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ORIGINAL

STUDY OF INJURIES IN THE SPANISH MEN'S NATIONAL SOCCER TEAM (2008-2015)

ESTUDIO DE LAS LESIONES DE LA SELECCIÓN MASCULINA ABSOLUTA ESPAÑOLA DE FÚTBOL (2008-2015)

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ABSTRACT

Lesional Incidence (LI) is known as the lesion number per 1,000 exposure hours. The aim was to determine the LI and the possible factors that could have any influence in the lesions of the Spanish male absolute selection soccer players from 2008 to 2015. During this period 85 players were convened. Exposure time was 10,450 hours of which, 8,800 hours corresponding to training sessions and 1,650 hours to competition. LI was 7.46 lesions per 1,000 exposure hours of which, 76.9% corresponded to competition matches and the remaining to training sessions. Muscle impairment was the most frequent injury (52.4%). Injury severity was significantly related to player position on the field and with lesion mechanism. In conclusion, Spanish male absolute soccer selection showed a LI in the average of the remaining top-level soccer teams in the world.

KEY WORDS: Lesional incidence, soccer injuries, muscular impairment, ligament tears

RESUMEN

La Incidencia Lesional (IL) se define como el número de lesiones por 1.000 horas de exposición. El objetivo fue determinar la IL y los posibles factores que pudieran tener alguna influencia en las lesiones en los jugadores de la selección española de fútbol masculina absoluta de 2008 a 2015. Durante este periodo se convocaron 85 jugadores. El tiempo de exposición fue de 10.450 horas de las que 8.800 correspondían a entrenamiento y 1.650 horas a competición. El IL fue 7,46 lesiones por 1.000 horas de exposición correspondiendo el 76,9% a partidos de competición y el resto a entrenamientos. Las lesiones musculares fueron las más frecuentes (52,4%). La severidad de la lesión estaba relacionada con la posición del jugador y con el mecanismo lesional. En conclusión, la selección española absoluta de fútbol presentó un IL en la media de otros equipos de la élite del fútbol mundial.

PALABRAS CLAVE: Incidencia lesional, lesiones del fútbol, daño muscular, rotura ligamentosa

INTRODUCTION

Soccer is the most popular sport in the world. According to a survey conducted by the FIFA (Fédération Internationale de Football Association) in 2006, there are almost 270 million people practicing it at all levels (1). Sports participation at any age or competitive level is always accompanied by the risk of injury. At the professional level, injuries represent enormous economic losses for the clubs, a great damage to players who suffer them and a significant impact in the show (2). Van Mechelen et al. (3) postulated that prevention of injuries should be preceded by epidemiological studies that define the most important risk factors. Adoption by FIFA and UEFA (Union of European Football Associations) of an

international consensus to unify criteria and terminology in this type of epidemiological studies has been decisive to allow for the comparison of the results worldwide (4,5).

Lesional incidence (LI) is defined as the number of injuries occurred during training seasons or official and friendly competitions per 1,000 hours of exposure (3).Total LI for professional leagues in England, United States or Sweden ranges between 6 and 9 lesions per 1,000 hours (6-9). The study by UEFA Medical Committee with data collected by different medical services of 27 teams from 10 countries, with 11 years of follow-up (from 2001 to 2012) and a total of 1,743 players, found 8,029 sport drop outs due to injuries (10). On average, each player suffered two injuries per season, with 50 injuries per team (10). Differentiation between sessions in which lesion has taken place is frequent in these studies. Therefore, training lesional index (TrLI) could be distinguished from competition lesional index (CoLI), and even more, official competition lesional index (OCoLI) could be differentiated from friendly game lesional index (NCoLI). CoLI has been reported to range from 25-28 lesions per 1,000 hours (8,11,12) and even reaching values of up to 45 lesions per 1,000 hours (13), while TrLI ranges from 3 to 6 lesions per 1,000 hours (8,11,12,14). Results published by Junge et al. in different competitions organized by FIFA and the International Olympic Committee (IOC), establish that CoLI is generally 4 to 6 times greater than TrLI (15,16). Epidemiological studies demonstrate that most injuries in soccer players occurred in muscles and ligaments and are located in lower limbs and mainly in the thigh (2,5).

