Sport Sciences for Health (2022) 18:863–870
https://doi.org/10.1007/s11332-021-00867-z

ORIGINAL ARTICLE

Injuries and risk factors in professional football players during four consecutive seasons

Emmanouil Smpokos[1] · Christos Mourikis[2] · Christos Theos[2,3] · George Manolarakis[1] · Manolis Linardakis[1]

Received: 28 December 2020 / Accepted: 24 October 2021 / Published online: 10 November 2021

Abstract

Purpose Few studies include data from different consecutive seasons to assess specific trends in injury risk over time. The current study aimed to investigate the presence and risk factors of injuries in professional football (soccer) players during four consecutive seasons.

Methods 166 professional football players in a Greek team were observed during four consecutive seasons, 2015/16 to 2018/19. Injuries were assessed and multiple regression analysis was used to evaluate the potential risk factors.

Results The prevalence of injured players was high (72.3%), with a mean number of 2.3 injuries per injured player, and the injury incidence was 86 injuries/1000 match-playing-exposure hours. The mean rehabilitation days were 29.0/injured player (95% CI 22.2–35.9) and 12.7/injury (95% CI 9.1–16.3). The majority of injuries were moderate-to-major/severe and most were traumatic rather than overuse ($p < 0.05$). The number of injuries was positively correlated with seasonal rotation from 2015/16 to 2018/19 (stand. beta = 0.123, $p = 0.016$), matches played (stand. beta = 0.203, $p < 0.001$), recurrence of injury (stand. beta = 0.527, $p < 0.001$) and days of rehabilitation (stand. beta = 0.372, $p < 0.001$).

Conclusion High prevalence of injuries was found while the increase of match-playing exposure hours, the frequency of official matches per week, the recurrence of injury, and the rehabilitation days were the main predicted risk factors. To reduce the risk of injuries, continuous efforts are required such as player rotation during the season.

Keywords Football · Injury prevalence · Risk factors · Clinical incidence

Introduction

Soccer is among the most popular complex sporting activities, characterized by short-duration and high-intensity motor tasks [1–3]. Both the considerable physical demands and the contact intensity between players account for the high injury incidence in soccer [1]. ACL injuries can be caused through contact (collision with another player) or non-contact mechanisms; the latter result from pivoting and cutting movements, landing after jumping, pressing, kicking, and heading [4–6]. Soccer injuries are the most significant problem for professional players, accounting for 10–35 injuries per 1000 match-playing hours [7–9]. As the lower limb is the most commonly affected, ankle sprains (1/3rd) and hamstring injuries are the most frequent events, while ankle injuries form up to one-third of all injuries [10, 11]. In an audit of soccer injuries, tackle scenarios were responsible for 54% of ankle sprains; however, the 39% that occurred during non-contact mechanisms have a potential influence on prevention strategies [12]. In a previous study [13], the

✉ Emmanouil Smpokos
manosmpok@yahoo.gr; msbokos@edu.med.uoc.gr

Christos Mourikis
mourichr@gmail.com

Christos Theos
christostheos@gmail.com

George Manolarakis
mosst377@gmail.com

Manolis Linardakis
linman@med.uoc.gr

[1] Department of Social Medicine, Faculty of Medicine, University of Crete, Diastavrosi Voutes-Stavrakia, Heraklion, 71003 Crete, Greece

[2] Laboratory of Football Performance, OF Club, Piraeus, Greece

[3] Piraeus Special Orthopedic Surgery (PirSOS), Head of the Medical Department, OF Club, Piraeus, Greece

injury rate was higher during matches than in training sessions. Current knowledge on football injuries indicates that the prevalence rate of injuries on professional football players is 15%, which means that for a 25-player team, approximately 4 players are not available to participate in every training session and/or in official matches [14]. Ninety-two percent of the muscle injuries occurred in the major muscle groups of the lower extremities (hamstrings being involved in 37%, adductors in 23%, quadriceps in 17%, and calf muscles in 13%) [15, 16] and on average every player sustains 0.6 muscle injuries per season.

Furthermore, soccer injuries are associated with a player's age, height, dominant kicking leg, playing position, and match-exposure playing time [17]. Exercise load (duration, intensity, and frequency of practice) strength, flexibility, injury recurrence, days of rehabilitation, as well as poor running performance are also suggested injury risk factors [15–19]. Woods and colleagues [20] showed that defenders sustained 15% more hamstrings strains than forwards, whereas in another study carried out by Dadebo and colleagues [21], the forwards' hamstring strains exceeded 10%. A survey in 306 male football players from the top 2 divisions in Iceland during one season showed that age and previous injuries were the leading injury risk factors among elite soccer players [22].

