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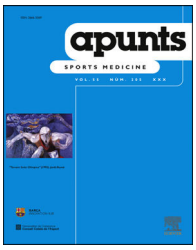

REVIEW

Injuries of a Spanish top-level sample of football referees. A retrospective study

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Abstract
Objective: To analyze the incidence and injury pattern in Spanish football (soccer) referees.
Method: In this retrospective study, Spanish referees filled out an online survey during a training camp organized by the Referees Technical Committee of the Real Federación Española de Fútbol. The survey included questions on aspects of refereeing qualifications, training and matches, injury patterns (type, location, and circumstances), and absence of the 2018–2019 season.
Results: A total of 28 elite referees (24.1%) out of 116 reported having suffered one injury during the season. Significant differences in the frequency of injuries between match (MRs) and assistant referees (ARs) were observed. MRs were 1.90 (95% CI 1.008–3.582) times as likely to suffer an injury compared to ARs. The incidence of match injuries for MRs officiating in the top division of the Spanish Football League was 1.30 (95% CI 0.0–3.82) per 1000 match hours while for ARs was 0.7 (95% CI 0.0–2.1); the incidence of training injuries was considerably lower in both groups (0.4 (95% CI 0.0–0.9) vs. 0.3 (95% CI 0.0–0.6). Hamstring- and calf-related muscle problems were the most common injury diagnoses in elite referees. Injured referees had, on average, 2 weeks of absence from training and competition.

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Conclusion: Elite MRs had a 90% increase in the risk of suffering an injury in comparison with elite ARs. The incidence of match injury or training injury was very low in both groups, despite that, they should continue carrying out preventive programs specially targeted for hamstring- and calf-related muscle problems.

Introduction

Football (soccer) is one of the most, if not the most, popular sports worldwide.[20] The game rules are enforced by match officials namely the match referee (MRs), two assistant referees (ARs), the fourth official and the video assistant referees. The Fédération Internationale de Football Association (FIFA) big count carried out in the mid-2000s revealed over 840,000 referees worldwide.[20] Based on this data, and accompanied by the constant football development, it would be possible to think that there are nowadays near 1 million referees around the world. In Spain, according to the latest available census of the 2019/2020 season, the Referees Technical Committee of the Real Federación Española de Fútbol summed a total of 15,821 referees.

Football refereeing requires endurance, agility, speed, and decision-making under enormous pressure.[31] The physiological demands of MRs are comparable to those shown by midfield players.[15] Furthermore, referees match high-intensity activity reported to be associated with that of the team they regulate.[31] Field referees reported to cover more total distance, same high-intensity activity but less total distance sprinting than players.[31] Elite level football referees are usually 10–15 years older than players,[29] and they reach their top performance in their late thirties early forties.[10] Experience are deemed to be a relevant variable for top performance in football referees and in some top football leagues referees older than 50 year may officiate top championship matches. Game demands, career length and age may put referees at risk of training and match injury.[3–7]

Injury surveillance is fundamental to protect the health of the athlete.[1] Despite the efforts undertaken to study injuries on football referees in the 1900s,[9,19] efforts were still needed around ten years ago to establish the injury rates of modern football referees. Previous authors analyzed injury profiles in 71 male referees of the 2 top divisions of the Swiss Football League.[3] They showed that MRs had an incidence of 6.8 match injuries per 1000 match hours, and 1.7 for ARs in the last 12 months. The most frequent injury suffered from Swiss referees were hamstring strains and ankle sprains. In a retrospective study on injuries in Croatian male football referees, the authors found similar injury rates 5.2 per 1000 hours of refereeing.[23] But also higher injury incidences, 16.4 injuries per 1000 hours for match officiating in elite Irish male referees,[32] and 19.6 injuries per 1000 hours during matches in professional Iranian male referees[24] were found.

Given the paucity of research on injuries of modern football referees, the purpose of this study was to analyze the incidence of training and match injuries and the injury pattern in Spanish football referees of different competitive levels.

Methods

Study design

The study design was a retrospective survey including male referees officiating in the 1st, 2nd, and 2ndB national divisions during the 2018–2019 competitive season. The study was performed following the guidelines for research ethics (the Declaration of Helsinki[33] and the Declaration of Taipei[34]) and was approved by the Ethics Committee of Clinical Research from the Government of Aragón [C.I. PI16/038]. All participants gave their signed informed consent to participate and were informed about the nature of the research.

