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Original article

Injuries in Spanish female soccer players

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Abstract

Background: Epidemiologic research to learn the incidence, type, location, and severity of female soccer injuries and the risk factors for sustaining a sport injury is the first step in developing preventive policies. The aim of this study was to analyze the incidence of injuries in the population of female soccer players in Spain.

Methods: The injuries incurred by 25,397 female soccer players were registered by the medical staff of the Spanish Football Federation during 1 season. A standardized medical questionnaire was used to classify the injury according to type, severity, location, and injury mechanism. A total of 2108 injuries was reported with an incidence of 0.083 injuries per player per season. Most injuries were in the lower limbs (73.4%), mainly affecting knee (30.4%) and ankle joints (17.9%).

Results: The proportion of injuries derived from contact with another player was higher during matches (36.9%) than during training (11.4%; $p < 0.001$). Noncontact injuries were classified as severe more frequently than were contact injuries (51.0% vs. 42.6%; $p < 0.001$). A higher incidence of injury was found in adult soccer players (≥ 18 years) vs. their counterparts younger than 18 years (0.093 vs. 0.073 injuries per player per year, respectively; $p < 0.001$). There were no differences between age groups in any other injury variable (e.g., type, mechanism, location, or severity; $p > 0.05$).

Conclusion: Most female soccer injuries were located at the knee and ankle; the injury mechanism determined the playing time lost; and the player's age did not affect injury characteristics.

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Keywords: Ankle; Epidemiology; Knee; Sport injuries; Women

1. Introduction

The popularity of soccer among girls and women in all parts of the world is on the increase. It is played officially in more than 100 countries, and the total number of female players worldwide can be estimated at around 30 million.¹ Epidemiologic injury studies in female soccer players have shown that 51%–83% of injuries occur through physical contact with an adversary,^{2,3} and 19%–39% are due to foul play.^{3,4} Injury studies have shown that 48%–70% of elite female soccer players sustain approximately 1 injury during the season,^{4,5} although the rate of injury is affected by factors such as age and competitive level.^{4,6–9} The rate of injury during training has been shown to range from 1.0 to 4.6 per 1000 h of exposure.^{6,7}

Like male players,^{10,11} female soccer players are at a greater risk of sustaining injury in match play compared with training situations, with reported rates varying from 6.1 to 24.0 per 1000 h of exposure in competition.^{4,6–8}

Regarding the time necessary for full recovery after an injury, previous research showed that about 44% of female soccer injuries were classified as slight (<1 week of time lost), 40% were classified as moderate (1–3 weeks lost), and 16% were severe (>3 weeks lost), depending on the research methodology.^{4,6,12–14} Interestingly, 69%–90% of female soccer injuries were classified as traumatic (sudden-onset injury, from a single incident with a known trauma),^{2,4–6,14,15} and most injuries were located in the lower extremities. Knees, ankles, and thighs have been shown to be the most common locations for injury in female players,^{4–6,16} although the knee has typically been referred to as the most frequent location for severe injuries.^{4–6} The most frequently diagnosed injuries were sprains and strains, with ankle sprains having the highest prevalence in both young^{6,13,15} and elite female soccer players.^{5,14}

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Epidemiologic research is the first step in developing preventive policies; it ascertains the incidence, type, location, and severity of female soccer injuries and the risk factors for sustaining a sport injury.^{17,18} Previous injury research has been carried out on elite adult female players^{4,5,14,19} or focused on young players,^{2,6,7,13,15,16} studying 1 or several women's soccer teams during 1 season. Thus, these investigations have included a limited number of participants, and the effects of factors such as age, performance level, and injury rate are inferred by comparisons among investigations. A global analysis that includes all the female soccer players in a federation competing in 1 country is still unexplored, although an investigation of these characteristics has been recently carried out for male players.¹⁰ The aim of this study was to analyze the incidence of injuries in the population of female soccer players in Spain by including all the female soccer players registered in the Spanish National Football Federation.

2. Materials and methods

2.1. Ethics statement

The study was revised by the Research Ethics Committee of the Camilo José Cela University in accordance with the latest version of the Declaration of Helsinki. The Research Ethics Committee indicated that this investigation did not require approval for bioethics considerations, and it approved the study design and methodology used in this experiment.

2.2. Participants

A retrospective cohort study of Spanish female soccer players was carried out during the 2010–2011 season (from September, 2010 till June, 2011), including the preseason and the competitive period. The study sample was composed of 25,397 female soccer players, including 12,857 adults (≥ 18 years) and 12,540 under 18 years (U-18), licensed by the Royal Spanish Football Federation (RSFF) and playing in official domestic leagues. The study sample was obtained from 4 adult categories (2 national and 2 regional) and 6 age group categories (with only 1 regional category).

