.(2, 4) The apparent discrepency between results, may also arise from different methodological issues. The rates of medical attention and/or minor injuries can be affected by clinicians invested in research relying on the data collection.(29) Also, some authors have differing injury definitions where some consider only

non-contact injuries or define injuries as not able to participate at 48h post-injury onset.(4, 5, 9, 10)

Injuries incidence and age-groups

Similar to other youth soccer epidemiology reports, the incidence of injuries increases with the age.(4, 6, 7, 10) In recent years, in elite youth soccer, the under 15-y age-group was found to have the highest probability of suffering a time-loss injury, which is slightly different from recent audits and the present study, where the highest injury incidence was found in U-16.(8, 17) The U-15 had the third (after U-17) highest incidence of time-loss injuries in our study. The contextual difference among studies is important to consider, as almost all investigations were performed in professional club academy settings and only a few in National team settings.(17) In Asia, U-16 is the first age-group to be involved in official Asian Football Confederation competition (AFC U-16 Championship qualifiers) which requires a dedicated international preparation including training camps and friendly tournaments, which is very different compared to club footballers playing matches once a week. Interestingly, the rate in the youth players (30 injuries/squad-season) was higher than the 23.6 injuries/squad-season reported in the adult's first division football league of Qatar.(30) The youth's higher injury incidence compared to senior players is not unusual and is in-line with a previous study from English professional football.(31) The youth high-level football players are more likely to suffer time-loss injuries than adults in the domestic professional league.(17, 32, 33)

Age-groups injury burden

When the injury data of our study is further compared, the findings indicate a low injury burden in the childhood age-groups (U-9 to U-12), increasing substantially through early- and middle- (U-13 to U-17) to reach the highest values in late-adolescence (U-18 and U-19) (Figure 1). Injury burden has not been extensively investigated in youth soccer and the results of the present study are not in line with the trend found in a Dutch cohort, where the peak overall

injury burden was 357 days lost/squad-season in U-16.(6, 17) The findings were aligned with Belgian's Professional academies, reporting a greater injury burden in older- (U13-15) in comparison with the youngest age-groups (U9-12).(11) The latter study' injury burden (652 days/squad-season in U13-15) is similar to the 627 days found in the present study for equivalent age-groups. However, the injury burden of their youngest age-group (275 days/squad-season) was three-fold greater than ours (83 days/squad-season). The increased burden of injuries across the age-group potentially hinder the optimal developmental processes. The burden of each age-group is an important consideration as it might have detrimental consequences on the individual development and long-term performance by missing certain optimal ''window of trainability'' of physical and technical characteristics.(34)

Injury types prevalence and age-groups

The most prevalent time-loss injuries obtained from this study, differs from most of the literature on elite youth soccer players, apart from the work of Kemper et al. with comparable outcomes.(12, 17) The growth related injuries accounted for 19% of all severe injuries (> 4 weeks) and is within the prevalence range (11% and 29%) of two other youth elite academy studies.(5, 35) Growth related injuries are recognised to be undereported and mistakenly diagnosed as muscle injuries.(36, 37) In youth soccer, they have not been well categorised and reported underneath overuse injuries.(6, 7, 11, 17) From U-10 to U-13, the growth related injuries were the second most frequent type of time-loss injury and in U-14 they were the leading cause. In Elite French players,(5) the U-14 had the most osteochondral disorders and a recent study in youth elite soccer players from different countries observed similar overall trend.(8) Sprains have been observed to be very common in youth soccer.(25) In this cohort, sprain was the leading diagnois in U-17 and U-18. Another unusual result in our study, is the low rate of muscle tear (6%) and the large amount of functional muscle disorders (14%). Muscular tears in youth elite male soccer has been found to be the most common type of

injuries in English soccer academy,(4, 10) and accounted for 15% to 46% of injuries.(8, 13, 25) A Swedish study reported similar frequency of muscle tear,(38) while a Brazilian study found muscle tears had the highest incidence in the oldest age-groups (U-18 and U-19).(7) Several interacting factors might play a role in this soft tissues outcome. Direct access to imaging (ultrasonography and magnetic resonance imaging) probably played a significant role in the accuracy and consistency of clinical investiguation and diagnosis, where actual tears were ruled out and then classified as functional muscle disorders.(21, 39) During the study period, all teams had a systematic individualised injury prevention plan alongside the football program. Such a framework was perhaps different from past research when injury prevention was not as popular and poorly implemented.(4, 5)

Type of injuries burden

The impact of injuries can be considered in relation to its burden using a risk matrix.(19) The overall two most burdensome type of injuries were sprain/ligament (Median lay-off: 14 days; Rate: 4.9 injury per squad-season) and growth-related condition (Median lay-off: 12 days; Rate: 4.8 injury per squad-season). Growth-related injuries were more common and burdensome than in previous studies,(17, 25) where they were reported to have a prevalence between 5% to 7% and a rate per squad/season between 0.8 to 2.1.(4, 5, 10) The overall higher rate and burden of growth related condition in this current youth elite population, in comparison to the literature, might reflect an increase of weekly soccer practice participation and higher intensity.(40) Meniscus-cartilage injuries had the longest lay-off. While meniscus injuries did occur in different age-groups, U-18 was the most impacted and it plays an important role in the total burden of this age-group. Meniscal tear incidence in adolescents has increased in recent years because of increased sports participation and more widespread use of MRI as a diagnostic tool.(41) Loss of meniscus integrity in young players leads to a greater prevalence of osteoarthritis development.(42) Looking after the knee in paediatric sports medicine is of prime