Economic burden due to injuries in soccer players are directly related to the time they are out of competition. Time out of competition is the criterion used to classify injuries according to severity. Hence, injury severity increases when time out of competition increases. Recurrence is another parameter which influences injury outcome. It is defined as an injury of the same type and location as any previous injury that occurs once player has been medically released (14). This work represents an epidemiological study of injuries in the Spanish Soccer First team squad players taken during an 8-year period, with the aim of the LI and the factors which may influence injuries.

MATERIAL AND METHODS

This epidemiological study includes medical records from the Spanish Soccer First team squad taken during the 2008-2015 period. This period includes 100 matches (60 official matches and 40 friendly games), starting on August 20th, 2008 with a non-official match against Denmark and finishing on June 14th, 2015 in Borisov (Belarus) where Spain played a match for the 2016 Europe Championship classification. In the study period, 85 players from 29 different clubs, mainly from the Spanish and English top leagues (Liga and Premier League) were convened. During this period 310 training programmed sessions in artificial grass surface took place. Methodology to take data was performed by analyzing medical records in each National Selection concentration during study period (17). Information was registered according FIFA and UEFA proposal through previously commented consensus using OSICS (Orchard Sports Injury Classification Sytem) (18). Information related to how medical

records were elaborated is shown in the Appendix (17). In order to minimize bias, the same medical team, composed by the same physicians and physiotherapists and following the same protocols and standards to take notes, examined soccer players. Soccer players gave their contentment and permission to use their data in present study.

Soccer players did not participate in the design, conduct and reporting of the research (Patient and Public Involvement statement).

Injury was defined as the event which occurs in a programmed training or competition session causing a player's drop-out in next training session or match. After clinical examination, accompanied by X-ray and/or magnetic resonance imaging (when necessary), they classified according to OSICS version 10 (18). ***Exposure time*** was considered as the time during a training or competition session in which players could have a lesion***. Lesional incidence (LI)*** was defined as the number of injuries occurred during training seasons or official and friendly competitions per 1,000 hours of exposure. ***Medical release*** was considered when player was able to train with the team, performing all contents proposed for training session, fulfilling each and every task. ***Severity*** of injury was determined according to elapsed time (days) from the date in which lesion took place to medical release. In these sense, according to their severity injuries were classified as minor (1 – 3 days), mild (4 -7 days), moderate (8 – 28 days) and serious (more than 28 days). ***Recurrence*** was considered when a player suffered an injury of same type and location as any other already suffered, which occurs after a player's return to full participation and within the next two months. ***Laterality*** refers to the side of the body in which the player has suffered the injury, options being the dominant side, non-dominant or not applicable. As an exception, in ambidextrous players injuries will be classified as dominant. Player determined dominant side as that most frequently used in daily and sport activities.

Statistical analysis was carried-out using the IBM SPSS Statistics version 22.0.0. software. Quantitative variables were expressed as the mean as central tendency measure and standard deviation as dispersion measure. Normality of quantitative variables was checked with the Kolmogorov-Smirnoff Test. Comparison of quantitative variables was carried-out using the Mann-Whitney U (2 independent variables) or the Kruskal-Wallis (more than 2 independent variables) non-parametric Tests. Categorical variables were expressed with the absolute frequency and the percentage and compared with the Pearson's $\chi 2$ Test. All hypothesis contrasts were bilateral and a $p\text{-value}<0.05$ was considered as statistically significant.