2.3. Procedures

All the female soccer players licensed by the RSFF were registered with the RSFF mutual benefit society, a unique nationwide insurance system. The mutual benefit society provides free medical support for soccer players who suffer from any physical complaint derived from soccer practice. When players are officially registered with the RSFF, they implicitly accept the injury insurance policy and agree to the recording of these injuries. As a result, all acute injuries that occur during training activities or during competition are reported and collected in the injury registry of the RSFF mutual benefit society. This investigation included all the injuries reported to the medical services of the mutual benefit society during 1 season. A medical practitioner specializing in soccer injuries recorded injury data on a paper player-injury audit questionnaire. Medical doctors were previously instructed how to correctly fill out the questionnaire and to report all the injuries that they

attended to during 1 season. The questionnaire was completed when a soccer player required the attention of a doctor, and the results were sent to the head of medical services at the RSFF. Doctors were made aware that a recordable injury was defined as “any physical complaint sustained by a player that resulted from a soccer match or training session, irrespective of the medical attention or time loss from soccer activities”. The questionnaire was based on the FIFA Medical Assessment and Research Centre consensus statement²⁰ and included the soccer player's age and several computable items, as follows.

(1) Injury conditions

The physician specified whether the injury was sustained during a match or during training and whether it was produced by a collision with another player (defined as contact injury) or not (defined as noncontact injury).

(2) Injury severity

The severity of the soccer injury was classified by the number of days that elapsed from the date of the injury to the date of the players' return to full participation in their soccer teams. Injuries were grouped as slight (<7 days), mild (7–14 days), moderate (15–21 days), or severe (>21 days).

(3) Injury classification

The soccer injuries were classified using an adapted version of the Orchard Sports Injury Classification.²¹ The questionnaire included specific items to identify the location on the body (including side) and the type of injury.

(4) Statistical analyses

All the information on the questionnaires was included in a database and associated software Hardware and Programming (Hardware and Programming SA, Madrid, Spain), which allowed cross-tabulation of the items specified. Standard statistical methods were used to calculate absolute and relative frequencies. The χ^2 test was performed to establish the significance of the difference between female players who suffered contact injuries and those who suffered noncontact injuries of any specific type, location, or severity. Two groups were then established by age (U18 and adult female players) to determine the effect of this variable on the characteristics of female soccer injuries. All the statistical procedures were performed with Excel 2013 for Windows (Microsoft, Redmond, WA, USA). The criterion for statistical significance was set at $p < 0.05$.

3. Results

Over the entire 2010–2011 season, the medical services of the RSFF treated 2108 injuries in the 25,397 female players (12,857 adults and 12,540 U18) with an overall incidence of 0.083 injuries per soccer player per year. There was a lower rate of injury in U-18 players than in their adult counterparts (0.072 for U-18 players vs. 0.094 for adult players; $p < 0.001$). Of the total number of injuries reported in 1 year, 964 (45.7%) occurred during training practice, 1135 (53.9%) occurred during matches, and 9 (0.4%) were categorized as undefined (e.g., sustained while traveling to soccer competitions). The

number of noncontact injuries (e.g., not involving a collision with another player) was 1614 (76.6% of the total). The proportion of injuries with or without contact varied between training and matches ($p < 0.001$). During training sessions, 854 (88.6%) injuries were related to noncontact mechanisms, whereas in matches, 752 (66.3%) were sustained without contact with another player. Injury mechanism (contact vs. noncontact) or injury condition (training vs. match) were not affected by the player's age (U-18 vs. adult soccer players).

The number of severe injuries (>21 days until full recovery) was 1033 (49.0%); moderate injuries (15–21 days) accounted for 368 (17.5%), mild injuries (7–14 days) accounted for 323 (15.3%), and slight injuries (<7 days) accounted for 384 (18.2%). In regard to the severity of the injuries, there were significant differences according to the injury mechanism (e.g., contact or noncontact, Fig. 1). The proportion of noncontact injuries was higher than that of contact injuries in those classified as severe ($p < 0.001$). However, the proportion of contact injuries was higher than that of noncontact injuries for those classified as mild ($p < 0.001$). Injury severity was similar between adult soccer players and U-18 players ($p = 0.548$), both in contact injuries ($p = 0.650$) and in noncontact injuries ($p = 0.800$).