importance, longer lay-offs and a more conservative approach to promote healing is required.(41, 43) Fractures accounted for 3% of all injuries similar to what is usually found in youth soccer (2-9%).(17) Half of the fractures were physeal fractures (1.7%), accounting for 12% of all severe injuires. There are no epidemiological studies from soccer academies reporting on physeal fractures, but they are accounting in peadiatric medicine for 15% to 30% of all fractures in children and for 30% in a soccer tournament.(44, 45) Interestingly, the burden of physeal fractures (2889 days; 12% of the total lay-off) was double that of mature bone fractures. This is not surprising, as the return to sport of young skeletally immature players from severe injuries involving the physis is considerably longer than adults.(46)

Common diagnosis

The most common diagnosis for the upper limb, was non-physeal fractures, with an important number of physeal fractures of the forearm and wrist. In the trunk, spondylolysis accounted for the most significant burden. A comparable trend of diagnosis for the spine and upper limb was found in a general paediatric sports population.(18) Sprain and tendinopathy were the most frequent knee diagnosis reported in a English youth academy.(47) In the present study, apophyseal osteochondroses were the primary diagnosis for the knee and the hip-pelvis. However, sprain, Osgood-Schlatter and meniscus tear were the three most prevalent diagnosis of severe injuries. In line with a previous study, the three foremost diagnosis of the foot/ankle were: sprain/ligament, contusion/bruise and apophyseal osteochondroses.(48) In the calf/lower leg, contusions were the most common, the physeal fractures were only ranked as the fifth most prevalent diagnosis, but accounted for the greatest burden. Growth plate injury was in the top five diagnosis of all location, except the head/face and the thigh locations. The outcomes highlight the difference of injury pattern between age groups, youth and adult soccer players, emphasising the importance for clinicians to be acquainted with and suspicious of growth plate

injuries in youth elite soccer whenever an injury is located around a physis.(45) Injury patterns were different than the current litterature from other regions in the world.

Strengths and limitations

We note at least one limitation, individual exposure time is missing from this work and therefore the incidence of injury in relation to exposure time are not presented. However, as suggested by latest international Olympic committee consensus statement, expressing the rates of injury per number of players per period of the concerned sports has been used.(19) The inclusion of specific additional items related to paediatric injuries in the injury surveillance system, provides a more accurate and consistent record, probably leading to a greater clinical contribution as previously recommended.(19, 49)

Summary

The mean incidence of time-loss injuries was 30 per squad-season, with an injury burden of 574 days lost/squad-season. The highest injury incidence was found in U-16 and the greatest injury burden in U-18, emphasising that although the peak injury incidence occurred earlier during middle-adolescence, the injury burden seems to increase throughout the academy period to reach its peak in late-adolescence. Growth plate injuries were prevalent, accounting for almost one third of the total lay-off. A high proportion of fractures involved the physis, highlighting the need for specific consideration in future prospective studies. We emphasise the necessity for more dedicated epidemiology studies in youth Asian elite soccer players.

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Compliance with Ethical standards

Ethical Approval

All procedures performed in this original study involving human participants were in accordance with the ethical standards. This research was approved by the scientific boards of ASPETAR and ASPIRE Academy and the ethics was granted by Qatar Anti-Doping Laboratory Ethics-Committee (SCH-ADL-070), conforming to the recommendations of the 1964 Helsinki-Declaration and its later amendments or comparable ethical standards.

Informed consent

Written informed consent to use regularly collected injury data for research purposes was obtained from all individual participant's guardian included in this original study.

Disclosure statement

Olivier Materne, Karim Chamari, Abdulaziz Farooq, Adam Weir, Per Holmich, Roald Bahr, Matt Greig and Lars R. McNaughton declare that they have no conflict of interest in the production of this research.

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Figure 1. Risk matrix based on the duration of time-loss illustrating the burden for all age-groups. Severity (mean of days lost) and incidence of injury per squad-season (25 players). The curved grey lines represent point with equal burden (days per squad-season). The vertical and horizontal error bars represent 95% CI (all dataset is available in Supplementary Table 2).

Figure 2. Risk matrix based on the duration of time-loss illustrating the burden for all type of injuries. Severity (median of days lost) and incidence of injury per squad-season (25 players). The curved grey lines represent point with equal burden (days per squad-season). The vertical and horizontal error bars represent 95% CI. The 95% CI upper bound for the Median of meniscus/cartilage injuries is 181 days (all dataset is available in Supplementary Table 2).

Figure 3. The five most prevalent time-loss injuries for each main location with their corresponding proportion of days lost during the 4 seasons (Prevalence % - % lay-off). The values are in relation to each specific location (100%).