Since many studies on injury risk and injury patterns in professional soccer players are of short duration (single season or during tournaments), only a few papers include data for more than three consecutive seasons and, therefore, little is known about the variation of injury profile among them [15]. The Greek professional Super League lacks continuous multiannual data to track the evolution of specific trends over time or screen for areas of concern and form an injury-prevention hypothesis for further investigation. No published studies to date have investigated the injury incidence, injury risk factors, and profiles among elite football players in Greece over a longer length of time.

Thus, the current study aimed to provide an updated estimate of the prevalence and potential risk factors of injuries in elite professional football players competing in the domestic National Greek League/Cup and European league matches over four consecutive seasons' appraisal.

Materials and methods

Participants

The present observational study derived data on players' injuries from a Greek professional soccer team during four consecutive seasons in the top National League division (Super League) 2015/16 ($n=38$), 2016/17 ($n=41$), 2017/18 ($n=44$) and 2018/19 ($n=43$) (Fig. 1). These players were: (a) part of the pre-season preparation list (from June to August each season), (b) players who joined the team at a later stage of the season due to transition, transfer, or loan, especially during the Christmas break (December to January), (c) active players in official or friendly matches, or (d) already registered for the official games of the domestic Greek National League, the National Cup, and the European Leagues (Champions League qualifications or UEFA Europa League groups) [23]. In total, data of 166 players were retrieved during the four seasons with $n=62$ were participated in the team for more than one season (multiple participations) as well as $n=104$ only one (stable sample size of players) (Fig. 1). All participants who met the above criteria

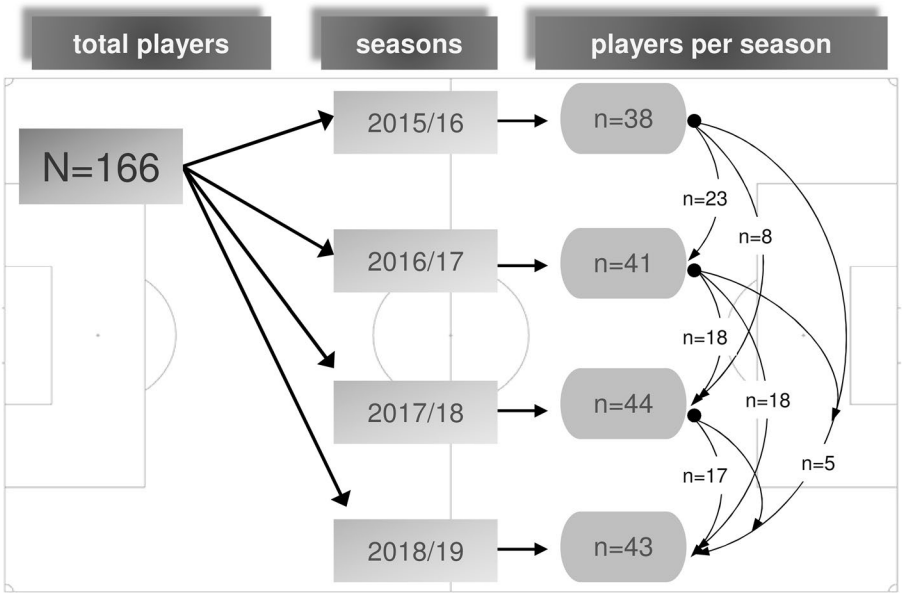

Fig. 1 Player participation in four consecutive seasons. Arcs show the common players among seasons, e.g. 63 players participated in one season in the team, 25 players in two, 11 in three and 5 in four seasons

during the four consecutive seasons (2015/16–2018/19) were categorized as uninjured or injured. Five recruited players participated in all 4 seasons; 63 joined the study for a single season, while 25 players participated for two and 11 for three seasons (Fig. 1). The institutional ethics board approved the study, while each player gave written informed consent at the beginning of each season. Moreover, detailed information on this research is available in an earlier report [23].

Measurements and records

At the beginning of each season (2015/16, 2016/17, 2017/18, and 2018/19), each individual's weight was measured on a calibrated digital scale with an accuracy of 0.1 kg (Seca 861, Seca, Hamburg, Germany), while their height was measured to the nearest 0.5 cm on a wall-mounted stadiometer (Seca 225, Seca, Hamburg, Germany). For those who participated in more than one season, average weight and age were calculated. The player's nationality, position on the field, and minutes of active play were also recorded.