Table 1 depicts the classification of the 2108 injuries according to type. The most common injury affected joints and/or ligaments (934, 44.3%), whereas 577 (27.4%) of the total injuries

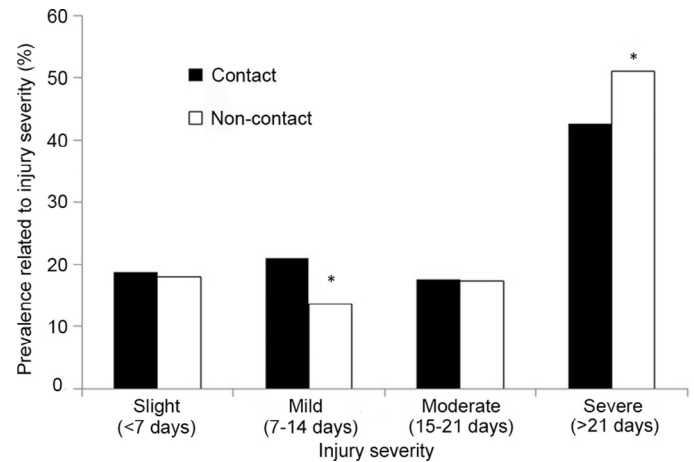


Fig. 1. Injury severity in female soccer players according to the mechanism of injury (contact vs. noncontact). The severity of each injury was classified by the number of days that elapsed from the date of the injury to the date of the player's return to full participation. * $p < 0.001$, compared with contact injuries within group.

were contusions, and 307 (14.6%) were muscle and tendon injuries (Table 1). Bone and nervous system injuries were the least frequent type occurring in female soccer players. There were significant differences in the types of injuries when taking into account the injury mechanism ($p < 0.001$). Overall, bone

Table 1

Types of 2108 injuries in amateur female players during the 2010–2011 season according to the mechanism of injury (contact vs. non-contact) and player's age (<18 years and ≥ 18 years). The types of soccer injuries were classified by main groupings and categories (n (%)).

Main grouping and category	Contact			Non-contact			Total ($n = 2108$)
	<18 years ($n = 195$)	≥ 18 years ($n = 299$)	All ($n = 494$)	<18 years ($n = 709$)	≥ 18 years ($n = 905$)	All($n = 1614$)	
Fractures and bone stress							
Fracture	23 (11.79)	25 (8.36)	48 (9.72)	31 (4.37)	40 (4.42)	71 (4.40)*	119 (5.65)
Other bone injuries	0 (0.00)	1 (0.33)	1 (0.20)	3 (0.42)	8 (0.89)	11 (0.68)	12 (0.57)
Total	23 (11.79)	26 (8.69)	49 (9.92)	34 (4.79)	48 (5.31)	82 (5.08)*	131 (6.22)
Joint and/or ligament							
Dislocation/subluxation	3 (1.54)	6 (2.01)	9 (1.82)	18 (2.54)	6 (0.66)	24 (1.49)	33 (1.57)
Ligament injury	68 (34.87)	91 (30.43)	159 (32.19)	279 (39.35)	373 (41.22)	652 (40.40)	811 (38.47)
Meniscus/cartilage	1 (0.51)	10 (3.34)	11 (2.23)	41 (5.78)	38 (4.20)	79 (4.89)*	90 (4.27)
Total	72(36.92)	107 (35.78)	179 (36.24)	338 (47.67)	417 (46.08)	755 (46.78)*	934 (44.31)
Muscle and tendon							
Muscle rupture	2 (1.03)	2 (0.67)	4 (0.81)	37 (5.22)	58 (6.41)	95 (5.89)*	99 (4.70)
Muscle tear/cramp	3 (1.54)	7 (2.34)	10 (2.02)	37 (5.22)	38 (4.20)	75 (4.65)*	85 (4.03)
Tendon injury	3 (1.54)	11 (3.68)	14 (2.83)	42 (5.93)	67 (7.40)	109 (6.75)*	123 (5.83)
Total	8 (4.11)	20 (6.69)	28 (5.66)	116 (16.37)	163 (18.01)	279 (17.29)*	307 (14.56)
Contusions							
Contusion/hematoma	76 (38.97)	127 (42.48)	203 (41.09)	157 (22.15)	206 (22.76)	363 (22.49)*	566 (26.85)
Abrasion	1 (0.51)	0 (0.0)	1 (0.20)	2 (0.28)	3 (0.33)	5 (0.31)	6 (0.28)
Laceration	2 (1.03)	2 (0.67)	4 (0.81)	0 (0.0)	1 (0.11)	1 (0.06)*	5 (0.24)
Total	79 (40.51)	129 (43.15)	208 (42.10)	159 (22.43)	210 (23.20)	369 (22.86)*	577 (27.37)
Nervous system							
Concussion	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
Nerve injury	0 (0.0)	0 (0.0)	0 (0.0)	1 (0.14)	2 (0.22)	3 (0.19)	3 (0.14)
Total	0 (0.0)	0 (0.0)	0 (0.0)	1 (0.14)	2 (0.22)	3 (0.19)	3 (0.14)
Other							
Dental	2 (1.03)	0 (0.0)	2 (0.41)	2 (0.28)	0 (0.0)	2 (0.12)	4 (0.19)
Other	11 (5.64)	17 (5.69)	28 (5.67)	59 (8.32)	65 (7.18)	124 (7.68)	152 (7.21)
Total	13 (6.67)	17 (5.69)	30 (6.08)	61 (8.60)	65 (7.18)	126 (7.80)	156 (7.40)
Total	195 (100.0)	299 (100.0)	494 (100.0)	709 (100.0)	905 (100.0)	1614 (100.0)	2108 (100.0)

* $p < 0.001$, compared with contact injuries.