Setting

The study was carried out using a web-based survey during a training camp (July 2019) organized by the Technical Committee of Referees of the Royal Spanish Football Federation.

Participants

A total of 246 referees were licensed to officiate in the 1st, 2nd, and 2ndB Spanish leagues in the 2018–2019 season. Based on the leagues, referees grouped as follows:

- Elite MRs and ARs, i.e. (Spanish La Liga Santander (1st division), and La Liga Smart Bank (2nd division) leagues.
- Non-elite MRs and ARs (Spanish 2ndB league).

Questionnaire and procedure

MRs and ARs were asked to complete a web questionnaire covered the following areas: personal characteristics (date of birth, level of studies, function, division, experience, and years in the current division); training and match characteristics (number of sessions, type of training and hours per week); injuries throughout the 2018–2019 season (location, type, circumstances, date of injury and return to training date). Absence or time-loss days were counted from the day after the onset that the referee was unable to train, through the day before the referee was fully available for training as recommended by the International Olympic Committee (IOC).[1] At the end of the questionnaire, a free-text comment was available to type any information that the referee could consider useful to know by the technical staff.

All referees filled out the questionnaire in the same teaching room, at the same time, according to the division group. A medical doctor and two sports scientists were present in the teaching room to answer any questions that may arise. All reported injuries cross-checked with medical

records recorded during the season for missing, incomplete, or inconsistent data.

In this study injury was defined as: ''Any physical complaint sustained by a referee that results from a football match or football training, irrespective of the need for medical attention or time loss from football activities''.[21] This definition applies, in theory, to both traumatic and overuse injuries. A recordable injury is defined as any injury that occurs during scheduled training sessions or matches and causes the player to interrupt the session or miss the following session.

A portable body composition monitor TANITA BC 780-MA S (Tanita Corp., Tokyo, Japan) with a 270-kg maximum capacity and 0.1-kg precision was used to measure total body water and to estimate body fat percentage. All referees followed the manufactured pre-testing guidelines. A sports medicine doctor took all measurements under the same conditions: room temperature, athletic mode, place, and so on.

Statistical methods

The statistical analyses were conducted with SPSS version 24.0 (SPSS Inc., Chicago, IL, USA). Results were reported as the mean, standard deviation (SD), and frequencies (%), unless otherwise stated. Injury incidence (injuries divided by total hours of exposure multiplied by 1000 and its 95% confidence intervals (incidence $\pm$ 1.96 times the incidence divided by the square root of the number of injuries, 95% CI) were calculated. The assumption of normality was not met, using the Shapiro–Wilk test. Group differences were analyzed by Kruskal–Wallis *H* test. An alpha-level of 0.05 was considered statistically significant ($p < 0.05$).

Results

Two-hundred and thirty-two referees out of 246 filled out the survey (Table 1). Six elite referees (two MRs and four ARs) were in an international training camp, and eight referees (two elite ARs and four non-elite MRs) did not fully reply to the questionnaire. The final sample was composed of 18 MRs and 34 ARs belonging to the 1st league, 22 MRs and 42 ARs to the 2nd league, and 116 MRs to the 2ndB league.

