Hand, Wrist, and Forearm Injuries in Male Professional Soccer Players

A Prospective Cohort Study of 558 Team-Seasons From 2001-2002 to 2018-2019

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Background: The literature on upper extremity injuries in professional soccer players is scarce, and further insight into the onset and cause of these injuries as well as potential differences between goalkeepers and outfield players is important.

Purpose: To investigate the epidemiology of hand, wrist, and forearm injuries in male professional soccer players between 2001 and 2019.

Study Design: Descriptive epidemiology study.

Methods: Between the 2001-2002 and 2018-2019 seasons, 120 European male soccer teams were followed prospectively for a varying number of seasons (558 team-seasons in total). Time-loss injuries and player-exposures to training sessions and matches were recorded on an individual basis in 6754 unique players. Injury incidence was reported as the number of injuries per 1000 player-hours, and between-group differences were analyzed using *Z* statistics and rate ratios (RRs) with 95% CIs. Between-group differences in layoff time were analyzed.

Results: In total, 25,462 injuries were recorded, with 238 (0.9%) of these affecting the hand (71.4%; n = 170), wrist (16.8%; n = 40), and forearm (11.8%; n = 28), producing an incidence of 0.065 injuries per 1000 hours. A majority of the injuries were traumatic with an acute onset (98.7%; n = 235). Fractures were the most common injuries recorded (58.8%; n = 140), often involving the metacarpal bones (25.2%; n = 60) and phalanges (10.1%; n = 24). The injury incidence was significantly higher for goalkeepers (115 injuries; 0.265 per 1000 hours) compared with outfield players (123 injuries; 0.038 per 1000 hours) (RR, 7.0 [95% CI, 5.4-9.0]). Goalkeepers also had a significantly longer mean layoff time than outfield players (23 ± 27 vs 15 ± 27 days; $P = .016$).

Conclusion: Injuries to the hand, wrist, and forearm constituted less than 1% of all time-loss injuries in male professional soccer players. Fractures were most common and constituted more than half of all injuries. Goalkeepers had a 7-fold higher incidence and an over 1-week longer mean layoff time compared with outfield players.

Keywords: athletic injuries; football; goalkeeper; injury incidence; upper extremity

Playing professional soccer often leads to a large number of injuries, and it has been estimated that a men's professional team with 25 players on the squad can expect, on average, approximately 50 time-loss injuries every season.[8] A majority of time-loss injuries are located on the lower extremities,[8] while approximately 3% are located on the upper extremities.[7]

Some studies have investigated shoulder injuries in soccer players, regardless of playing level, with a primary interest in goalkeepers.[5,11,19,26] Little is, however, known about the epidemiology and characteristics of hand, wrist, and forearm injuries in soccer players[7,24]; in fact, there is, to our knowledge, no previous study that has evaluated the epidemiology of these injuries in detail in professional soccer players. Outfield players can often, at least empirically, participate fully in training and competition early after various injuries to the upper extremity or even have no time loss at all; a complex hand, wrist, or forearm injury can, however, lead to long periods on the sidelines and even be career ending to goalkeepers.

Nonunion of scaphoid fractures, malunion of wrist fractures, and intra-articular fractures of the metacarpal base of the thumb as well as overlooked wrist ligament injuries, particularly scapholunate ligament (SL) injuries and

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injuries leading to distal radioulnar joint instability, could develop into posttraumatic degenerative arthritis within 3 to 10 years.[1-4,15,21,29]

The purpose of this study was to investigate the epidemiology of hand, wrist, and forearm injuries in male professional soccer players between 2001 and 2019. The specific objective was to determine the incidence and characteristics of these injuries, with a special interest in goalkeepers.