Table 2
Body location for 2108 injuries in amateur female players during the 2010–2011 season according to the mechanism of injury (contact vs. non-contact) and player's age (<18 years and ≥18 years) (*n* (%)).

Body location	Contact			Non-contact			Total (<i>n</i> = 2108)
	<18 years (<i>n</i> = 195)	≥18 years (<i>n</i> = 299)	All (<i>n</i> = 494)	<18 years (<i>n</i> = 709)	≥18 years (<i>n</i> = 905)	All (<i>n</i> = 1614)	
Head and neck							
Head/face	17 (8.72)	29 (9.70)	46 (9.31)	20 (2.82)	25 (2.76)	45 (2.79)*	91 (4.32)
Neck/cervical spine	5 (2.56)	9 (3.01)	14 (2.84)	7 (0.99)	10 (1.10)	17 (1.05)*	31 (1.47)
Total	22 (11.28)	38 (12.71)	60 (12.15)	27 (3.81)	35 (3.86)	62 (3.84)*	122 (5.79)
Upper limb							
Shoulder/clavicle	10 (5.13)	18 (6.02)	28 (5.67)	20 (2.82)	28 (3.09)	48 (2.97)*	76 (3.60)
Upper arm	1 (0.51)	2 (0.67)	3 (0.61)	1 (0.14)	1 (0.11)	2 (0.12)	5 (0.24)
Elbow	2 (1.03)	3 (1.00)	5 (1.01)	8 (1.13)	9 (1.00)	17 (1.05)	22 (1.04)
Forearm	7 (3.59)	2 (0.67)	9 (1.82)	6 (0.85)	9 (1.00)	15 (0.93)	24 (1.14)
Wrist	4 (2.05)	8 (2.68)	12 (2.43)	28 (3.95)	16 (1.77)	44 (2.73)	56 (2.66)
Hand/fingers	10 (5.13)	13 (4.35)	23 (4.66)	34 (4.79)	32 (3.54)	66 (4.09)	89 (4.22)
Total	34 (17.44)	46 (15.39)	80 (16.20)	97 (13.68)	95 (10.51)	192 (11.89)*	272 (12.90)
Trunk							
Upper trunk	3 (1.54)	16 (5.35)	19 (3.85)	5 (0.70)	8 (0.88)	13 (0.81)*	32 (1.52)
Abdomen	1 (0.51)	1 (0.33)	2 (0.40)	0 (0.0)	3 (0.33)	3 (0.19)	5 (0.24)
Lower back	8 (4.10)	8 (2.68)	16 (3.24)	28 (3.95)	28 (3.09)	56 (3.47)	72 (3.41)
Hip/groin	0 (0.00)	2 (0.67)	2 (0.40)	18 (2.54)	26 (2.87)	44 (2.73)*	46 (2.18)
Total	12 (6.15)	27 (9.03)	39 (7.89)	51 (7.19)	65 (7.17)	116 (7.20)	155 (7.35)
Lower limb							
Thigh	4 (2.05)	8 (2.68)	12 (2.43)	69 (9.73)	90 (9.95)	159 (9.85)*	171 (8.11)
Knee	42 (21.54)	82 (27.42)	124 (25.10)	228 (32.16)	289 (31.93)	517 (32.03)*	641 (30.41)
Lower leg	22 (11.28)	20 (6.69)	42 (8.50)	55 (7.76)	88 (9.72)	143 (8.86)	185 (8.78)
Ankle	34 (17.44)	42 (14.04)	76 (15.38)	132 (18.62)	170 (18.79)	302 (18.71)	378 (17.93)
Foot/toe	25 (12.82)	36 (12.04)	61 (12.35)	50 (7.05)	73 (8.07)	123 (7.62)*	184 (8.73)
Total	127 (65.13)	188 (62.87)	315 (63.76)	534 (75.32)	710 (78.46)	1244 (77.07)*	1559 (73.96)
Total	195 (100)	299 (100)	494 (100)	709 (100)	905 (100)	1614 (100)	2108 (100)

* $p < 0.001$, compared with contact injuries.

injuries and contusions were more frequently produced in contact incidents, whereas joint and/or ligament and muscle and tendon injuries were more frequently produced in noncontact incidents ($p < 0.001$). Specifically, fractures, contusions or hematomas, and lacerations were more frequently produced during soccer actions that included contact with another player. On the other hand, muscle, tendon, and meniscus or cartilage injuries were more frequently produced during noncontact soccer actions (Table 1; $p < 0.001$). The proportions of injuries according to type and mechanism were very similar between U-18 and adult soccer players ($p > 0.05$).