RESULTADOS

Epidemiologic factors

Between 2008 and 2015, the Spanish Soccer First team squad participated in 100 matches (60 official and 40 non-official matches) and 310 training sessions. Exposure time was 10,450 hours, in which 8,800 hours corresponded to training

sessions and 1,650 hours to competition (990 hours to official matches and 660 hours to non-official matches). A total of 78 players, with 57 players as debutants, were convened. Mean age of the players was 26.17 ± 3.02 years (mean ± SD). Thirty seven of these 78 players (47.4%) had at least one previous lesion. In these 37 players a total of 78 lesions were observed. Sixty injuries (76.9%) occurred during matches [36 (46.2%) in official matches and 24 (30.7%) in non-official matches] while the remaining 18 injuries took place during training sessions (Figure 1A). In the 60 injuries that occurred during matches, players had almost the same probability of having the lesion either during the first or second part of the match [26/60 (43.3%) and 29/60 (48.3%); respectively] (Figure 1B). The percentage of players having an injury was higher when their team was winning (35/60: 58.3%) than when tying or losing (Figure 1C).

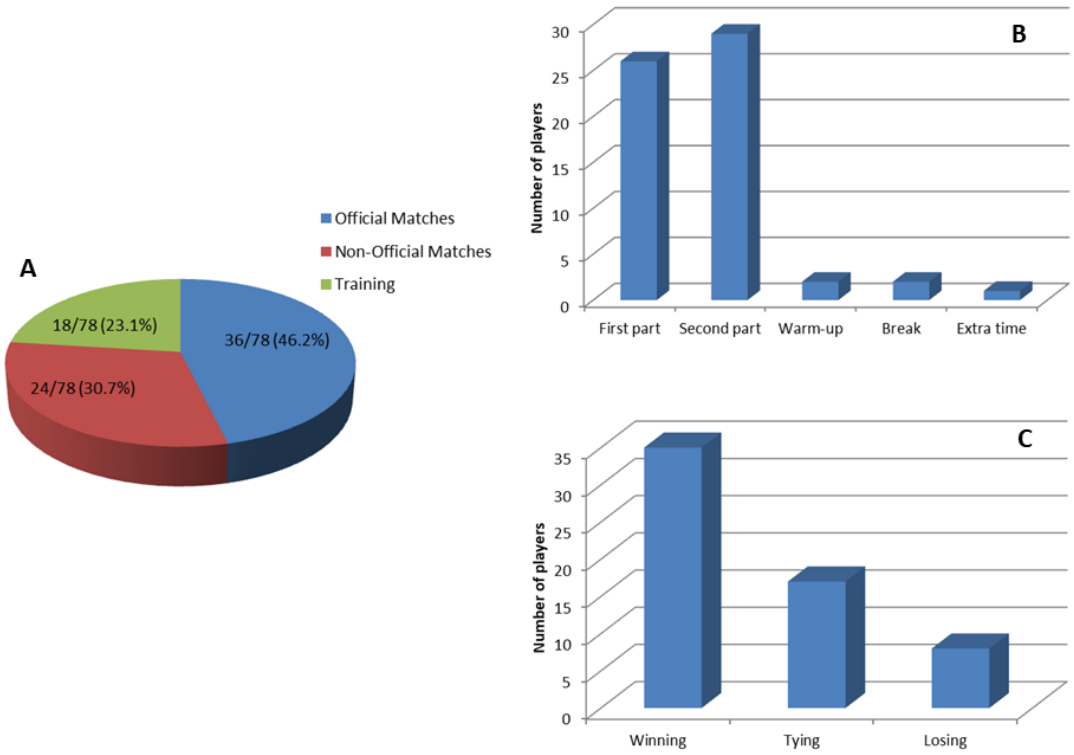


Figure 1. Lesion distribution according to type of event (A). In injuries occurred during a match, number of injuries at any moment of the game (B). Injury distribution according to the match result at the moment they took place (C)

Lesion number distribution among the players is depicted in Figure 2. Most players [20/37 (54.0%)] had only one lesion (Figure 2).

