Original Article

Analysis of Injury Epidemiology in Soccer Players in the 2019 Confederation of North, Central America and Caribbean Association Football Gold Cup as Reported by Team Physicians

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Purpose: To describe and characterize injuries reported in professional soccer athletes participating in the 2019 Confederation of North, Central America and Caribbean Association Football (CONCACAF) Gold Cup tournament. **Methods:** Data were collected from electronic medical reports submitted after each match of the 2019 CONCACAF Gold Cup tournament. Reports were generated from a 20-question online survey completed by team physicians from all 16 participating teams. For every recorded injury, a separate survey was completed by team physicians documenting athlete demographic characteristics, context of injury, injury characteristics, and expected time lost from injury. **Results:** A total of 62 surveys were distributed, of which 80% (50 of 62) were collected for analysis. A total of 27 injuries (7%) were recorded among the 368 participating athletes. Injuries most frequently occurred during matches (92%, 24 of 27), with a significantly higher number of injuries recorded between the 61st and 75th minutes of play ($P < .05$). New injuries constituted 85% of all injuries (23 of 27), whereas 15% of injuries (4 of 27) were recorded as recurrences of prior injuries. Defenders had the highest number of injuries (41%, 11 of 27). Injuries to the lower extremities comprised 52% of all injuries (14 of 27), with thigh strains being the most common. **Conclusions:** During the 2019 CONCACAF Gold Cup, injuries were recorded in 7% of athletes (27 of 368), with 89% of injuries recorded as occurring during match play, primarily consisting of injuries involving strains to the thigh. **Clinical Relevance:** Understanding the epidemiology of soccer (football) injuries can help physicians better educate athletes including their patients.

Soccer (internationally known as football) is the most popular sport in the world, with the Fédération Internationale de Football Association (FIFA) reporting more than 240 million athletes participating in soccer on over 1.5 million teams and 300,000 clubs globally.[1] Professional international soccer tournaments garner worldwide attention, with the 2018 FIFA World Cup estimated to have been viewed by over 3.6 billion persons worldwide.[2,3] To promote the sport while ensuring player safety, both national and international football organizations have continued to emphasize the importance of athlete safety and health by examining injury epidemiology to optimize injury prevention.[4-7]

Prior studies examining injury epidemiology in professional soccer athletes have primarily focused on injury occurrence over a single season or multiple seasons in professional soccer leagues in Europe, Africa, Asia, Australia, and the United States.[8-18] However, there remain limited data evaluating injury incidence and type during international soccer tournaments. As such, a better understanding of injury patterns during international tournaments is required to determine whether there are any differences when compared with those of professional leagues.

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The purpose of this study was to describe and characterize injuries reported in professional soccer athletes participating in the 2019 Confederation of North, Central America and Caribbean Association Football (CONCACAF) Gold Cup tournament. We hypothesized that the overall injury incidence would be similar to that in previously reported studies of professional soccer leagues and lower-extremity injuries primarily involving strains of the thigh/hamstring and that ankle sprains would be the most commonly reported injuries.

Methods

Data Collection

This investigation was conducted in accordance with the consensus statement for identifying and investigating injuries sustained by soccer athletes.[19,20] All 16 teams qualifying for competition in the Gold Cup in June and July 2019 were asked to participate in this study. Each team had access to a team physician and full medical services. During the 2019 Gold Cup tournament, an injury was defined as any musculoskeletal complaint or concussion requiring medical evaluation by a team physician occurring during training and match play.[20] All injuries, regardless of absence from future training or matches, were recorded by the chief physician of each team on a specifically designed online injury surveillance survey that was completed after each tournament match. The same methodology was used and validated by Junge and Dvořák[21] when analyzing football injuries during FIFA tournaments from 1998 to 2001, as well as during the Olympic Games. Recorded injuries included those occurring during the tournament matches, as well as training leading up to an individual match. During the 2019 tournament, 31 matches were played. Teams that only participated in the group stage played a total of 3 games, whereas teams qualifying for quarterfinals, semifinals, and/or finals played an additional game during each subsequent level of competition.