As expected, the 2nd league ARs and the 2ndB league MRs were significantly younger ($\chi^2(4) = 66.438$, $p = <0.001$) and less experienced ($\chi^2(4) = 81.874$, $p = <0.001$) than the 2nd league MRs, 1st league ARs and MRs (for age and experience, 1st MRs–2nd ARs ($\chi^2 = -97.810$, $p = <0.001$ and $\chi^2 = -96.472$, $p = <0.001$) 1st MRs–2ndB MRs ($\chi^2 = -106.216$, $p = <0.001$ and $\chi^2 = -105.422$, $p = <0.001$) 2nd MRs–2nd ARs ($\chi^2 = -50.219$, $p = 0.045$ and $\chi^2 = -63.598$, $p = 0.003$) 2nd MRs–2ndB MRs ($\chi^2 = -58.625$, $p = 0.002$ and $\chi^2 = -72.548$, $p = <0.001$) 1st ARs–2nd ARs ($\chi^2 = -62.515$, $p = 0.001$ and $\chi^2 = -75.917$, $p = <0.001$) 1st Ars–2ndB MRs ($\chi^2 = -70.921$, $p = <0.001$ and $\chi^2 = -84.866$, $p = <0.001$)). The 2nd league ARs were shorter than any other MRs group ($\chi^2(4) = 17.124$, $p = 0.002$; 1st MRs–2nd ARs ($\chi^2 = -62.619$, $p = 0.009$) 2nd MRs–2nd ARs ($\chi^2 = -59.581$, $p = 0.007$) 2ndB MRs–2nd ARs ($\chi^2 = -33.954$, $p = 0.049$). There was no difference between groups for weight, body mass index, and body fat percentage variables.

Regarding matches and training, the 2ndB league MRs officiated fewer matches than any other group ($\chi^2(4) = 73.530$, $p = <0.001$; 1st MRs–2ndB MRs ($\chi^2 = -93.507$, $p = <0.001$) 2nd MRs–2ndB MRs ($\chi^2 = -58.694$, $p = 0.002$) 1st ARs–2ndB MRs ($\chi^2 = -91.711$, $p = <0.001$) 2nd ARs–2ndB MRs ($\chi^2 = -45.701$, $p = 0.002$)). On the contrary, the 1st league MRs spent significantly more hours per week in training than any other group ($\chi^2(4) = 11.261$, $p = 0.024$; 1st MRs–2nd MRs ($\chi^2 = -73.689$, $p = 0.005$) 1st MRs–1st ARs ($\chi^2 = -70.828$, $p = 0.003$) 1st MRs–2nd ARs ($\chi^2 = -60.655$, $p = 0.012$) 1st MRs–2ndB MRs ($\chi^2 = -96.136$, $p = <0.001$).

There were significant differences between groups in the incidence rate of match injuries ($\chi^2(4) = 158.253$, $p = <0.001$). The MRs showed a higher incidence rate of match injuries (approximately 1.8–2.8 times) than ARs; for instance, the incidence rate was 1.3 (95% CI 0.0–3.8) for the 1st league MRs while it was 0.7 (95% CI 0.0–2.1) for the 1st league ARs. Among them, the highest rate was found for the 2nd league, MRs or ARs equally (1st MRs–2nd MRs ($\chi^2 = -90.972$, $p = <0.001$) 2nd MRs–1st ARs ($\chi^2 = -131.500$, $p = <0.001$) 2nd MRs–2nd ARs ($\chi^2 = -80.893$, $p = <0.001$) 1st ARs–2nd ARs ($\chi^2 = -50.607$, $p = 0.011$)). Although the incidence rate of training injuries was considerably lower, close to 0.5 injuries per 1000 hours of training, the differences between groups were almost equal to the ones previously described ($\chi^2(4) = 139.656$, $p = <0.001$). Injuries led to 9 (95% CI 3–15) to 23 (95% CI 16–30) time-loss days of the referees from training sessions ($\chi^2(4) = 112.671$, $p = <0.001$).

A total of 28 elite referees (24.1%) out of 116 (MRs and ARs belonging to the 1st and 2nd leagues) reported having suffered one injury during the previous season. Fourteen elite MRs (35.0%) out of 40 and 14 ARs (18.4%) out of 66 reported an injury during the 2018–2019 season. Therefore, elite MRs were 1.90 (95% CI 1.008–3.582) times as likely to suffer an injury compared to AS. In other words, elite MRs had a 90% increase in risk of having an injury.

Table 2 shows the injury pattern, frequencies, incidence rate per 1000 hours of exposure (training and match), and time-loss days among Spanish referees. The most common injured sites were thigh, lower leg for the elite- and non-elite MRs and ankle for elite-ARs as well. The elite-MRs reported six thigh-injuries (42.9%) with an incidence rate of 0.4 (95% CI 0.1–0.7) and an absence of 9 (95% CI 2–16) days. The calf was another site-related injury in this group (five injuries (35.7%), 0.3 injuries per 1000 hours of exposure) (95% CI 0.0–0.6) and a mean time-loss day of 7 (95% CI 1–13). Similar data in the non-elite MRs were found (for details, see Table 2).