The team medical staff (physiotherapist and orthopedist) recorded all types of injuries that kept players as time-loss from training or match play. These players were considered injured until the physician's consent for full participation in pre-game training and matches. Injuries were categorized according to severity [24], based on the number of absence days, as minimal (1–3 days), minor (4–7 days), moderate (8–28 days), and major/severe injury (over 28 days) [23]. All injuries were monitored until the completion of the rehabilitation course.

Injury definitions and data collection procedures were consistent with the Fédération Internationale de Football Association (FIFA) Medical Assessment and Research Centre (F-MARC) injury guidelines for soccer and were applied in the same manner as that used by Reis and colleagues [24, 25]. The anatomic sites of injury were determined as head/neck, upper limbs, trunk, and lower limbs, while the type of injury was classified as fracture/bone stress, joint (non-bone)/ligament, muscle/tendon, contusion, laceration/skin injury, central/peripheral nervous system, and other [24]. The team physician, aided by medical imaging, made all diagnoses. According to the mechanism, every injury classified as traumatic resulted from a specific and identifiable event by acute onset or overuse injury. Musculoskeletal pain syndrome characterized every case of insidious onset without any known trauma that might have given previous symptoms [7, 24].

Statistical analysis

The analysis was performed through SPSS software (IBM SPSS Statistics for Windows, version 25.0. Armonk, NY: IBM Corp.). Frequency distributions of injury indices and the players' descriptive characteristics were initially evaluated. Comparisons between uninjured/injured players were based on chi-square (χ^2), binomial, Student's t, and Mann–Whitney tests. Injury prevalence, the 95% confidence intervals (95% CI), along with the rates of clinical incidence (the ratio of the sum of injuries per total number of players or, alternatively, the risk of injury for each player at the beginning of the season), as well their 95% CIs were calculated according to the suggestions of Knowles and colleagues [26].

The injury incidence (injuries per 1000 match-playing exposure hours) and the corresponding 95% CIs were also assessed [19]. The mean rehabilitation days per injured player and the mean days per injury were also estimated by standardizing the relevant indices due to differentiation among players and their injuries between seasons. Hierarchical modeling based on multiple linear regression analysis of potential risk factors on the number of injuries (from 0 to 7) in 166 uninjured and injured players was also applied. Descriptive characteristics such as age, height, player's position, preferred kicking leg, nationality, matches played, injury recurrence, and days of rehabilitation were used as predictive factors in both models.

Results

The characteristics of the 166 soccer players for the four consecutive seasons (2015/16–2018/19) are presented in Table 1. Among those, 72.3% ($n=120$) were injured and 27.7% ($n=46$) were not ($p<0.001$), with no significant differences in relation to age, height, weight or BMI ($p>0.05$). 39.8% were Greek, presenting the lowest percentage of injured compared to non-injured players (36.7% vs. 47.8%, $p=0.002$). The majority (45.2%) of all players were midfielders, 62.7% with right kicking leg. The mean time of active match-playing in all of the competitions (Greek National League, Champions League, UEFA League, and Greek Cup matches) was 1346 min; this was significantly higher in injured players (1472 vs. 971 min, $p=0.014$), who also played in more matches (20.6 vs. 13.6 matches, $p=0.005$).

The injury profile of the 120 injured players is shown in Table 2. 35.3% of these players had a single injury while 10.0% sustained five to seven injuries. The total number of all injuries was 276, with a mean of 2.3 injuries/injured player (95% CI 2.0–2.6) and a median of 2.0 injuries/injured player (95% CI 2.0–3.0). The injury incidence was 86 per 1000 match-playing-exposure hours, with a clinical incidence of 1.66 injuries for all players. The sum of days spent in rehabilitation was 3486, while the mean number of rehab-days/injured players was 29.0 (95% CI 22.2–35.9). The mean of rehab-days/injury was 12.7 (95% CI 9.1–16.3) while the

Table 1 Characteristics of 166 Greek team football players in the four consecutive seasons (2015/16–2018/19)