Injury Reporting

The online injury surveillance survey consisted of 20 questions, which included team name and date and time of the match. The following data were recorded for every injury sustained by an athlete: player number, age, height, weight, position (goalkeeper, defender, midfielder, or forward), injury setting (training, match, or overtime), mechanism of injury (contact vs noncontact), elapsed time during the match in which the injury occurred (grouped by interval as 0-15, 16-30, 31-45, 46-60, 61-75, and 76-90 minutes), and expected time of recovery required for each athlete. Injury location (lower extremity vs upper extremity/truncal) and diagnosis were recorded based on a previously defined code, in addition to documentation of injury treatment and whether the injury was new or a recurrence of a prior injury.

A defined coding system was used to indicate both the location and type of injury sustained and consisted of the following: trunk (1, head; 2, neck; 3, sternum and ribs; 4, thoracic spine; 5, abdomen; 6, lumbar spine; 7, pelvis and sacrum), upper limb (8, shoulder; 9, arm; 10, elbow; 11, forearm; 12, wrist; 13, hand; 14, fingers; 15, thumb), and lower limb (16, groin; 17, hip; 18, thigh; 19, knee; 20, shin; 21, Achilles tendon; 22, ankle; 23, foot; 24, toes). Diagnosis codes consisted of the following: 1, concussion and loss of consciousness; 2, concussion without loss of consciousness; 3, fracture; 4, dislocation; 5, muscular rupture; 6, tendon strain; 7, ruptured ligament with instability; 8, ruptured ligament without instability; 9, meniscal injury; 10, sprain; 11, strain; 12, contusion; 13, bursitis; 14, tendinitis; 15, laceration or abrasion; and 16, other. All documentation of injury location, diagnostic coding, reporting of injury as a new injury versus recurrence of a prior injury, and injury severity was at the discretion of the team physician during medical evaluation (e.g., physical examination and imaging) and survey completion.

Statistical Analysis

Injury reporting data were analyzed to determine the presence of a normal distribution. Comparisons of continuous variables were assessed via independent t tests or Mann-Whitney U tests, where appropriate. Comparisons of categorical data were performed using χ^2 and Fisher exact tests, where appropriate. All P values were 2-tailed, and $P < .05$ was considered statistically significant. Analyses were performed using RStudio software (version 3.6.2; R Foundation for Statistical Computing, Vienna, Austria).

Results

All 16 teams qualifying for competition in the 2019 Gold Cup agreed to participate in this study. A total of 62 electronic injury surveillance surveys were distributed (2 surveys for each of the 31 games played during the tournament), of which 81% (50 of 62) were successfully entered into the database and analyzed. Any injury that took place outside of a match was recorded on the subsequent match's injury surveillance survey.

Injured Player Characteristics

Each of the 16 qualifying teams had a total of 23 male players dressed for competition, comprising a total of 368 players participating in the 2019 Gold Cup tournament. Of the 368 players, 48 were classified as goalkeepers; 115, defenders; 131, midfielders; and 74, forwards.

Injuries were documented in 7% of athletes (27 of 368) over the course of the tournament (Table 1). New injuries constituted 85% of all reported injuries (23 of

Table 1. Characterization of Players Injured in 2019 CONCACAF Gold Cup

	Mean ± SD or n (%)
Injured player demographic characteristics	
Total injured players*	27 (7)
Age, yr	26.0 ± 4.6
Height, cm	172.5 ± 21.4
Weight, kg	76.0 ± 7.2
Injury circumstances	
Injured during match	24 (92)
Injured during training	3 (12)
Noncontact injury	17 (63)
Contact injury	10 (38)
Foul injury	4 (15)
Referee sanction	4 (15)
Injury management	
Formal treatment†	13 (48)
Rest-focused treatment‡	10 (37)
Post-concussion management	2 (7.4)
Closed reduction§	1 (3.7)
Supportive/none‖	1 (3.7)
Expected days of absence¶	6.38 ± 11.53

CONCACAF, Confederation of North, Central America and Caribbean Association Football; SD, standard deviation.

*The injury percentage is representative of the injury rate for all players participating in the 2019 Gold Cup competition. All other percentages are representative of the rate only within the cohort.

†Includes formal physiotherapy, massage, cryotherapy, kinesiology taping, imaging, and nonsteroidal anti-inflammatory drug therapy.