METHODS

The study protocols were approved by the Union of European Football Associations (UEFA) Football Development Division and the UEFA Medical Committee. Written informed consent was collected from each player in accordance with the guidelines of the Declaration of Helsinki. Ethical approval was also obtained from the regional ethical review boards in Scandinavia. Between the 2001-2002 and 2018-2019 seasons, 120 European male soccer teams were followed prospectively for a varying number of team-seasons. In total, 6754 unique players (6052 outfield players and 702 goalkeepers) were followed during 558 team-seasons. As the numbers of hand, wrist, and forearm injuries were expected to be much lower compared with the number of lower limb injuries, we used several cohorts of male professional players:

- The UEFA Elite Club Injury Study, 2001-2019 (55 unique teams);
- The English Premier League Injury Study, 2011-2014 (14 unique teams);
- The Artificial Turf Injury Audit, 2003-2010 (12 unique teams);
- The Swedish First League Injury Audit, 2001, 2002, and 2005 (15 unique teams);
- The Danish First League Injury Audit, 2001 (7 unique teams); and
- The Nordic Football Injury Audit, 2010-2011 (17 unique teams).

Study Design and Data Collection

The study design followed the consensus statement on definitions and data collection procedures for epidemiological studies on injuries in football (soccer).[9] In addition, the methodology and definitions have previously been reported in detail.[12] Briefly, all teams were provided with a study manual (translated to the proper languages needed) describing the definitions used and procedures needed to record data. The Orchard Sports Injury Classification System was used to classify injuries.[22]

All contracted players from the first teams were invited to participate in the study. Teams were followed prospectively during full seasons including both the preseason and the competitive season. Baseline player data were collected at the time of study inclusion on an annual basis. Individual participation in training sessions and matches (minutes of exposure) was registered by the team's contact person on a standard exposure form. The medical staff recorded every injury and the related diagnosis, nature, and circumstance of its occurrence on a standard injury form. The exposure and injury data were sent to the study investigators on a monthly basis; they checked all reports continuously, and feedback was sent to the teams, if needed, to correct any missing or unclear data. If a player left a team during the season, regardless of the reason (eg, because of transfer to another club), the registered data were included for the length of his participation period.

All injuries resulting in a player's inability to fully participate in training sessions or matches were recorded and followed until the final day of rehabilitation. The player was considered injured until the medical staff of the specific team allowed full participation in training and availability for match play. Injury severity was categorized according to the consensus statement into slight (layoff of 0 days), minimal (layoff of 1-3 days), mild (layoff of 4-7 days), moderate (layoff of 8-28 days), and severe (layoff of $>$28 days).[8] No specific diagnostic criteria for the different injury types and subtypes were used, and it was up to the medical staff to classify the injuries and refer the player for imaging or any other consultations as needed.

Statistical Analysis

Players' demographics and layoff times were reported with descriptive statistics using means ± SDs and medians (interquartile ranges). We analyzed between-group differences in demographic variables using an independent-samples t test and in layoff times using the Mann-Whitney U test because of skewed data distribution. Injury incidence was reported as the number of injuries per 1000 player-hours, and the between-group difference was

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TABLE 1
Injury Distribution for Goalkeepers and Outfield Players[a]

	Hand Injury (n = 170)	Wrist Injury (n = 40)	Forearm Injury (n = 28)	Total (n = 238)
Overall				
Goalkeepers	94 (55.3)	14 (35.0)	7 (25.0)	115 (48.3)
Outfield players	76 (44.7)	26 (65.0)	21 (75.0)	123 (51.7)
Training	90 (52.9)	23 (57.5)	11 (39.3)	124 (52.1)
Goalkeepers	70 (41.2)	12 (30.0)	3 (10.7)	85 (35.7)
Outfield players	20 (11.8)	11 (27.5)	8 (28.6)	39 (16.4)
Match	80 (47.1)	17 (42.5)	17 (60.7)	114 (47.9)
Goalkeepers	23 (13.5)	2 (5.0)	4 (14.3)	29 (12.2)
Outfield players	57 (33.5)	15 (37.5)	13 (46.4)	85 (35.7)

[a]Data are reported as n (%).

analyzed using Z statistics and rate ratios (RRs) with 95% CIs. Findings for outfield players were used as the denominator (reference) in injury incidence comparisons between goalkeepers and outfield players. The significance level was set at $P < .05$.