	Players			*p* value
	Total	Uninjured	Injured	
	Mean ± stand. dev			
Players, number (%)	166	46 (27.7)	120 (72.3)	< 0.001
Age, years	24.5 ± 4.4	23.5 ± 4.3	24.9 ± 4.3	0.072
Height, m	1.82 ± 0.07	1.83 ± 0.07	1.82 ± 0.07	0.817
Weight, kg	75.5 ± 6.8	74.7 ± 5.4	75.8 ± 7.3	0.338
Body Mass Index, kg m^{-2}	22.7 ± 1.4	22.4 ± 1.0	22.8 ± 1.5	0.103
Nationality/Region				
Greece	66 (39.8)[a]	22 (47.8)	44 (36.7)	0.002
Europe	50 (30.1)	10 (21.7)	40 (33.3)	
Latin America	24 (14.5)	5 (10.9)	19 (15.8)	
Africa	21 (12.6)	4 (8.7)	17 (14.2)	
Asia	5 (3.0)	5 (10.9)	–	
Position				
Goalkeeper	18 (10.8)	7 (15.2)	11 (9.2)	0.304
Defender	29 (17.5)	6 (13.0)	23 (19.2)	
Wingback	26 (15.7)	6 (13.0)	20 (16.7)	
Midfielder	75 (45.2)	19 (41.3)	56 (46.7)	
Forward	18 (10.8)	8 (17.4)	10 (8.3)	
Kicking leg				
Both	18 (10.8)	6 (13.0)	12 (10.0)	0.772
Right	104 (62.7)	27 (58.7)	77 (64.2)	
Left	44 (26.5)	13 (28.3)	31 (25.8)	
Minutes playing	1,346 [1206][b]	971 [825]	1,472 [1461]	0.014
Matches played	18.8 [19.0][b]	13.6 [10.5]	20.6 [24.0]	0.005

Players include all players at the beginning of each season and/or the transfers during each season. Binomial, Student *t*, χ^2 and Mann–Whitney methods were performed

Values are: [a]*n* (%), [b]mean [median]

median was 7.4 (95% CI 5.5–9.3). Severity classification showed that 67.5% of the injured sustained moderate-to-major/severe injuries.

Table 3 illustrates the distribution of 276 injuries in 120 football players. One hundred and six players (88.3%) sustained lower limb injuries. The most commonly injured sites were the joints (non-bone)/ligaments ($n = 50$ players; 41.7%) and the muscles/tendons ($n = 96$; 80.0%). Among the injured, 80.8% ($n = 97$) suffered direct trauma and 19.2% had overuse injuries. Early relapse was recorded in 26.7% ($n = 32$ players). The most common site was again the lower limb: 223 injuries (80.8%), including 185 (67.0%) muscle/tendon injuries. The prevalence of traumatic injuries was significantly higher (69.9%; 95% CI 64.5–75.3) than that of overuse (25.0%; 95% CI 19.9–30.1) or recurrent injuries (30.4%; 95% CI 25.0–35.8) concerning early/late-onset.

Finally, Table 4 presents the hierarchical modeling of multiple linear regression in two models of different potential risk factors on the number of injuries (0–7) in 166 players. In the first model, the higher injury number seems to relate to the defenders' position compared to counterparts (stand. beta = 0.250, $p = 0.019$) or those playing as wingbacks compared to counterparts (stand. beta = 0.323, $p = 0.019$). The higher number of injuries seems to be related to the higher number of matches played (stand. beta = 0.332, $p < 0.001$). In the second model, relationships appear to change as the higher number of injuries seems to be related with the season, from 2015/16 to 2018/19 (stand. beta = 0.123, $p = 0.016$), the higher number of the matches played (stand. beta = 0.203, $p < 0.001$), injury recurrence (stand. beta = 0.527, $p < 0.001$) and a higher number of rehabilitation days (stand. beta = 0.372, $p < 0.001$).

Discussion

The present study investigated the presence and risk factors of injuries in professional football (soccer) players competing in National Greek League and European matches. The study's main finding was the high prevalence of injuries in professional players (about two-thirds of the total, mainly defenders) of a particular Greek soccer team for over four

Table 2 Profile of 120 injured football players

	n	%	95% CIs
Players			
Injured	120	72.3	65.1, 78.7
Injuries			
One	43	35.8	27.7, 44.7
Two	40	33.3	25.4, 42.1
Three	13	10.8	6.2, 17.3
Four	12	10.0	5.6, 16.3
Five to seven	12	10.0	5.6, 16.3
Sum of injuries	276		
Mean number	2.3		2.0, 2.6
Median number	2.0		2.0, 3.0
Injury incidence			
Rate[a]	86		69, 106
Clinical incidence			
Rate[b]	1.66		1.59, 1.73
Rehabilitation			
Sum of days	3486		
Mean days per injured player	29.0		22.2, 35.9
Median days per injured player	17.0		11.0, 21.0
Mean days per injury	12.7		9.1, 16.3
Median days per injury	7.4		5.5, 9.3
Severity of injuries			
Minimal (1–3 days)	18	15.0	9.5, 22.2
Minor (4–7 days)	21	17.5	11.5, 25.0
Moderate (8–28 days)	42	35.0	26.9, 43.8
Major to severe (28 + days)	39	32.5	24.6, 41.2

95% CIs were estimated based on bootstrap techniques with the exception of clinical incidence (rate) where they were estimated according to Knowles and colleagues [26]

[a]Injuries per 1000 match-playing-exposure hours

[b]Injuries per total number of the players (sum of injuries: 166)

years (2015/16–2018/19). Another important finding was the high injury incidence: 86 per 1000 match-playing-exposure hours and, finally, the positive correlation of the number of injuries with season change, game-playing-exposure time, high frequency of official matches in different competitions per week, injury recurrence, and rehabilitation days.