The incidence of injuries according to anatomic site is reported in Table 2. Most injuries were located in the lower limbs (1559, 74.0%), with the majority affecting knees (641, 30.4%) and ankles (378, 17.9%). A smaller proportion of injuries was located in the upper limbs, trunk, and head or neck. There were significant differences in the body location of soccer injuries when accounting for the mechanism ($p < 0.001$). Overall, upper limb and head or neck injuries were more frequently produced in contact incidents, whereas lower limb injuries were more frequently associated with noncontact incidents ($p < 0.001$). Specifically, thigh, knee, and hip or groin injuries were more often associated with noncontact mechanisms ($p < 0.001$); head or face, neck or cervical spine, shoulder or clavicle, upper trunk, and foot or toe injuries were more associated with contact mechanisms ($p < 0.001$); and the proportion

of ankle injuries according to injury mechanism was similar in the 2 groups ($p > 0.05$). The proportion of injuries according to body location was similar between younger and older soccer players in both contact and noncontact injuries ($p > 0.05$).

From the total, 266 (12.6%) injuries were located in the ankle and affected the ligament. Of this number, 219 (82.3%) were sustained in the lateral ligament complex, whereas the remaining 47 (17.7%) were located in the medial ligament complex. The lateral ligament was more frequently affected than the medial ligament in both the right (138 lateral vs. 27 medial; $p < 0.001$) and left ankles (81 lateral vs. 20 medial; $p < 0.001$), whereas the number of ankle ligament injuries in the right ankle was higher than in the left. The higher prevalence of lateral ligament injury in female soccer players was not affected by the contact or noncontact mechanism ($p = 0.685$; Fig. 2) or the age of the players ($p = 0.962$).

From the total number of injuries reported during the 2010–2011 season, 222 (10.5%) were classified as knee ligament injuries. Considering knee ligament injuries as a whole, the highest incidence of injury was in the anterior cruciate ligament (87, 39.2%), followed by the lateral collateral ligament (79, 35.6%), in both the right and the left knees. There were significant differences in the proportions of ligament injuries between contact and noncontact injuries (Fig. 3, $p = 0.03$). The percentage of ACL injuries was higher in noncontact injuries (74 (43%) of 172 noncontact knee ligament injuries vs. 13 (26%) of

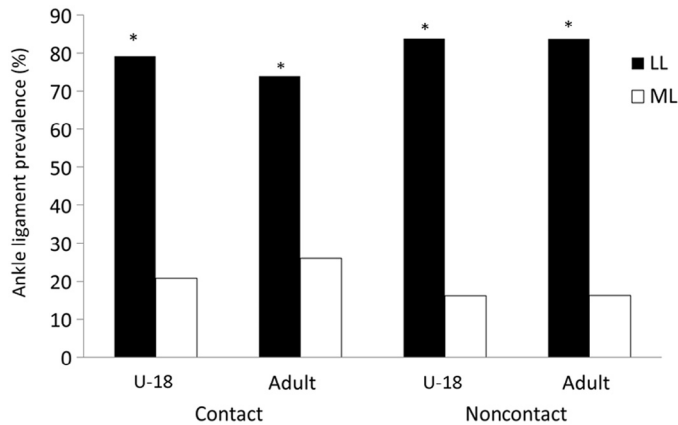


Fig. 2. Distribution of 266 ankle ligament injuries in female soccer players according to the mechanism of injury (contact vs. noncontact) and player's age (<18 years (U-18) and ≥ 18 years of age (adult)). * $p < 0.05$, compared with ML within group. LL = lateral ligament; ML = medial ligament.