RESULTS

In total, 25,462 injuries were registered, with 238 (0.9%) being injuries to the hand (71.4%; n = 170), wrist (16.8%; n = 40), and forearm (11.8%; n = 28). Goalkeepers sustained 115 (48.3%) of these injuries compared with 1678 (6.6%) of all injuries and 1064 (4.8%) of lower limb injuries. Overall, 3,686,838 exposure hours (3,136,111 hours in training and 550,727 hours in match play) were registered: 2,754,012 hours in training and 498,151 hours in match play for outfield players and 382,099 hours in training and 52,576 hours in match play for goalkeepers. Goalkeepers were significantly older (age, 27 ± 6 vs 25 ± 4 years), taller (height, 189.7 ± 3.8 vs 182.9 ± 5.4 cm), and heavier (mass, 85.7 ± 6.1 vs 78.9 ± 7.2 kg) ($P < .001$ for all) compared with outfield players.

Injury Characteristics

A majority of injuries affected the right arm (55.5%; n = 100): 69 of 170 (40.6%) for hand injuries, 20 of 40 (50.0%) for wrist injuries, and 11 of 28 (39.3%) for forearm injuries. Injuries to the hand and wrist were more common during training, whereas forearm injuries were more common during match play (Table 1). Two-thirds of the 60 (66.7%; n = 40) metacarpal bone fractures occurred during match play.

The vast majority of injuries were traumatic with an acute onset (98.7%; n = 235). Only 1 overuse-related hand injury (goalkeeper; bone edema) and 2 overuse-related wrist injuries (both goalkeepers; synovitis and combined degenerative chondral and ligament injury) were recorded; all occurred during training. Similarly, only 5 reinjuries (4 outfield players, 1 goalkeeper) were recorded; 4 of 5 of the reinjuries occurred during training.

TABLE 2
Types of Hand, Wrist, and Forearm Injuries for Goalkeepers and Outfield Players[a]

	Hand Injury (n = 170)	Wrist Injury (n = 40)	Forearm Injury (n = 28)	Total (n = 238)
Fractures[b]	92 (54.1)	24 (60.0)	24 (85.7)	140 (58.8)
Goalkeepers	31 (18.2)	3 (7.5)	4 (14.3)	38 (16.0)
Outfield players	61 (35.9)	21 (52.5)	20 (71.4)	102 (42.9)
Joint and ligament sprains	50 (29.4)	12 (30.0)	0 (0.0)	62 (26.1)
Goalkeepers	41 (24.1)	8 (20.0)	0 (0.0)	49 (20.6)
Outfield players	9 (5.3)	4 (10.0)	0 (0.0)	13 (5.5)
Muscle and tendon strains	6 (3.5)	1 (2.5)	1 (3.6)	8 (3.4)
Goalkeepers	4 (2.4)	1 (2.5)	1 (3.6)	6 (2.5)
Outfield players	2 (1.2)	0 (0.0)	0 (0.0)	2 (0.8)
Contusions/hematomas/ lacerations	22 (12.9)	3 (7.5)	3 (10.7)	28 (11.8)
Goalkeepers	13 (7.6)	2 (5.0)	2 (7.1)	17 (7.1)
Outfield players	9 (5.3)	1 (2.5)	1 (3.6)	11 (4.6)

[a]Data are reported as n (%).
[b]No stress fractures/bone stress were recorded.

Fractures dominated the injury profile (Table 2) but were particularly frequent among the forearm injuries (85.7%; n = 24). Other fractures most commonly involved the metacarpal bones (25.2%; n = 60) and phalanges (10.1%; n = 24). Scaphoid fractures (5.0%; n = 12), other carpal fractures (1.7%; n = 4), and distal radial/ulnar fractures (2.5%; n = 6) were less common.

Injury Incidence and RR

The overall injury incidence was 0.065 per 1000 hours and was consistently higher during match play compared with training (Table 3). This means that a team with a typical 25-player squad would expect fewer than 1 hand, wrist, or forearm injury each season (1 hand injury every third season, 1 wrist injury every 14th season, and 1 forearm injury every 20th season).

There was an overall 5-fold increased incidence during match play compared with training (0.202 vs 0.040 per 1000 hours; RR, 5.0 [95% CI, 3.9-6.4]) that was most pronounced for forearm injuries (0.031 vs 0.004 per 1000 hours; RR, 8.8 [95% CI, 4.1-18.8]). The injury incidence and RR for goalkeepers and outfield players are displayed in Table 3.