‡Includes any combination of rest, ice, compression, and elevation; informal stretching exercises; and/or independent strengthening exercises.

§Nasal fracture requiring closed reduction.

‖Lip laceration not requiring stitches.

¶Number of days of expected absence after injury as determined by chief physician.

27); the remaining 15% of injuries (4 of 27) were classified as recurrences of prior injuries. Injuries most frequently occurred during matches, at a rate of 89% (24 of 27), yielding an average of 0.77 injuries per match. Noncontact injuries were the most reported mechanism of injury, at 63% (17 of 27). Physiotherapy was the primary treatment mechanism, used to treat 48% of injuries (13 of 27), incorporating a variety of conservative modalities (physical therapy, ultrasound, functional rehabilitation focusing on stretching and strengthening, massage, and anti-inflammatory medication), whereas 37% of injuries were treated with a focus on rest and individualized stretching and strengthening.

Player Position

On the basis of position, defenders were the most injured athletes, accounting for 41% of all injuries (11 of 27), followed by midfielders, at 26% (7 of 27) (Table 2). The distribution of injuries based on athlete position was not found to be statistically different ($P > .6$) from a uniform distribution. Most injuries occurring during match competition were reported during the second half (18 of 24, 66%), with 33% of injuries (8 of 24) occurring between the 61st and 75th minutes (Fig 1). Defenders and midfielders (9 of 14, 64%) accounted for most of the injuries during the final 30 minutes of match play.

Injury Rates

The average injury rate per sequential match was as follows: match 1, 1.0 injuries/game; match 2, 0.75 injuries/game; match 3, 1.0 injuries/game; match 4, 0.5 injuries/game; match 5, 0 injuries/game; and match 6, 0 injuries/game. The distribution of injury rates per sequential game was not found to be statistically significant ($P > .7$).

Injury Type

Fourteen lower-extremity and 13 upper-extremity, truncal, or head injuries were recorded over the course of the tournament. Injuries to the thigh were the most commonly reported lower-extremity injury, at 43% (6 of 14), whereas muscular injuries accounted for 64% of lower-body injuries (9 of 14) (Table 3).

Of the upper-extremity, truncal, and head injuries, 46% (6 of 13) involved the head, consisting of concussions, contusions, or lacerations/abrasions (Table 4). Over the course of the tournament, 3 concussions were recorded, accounting for 11% of all recorded injuries (3 of 27).

Discussion

The main findings of this study are that during the 2019 Gold Cup tournament, injuries were recorded in 7% of athletes (27 of 368), with 89% of reported injuries (24 of 27) occurring during match play, averaging 0.77 injuries per match. Defenders were the most

Table 2. Type of Injury by Player Position in 2019 CONCACAF Gold Cup

	No. of Injuries	Injuries During Match, n (%)	Injuries During Training, n (%)	Contact Injuries, n (%)	Noncontact Injuries, n (%)
Goalkeepers	4	4 (100)	0 (0)	2 (50)	2 (50)
Defenders	11	10 (91)	1 (9)	7 (64)	4 (36)
Midfielders	7	6 (86)	1 (14)	0 (0)	7 (100)
Forwards	5	4 (80)	1 (20)	1 (20)	4 (80)

CONCACAF, Confederation of North, Central America and Caribbean Association Football.