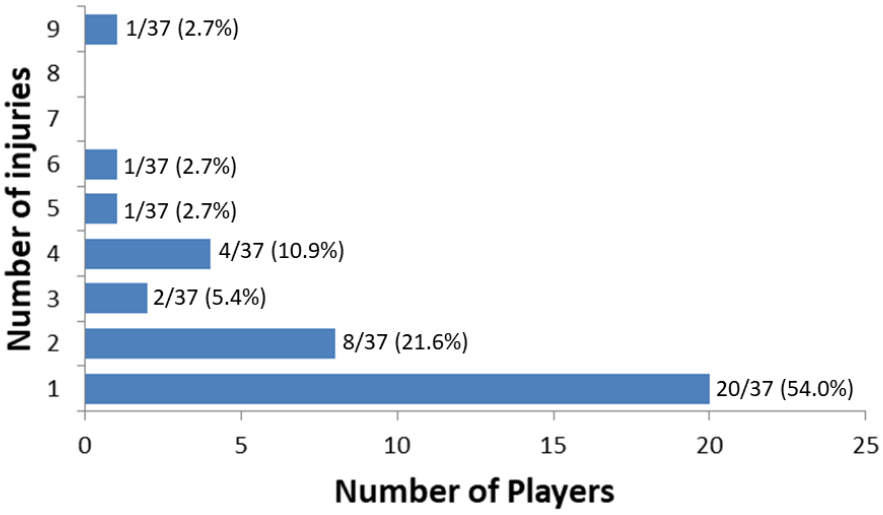


Figure 2. Distribution of lesion number among the Spanish Soccer First team squad players

As shown in Table 1, most injuries occurred in the center-back players [20/78 (25.6%)] and goalkeepers were the players who suffered the lowest number of injuries [5/78 (6.4%)]. In 43/78 (55.1%) lesion laterality occurred in the dominant side.

Table 1. Field position of injured players

Centre-back	20 (25,6%)
Defensive Midfielder	14 (17,9%)
Winger	13 (16,7%)
Forward	13 (16,7%)
Attacking Midfielder	13 (16,7%)
Goalkeeper	5 (6,4%)
TOTAL	78 (100,0%)

Lesional Incidence

Overall LI and LI calculated in players with recurrence are depicted in Table 2. LI corresponding to training sessions, competition (official and non-official matches) are also consigned (Table 2). Both, overall and recurrence IL during competitions were several times higher than that estimated during training sessions (Table 2).

Table 2. Lesional Incidence (LI) estimated as the number of injuries per 1.000 hours of exposure. LI has been calculated for all 78 injuries appearing in the time period considered in this study (Overall IL). LI has been also estimated for patients with recurrence.

		Exposure time (h)	Overall		Recurrences	
			Number of injuries	LI	Number of injuries	LI
Total		10,450	78	7.46	20	1.91
	Training	8,800	18	2.05	6	0.68
	Competition	1,650	60	36.36	14	8.48
	Official	990	36	36.36	6	6.06
	Non-official	660	24	36.36	8	12.12

Mechanisms of production and injury location

In 57 cases (73.1%) injury took place without coming into contact with another player whereas in the remaining 21 players (26.9%) injury occurred after a contact with other players. Injury mechanism is shown in Table 3. In most cases a clear mechanism could not be established and were classified as non-specified injuries [19/78 (24.4%)]. In the cases of known injury mechanism players were frequently injured by a kick or stomp executed by an opponent [12/78 (15.4%)] or by muscle overload [12/78 (15.4%)] (when an increment in training load or volume exists, conditioning existence of muscle disorders such as post-exercise pain, contracture or DOMS: Delayed Onset Muscular Soreness) (Table3).

Table 3. Injury mechanisms in included players

Mechanism	Number of injuries	Percentage
Non-specified	19	24,4
Kick/Stomp	12	15,4
Overload	12	15,4
Changing pace	7	8,9
Changing direction	5	6,4
Jumping	4	5,1
Collision	3	3,8
Unstable contact on weight-bearing	3	3,8
Ball control	2	2,6
Dribbling	2	2,6
Ball kicking	2	2,6
Other	7	9,0
TOTAL	78	100,0

Changing pace (accelerating or deaccelerating) was another relative frequent cause of injury [7/78 (8.9%)]. Distribution of injury types is depicted in Table 3. Muscular damage was the most frequent lesion [41/78 (52.4%)].