Injury Severity and Layoff Times

More than half of all injuries resulted in a layoff time of more than 1 week, and one-fifth were severe, with a layoff time of at least 4 weeks (Table 4). Because of the skewed data distribution, the median layoff time was only 10 days, whereas the mean layoff time was 19 days (Table 5). The longest

TABLE 3
Injury Incidence and RR for Goalkeepers and Outfield Players[a]

	Injury Incidence (95% CI)				
	All Players	Goalkeepers	Outfield Players	RR (95% CI)	*P* Value
Overall	0.065 (0.057-0.073)	0.265 (0.220-0.318)	0.038 (0.032-0.045)	7.0 (5.4-9.0)	**<.001**
Training	0.040 (0.034-0.048)	0.228 (0.185-0.281)	0.015 (0.011-0.020)	15.7 (10.8-22.8)	**<.001**
Match	0.202 (0.167-0.243)	0.533 (0.368-0.771)	0.167 (0.134-0.207)	3.2 (2.1-4.9)	**<.001**
Hand	0.046 (0.040-0.054)	0.216 (0.177-0.265)	0.023 (0.019-0.029)	9.3 (6.8-12.5)	**<.001**
Training	0.030 (0.024-0.036)	0.188 (0.150-0.237)	0.008 (0.005-0.012)	24.7 (15.2-40.2)	**<.001**
Match	0.140 (0.112-0.175)	0.418 (0.276-0.635)	0.110 (0.085-0.144)	3.8 (2.3-6.2)	**<.001**
Wrist	0.011 (0.008-0.015)	0.032 (0.019-0.054)	0.008 (0.005-0.012)	4.0 (2.1-7.7)	**<.001**
Training	0.007 (0.005-0.011)	0.031 (0.018-0.055)	0.004 (0.002-0.007)	7.9 (3.5-17.8)	**<.001**
Match	0.031 (0.019-0.050)	0.038 (0.010-0.152)	0.030 (0.018-0.050)	1.3 (0.3-5.5)	.756
Forearm	0.008 (0.005-0.011)	0.016 (0.008-0.034)	0.006 (0.004-0.010)	2.5 (1.1-5.9)	**.036**
Training	0.004 (0.002-0.006)	0.008 (0.003-0.024)	0.003 (0.001-0.006)	2.7 (0.7-10.2)	.142
Match	0.031 (0.019-0.050)	0.076 (0.029-0.203)	0.026 (0.015-0.045)	2.9 (1.0-8.9)	.061

[a]Bolded *P* values indicate statistical significance ($P < .05$). RR, rate ratio.

TABLE 4
Injury Severity for Goalkeepers and Outfield Players[a]

	Slight	Minimal	Mild	Moderate	Severe
Overall	9 (3.8)	47 (19.7)	42 (17.6)	91 (38.2)	49 (20.6)
Goalkeepers	3 (2.6)	19 (16.5)	21 (18.3)	40 (34.8)	32 (27.8)
Outfield players	6 (4.9)	28 (22.8)	21 (17.1)	51 (41.5)	17 (13.8)
Hand	6 (3.5)	37 (21.8)	34 (20.0)	59 (34.7)	34 (20.0)
Goalkeepers	3 (3.2)	16 (17.0)	19 (20.2)	31 (33.0)	25 (26.6)
Outfield players	3 (3.9)	21 (27.6)	15 (19.7)	28 (36.8)	9 (11.8)
Wrist	2 (5.0)	6 (15.0)	6 (15.0)	23 (57.5)	3 (7.5)
Goalkeepers	0 (0.0)	2 (14.3)	1 (7.1)	8 (57.1)	3 (21.4)
Outfield players	2 (7.7)	4 (15.4)	5 (19.2)	15 (57.7)	0 (0.0)
Forearm	1 (3.6)	4 (14.3)	2 (7.1)	9 (32.1)	12 (42.9)
Goalkeepers	0 (0.0)	1 (14.3)	1 (14.3)	1 (14.3)	4 (57.1)
Outfield players	1 (4.8)	3 (14.3)	1 (4.8)	8 (38.1)	8 (38.1)

[a]Data are reported as n (%).