Six calf strains (42.9%) with an incidence rate of 0.2 (95% CI 0.0–0.4) and an absence of 15 days (95% CI 3–27), and four ankle sprains (28.6%) with 0.1 injuries per 1000 hours of exposure (95% CI 0.0–0.3) and 13-time-loss days (95% CI 0–26) were the most common diagnoses in the elite ARs.

Discussion

This is the first study that examined the incidence of injuries in Spanish referees across the competitive season. The main finding of this study was the low injury rate in either the MRs and ARs. We found that the referees officiating in the 1st league had similar injury rates (1.3 for MRs and 0.7

Table 1 Characteristics of match referees (MRs) and assistant referees (ARs), exposure and injuries of the 2018–2019 season by competitive levels.

	Elite referees ($n = 116$)				Non-elite referees ($n = 116$)
	1st league		2nd league		2ndB league
	MRs ($n = 18$)	ARs ($n = 34$)	MRs ($n = 22$)	ARs ($n = 42$)	MRs ($n = 116$)
Age (y)	38.9 ± 3.0	36.3 ± 5.5	34.5 ± 3.4	30.8 ± 4.9[a,b,c]	30.2 ± 4.3[a,b,c]
Weight (kg)	74.5 ± 4.4	72.7 ± 7.2	75.1 ± 4.8	71.9 ± 6.5	72.0 ± 5.9
Height (cm)	182.5 ± 4.9	179.8 ± 5.7	182.0 ± 3.8	177.2 ± 5.3[a,c]	180.0 ± 4.9[d]
BMI (kg/m^2)	22.4 ± 0.7	22.5 ± 1.7	22.7 ± 1.2	22.9 ± 1.7	22.2 ± 1.3
Body fat (%)	9.8 ± 2.0	10.9 ± 3.5	10.5 ± 3.6	11.3 ± 3.7	10.4 ± 3.0
Experience (y)	22.8 ± 4.2	20.7 ± 4.8	19.2 ± 3.6	14.2 ± 5.0[a,b,c]	13.5 ± 4.4[a,b,c]
Years officiating in the division (y)	5.9 ± 3.3	6.8 ± 5.1	4.3 ± 2.8	3.7 ± 3.2[b]	4.7 ± 3.0
Matches in the season	28.8 ± 12.0	27.8 ± 8.9	21.7 ± 6.9	20.5 ± 5.6[b]	16.7 ± 7.2[a,b,c,d]
Trainings per week (sessions)	5.9 ± 1.0	5.2 ± 1.3	5.1 ± 1.1	5.1 ± 1.3	4.8 ± 1.4[a]
Training hours per week	8.7 ± 1.5	6.5 ± 2.2[a]	6.3 ± 1.7[a]	6.7 ± 2.1[a]	5.7 ± 2.0[a,d]
Incidence of match injuries Injuries per 1000 match hours (95% CI)	1.3 (**0.0**–3.8)	0.7 (**0.0**–2.1)	4.2 (**0.0**–8.9)[a,b]	1.5 (**0.0**–3.7)[b,c]	3.8 (1.6–6.0)[a,b,d]
Incidence of training injuries Injuries per 1000 training hours (95% CI)	0.4 (**0.0**–0.9)	0.3 (0.0–0.6)	0.6 (0.0–1.2)[a,b]	0.3 (0.0–0.6)[c]	0.6 (0.3–0.9)[a,b,d]
Mean time loss (days (95% CI)	10 (2–18)	17 (4–30)[a]	9 (3–15)[b]	10 (3–17)[b]	23 (16–30)[a,b,c,d]

[a] Compared to 1st league MRs.
[b] Compared to 1st league ARs.
[c] Compared to 2nd league MRs.
[d] Compared to 2nd league ARs.
The bold type means that 95% CI were negative.

for ARs) per 1000 match hours to those reported for UEFA referees[23] and top-level international referees.[4] Moreover, we examined the risk of refereeing between elite MRs and ARs, founding that elite MRs had a 90% increase in the risk of having an injury compared to elite ARs. Finally, our results showed that the lower limbs, specifically hamstring- and calf-muscle related injures for MRs, and calf muscle injuries, and ankle sprains for ARs, are the most common injuries among them.