The high prevalence of injured soccer players (72.3%) reported in the present study reports over these 4 years matches that in previously published works, ranging from 65 to 95% [14, 27].

Concerning the lower extremity as the most injured part of the body, the findings of the present study are consistent with those in the literature [7, 15, 28, 29]. The majority of injuries (88.3%) for all 166 players of the present study affected the lower extremities, in agreement with other studies that have reported similar results (83.5–95%) [22, 29]. In the present study, joint/ligament injuries were the second most frequent, representing 41.7% of the total. These results based on Greek soccer league players align with those on European professionals [15, 28, 30].

The overall incidence of injuries observed during matches in the present study (86/1000 match-playing exposure hours) was greater than that reported by the Union Of European Football Association (UEFA) teams (mean of 27.5/1000 h) [15] or other epidemiological studies as they have demonstrated a frequency range between 13 and 40.3 injuries/1000 h [22, 31, 32]. As higher competition standards in more expressive and competitive championships set higher physical requirements, this may be amongst the reasons for higher injury incidence [33]. It should be noted that the players in the present study had played in domestic and European games for four consecutive years, meaning that they participated in demanding competitions alongside the short game-rotation schedule required for the club to effectively fulfill its competitive obligations.

As previously mentioned, the soccer club in this study joined the European competitions (from the mid-July UEFA Champions League or Europa League group qualification games) and the domestic competitions, such as the Greek Super League and Cup, almost simultaneously, for four consecutive seasons, resulting in a higher density of match-play per season and shorter summer breaks. Considering that many international competitions are usually held during the summer, all the above together result in the accumulation of fatigue, which could influence the injury incidence.

The clinical incidence of 1.66 injuries for all 120 players of the present study was in agreement with other studies reporting a high injury incidence in soccer; between 65 and 82% of players will sustain at least two injuries per season on average [15, 22].

The mean number of days lost from soccer participation in moderate-to major/severe injuries was 67.5% per injured player. This result differs from previous studies, where most injuries were classified as a minimal or minor injury, resulting in less than 3 days' absence from sports activities [7, 32]. In English professional players, moderate injuries (8–28 days of absence) were more common [9, 15]. The higher incidence of injuries revealed by the present study may be attributed to the constant physical performance requirements for each match and to the club's heavily congested competition schedule. The more competitive the game, like the European ones, the greater the speed of movement and body contact; these all increase the likelihood of injury. Eirale et al. [34] observed a strong correlation between injury incidence and higher league ranking, increased number of games won, higher goal-scoring, broader goal difference, and the total number of points earned in a season. The injury incidence (86/1000 playing-exposure hours) in the present study was also much higher than the 26.2–30.5/1000 reported in previous studies [7, 15, 29].

Table 3 Distribution of 276 injuries of 120 injured football players

	Players			Injuries		
	n	%	95% CIs	*n*	%	95% CIs
Location						
Neck, head	6	5.8	2.6, 11.1	7	2.5	1.8, 6.6
Upper limbs	6	5.0	2.1, 10.0	6	2.2	0.7, 4.3
Trunk	24	20.0	13.6, 27.8	26	9.4	6.0, 12.8
Lower limbs	106	88.3	81.7, 93.2	223	80.8	76.2, 85.5
Type[a]						
Fracture/bone stress	10	8.3	4.4, 14.3	11	4.0	1.7, 6.3
Joint (non-bone)/ligament	50	41.7	33.1, 50.6	67	24.3	19.2, 29.4
Muscle/tendon	96	80.0	72.2, 86.4	185	67.0	61.5, 72.6
Central/peripheral nervous system	2	1.7	0.3, 5.2	2	0.7	0.1, 1.7
Other[b]	14	11.7	6.8, 18.3	18	6.5	3.6, 9.4
Mechanism						
Traumatic	97	80.8	73.6, 87.9	193	69.9	64.5, 75.3
Overuse	52	43.3	34.4, 52.2	69	25.0	19.9, 30.1
Recurrence						
Recurrent	48	40.0	31.2, 48.8	84	30.4	25.0, 35.8
Early	32	26.7	18.8, 34.6	56	20.3	15.5, 24.9
Late	24	20.0	12.8, 27.2	28	10.1	6.6, 13.7