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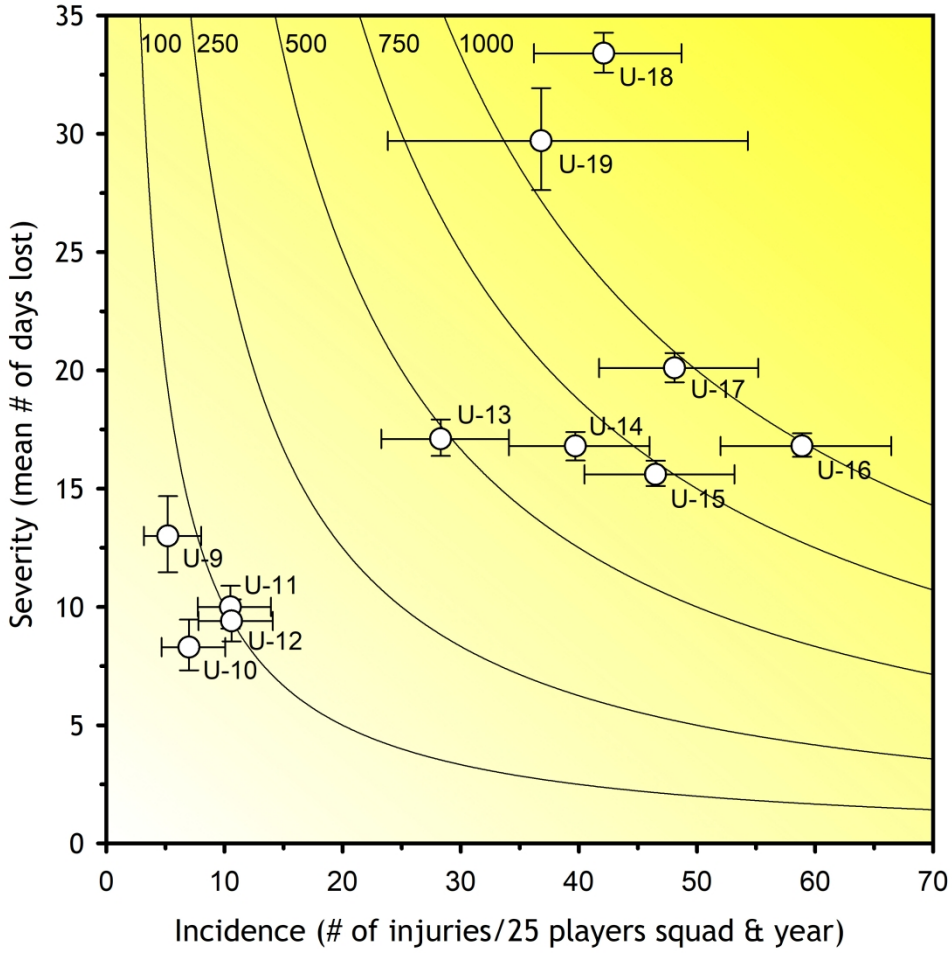

Figure 1. Risk matrix based on the duration of time-loss illustrating the burden for all age-groups. Severity (mean of days lost) and incidence of injury per squad-season (25 players). The curved grey lines represent point with equal burden (days per squad-season). The vertical and horizontal error bars represent 95% Cis.

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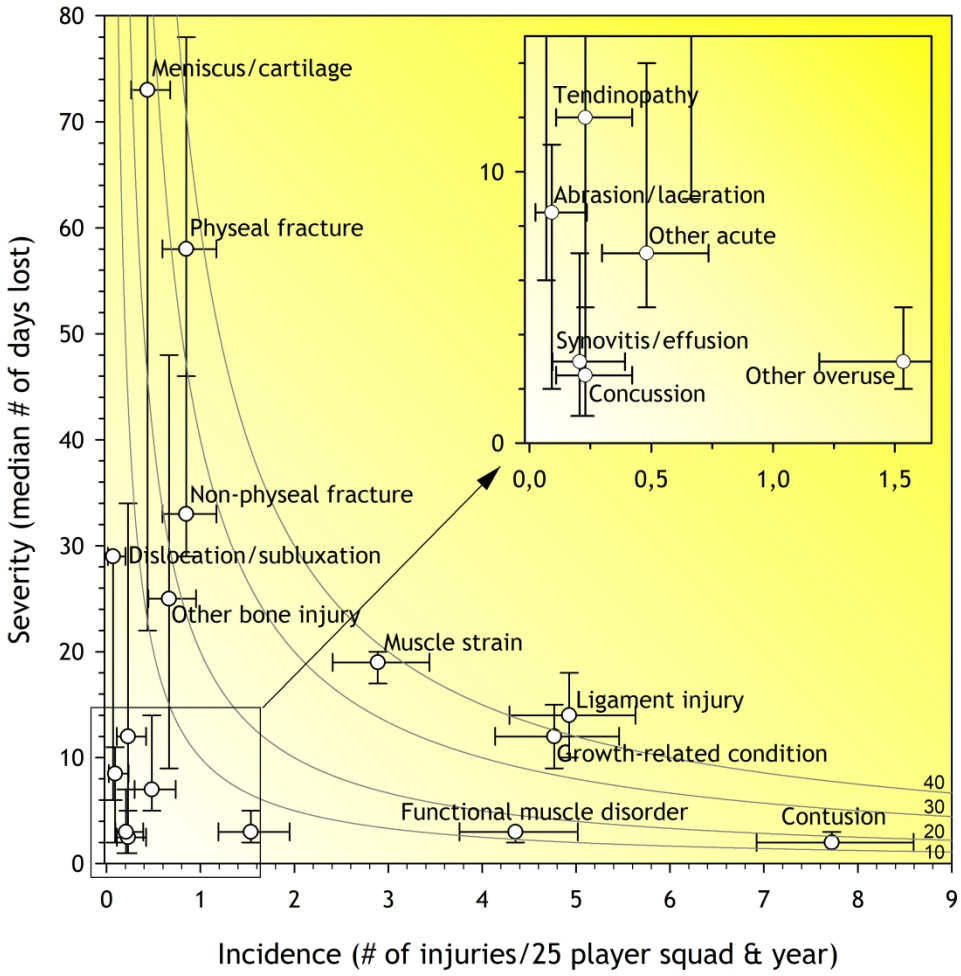