Table 4. Type of injury in included players

Type of injury	Number of players	Percentage
Muscular	41	52,4
Ligaments	13	16,6
Contusion	11	14,1
Bone edema	2	2,6
Groin injury	2	2,6
Enthesopathy	2	2,6
Tendinitis	2	2,6
Concussion	1	1,3
Lumbago	1	1,3
Luxation	1	1,3
Bone fracture	1	1,3
Chondral lesion	1	1,3
TOTAL	78	100,0

Ligament damage, including ligament tears or sprains, was the second injury cause in our players [13/78 (16.6%)] and contusion was the third one [11/78 (14.1%)] (Table 4). Most injuries were located in hamstrings [17/78 (21.8%)], knee [11/78 (14.1%)] and ankle [10/78 (12.8%)] (Table 5).

Table 5. Anatomic location of injuries

Location	Number of players	Percentage
Hamstrings	17	21,8
Knee	11	14,1
Ankle	10	12,8
Quadriceps	8	10,3
Foot	6	7,7
Abductors	5	6,4
Calf	5	6,4
Hip/Groin	4	5,1
Dorsal spine	3	3,8
Ribcage	2	2,6
Fith finger	1	1,3
Head	1	1,3
Face	1	1,3
Dorsolumbar spine	1	1,3
Lumbar spine	1	1,3
Buttocks	1	1,3
Shoulder	1	1,3
Total	**78**	**100,0**

Severity

Percentage of each injury type attending to severity is represented in Figure 3.

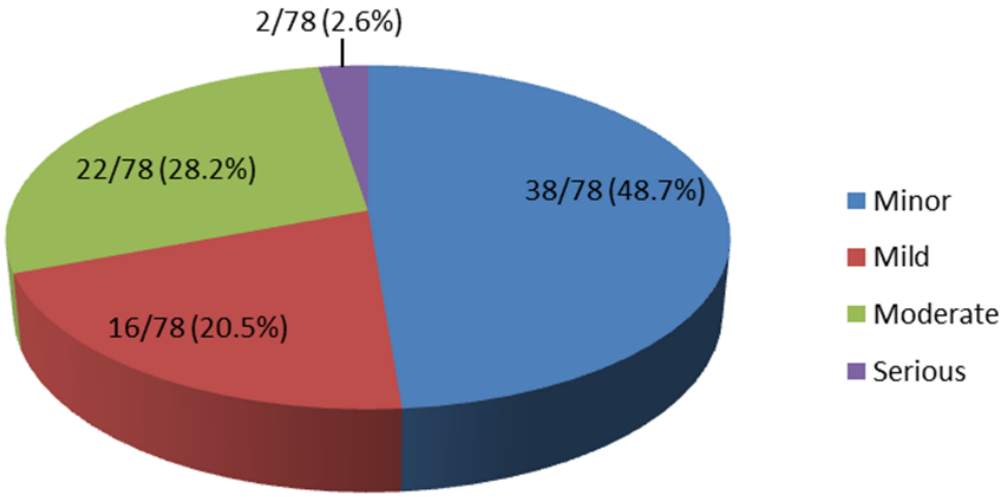
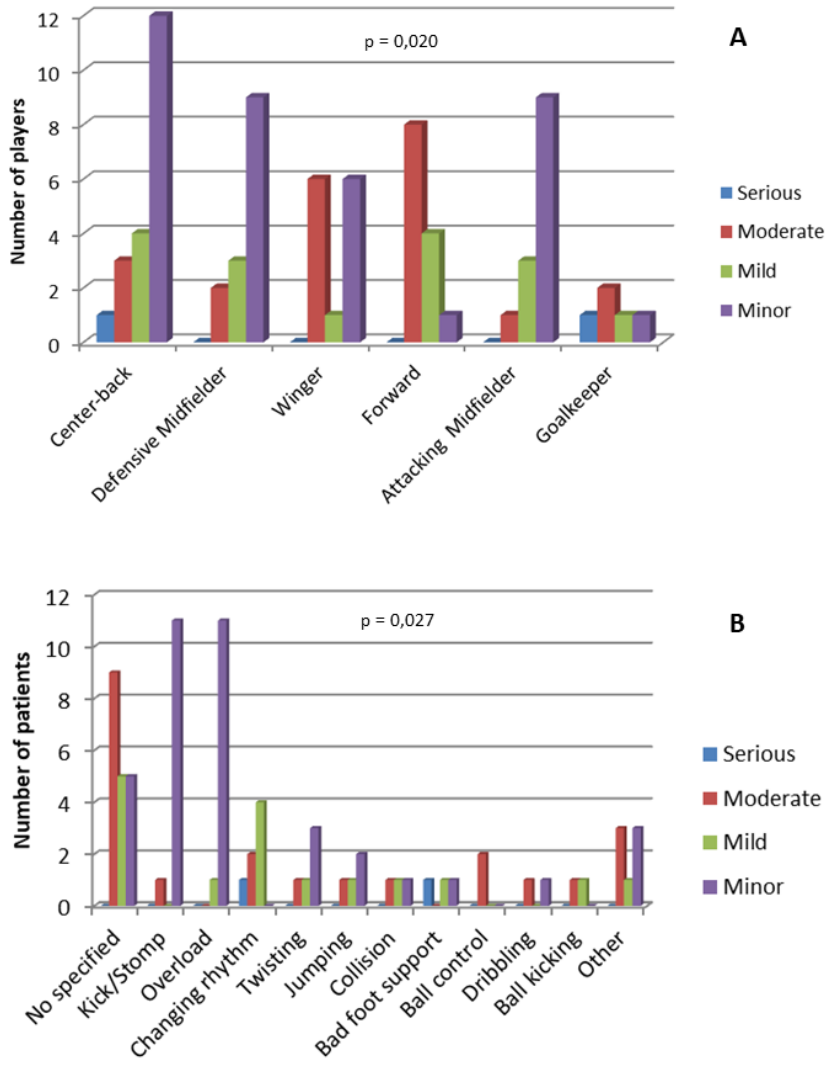