95% CIs

[a]Type also contains infrequent "*concussions*" and "*laceration/skin injury*"

[b]"*Other*" includes cases of "*common cold-flu*" (location categorized as "*neck, head*")

Any difference in the risk of injury between our team's players and other professional footballers from different European leagues could be related to the level of difficulty concerning the requirements of each competition, the grading infrastructure and the particular features of each league category, the international ranking of each national league, the anthropometric data (e.g., weight and height), as well as the skills/ability of players in avoiding injuries [7, 29]. Fixture schedule congestion leads to increased injury incidence [35]. In the Greek soccer Cup tournament, for example, numerous matches have to be played during the first five qualifying rounds up to the 16th round, not including the last four up to the final.

The mean number of days lost due to injury was 12.7. Major-to-severe injuries accounted for 32.5% of all injuries, which is inconsistent with the results reported from Danish (12%) and Swedish leagues (9%). This discrepancy could be attributed to the training or playing level, or the frequency of matches played per week. In terms of injury type, muscle/trauma accounted for 80% and joint injuries for 41.7% of injuries. These were the top two injury types, similar to those reported by Salces and colleagues [32]. Concerning the body area, 88.3% of injuries occurred in the lower limbs, in full accordance with the same study.

Assessing the injury mechanism, 80.8% of players experienced traumatic injuries due to a recognizable event, and 43.3% due to overuse. Indeed, most studies agree that the majority of soccer injuries are caused by traumatic mechanisms [32].

Limitations and strengths of the study

One of the limitations of the present study was the absence of training session load including the match load recordings, meaning that additional information was lacking, particularly the load-fatigue relationships necessary for estimating the optimal ratio for each player. This last is of great importance in predicting the risk of injury; thus, we strongly recommend its use for future research. This study also recorded the official match-exposure minutes playing in a Greek professional soccer team, not the exact time in training hours per player, ruling out the possibility of determining the injury incidence per training-exposure time. What players were doing in between the leagues can have impact on the injuries happened during national league. Whether they were playing any other league or not, or doing training.

This study assesses the type and frequency of injuries, noting the consequences on the team's overall performance. It also suggests that these findings can be used to predict injuries and reduce their effects, benefiting players' rapid recovery.

Table 4 Hierarchical modeling of multiple linear regression analysis of risk factors on number of injuries in 166 football players from the four consecutive seasons (2015/16–2018/19)

Risk factors	Number of injuries (0–7)							
	1st Model				2nd Model			
	Beta	Stand. beta	*t*	*p* value	Beta	Stand. beta	*t*	*p* value
Age (years)	0.031	0.084	1.05	0.297	−0.017	−0.047	−0.85	0.397
Height (m)	1.828	0.082	0.79	0.430	0.583	0.026	0.37	0.711
Seasons (2015/16 to 2018/19)	−0.137	−0.095	−1.36	0.177	0.178	0.123	2.44	0.016
Position 1 (defenders vs others)	1.047	0.250	2.36	0.019	0.439	0.105	1.44	0.152
Position 2 (wingbacks vs others)	1.414	0.323	2.38	0.019	0.258	0.059	0.63	0.533
Position 3 (midfielders vs others)	0.550	0.172	1.07	0.285	0.107	0.034	0.31	0.760
Position 4 (forwards vs others)	0.134	0.026	0.24	0.808	−0.175	−0.034	−0.47	0.642
Kicking leg 1 (right vs left and/or both)	0.198	0.060	0.50	0.615	0.122	0.037	0.46	0.650
Kicking leg 2 (left vs right and/or both)	−0.426	−0.118	−0.99	0.326	−0.516	−0.143	−1.75	0.082
Nationality (other vs Greek)	0.269	0.083	0.98	0.328	0.312	0.096	1.66	0.099
Matches played (total number of matches)	0.039	0.332	4.42	<0.001	0.024	0.203	3.92	<0.001
Recurrence of injury (yes vs no)					1.853	0.527	9.55	<0.001
Days of rehabilitation (total days)					0.017	0.372	7.19	<0.001
F (d.f.)	6.6 (154)				22.6 (152)			
p value	<0.001				<0.001			
Effect size (η^2)	24.9%				65.8%			
Adjusted R^2	0.196				0.629			

Non-injured players have taken zero days of rehabilitation or "no" recurrence of injury

Conclusion

The current cohort study recorded and analyzed both the injuries and their risk factors in 166 professional soccer players. Two-thirds of injuries were from moderate to severe, all acute, involving the lower extremities. The number of injuries was positively correlated with the change of the playing seasons, the match-playing-exposure time, the frequency of official matches in different competitions per week, injury recurrence, and rehabilitation days. Reducing the risk of injuries requires various interventions such as player rotation during the season or the competitive and demanding weeks for the in-season official matches.