TABLE 5
Layoff Times (in Days) for Goalkeepers and Outfield Players[a]

	All Players	Goalkeepers	Outfield Players	*P* Value
Overall				**.016**
Mean ± SD	19 ± 27	23 ± 27	15 ± 27	
Median (IQR)	10 (4-25)	11 (5-35)	9 (3-18)	
Hand				**.009**
Mean ± SD	16 ± 17	20 ± 21	11 ± 10	
Median (IQR)	9 (3-25)	10 (4-30)	7 (2-14)	
Wrist				.250
Mean ± SD	15 ± 18	23 ± 28	11 ± 8	
Median (IQR)	11 (4-18)	13 (8-19)	10 (4-17)	
Forearm				.212
Mean ± SD	45 ± 58	67 ± 60	37 ± 57	
Median (IQR)	25 (9-66)	72 (6-133)	20 (11-35)	

[a]Bolded *P* values indicate statistically significant difference ($P < .05$). IQR, interquartile range.

layoff time was seen for forearm injuries, whereas it was shorter and similar for hand and wrist injuries (Table 5).

Goalkeepers Versus Outfield Players

A majority of the 115 injuries in goalkeepers affected the hand (81.7%; n = 94). Some specific injuries were more common in goalkeepers, such as phalanx fractures (15/24 injuries), finger dislocations (41/50 injuries), and thumb injuries (14/20 injuries), whereas metacarpal fractures affected goalkeepers in a minority of cases (12/60 injuries). Almost two-thirds of the severe injuries (65.3%; n = 32) affected goalkeepers (Table 4).

Goalkeepers had a significantly higher injury incidence than did outfield players in general, except for training-related forearm injuries and match-related wrist and forearm injuries (Table 3). There was an overall 7-fold higher injury rate in goalkeepers compared with outfield players that was most pronounced for training-related hand injuries (RR, 24.7). In contrast, the rate of lower limb injuries was significantly lower in goalkeepers than outfield players during training (677 injuries [1.77 per 1000 hours] vs 9817 injuries [3.56 per 1000 hours]; RR, 0.50 [95% CI, 0.46-0.54]) and match play (387 injuries [7.36 per 1000 hours] vs 11,431 injuries [22.95 per 1000 hours]; RR, 0.32 [95% CI, 0.29-0.35]). Goalkeepers also had significantly longer layoff times than did outfield players, particularly for hand injuries (Table 5).

DISCUSSION

The principal finding of this study was that injuries to the hand, wrist, and forearm constituted less than 1% of all time-loss injuries in male professional soccer players. Other

important findings of this study were that a vast majority of injuries were traumatic with an acute onset (98.7%), that fractures constituted more than half of all injuries, and that goalkeepers had a several-fold higher incidence and a significantly longer layoff time than did outfield players.

Injury Characteristics

Some studies have investigated shoulder injuries in soccer players, regardless of the playing level, with a primary interest in goalkeepers.[5,11,19,26] In addition, a number of studies have reported on soccer-related injuries seen in emergency departments.[16,17,23,25,27] For example, Sytema et al[25] described that upper extremity injuries constituted 27% of all soccer injuries seen at an emergency department. However, hospital-based studies of injuries seen at various emergency departments are not comparable with injuries seen on the field, as different designs, definitions, and data collection methods are applied.

Importantly, we are not aware of any other previous study evaluating injuries to the hand, wrist, and forearm in professional soccer players from a field perspective. The main finding of the present study was that these injuries were in fact uncommon (<1%) among male professional soccer players but in line with the aforementioned hospital-based studies[16,17,23,25,27]; our findings showed that fractures also dominated the injury pattern (58.8%).

Goalkeepers as Most Susceptible

Even if goalkeepers only constituted 10.4% of all players in the present study, they incurred almost half of all hand, wrist, and forearm injuries (48.3%). For example, sprains, fractures, and dislocations of the thumb and finger phalanges were particularly common in goalkeepers, whereas metacarpal fractures were more frequent in outfield players. Taking player-exposures into consideration, goalkeepers had a 7-fold higher incidence of hand, wrist, and forearm injuries than did outfield players. This sharply contrasted with the incidence of lower limb injuries that we had noted, which was significantly lower in goalkeepers. Our findings are in line with those of Marom and Williams,[20] who showed that goalkeepers have up to 5 times more upper extremity injuries, many of them requiring substantial layoff times and rehabilitation efforts. In addition, Hilber et al[13] showed a higher degree of deficits, such as limited range of motion, pain, and swelling in the fingers, hands, and wrists, in former goalkeepers compared with outfield players.