Figure 2. Risk matrix based on the duration of time-loss illustrating the burden for all type of injuries. Severity (median of days lost) and incidence of injury per squad-season (25 players). The curved grey lines represent point with equal burden (days per squad-season). The vertical and horizontal error bars represent 95% CI. The 95% CI upper bound for the Median of meniscus/cartilage injuries is 181 days (all dataset is available in Supplementary Table 2).

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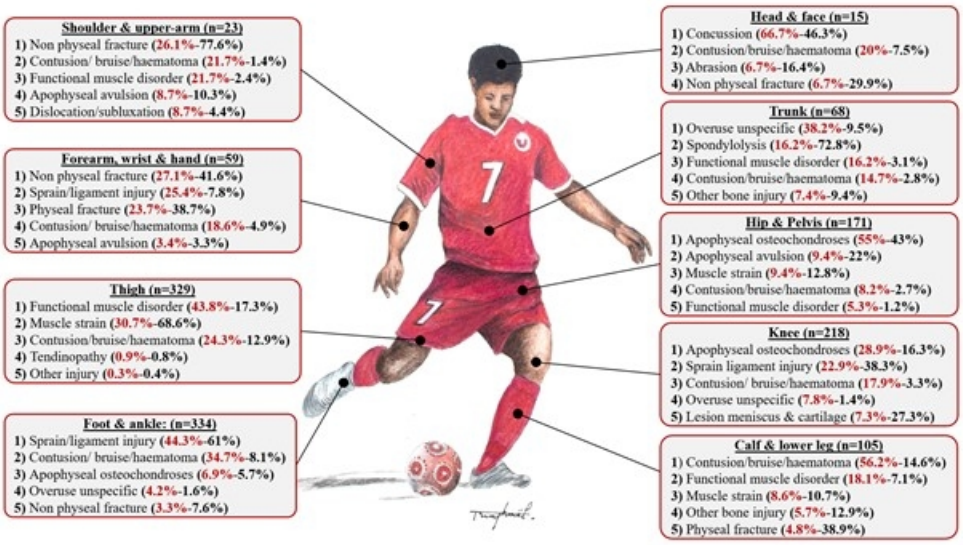

Figure 3. The five most prevalent time-loss injuries for each body-parts with their corresponding proportion of days lost during the 4 seasons (Prevalence % - % lay-off).