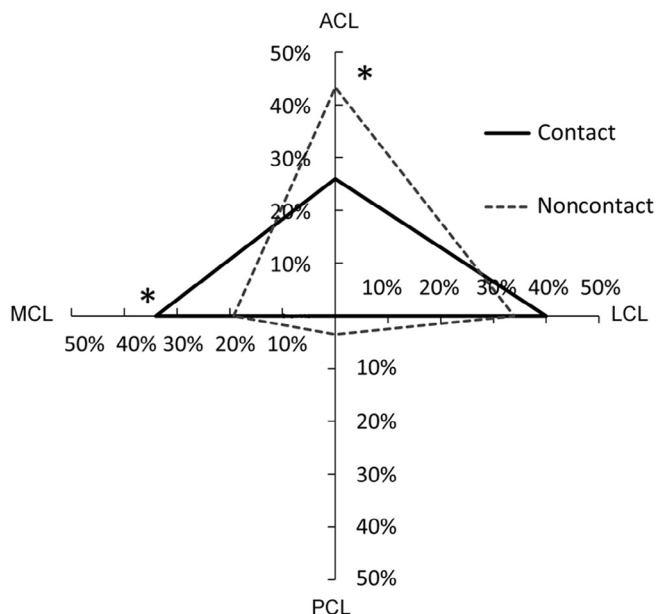


Fig. 3. Distribution of 222 knee ligament injuries according to the mechanism of injury (contact vs. noncontact). * $p < 0.001$, significant differences between contact vs. noncontact injuries. ACL = anterior cruciate ligament; LCL = lateral collateral ligament; MCL = medial collateral ligament; PCL = posterior cruciate ligament.

50 contact knee ligament injuries), whereas the percentage of medial collateral ligament injuries was higher when the injury was produced through contact with another player (17 (34%) of 50 contact knee ligament injuries vs. 33 (19.3%) of 172 noncontact knee ligament injuries). Nevertheless, the distribution of knee ligament injuries and its relationship with the injury mechanism was not affected by the player's age ($p = 0.991$).

4. Discussion

Several research projects have studied the epidemiology of soccer injuries in both elite female^{5,14,22} and young players.^{2,6,7,15,16}

Most of these investigations were carried out with small sample sizes (1 or several teams), and the results are mainly applicable to high-level female soccer players. The present investigation includes an analysis of all competitive female soccer players in Spain, and therefore its results might be more applicable to female soccer players of different levels and categories. The main outcomes in the present investigation indicate that age is a determinant variable in injury epidemiology because it affects the ratio of injuries per year. Our data showed that younger soccer players sustained a lower rate of injury than their adult counterparts (0.072 for U-18 soccer players vs. 0.094 for adult soccer players; $p < 0.001$).

The explanation for the lower risk of injury in younger players might be related to age-associated changes and underlying physiological mechanisms, such as reduction in muscle mass and muscle force output, decrease in bone mass, and even declines in reaction times for voluntary movements. However, it is likely that these mechanisms had a minor influence in our investigation, because the cutoff value for grouping soccer players (18 years) is an age at which most of these physical and physiological responses have not yet declined as a consequence of aging. The lower risk of injury in younger players might also be a result of their lower participation time in training and matches, at least when compared with adult counterparts. In the present investigation, we were unable to record exposure times for each player because of the high number of participants. However, we speculate that adult female soccer players accumulated more hours of training and match exposure, thus affecting the risk of injury during soccer play.

Previous studies have presented the number of injuries per 1000 h of exposure to standardize the frequency of injuries among investigations. These investigations have also found a lower frequency of injuries in younger soccer players: the number of soccer injuries in the adult population ranged 14.3–24.0 per 1000 player-hours in official matches and 2.7–7.0 per 1000 player-hours in training;^{4,12,19} younger soccer teams (e.g., 11–14 years) presented ranges 6.1–10.6 in matches and 1.0–2.1 per 1000 player-hours in training.^{7,8} Nevertheless, the interpretation of the comparison among these investigations should be made with caution because all these studies have been carried out in different countries with different methodologies.

The lower risk of injury in the current investigation could also be affected in part by the reduced intensity in matches and training sessions of the younger players. The age range in the U-18 group (8–17 years) suggests a lower competitive level in U-18 soccer teams, likely because of the lower adaptations of training in physical, technical, and tactical aspects. However, this speculation is contrary to a previous study performed with a cohort of elite female soccer players in France,⁶ in which younger players (under 15) had a higher incidence of injury than older players (under 19). All this information taken together might indicate that the elite level in young soccer players could offset the effects of reduced intensity as a probable cause of the minor incidence of injuries in younger players.

Interestingly, the present investigation did not reveal any difference between U18 female soccer players and adult counterparts for type of injury, severity, or body location (Tables 1

and 2). These results suggest that a player's age is not a main variable in determining the specificity of female soccer injuries. Other factors, such as soccer level, training strategies, or playing surface, could interfere in drawing conclusions when comparing female elite adult *vs.* young players. Although the present data indicate that age might increase the incidence of soccer injuries in female players without affecting the characteristics of the injuries, more scientific information is necessary to elucidate the complete effect of a player's age on the epidemiology of female soccer injuries.