During a competitive match, MRs are reported to cover 15% of match total distance cope with the at high-intensity.[26,31] In this scenario, adequate training loads and the implementation of injury-prevention programs are essential to avoid non-contact- and overuse injuries. Beside match demands age was reported to be a covariant in injury rate in elite level MRs.[6]

In this study, we considered injury according to the definition provided by Fuller et al.[21] However, the IOC consensus statement has recently defined an injury as: ''*tissue damage or other derangement of normal physical function due to participation in sports, resulting from rapid or repetitive transfer of kinetic energy*''.[1] Regardless of using Fuller's or IOC's definitions, the authors do believe that both of them mean identically the same from a practical point of view: any tissue damage because of refereeing a football match or training involving the stop of training and absence from football-related activities.

The Spanish top-level football referees included in this study were quite similar in descriptive characteristics (age, weight, and height) and experience to top-class,[16] Italian,[14] English,[27,30] Spanish[10] and other European top-elite referees.[23,25] However, Spanish referees had a body fat percentage near to 10%, which is considerably lower than that found on top-class soccer referees,[16] and similar to body composition profile described previously.[11,12] The elite- and non-elite referees showed a BMI value below 23 kg/m^2, which is favorable for refereeing performance.[15]

Of all Spanish elite referees, 14 MRs (35%) and 14 ARs (18.4%) reported having suffered at least one injury during the 2018–2019 season. These data resulting in and incidence of 1.3, and 4.2 injuries per 1000 match hours for MRs from 1st and 2nd leagues, respectively. The incidence of match injuries found in Spanish elite referees is lower to those previously reported in studies conducted for referees of the same level of different countries.[3,23,24,32] In fact, the rate of approximately 2 injuries per 1000 match among

Table 2 Injury pattern among referees in Spain.

Region -Type *Diagnosis*	Elite MR			Elite AS			Non-elite MR		
	Injuries *n* (%)	Incidence Injuries per 1000 hours (95% CI)	Meantime-loss Days (95%CI)	Injuries *n*	Incidence Injuries per 1000 hours (95% CI)	Mean time-loss Days (95%CI)	Injuries *n*	Incidence Injuries per 1000 hours (95% CI)	Mean time-loss Days (95%CI)
Trunk	1 (7.1)	0.1 (**0.0**–0.3)	6 (**0**–18)	–	–	–	2 (5.4)	0.0 (0.0–0.1)	88 (**0**–210)
-Lower back *Lumbalgia*									
Lower limbs	13 (92.9)	0.8 (0.4–1.2)	7 (1–13)	14 (100)	0.5 (0.2–0.8)	14 (7–21)	35 (94.6)	1.0 (0.7–1.3)	19 (13–25)
-Thigh	6 (42.9)	0.4 (0.1–0.7)	9 (2–16)	–	–	–	11 (31.4)	0.3 (0.1–0.5)	18 (7–29)
Muscle injury	5 (83.3)	0.3 (0.0–0.6)	11 (1–21)	3 (21.4)	0.1 (0.0–0.2)	14 (**0**–30)	10 (90.9)	0.3 (0.1–0.5)	12 (5–19)
Tendon injury	1 (16.7)	0.1 (**0.0**–0.3)	0	–	–	–	1 (9.1)	0.0 (0.0–0.1)	74 (0–219)
-Groin *Muscle injury*	–	–	–	1 (7.1)	0.0 (0.0–0.1)	6 (**0**–18)	1 (2.9)	0.0 (0.0–0.1)	0
-Knee *Tendon injury*	–	–	–	–	–	–	4 (11.4)	0.1 (0.0–0.2)	30 (1–59)
-Calf *Muscle injury*	5 (35.7)	0.3 (0.0–0.6)	7 (1–13)	6 (42.9)	0.2 (0.0–0.4)	15 (3–27)	12 (34.3)	0.3 (0.1–0.5)	10 (4–16)
-Ankle	–	–	–	4 (28.6)	0.1 (0.0–0.3)	13 (0–26)	–	–	–
Sprain	–	–	–	3 (75.0)	0.1 (0.0–0.2)	16 (**0**–34)	3 (8.6)	0.1 (0.0–0.2)	3 (**0**–6)
Tendon injury	–	–	–	1 (25.0)	0.0 (0.0–0.1)	4 (**0**–12)	–	–	–
-Foot *Fractures*	2 (14.3)	0.1 (**0.0**–0.3)	15 (**0**–36)	–	–	–	–	–	–
Tendon injury	–	–	–	–	–	–	4 (11.4)	0.1 (0.0–0.2)	14 (0–28)

The bold type means that 95% CI were negative.