Acknowledgements The authors would like to thank all of the team's coaches, youth players, their families and technical staff for their cooperation during all data collection procedures. They also thank Dr. Rosemary Tzanaki for her valuable assistance in the English editing of the manuscript.

Funding No funding was received.

Declarations

Conflict of interest The authors declare that they have no conflict of interest.

Ethical approval All procedures performed in studies involving human participants were in accordance with the ethical standards of the Ethics Committee of the University Hospital of Heraklion, Crete, Greece, and with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards.

Informed consent Informed consent was obtained from all individual participants included in the study.

References

1. Shalaj I, Tishukaj F, Bachl N, Tschan H, Wessner B et al (2016) Injuries in professional male football players in Kosovo: a descriptive epidemiological study. BMC Musculoskelet Disord 17:338. https://doi.org/10.1186/s12891-016-1202-9
2. Trecroci A, Cavaggioni L, Lastella M, Broggi M, Perri E et al (2018) Effects of traditional balance and slackline training on

physical performance and perceived enjoyment in young soccer players. Res Sports Med 26:1–12. https://doi.org/10.1080/15438627.2018.1492392
3. Trecroci A, Longo S, Perri E, Iaia F, Alberti G (2018) Field-based physical performance of elite and sub-elite middle-adolescent soccer players. Res Sports Med 27:1–12. https://doi.org/10.1080/15438627.2018.1504217
4. Eirale C, Ekstrand J (2013) Recurrence of an injury wasestimated as a repeatable of the same injury. Aspetar Sport Med J 2:144-149
5. Gupta R, Kapoor A, Soni A, Khatri S, Masih GD (2020) Anterior cruciate ligament tear due to non-contact mode of injury associated with higher incidence of meniscal and chondral damage. J Clin Orthop Trauma 11:S342–S345
6. Waldén M, Krosshaug T, Bjørneboe J, Andersen TE, Faul O et al (2015) Three distinct mechanisms predominate in non-contact anterior cruciate ligament injuries in male professional football players: a systematic video analysis of 39 cases. Br J Sports Med 49:1452. https://doi.org/10.1136/bjsports-2014-094573
7. Hägglund M, Waldén M, Ekstrand J (2006) Previous injury as a risk factor for injury in elite football: a prospective study over two consecutive seasons. Br J Sports Med 40:767–772. https://doi.org/10.1136/bjsm.2006.026609
8. Lee J, Mok K, Chan H, Yung P, Chan K (2014) A prospective epidemiological study of injury incidence and injury patterns in a Hong Kong male professional football league during the competitive season. Asia Pac J Sports Med Arthrosc Rehabil Technol 1:119–125. https://doi.org/10.1016/j.asmart.2014.08.002
9. Waldén M, Hägglund M, Orchard J, Kristenson K, Ekstrand J (2011) Regional differences in injury incidence in European professional football. Scand J Med Sci Sports 23:424–430. https://doi.org/10.1111/j.1600-0838.2011.01409.x
10. Arnason A, Sigurdsson SB, Gudmundsson A, Holme I, Engebretsen L et al (2004) Physical fitness, injuries, and team performance in soccer. Med Sci Sports Exerc 36:278–285
11. Wong P, Hong Y (2005) Soccer injury in the lower extremities. Br J Sports Med 39:473. https://doi.org/10.1136/bjsm.2004.015511
12. Farquharson C, Greig M (2017) Kinesiology tape mediates soccer-simulated and local peroneal fatigue in soccer players. Res Sports Med 25:1–9. https://doi.org/10.1080/15438627.2017.1314294
13. Bayne H, Schwellnus M, van Rensburg D, Botha J (2018) Incidence of injury and illness in South African professional male soccer players: a prospective cohort study. J Sports Med Phys Fit 58:875–879. https://doi.org/10.23736/S0022-4707.17.07452-7
14. Castillo D, Raya-González J (2017) The prevalence of injuries in professional soccer players. J Orthop Res Ther 2017:1–2. https://doi.org/10.29011/jort-150.000050
15. Ekstrand J, Hagglund M, Walden M (2011) Epidemiology of muscle injuries in professional football (soccer). Am J Sports Med 39:1226–1232. https://doi.org/10.1177/0363546510395879