In our research, we recorded a total 2108 soccer injuries in 25,397 female players, with an overall incidence rate of 0.083 injuries per soccer player per year. In male amateur soccer players, a previous study with the same methodology and experimental design recorded 15,243 injuries in Spain with a study sample of 134,570 soccer players (0.11 injuries per amateur player¹⁰). Thus, the comparison of these 2 investigations suggests a slightly higher ratio of injuries in amateur male soccer players when compared with female counterparts. Although a player's age and skill level have been proposed to have more influence on the risk of injury than gender alone,²³ the higher ratio of injury in men has been repeatedly found in previous research comparing male and female soccer players. For instance, using data from a national insurance system, Mufty et al.²⁴ found injury rates of 0.052 injuries per female soccer player and 0.068 injuries per male soccer player. Similarly, Hagglund et al.²⁵ recorded greater injury incidence for male *vs.* female elite soccer players in the Swedish premier league. Thus, these data suggest that male soccer players had a higher risk of injury than female soccer players, even when age and level are similar between sexes.

One of the main findings of this investigation was that the female soccer population in Spain was at a high risk of injuring lower limbs (74.0% of the total injuries reported), with approximately half of the total injuries located at the knee and the ankle (30.4% and 17.9%, respectively). The high proportion of injuries located in the knee and ankle joints agrees with previous investigations carried out on both elite^{4,22} and adolescent soccer players.^{2,16} Likewise, in Spanish male soccer players,¹⁰ most of the injuries were located in the lower limbs (69.8%), mainly affecting the knee (29.9%) and ankle (12.4%) joints. In elite soccer players,²⁵ similar results are evident (70% and 73% for the lower limbs of male and female soccer players, respectively), although the thigh was the location most frequently injured (23% for both men and women), followed by the knee (16% and 22%) and ankle (14% and 16%). Thus, although there might be differences in the risk of injury between sexes, the variations in the body location are minor when comparing male and female soccer players.

The most common types of injuries sustained by female soccer players were ligament injuries and contusions (65.8% of total injuries), with ligament injuries being the most common type in this category (38.5% of total injuries). Ligament injuries appear to be the primary type of soccer injuries in both male and female soccer players;^{4-6,10,24,26} for example, in male amateur soccer players in Spain, 32.1% of the total injuries were to ligaments.¹⁰ In the present investigation, the proportion

of ligament injuries represented 38.5% of all injuries reported during 1 year, indicating an overall higher proportion of ligament injuries in female soccer players than in men for 1 year. Previous research has suggested that of all the types of ligament injuries, injuries to the ACL of the knee occur more frequently in female than in male soccer players.^{26,27} Interestingly, by comparing our data with the ones obtained by Herrero et al.¹⁰ in Spanish male soccer players, we found that the ACL was the most frequently injured knee ligament in both male and female soccer players, although the frequency of this injury in respect to total knee ligament injuries was slightly higher in the female population (39.2% in women *vs.* 34.8% in men). As previously reported, female players are more prone to suffering injuries in the ACL. However, the present investigation also indicates that the prevalence of overall ligament injuries is higher in Spanish female soccer players, as has been reported in other cohort studies, in which ligament sprain incidence was slightly higher in female than in male soccer players.^{24,25}

According to the results of previous studies in young^{6,13,15} elite female soccer players,^{5,14} ankle ligament injuries are the most common type and location of injury diagnosed in female players. In these injuries, the lateral ligament, both in the right and in the left ankle, was affected most often. Of the total number of injuries analyzed in this investigation, 12.6% were ankle ligament injuries, representing the most common injury apart from knee ligament injuries. In male amateur soccer players, ankle ligament injuries accounted for 9.6% of the total during 1 season,¹⁰ although the frequency of ankle ligament injuries was less than that of knee ligament injuries in the male population. In our data, however, the lateral ligament was the most frequent site of ankle injury.¹⁰ These data involve rates of injury also seen in men's professional soccer;²⁸ although an overall higher injury incidence has been found in female players than in male players,³ between-sex differences, specifically for ankle injuries, are still unclear.

The causes of an increased prevalence of ligament injuries in female players cannot be inferred from our data. Hormonal factors (i.e., estrogen, progesterone, and relaxin) associated with menstrual phases are reported to increase ligamentous laxity and to decrease neuromuscular performance and thus might play a role in both passive and active knee stability in female athletes.²⁹ In addition, it has been found that injured female soccer players showed more general joint laxity than noninjured female soccer players during 1 season; this general joint laxity was seen as a significant predictor of knee injury. (In soccer players with increased joint laxity, the odds ratio was 5.3 *vs.* players with less general joint laxity.¹²)