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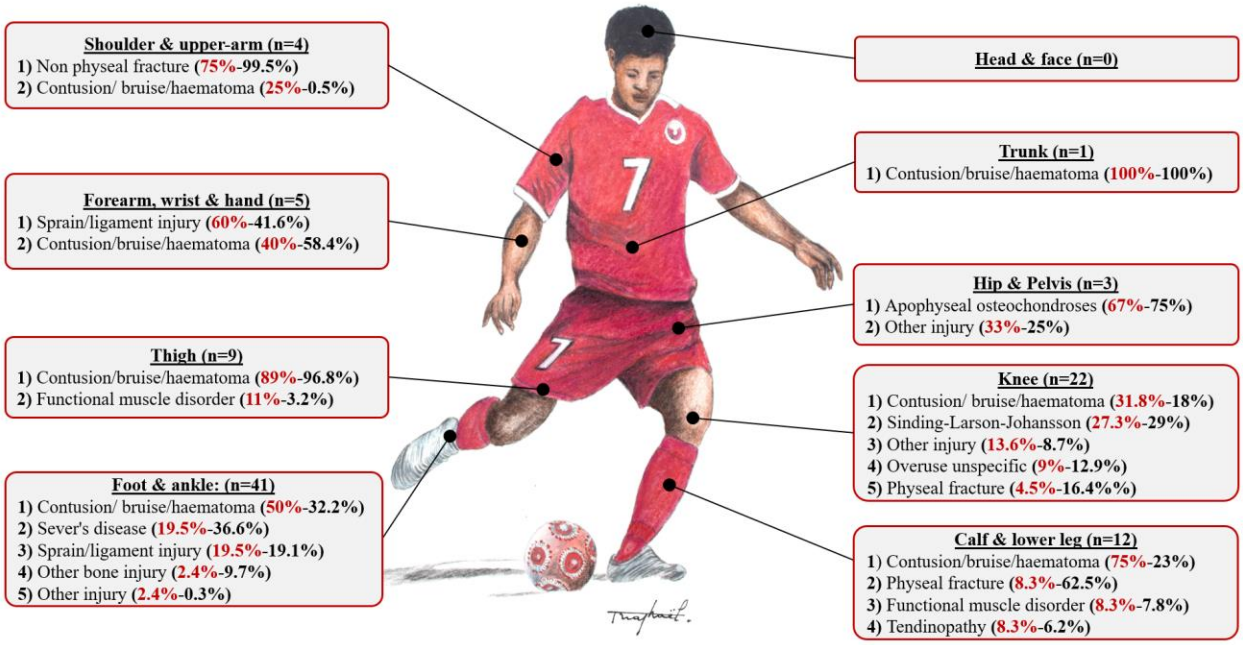
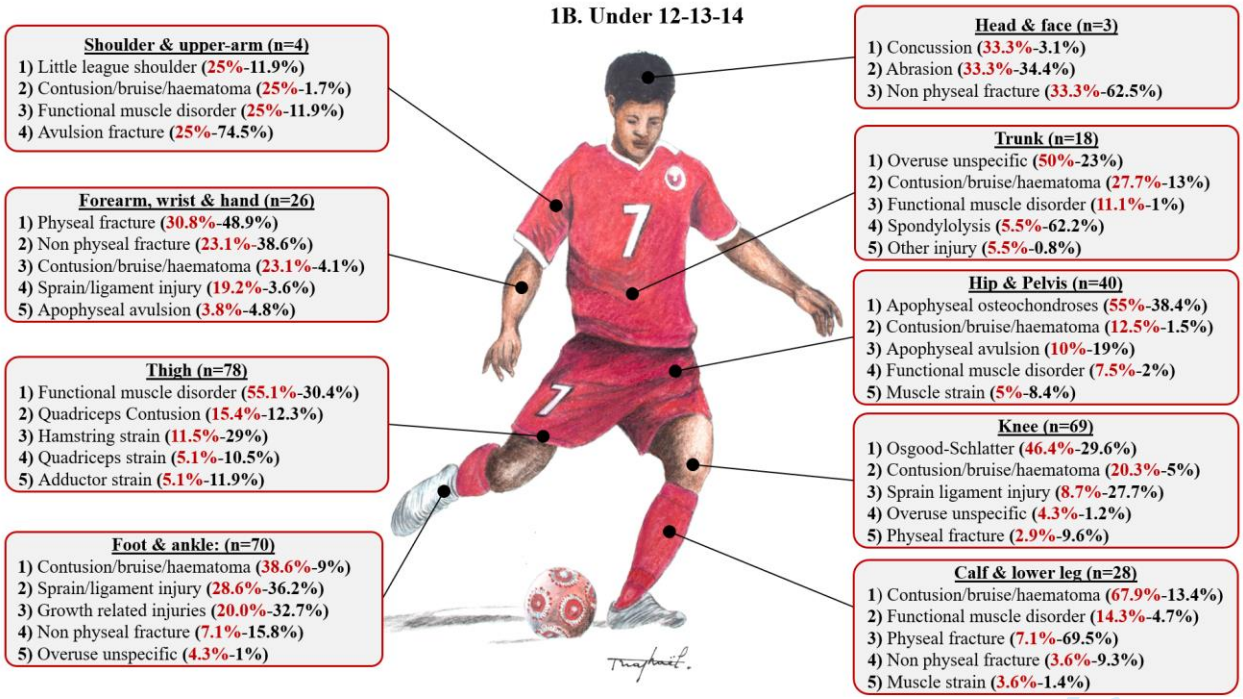
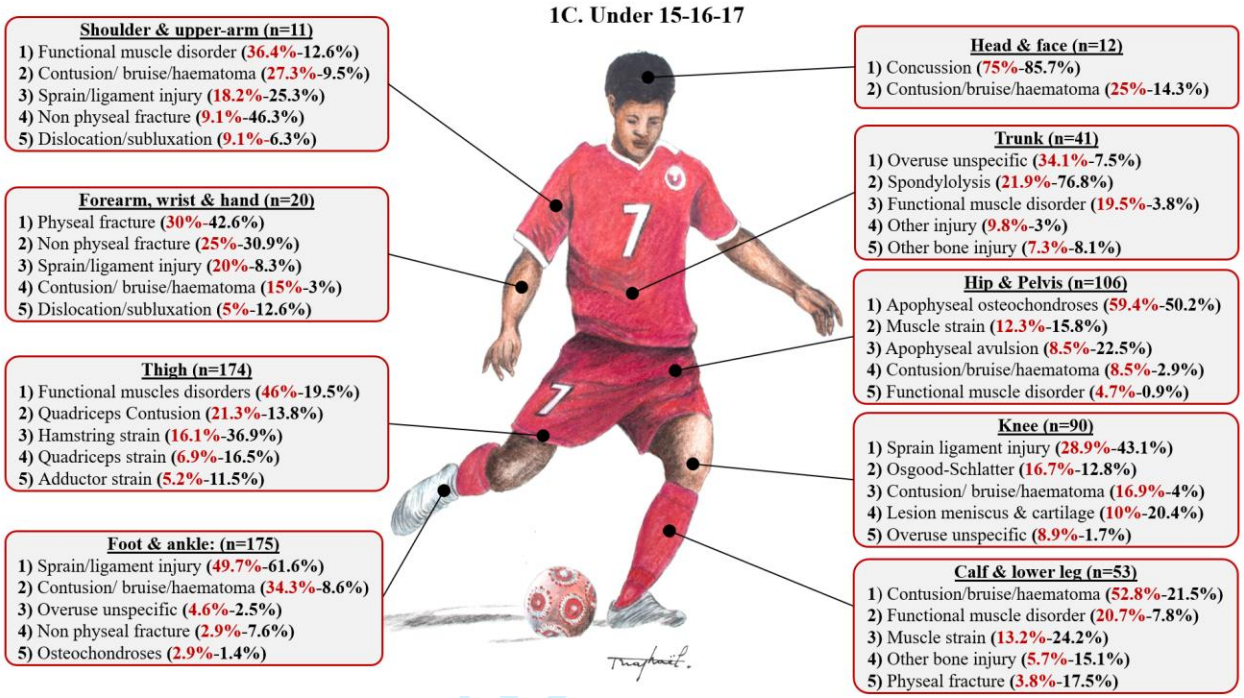
1A. Under 9-10-11