16. Svensson K, Alricsson M, Karnebäck G, Magounakis T, Werner S (2015) Muscle injuries of the lower extremity: a comparison between young and old male elite soccer players. Knee Surg Sports Traumatol Arthrosc 24:2293–2299. https://doi.org/10.1007/s00167-015-3527-6
17. Bengtsson H, Ekstrand J, Hägglund M (2013) Muscle injury rates in professional football increase with fixture congestion: an 11-year follow-up of the UEFA Champions League injury study. Br J Sports Med 47:743. https://doi.org/10.1136/bjsports-2013-092383
18. Del Coso J, Herrero H, Salinero JJ (2018) Injuries in Spanish female soccer players. J Sport Health Sci 7:183–190. https://doi.org/10.1016/j.jshs.2016.09.002
19. Hägglund M, Waldén M, Ekstrand J (2012) Risk factors for lower extremity muscle injury in professional soccer the UEFA Injury Study. Am J Sports Med 41:327–335. https://doi.org/10.1177/0363546512470634
20. Woods C, Hawkins R, Maltby S, Hulse M, Thomas A et al (2004) The Football Association Medical Research Programme: an audit of injuries in professional football–analysis of hamstring injuries. Br J Sports Med 38:36–41. https://doi.org/10.1136/bjsm.2002.002352
21. Dadebo B, White J, George KP (2004) A survey of flexibility training protocols and hamstring strains in professional football clubs in England. Br J Sports Med 38:388. https://doi.org/10.1136/bjsm.2002.000044
22. Arnason A, Sigurdsson S, Gudmundsson A, Holme I, Engebretsen L et al (2004) Risk factors for injuries in football. Am J Sports Med 32:5S-16S. https://doi.org/10.1177/0363546503258912
23. Smpokos-Sbokos E, Mourikis C, Theos C, Linardakis M (2018) Injury prevalence and risk factors in a Greek team's professional football (soccer) players: a three consecutive seasons survey. Res Sports Med 27:1–13. https://doi.org/10.1080/15438627.2018.1553779
24. Reis G, Santos T, Lasmar R, Oliveira Junior O, Lopes R et al (2015) Sports injuries profile of a first division Brazilian soccer team: a descriptive cohort study. Braz J Phys Ther 19:390–397. https://doi.org/10.1590/bjpt-rbf.2014.0120
25. Fuller C, Ekstrand J, Junge A, Andersen T, Bahr R et al (2006) Consensus statement on injury definitions and data collection procedures in studies of football (soccer) injuries. Clin J Sport Med 16:97–106
26. Knowles S, Marshall S, Guskiewicz K (2006) Issues in estimating risks and rates in sports injury research. J Athl Train 41:207–215
27. Yamaner F, Gümüşdağ H, Kartal A, Gümüş M, Güllü A et al (2011) The prevalence of injuries in professional Turkish soccer players. Biomed Hum Kinet 3:6–9. https://doi.org/10.2478/v10101-011-0002-9
28. Noya Salces J, Sillero Quintana M (2013) Epidemiología de las lesiones en el fútbol profesional español en la temporada 2008–2009. Archivos de Medicina del Deporte 30:750–766
29. Walden M, Hagglund M, Ekstrand J (2005) UEFA Champions League study: a prospective study of injuries in professional football during the 2001–2002 season. Br J Sports Med 39:542–546. https://doi.org/10.1136/bjsm.2004.014571
30. Mallo J, Dellal A (2012) Injury risk in professional football players with special reference to the playing position and training periodization. J Sports Med Phys Fit 52:631–638
31. Mallo J, Gonzalez P, Veiga S, Navarro E (2011) Injury incidence in a spanish sub-elite professional football team: a prospective study during four consecutive seasons. J Sports Sci Med 10:731–736
32. Salces J, Carmona P, Gracia-Marco L, Moliner-Urdiales D, Quintana M (2014) Epidemiology of injuries in First Division Spanish football. J Sports Sci 32:1–8. https://doi.org/10.1080/02640414.2014.884720
33. Condessa L, Cabido C, Maia-Lima A, Coelho D, Rodrigues V et al (2015) Analysis and comparison of intensity in specific soccer training sessions. Motriz Revista de Educação Física 21:54. https://doi.org/10.1590/s1980-65742015000100007
34. Eirale C, Farooq A, Smiley F, Tol J, Chalabi H (2013) Epidemiology of football injuries in Asia: a prospective study in Qatar. J Sci Med Sport 16:113–117. https://doi.org/10.1016/j.jsams.2012.07.001
35. Dupont G, Nedelec M, McCall A, McCormack D, Berthoin S et al (2010) Effect of 2 soccer matches in a week on physical performance and injury rate. Am J Sports Med 38:1752–1758. https://doi.org/10.1177/0363546510361236