In addition, almost two-thirds of the severe injuries in the present study affected goalkeepers, who also had longer mean layoff times, which is in line with previous findings in this cohort for upper extremity injuries.[6] Interestingly, the largest between-group differences in the injury incidence and layoff time in the present study were seen for hand injuries. All these aforementioned findings related to the injury profile and injury incidence most likely reflect the different soccer-specific demands between the playing positions as well as the general effect of the injuries in goalkeepers compared with outfield players. Goalkeepers are likely more prone to sustaining direct trauma, and outfield players are more prone to sustaining indirect trauma. In addition, an outfield player can often play with a finger splint or a braced wrist (if approved by the referee), whereas this often disqualifies a goalkeeper. Goalkeepers also have a unique exposure, especially as it pertains to training sessions in which they encounter a high number of shots from their own teammates and coaches during drills and other simulated match situations. This may partly account for the large RRs seen for training injury incidences in the present study.

Methodological Considerations

The present study is, to the best of our knowledge, the first to prospectively describe the epidemiology and characteristics of hand, wrist, and forearm injuries in detail in professional soccer players. The major strength of this study is the large and homogeneous group of male professional athletes playing in various top leagues in Europe. In addition, the study design and data collection procedures complied with the international consensus statement for football injury surveillance.[9,12]

This study also has a number of limitations. First, by using a time-loss injury definition, some physical symptoms, such as tendinopathies and other gradual-onset pain conditions as well as some acute soft tissue injuries, have not been recorded as injuries if the player could continue to play fully in parallel with tissue healing and symptom regression. It is also possible that traumatic events with some physical symptoms were recorded as injuries in goalkeepers but did not lead to any time loss in outfield players, as they, unlike goalkeepers, often can continue training and play matches despite transient pain and reduced function of the hand or wrist. Second, no specific diagnostic criteria were used, and all injury data were collected through a general 1-page injury form; therefore, little is known about specific diagnoses, injury mechanisms, fracture classifications, and treatment details. For example, there were only 12 wrist sprains recorded in total, among them 1 SL injury and 2 triangular fibrocartilage complex injuries. It is well known that some wrist ligament injuries and sometimes even scaphoid fractures are overlooked in the acute phase but are associated with increasing pain and disability over the next 3 to 4 months.[2,4] Displaced distal radius and ulna fractures are also accompanied by significant concomitant wrist ligament injuries in over 40% of cases,[3,10,18] and waist fractures of the scaphoid display concomitant SL injuries in 20% of cases.[14] Such injuries can, if not treated properly in the early setting, lead to severe complications, such as carpal instability, scapholunate advanced collapse, and degenerative arthritis over time.[2,4,29] For example, late SL reconstruction, instead of early diagnosis and early ligament repair, could be career ending for a goalkeeper, as only approximately 70% of range of motion and grip strength can be expected after surgery.[2] Third, even if a large cohort of players has been followed for almost 600 team-seasons between 2001 and 2019, the number of injuries was low, and some specific diagnoses comprised only a few cases. Consequently, data

for these rare injuries are less robust, which is reflected by the large SDs and 95% CIs in some cases. Similarly, although being numerically very different, the difference in mean layoff times between goalkeepers and outfield players for forearm injuries was not significant. Fourth, the lack of data on time trends and any regional differences is also a limitation. However, a proper time trend analysis[6] was not possible because of few, or even zero, injuries for some seasons and/or injury categories. In addition, it was beyond the scope of the present study to properly investigate any influence of regional differences, as has been done previously.[28] Fifth, as only lower limb dominance was recorded at player inclusion, we do not know if injuries were overrepresented in the dominant arm or not. This article also only deals with professional adult soccer players. More injuries may be seen in other populations (eg, younger players with open physes).

CONCLUSION

In this study on male professional soccer players, injuries to the hand, wrist, and forearm constituted less than 1% of all time-loss injuries; fractures constituted more than half of these injuries. Goalkeepers had a 7-fold higher incidence and a significantly longer layoff time than did outfield players. Future epidemiological studies on upper extremity injuries in soccer players should focus more on specific diagnoses and on any surgical treatment.

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