Figure 3. Injury severity according to elapsed time (days) from the date in which lesion took place to medical release: minor (1 – 3 days), mild (4 -7 days), moderate (8 – 28 days) and serious (more than 28 days)

Almost a half of the injuries [38/78 (48.7%)] were considered minor and only in 2 cases (2.6%) the injury was classified as serious. No statistically significant relationship between severity and age (p=0.421), event (competition or training) (p=0.680), moment of the match where injury occurred (p=0.707), match outcome (p=0.137), laterality (p=0.428), contact with other players (p=0.258), location (p=0.454) and type of injury (p=0.505) was found. In contrast, severity was significantly related to field position (p=0.020) (Figure 4A) and with injury mechanism (p=0.027) (Figure 4B). A goal-keeper and a center-back were the players who suffered the only two serious lesions observed whereas moderate injuries were more associated with wingers and forwards (Figure 4A). With respect to injury mechanism, serious lesions occurred while player was changing pace in one case and after unstable contact on weight-bearing in the other. Minor severity was mainly associated to an opponent's kick or stomp and to muscle overload (Figure 4B).

Figure 4. Injury severity distribution according to players' field position (A) and to mechanism of injury production (B).In both cases a statistically significant relationship was found (p=0.020 and p=0.027. respectively; Pearson's χ2 Tests)



Recurrence

Among the 78 injuries, in 20 cases (25.6%) the lesion corresponded to a recurrence from a previous one. No statistically significant relationship between recurrence and age (p=0.691), field position (p=0.227), event type (p=0.244), moment of the match where injury occurred (p=0.925), match outcome (p=0.464), laterality (p=0.283), existence of contact with other player (p=0.077), location (p=0.188) and injury mechanism (p=0.233) was found. In contrast, recurrence was statistically related to type of lesion (p=0.030). Hence, recurrences were mainly associated to muscular injuries and to bone edema, chondral lesions and luxation (Figure 5).