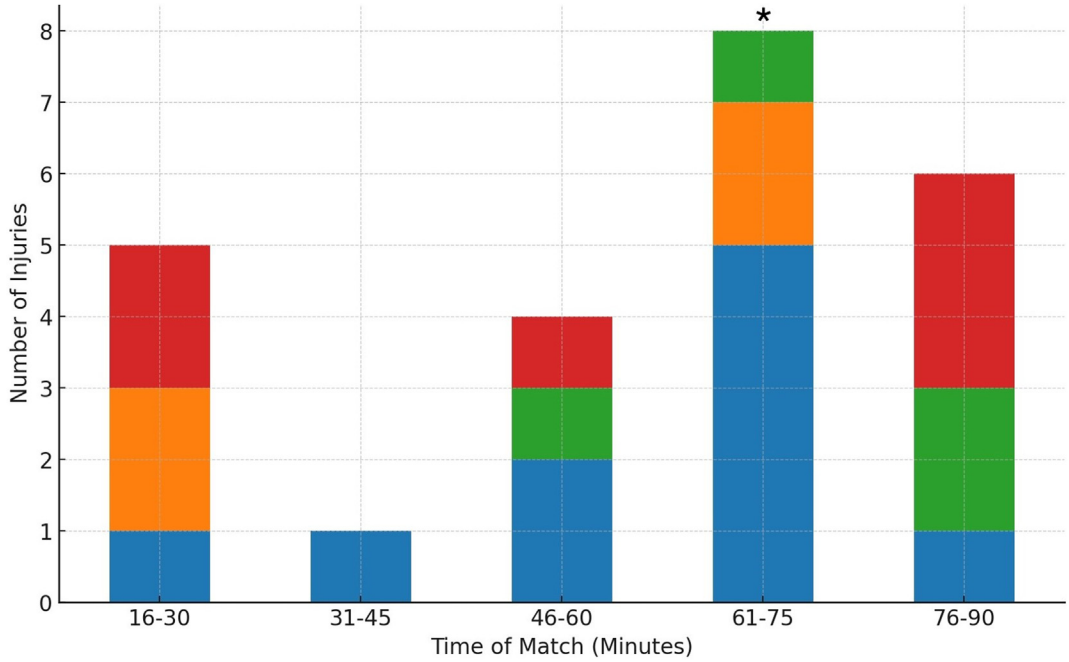

Fig 1. Injuries by time of match and player position in 2019 Confederation of North, Central America and Caribbean Association Football (CONCACAF) Gold Cup. Blue indicates defender position; orange, forward position; green, goalkeeper position; and red, midfielder position. The asterisk indicates statistical significance ($P < .05$).

commonly injured athletes, with 66% of injuries (18 of 24) occurring during match play recorded during the second half of play. All injuries were treated conservatively, most commonly using physiotherapy modalities, at 48% (13 of 27). Lower-extremity injuries were the most commonly recorded injury type, consisting primarily of muscular strains involving the thigh, whereas concussion, strains, and contusions constituted the most commonly reported upper-extremity, truncal, or head injuries. The injury rate per subsequent game did not significantly increase over the course of the tournament.

The reported average rate of 0.77 injuries per match during the 2019 Gold Cup tournament is comparable to the injury rate of 1.07 per match reported during the 2017 Gold Cup[22] and is lower than the injury rates recorded during the 2014 World Cup (1.68 injuries per

Table 3. Characterization of Lower-Body Injuries in 2019 CONCACAF Gold Cup

	Injury Incidence (% of Total Injuries)
Lower-body injury location	
Achilles	1 (7)
Ankle	1 (7)
Foot	2 (14)
Hip	1 (7)
Knee	2 (14)
Shin	1 (7)
Thigh	6 (43)
Total	14
Injury type	
Plantar fasciitis	1 (7)
Leg (muscle) cramp	1 (7)
Muscle contusion	3 (21)
Muscle strain	7 (50)
Sprain	2 (14)
Muscular lesion	1 (7)
Tendon lesion	1 (7)
Total	14

CONCACAF, Confederation of North, Central America and Caribbean Association Football.

Table 4. Characterization of Upper-Body Injuries in 2019 CONCACAF Gold Cup

	Injury Incidence (% of Total Injuries)
Upper-body injury location	
Arm	1 (7)
Hand	1 (7)
Head	6 (46)
Lumbar spine	3 (23)
Shoulder	2 (15)
Total	13
Injury type	
Laceration or abrasion	1 (7)
Contusion	3 (23)
Strain	3 (23)
Sprain	2 (15)
Concussion	3 (23)
Fracture	1 (7)
Total	13

CONCACAF, Confederation of North, Central America and Caribbean Association Football.

match) and 2015 America Cup (1.55 injures per match).[6,21] A possible explanation for this decrease in tournament injuries is an increased focus on player safety, resulting in improved conditioning and contact injury prevention. Namely, Junge and Dvořák[21] noted a 14% to 17% decrease in injuries sustained during each proceeding FIFA World Cup from 2002 to 2014. This coincided with significant rule changes prior to the 2002 tournament involving player safety, with stricter punishment for dangerous plays such as elbow-to-head tackles.[21] The authors attributed the decrease in injury incidence to both strict refereeing and improved fair play between players. Several systematic reviews have similarly reported that the implementation of injury prevention programs, such as FIFA 11+, have contributed to the reduction in injury incidence in soccer players.[7,23] These prevention programs emphasize the importance of targeted warm-up exercises prior to training and competitive play as a means of reducing injury risk during intense activity. The potential impact of squad rotation during tournament group play, or resting players for strategic purposes during qualifying rounds, may also play a role in lower injury rates.