1B. Under 12-13-14





Supplementary Figure 1. The five most prevalent time-loss injuries for all age groups by the main location with their corresponding proportion of days lost during the 4 seasons (Prevalence % - % lay-off). The values are in relation to each specific location (100%). All age groups have been sub-grouped as **1A.** Childhood teams (Under 9-10-11); **1B.** Early-adolescence teams (Under 12-13-14); **1C.** Mid-adolescence teams (under 15-16-17) and **1D.** Late-adolescence teams (under 17-18).

Supplementary Table 1. Description of the terminology used in this study.

Terminology	Description
Muscle	
Strain/rupture	Include muscles injuries with structural damage.
Functional muscle disorder	Include muscles injuries presenting a clinical functional limitation without structural damage (e.g. Fatigue-induced muscle disorder, delayed onset muscle soreness, spine-related neuromuscular or muscle-related neuromuscular disorders).
Bone	
Physeal bone	
Growth related injuries	Include all physeal injuries (e.g. Osteochondrosis, apophyseal injuries, Bi-partita, Scheuermann's disease).
Physeal fracture	Include all physeal and epiphyseal fractures (e.g. Salter-Harris or complex growth plate fracture).
Mature bone	
Fracture (Non physeal)	Include all traumatic mature bone injuries.
Other bone injury	Include bone marrow oedema, stress fracture, periostitis.
Others	
Other injury	An acute or unclear onset mechanism reported without specific tissue pathology diagnosed.
Overuse unspecific	A gradual onset mechanism reported without specific tissue pathology diagnosed.
Mechanisms	
Non-contact	Include all injury circumstance occurring outside of any extrinsic agent.
Contact	include all direct and indirect contact with a player or with a ball/object

Supplementary Table 2. Mean age group, median type of injuries, incidence per squad-season* and 95% Confidence Interval of time-loss injuries (*The incidence per squad per season is established on a squad of 25 players).

	Mean Time-loss Injuries	95% Confidence Interval		Time-loss Injury Incidence*	95% Confidence Interval	
	(days)	Lower Bound	Upper Bound		Lower Bound	Upper Bound
Age Groups						
U-9	67.7	8.0	8.8	5.2	2.0	2.8
U-10	58.7	7.2	7.9	7.0	2.3	3.1
U-11	104.8	9.2	9.8	10.5	2.8	3.4
U-12	99.5	9.1	9.7	10.6	2.8	3.5
U-13	485.5	21.6	22.3	28.3	5.0	5.8
U-14	667.0	23.7	24.4	39.7	5.6	6.3
U-15	727.6	24.4	25.1	46.5	6.0	6.7
U-16	992.2	29.0	29.6	58.9	6.9	7.6
U-17	967.5	29.4	30.1	48.1	6.4	7.1
U-18	1408.3	35.2	35.8	42.1	5.9	6.6
U-19	1092.6	77.2	81.5	36.8	13.0	17.5
	Median Time-loss Injuries	**95% Confidence Interval**		**Time-loss Injury Incidence***	**95% Confidence Interval**	
	(days)	**Lower Bound**	**Upper Bound**		**Lower Bound**	**Upper Bound**
Type of Injuries						
Lesion of meniscus and cartilage	73.0	22.0	181.0	0.4	0.3	0.7
Physeal fracture	58.0	33.0	78.0	0.8	0.6	1.2
Fracture (Non physeal)	33.0	29.0	46.0	0.8	0.6	1.2
Dislocation/Subluxation	29.0	6.0	29.0	0.1	0.0	0.2
Other bone injury	25.0	9.0	48.0	0.7	0.4	1.0
Muscle strain/rupture	19.0	17.0	20.0	2.9	2.4	3.4
Sprain/ligament injury	14.0	10.0	18.0	4.9	4.3	5.6
Tendinopathy	12.0	3.0	34.0	0.2	0.1	0.4
Growth related condition	12.0	9.0	15.0	4.8	4.1	5.5
Abrasion/laceration	8.5	2.0	11.0	0.1	0.0	0.2
Other injury	7.0	5.0	14.0	0.5	0.3	0.7
Synovitis/effusion	3.0	1.0	7.0	0.2	0.1	0.4
Overuse unspecific	3.0	2.0	5.0	1.5	1.2	1.9
Functional muscle disorder	3.0	2.0	3.0	4.4	3.8	5.0
Concussion	2.5	1.0	5.0	0.2	0.1	0.4
Contusion/bruise/hematoma	2.0	2.0	3.0	7.7	6.9	8.6

Supplementary Table 3 Summary of time loss injuries diagnosis by body-regions during the four consecutive seasons displayed as: Frequency (%), Rates per squad-season (*The rate per squad per season is established on a squad of 25 players), Total time loss (days), Median time loss (Interquartile 25th – 75th) and burden by season (95% CI).