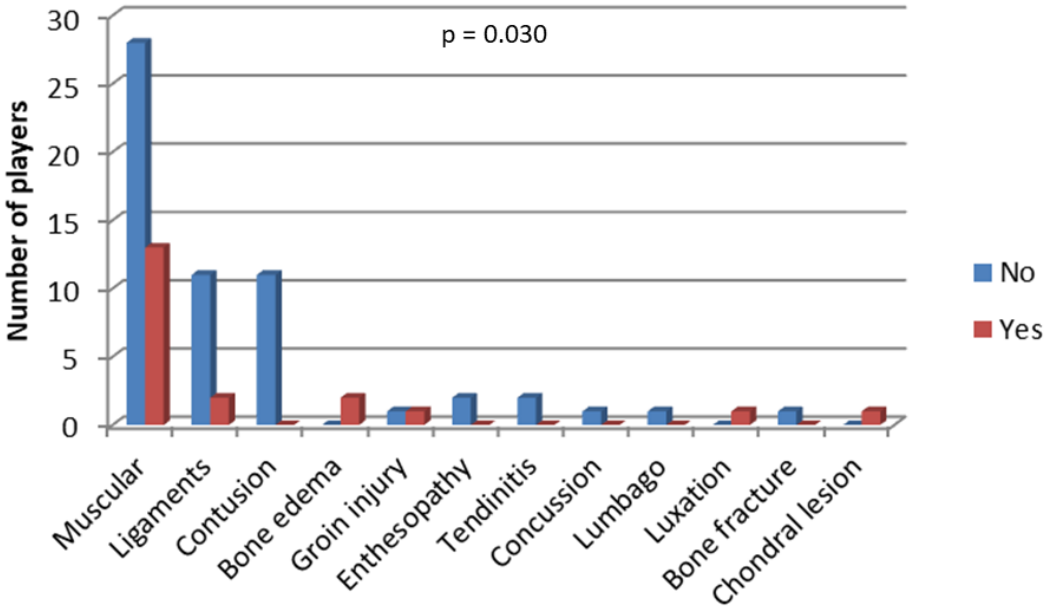


Figure 5. Relapse distribution according to mechanism of injury. A statistical relationship between both variables was found (p=0.030. respectively; Pearson's χ2 Tests)

DISCUSSION

Prevention of injuries in soccer is of vital importance due to the significant impact they represent for clubs (2,3). This epidemiological study, performed in the Spanish Soccer First team squad players along 8 years (from 2008 to 2015), represents a first attempt to elucidate the factors related to injuries in high-performance competition. Most exposure time in our work, 84.2%, corresponded to training sessions and the remaining 15.8% corresponded to competition (training/competition ratio of 5.3/1). This ratio varies depending on the team level. Top level teams usually compete more often and have few training sessions, therefore showing a low ratio. The first team squad plays matches to qualify for or in a final phase with no more than 3 or 4 days between them to rest and/or train. Noya et al. (19) reported that Spanish Liga 1st division teams which participated in European competitions had a training/competition ratio of 9.1/1, whereas the ratio turned out to be 11.5/1 in those 1st division teams without European competitions or 2nd division teams. Other studies have confirmed that top level teams have a low ratio and a high competition density in Spain and the rest of Europe (9,20,21).