1st MRs is similar to the data reported for top-level international referees.[4,23] FIFA promoted and disseminated the FIFA 11+ injury prevention program.[2,8] The implementation of prevention programs and the modeling of training loads provided by the Referees Technical Committee could explain why Spanish soccer referees had a reduced injury incidence.

The incidence during training ranged between 0.3 and 0.6 injuries per 1000 training hours for elite referees. These values are between 2.3- and 7-fold lower than the observed incidence during refereeing. Again, our results showed a much lower incidence of training injury compared to previous studies carried out in professional soccer referees; 2.16 injuries per 1000 training hours for referees officiating in the Parana's Football Championship[18] or the elite Irish League[32] (8.8 injuries per 1000 hours of training).

The best of this author's knowledge this is the first study that addressed differences in relative injury risk between elite MRs and ARs in the same study. When sampled top-division referees, previous authors found a higher percentage of injured MRs (36%) in comparison with ARs (20%).[3] Our percentage of injuries are exactly the same (MRs 35.0%, and ARs 18.4%), and we compared the relative risk between them, and found that elite MRs were 1.90 times as likely to suffer an injury compared to ARs. In other words, elite MRs had a 90% increase in risk of having an injury. It could be explainable by pointing out the differences between MRs and ARs activities during the game; short-intense sprints with long low-intensity periods[25] compared with sprints at a high intensity over long distance with match activities changing every 5–6 s.[31]

The reported injuries led from 9 to 23 days of absence from the training. Our results are in accordance with previous studies[24] that noted moderate injuries led 8- to 28-time-loss days. Further analyses are not worthy because absence is always injury- and gravity-dependent.

Hamstring- and calf-related muscle problems were the most common injury diagnoses in referees officiating in the top divisions of the Spanish soccer leagues. This finding is in line with data reported in the scientific literature.[3,4,6,32] Hamstring region is commonly injured among sprinters.[35] Referees covered a wide range of match high-speed running distance.[13,28] Furthermore, elite level MRs are reported to accumulate less distance sprinting but to perform longer sprint bouts than players.[31] As a result, their upper leg is biomechanically and anatomically challenged when officiating. Moreover, match officiating involves constantly changing directions and backwards running.[31] These activities put calf muscles under heavy eccentric and rotational loads. Besides, other factors, like training habits, training and match shoes, and non-orthodox running modes (i.e., sideways and backward running), could contribute to calf injuries.

The major limitation of our retrospective study is the associated recall bias.[17] Despite that, each reported injuries cross-checked with medical records recorded because the IOC recommends limiting injury data to body area when they are reported by athletes.[22] Another limitation is that referees undertook different recovery protocols. For this reason, the days of injury loss must be taken with caution when comparing them with other studies. However, our strengths are that we have evaluated all referees officiating one of the most important leagues worldwide. National and international refereeing governing bodies could develop similar studies to improve research into the injury refereeing profiles.

Conclusion

Elite MRs had a 90% increase in the risk of suffering an injury in comparison with elite ARs. The incidence of match injuries (1.3 or 0.7 injures per 1000 hours), and training injuries (0.4 or 0.3 injuries per 1000 hours) were low in both groups. Nevertheless, referees should continue carrying out preventive programs targeting hamstring- and calf-related muscles.

Authors' contributions

AML collected data, built the database, carried out the statistical analyses, and wrote the first draft of the manuscript. JS collected data and reviewed the manuscript, CC reviewed the manuscript, and JAC collected data, built the database, and reviewed the final manuscript.

Conflict of interests

The Authors declare that they don't have any conflict of interests.

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