Body-regions *Diagnosis*	Frequency (%)	Rate per squad*/season (95% CI)	Total time loss Days	Median time loss (Interquartile 25th - 75th) Days	Burden (95% CI) Time loss per season Days
Head & neck	**20 (1.5%)**	**0.46 (0.28 - 0.71)**	**86**	**3 (1 - 6)**	**21.5 (17.2 - 26.6)**
Concussion	10 (0.8%)	0.23 (0.11 - 0.42)	31	3 (1 - 5)	7.8 (5.3 - 11.0)
Nose fracture (Non physeal)	1 (0.1%)	0.02 (0.00 - 0.13)	20	20 (20 - 20)	5.0 (3.1 - 7.7)
Functional muscle disorder	5 (0.4%)	0.11 (0.04 - 0.27)	19	3 (2 - 6)	4.8 (2.9 - 7.4)
Upper limb	**77 (5.8%)**	1.76 (1.39 - 2.21)	**1557**	**7 (2 - 27)**	**389.3 (370.2 - 409.1)**
Clavicular Fracture (Non physeal)	5 (0.4%)	0.11 (0.04 - 0.27)	584	80 (58 - 116)	146.0 (134.4 - 158.3)
Forearm physeal fracture	9 (0.7%)	0.21 (0.09 - 0.39)	218	26 (21 - 31)	54.5 (47.5 - 62.2)
Hand/finger fracture (Non physeal)	10 (0.8%)	0.23 (0.11 - 0.42)	175	11 (2 - 31)	43.8 (37.5 - 50.7)
Forearm fracture (Non physeal)	6 (0.5%)	0.14 (0.05 - 0.30)	150	27 (6 - 33)	37.5 (31.7 - 44.0)
Hand/finger physeal fracture	5 (0.4%)	0.11 (0.04 - 0.27)	84	22 (9 - 25)	21.0 (16.8 - 26.0)
Arm physis injury (avulsion/osteochondrosis)	2 (0.2%)	0.05 (0.01 - 0.17)	45	23 (7 - 38)	11.3 (8.2 - 15.1)
Elbow physis injury (avulsion/osteochondrosis)	1 (0.1%)	0.02 (0.00 - 0.13)	44	44 (44 - 44)	11.0 (8.0 - 14.8)
Hand/fingers sprain/ligament	11 (0.8%)	0.25 (0.13 - 0.45)	43	4 (1 - 6)	10.8 (7.8 - 14.5)
Shoulder dislocation/Subluxation	2 (0.2%)	0.05 (0.01 - 0.17)	35	18 (6 - 29)	8.8 (6.1 - 12.2)
Elbow fracture (Non physeal)	1 (0.1%)	0.02 (0.00 - 0.13)	33	33 (33 - 33)	8.3 (5.7 - 11.6)
Trunk	**68 (5.1%)**	1.56 (1.21 - 1.98)	**1866**	**7 (2 - 25)**	**466.5 (445.6 - 488.2)**
Spondylolysis & spondylolisthesis	11 (0.8%)	0.25 (0.13 - 0.45)	1358	115 (78 - 160)	339.5 (321.7 - 358.0)
Overuse unspecific pathology	23 (1.7%)	0.53 (0.33 - 0.79)	175	6 (2 - 10)	43.8 (37.5 - 50.7)
Bone and pars stress reaction	4 (0.3%)	0.09 (0.02 - 0.23)	168	43 (32 - 52)	42.0 (35.9 - 48.9)
Functional muscle disorder	10 (0.8%)	0.23 (0.11 - 0.42)	56	3 (1 - 8)	14.0 (10.6 - 18.2)
Ribs contusion	4 (0.3%)	0.09 (0.02 - 0.23)	17	5 (2 - 7)	4.3 (2.5 - 6.8)
Hip & pelvis	**171 (12.9%)**	3.92 (3.35 - 4.55)	**3042**	**12 (4 - 25)**	**760.5 (733.7 - 788.0)**
Physis injury (avulsion/osteochondrosis)	110 (8.3%)	2.52 (2.07 - 3.04)	1978	13 (5 - 25)	494.5 (472.8 - 516.7)
Ilio-psoas and gluteus strain	16 (1.2%)	0.37 (0.21 - 0.60)	388	24 (18 - 31)	97.0 (87.6 - 107.1)
Bone stress reaction	7 (0.5%)	0.16 (0.06 - 0.33)	248	18 (3 - 83)	62.0 (54.5 - 70.2)
Contusion	14 (1.1%)	0.32 (0.18 - 0.54)	83	1 (1 - 3)	20.8 (16.5 - 25.7)
Overuse unspecific pathology	8 (0.6%)	0.18 (0.08 - 0.36)	64	6 (3 - 11)	16.0 (12.3 - 20.4)
Thigh	**329 (24.9%)**	7.54 (6.75 - 8.40)	**3356**	**4 (2 - 14)**	**839.0 (810.9 - 867.9)**
Hamstring strain	53 (4.0%)	1.21 (0.91 - 1.59)	1375	20 (13 - 29)	343.8 (325.8 - 362.4)