Several studies performed in professional leagues from United States, England and Sweden have published a LI value ranging from 6 to 9 injuries per 1,000 h of exposure (6-9,11,22,23).The value found in our study, 7.46 injuries per 1,000 h exposure is within the average of such values. LI value in training sessions (TrLI) found in our work, 2.05 injuries per 1,000 h of exposure, is lower compared with other studies in which the value ranges from 3.83 to 9.20 injuries per 1,000 h of exposure (6,8,10-12,24-27). TrLI is usually low in top performance teams and one of the reasons which could explain this fact could

be high competition frequency of these top-level teams. When the number of matches increases the aim of training is the player's recovery which is why training load is usually low. LI in competition (CoLI) found in our study, 36.36 injuries per 1,000 h of exposure is closer to that found in other studies (10,13,18,28). Interestingly, same LI, 36.36 injuries per 1,000 h of exposure, was found in official (OCoLI) and in friendly matches (NCoLI). Mallo et al. (13) reported a value of 55.8 in OCoLI and 22.6 in NCoLI. High friendly-match frequency has been reported as being related to lesional risk increase (28,29). There is not a clear explanation for this fact, but it could be speculated that this difference between both indexes, OCoLI and NCoLI, could be lower as participating teams' level increases, with the friendly match becoming more similar to an official match. Junge et al. (30,31) reported in competitions held by FIFA and International Olympic Committee that CoLI is 4 to 6-fold higher than TrCo. We have found a ratio 18-fold higher in our study. This difference could be explained by the high competitive burden and reduced training density in top-level teams. Another explanation arises from the Ryynänen et al. (32,33) results after studying the relationship of match outcome with injury frequency. Authors conclude that players in a "winning" team have more risk of suffering a lesion during competition.

Most injuries in our study took place without contact with other players, which agrees with previously published studies (26,27,34). However, with respect to the mechanism of injury production our results are different to those found by other authors (26,34,35). "Overload" mechanism, which is the most frequent in other studies (27) is not the main mechanism of lesion production in our study. It could be due to the adequate fatigue and competitive burden management. It has been demonstrated that muscular injuries are the most common lesions in soccer players, followed by ligamentous injuries (2,5, 24-27,35-37). In the present study, further to being the most frequent among those with a known mechanism, muscular lesions also show a higher incidence than that found by other authors. One possible explanation could be the different methodologies used to record lesions among studies. Concussions are one of the least frequent injuries in soccer. We only had one and the player did not show loss of consciousness. Lower limbs were the most frequent location in our players (78.2%), with hamstrings, knee quadriceps and abductors as the most frequently injured anatomic regions in soccer players. Hence, the thigh is the body part with the highest incidence of lesion in players, followed by the knee and the ankle, which agrees with other studies (6,14,26,31,34,35).

In the present study 2.6% injuries were classified as serious and 28.2% as moderate. Our results agree with those of some authors (6,8,11,25) but are different from others' (24,26,34,35). This discrepancy could be explained by different methodology and criteria used to collect data. However, this hypothesis should be addressed in future studies. One considered aspect in the present work was injury severity and the possible factors affecting severity. Injury severity was statistically related to players' field position and to injury mechanism. Although relationship between field position and severity has not been found in other studies, there are numerous publications mentioning the role of field position in frequency and type of injury, although data are not concluding (2,29,38). With respect to injury mechanism, severity is lower in

“overload” mechanism whereas mechanisms such as “ball control” and “changing pace” are related to moderate or mild severity. Noya et al. (19) claimed that severe lesions occurred after contact with the opponent.[18] Our results make us think that this affirmation is not always true, since we have found some relatively serious self-injuries.

In sports, injury recurrence is a great concern. In the present study recurrence represents 25.6% of all injuries. In other studies, recurrence ranges from 7% to 35% (6,7,23,26,27,34,35,39,40). A premature return to competition, sometimes precipitously, is one of the most important risk factors in recurrence (6,27). In the Spanish National team, convened players have usually played on the previous day for their clubs, and have received medical release to compete. We have found that recurrences were related to lesion type and were mainly associated to muscular injuries, bone edema and to chondral lesion and luxation to a lesser extent. However, there is no consensus about factors which may affect injury recurrence. Hägglund et al. (41) reported that recurrence has decreased over the past decade and proportion decreased in top professional soccer level.

CONCLUSION, The Spanish Soccer First team squad from 2008 to 2015, shows an average LI although with injuries of lower severity than that found in other top-level soccer teams.

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