In the current study, almost half the injuries attended to by the RSFF medical services were categorized as severe, in contrast to previous investigations, which reported that 12%–22% of injuries were severe.^{4-6,12-14} On the other hand, less than 20% of the injuries in the present study were catalogued as slight, a proportion less than that found by other soccer injury researchers (31%–51%). We speculated that the difference between this and previous investigations might be related to the methodology used. Instead of using medical reports from the medical staff of the team, our investigation was based on the medical

reports generated when female soccer players requested medical attention from the RSFF medical services. It is likely that players did not have recourse to medical services when the injury was minor, and thus the present data may underestimate the percentage of minor injuries in the female soccer population. Similarly, previous research with male soccer players in Spain (also based on RSFF medical services) revealed very similar data to those of the current population of female players, in which 47.4% were severe injuries, 16.7% were moderate, 16.7% were mild, and 19.2% were slight.¹⁰ Injury severity is therefore very similar between male and female soccer players in Spain, at least when comparing amateur players.

Soccer is a contact sport with many collisions during play. Interestingly, in the present study, injuries with contact mechanisms represented only 1 of 4 injuries in female soccer players, a proportion very similar to that described in a similar investigation with male soccer players in Spain.¹⁰ These data are lower than those reported by Soligard et al.² in young female soccer players. These authors found that 51% of total injuries were related to contact mechanisms. As would be expected, the percentage of contact injuries in the current investigation was higher in matches than in training. Similarly, but with a higher incidence of contact injuries, Fuller et al.³⁰ found that contact injuries in male and female soccer players in training represented 48.6% of total injuries on artificial turf and 43.7% of injuries on grass, whereas the proportion of contact injuries during soccer matches increased to 73.0% and 76.4% on artificial turf and grass, respectively.³¹ Official matches and their logical higher intensity and aggressiveness could result in more frequent contacts and a higher number of contact injuries in matches than in training conditions.

The difference in the mechanism of injury (e.g., contact or noncontact) resulted in differences in body location and type of injury in women's soccer. Fractures, contusions, and lacerations were more frequent in contact injuries, whereas meniscus, muscle, and tendon injuries were the more common noncontact injuries. Knee ligament injuries were also affected by the mechanism of injury: the lateral collateral and medial collateral ligaments were the most affected knee ligaments, representing 40% and 34%, respectively, of total knee ligament contact injuries. However, in knee injuries produced without contact, the ACL and the lateral collateral ligament were the most frequently injured knee ligaments. In quick stopping and cutting sports, such as soccer, female players have an increased proportion of ACL injuries.³²

This descriptive epidemiologic study presents some limitations that must be discussed to improve the interpretation and application of the outcomes. First, the current research was based on the medical reports obtained from a nationwide insurance system belonging to the RSFF. The data were obtained by trained and experienced medical practitioners working with the RSFF; the medical staff of the teams did not contribute to the collection of injury information, mainly because amateur teams do not usually have medical staff. This methodology permitted us to obtain a large sample size by including the whole population of female football players in Spain, but it lacks the meticulousness reported in other investigations carried out on a

single team. Second, the software used for the storage and organization of the injuries did not permit the inclusion of multiple body locations for those injuries that affected different body parts. Thus, only the most affected anatomic structure (and its accompanying information, such as type of injury and severity) was consigned in the database for those injuries that had affected several body parts. However, only 124 injuries (5.9% of the total) were reported as affecting multiple body locations, and it is assumed that the missing information is completely random, as previously suggested.²⁴ In addition, players had the right to choose to record a specific injury under the RSFF insurance or under their own public or private health insurance, so the number of injuries per player per year could be slightly underestimated. Finally, given the size of the sample, it was not feasible to record valid data regarding training and/or match intensity and exposure time. For this reason we were unable to determine the incidence of injuries per 1000 h of playing time, as has been done in similar investigations with large sample sizes.⁹

5. Conclusion

In summary, the present study showed that the overall injury incidence in female soccer players was lower in the U-18 group when compared with their adult counterparts. However, player age was not a key variable in establishing differences among female soccer injury characteristics such as type, body location, and severity. The ankle and knee were the most common locations of female soccer players' injuries, and additionally the mechanism of injury (contact with other player vs. noncontact) affected type, body location, and severity of the injury. Because most of the female soccer injuries had a noncontact mechanism, preventive strategies must be developed to reduce this type of injury. Preventive programs such as the FIFA 11+ warm-up program or neuromuscular training programs have led to a significant reduction in soccer injuries.^{9,33}

Authors' contributions

JDC conceived of the study and participated in its design and helped to draft the manuscript; HH conceived of the study and participated in its design and data collection; JJS conceived of the study and participated in its design, performed the statistical analysis, and drafted the manuscript. All authors have read and approved the final version of the manuscript and agree with the order of presentation of the authors.

Competing interests

None of the authors declare competing financial interests.

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