Quadriceps strain	28 (2.1%)	0.64 (0.43 - 0.93)	560	19 (11 - 22)	140.0 (128.6 - 152.1)
Adductor strain	20 (1.5%)	0.46 (0.28 - 0.71)	367	17 (13 - 24)	91.8 (82.6 - 101.6)
Quadriceps contusion	64 (4.8%)	1.47 (1.13 - 1.87)	367	3 (1 - 6)	91.8 (82.6 - 101.6)
Hamstring functional muscle disorder	64 (4.8%)	1.47 (1.13 - 1.87)	225	2 (1 - 4)	56.3 (49.1 - 64.1)
Adductor functional muscle disorder	49 (3.7%)	1.12 (0.83 - 1.48)	195	3 (1 - 5)	48.8 (42.1 - 56.1)
Quadriceps functional muscle disorder	27 (2.0%)	0.62 (0.41 - 0.90)	151	4 (2 - 6)	37.8 (32.0 - 44.3)
Knee	**218 (16.5%)**	5.00 (4.35 - 5.70)	**7705**	**11 (3 - 29)**	**1926.3 (1883.5 - 1969.7)**
Sprain/ligament	50 (3.8%)	1.15 (0.85 - 1.51)	2949	24 (10 - 42)	737.3 (710.9 - 764.3)
Meniscus (tear, discoid) & cartilage damage	16 (1.2%)	0.37 (0.21 - 0.60)	2100	80 (21 - 170)	525.0 (502.8 - 547.9)
Knee physis injury (avulsion/osteochondrosis)	66 (5.0%)	1.51 (1.17 - 1.92)	1358	10 (6 - 22)	339.5 (321.7 - 358.0)
Physeal fracture	6 (0.5%)	0.14 (0.05 - 0.30)	512	75 (58 - 86)	128.0 (117.2 - 139.6)
Knee contusion	39 (3.0%)	0.89 (0.64 - 1.22)	257	3 (2 - 10)	64.3 (56.6 - 72.6)
Overuse unspecific pathology	17 (1.3%)	0.39 (0.23 - 0.62)	106	2 (1 to 7)	26.5 (21.7 - 32.1)
Lower leg & calf	**105 (7.9%)**	2.41 (1.97 - 2.91)	**1360**	**4 (1 - 9)**	**340.0 (322.2 - 358.6)**
Lower leg physeal fracture	5 (0.4%)	0.11 (0.04 - 0.27)	529	43 (40 - 58)	132.3 (121.2 - 144.0)
Lower leg fracture (Non physeal)	3 (0.2%)	0.07 (0.01 - 0.20)	197	61 (55 - 81)	49.3 (42.6 - 56.6)
Lower leg bone stress injury	6 (0.5%)	0.14 (0.05 - 0.30)	176	14 (4 - 55)	44.0 (37.7 - 51.0)
Calf muscles strain	9 (0.7%)	0.21 (0.09 - 0.39)	146	17 (11 - 18)	36.5 (30.8 - 42.9)
Lower leg contusion	42 (3.2%)	0.96 (0.69 - 1.30)	142	2 (1 - 5)	35.5 (29.9 - 41.8)
Calf muscles functional muscle disorder	15 (1.1%)	0.34 (0.19 - 0.57)	78	5 (1 - 7)	19.5 (15.4 - 24.3)
Calf contusion	17 (1.3%)	0.39 (0.23 - 0.62)	56	2 (1 - 5)	14.0 (10.6 - 18.2)
Foot & ankle	**334 (25.3%)**	7.65 (6.85 - 8.52)	**6062**	**7 (2 - 21)**	**1515.5 (1477.6 - 1554.1)**
Ankle sprain/ligament	142 (10.7%)	3.25 (2.74 - 3.84)	3662	15 (4 - 34)	915.5 (886.1 - 945.6)
Foot/toes physis injury (avulsion/osteochondrosis)	27 (2.0%)	0.62 (0.41 - 0.90)	522	9 (4 - 23)	130.5 (119.5 - 142.2)
Ankle cartilage injury	3 (0.2%)	0.07 (0.01 - 0.20)	348	60 (29 - 259)	87.0 (78.1 - 96.6)
Foot/toes fracture (Non physeal)	9 (0.7%)	0.21 (0.09 - 0.39)	334	34 (30 - 44)	83.5 (74.8 - 93.0)
Foot/toes contusion	74 (5.6%)	1.70 (1.33 - 2.13)	274	3 (1 - 5)	68.5 (60.6 - 77.1)
Ankle contusion	42 (3.2%)	0.96 (0.69 - 1.30)	214	3 (1 - 7)	53.5 (46.6 - 61.2)
Ankle impingement, os trigonum	6 (0.5%)	0.14 (0.05 - 0.30)	143	6 (1 - 46)	35.8 (30.1 - 42.1)
Foot/toes bone stress reaction	2 (0.2%)	0.05 (0.01 - 0.17)	141	71 (29 - 112)	35.3 (29.7 - 41.6)
Foot/toes sprain/ligament	6 (0.5%)	0.14 (0.05 - 0.30)	36	7 (2 - 7)	9.0 (6.3 - 12.5)