Most of the injuries sustained during the 2019 Gold Cup tournament occurred during matches, not training. Similar findings have been reported in epidemiologic studies following soccer leagues in Sweden, Qatar, and Spain,[10,15,24] in which in-game injury rates have been reported to range between 14.5 and 43.53 injuries per 1,000 playing hours as compared with training injury rates ranging from 3.55 to 5.2 injuries per 1,000 playing hours. Ekstrand et al.[25] investigated the epidemiology of upper-extremity injuries in European soccer athletes and similarly found an injury rate 7 times greater during match play when compared with the injury rate reported during training. These findings are likely because of the increased intensity of play during competitive matches, emphasizing the need to identify and target specific match-related injuries to optimize player safety.

A total of 66% of injuries during match competition occurred during the second half, with 33% of injuries occurring between the 61st and 75th minutes ($P < .05$). This distribution of injuries is similar to that reported during the 2017 Gold Cup, where 78% of injuries were reported during the second half of competition, with 32% of injuries recorded between the 61st and 75th minutes.[22] Other studies have similarly reported in-game soccer injuries to increase during the second half or at the end of each half.[6,13] This may be because of the increased intensity of play prior to the end of a match or half. Bowen et al.[26] reported that noncontact injury was significantly increased with a high acute high-speed distance (>20 km/h). Although no statistically significant differences were found in the number of injuries based on athlete position, 64% of all injuries during the final 30 minutes were sustained by midfielders or defenders, suggesting that these positions may be at greater risk during intense game play, requiring a high high-speed distance, toward the end of a match. As such, injury prevention programs should continue to focus on the types and mechanisms of injuries occurring during match play, especially between the 61st and 75th minutes of competition, while also aiming to mitigate injuries in midfielders and defenders.

Lower-limb injuries accounted for 52% of total injuries, with most lower-limb injuries involving the thigh and consisting of muscular injuries. Similar distributions of injuries have been identified in both seasonal and tournament settings in professional soccer athletes. Junge and Dvořák[21] surveyed injuries during the 2014 FIFA World Cup and reported that 61% of injuries involved the lower extremity, with thigh strains being the most commonly documented injury. Ekstrand et al.[13] recorded 4,483 injuries over the course of 7 European professional soccer seasons and found that 87% of injuries were sustained to the lower limb, with thigh strains representing the most common injury subtype, followed by adductor pain/strains and ankle sprains. Previous studies have identified several risk factors for lower-limb muscle injuries in soccer athletes, including prior injury and increasing age, with higher injury risk to the dominant kicking leg.[16] Although most players are reported to return to play after lower-limb muscle injuries within 4 weeks, recurrence of a prior injury has been shown to result in up to 30% longer absences from play.[12] Moreover, the mechanism of injury has been shown to impact return to play. Ueblacker et al.[27] recorded a total of 2,287 muscular thigh injuries in professional football athletes and reported that 88% were due to indirect mechanisms whereas only 12% were attributed to direct contact. The average amount of time lost after indirect injuries was 18.5 days compared with 7.5 days for direct injuries.[27] The authors speculated that contact injuries, typically contusions, are less likely to result in muscle tears than noncontact injuries, allowing for quicker rehabilitation and faster recovery.[27] Given the increased severity of noncontact muscle injuries in the lower limb, implementation of injury prevention programs targeting the lower extremity, such as the Nordic Hamstring Exercise, should remain a priority for teams during seasonal and tournament play.[21]

Injuries to the head constituted 22% of all injuries, with 3 total concussions recorded over the duration of the tournament. The incidence of head injuries sustained is consistent with findings of previous tournament play given that 18% of all injuries during the 2014 FIFA World Cup were reported to involve the head, face, or neck.[21] However, when evaluating a total of 26 teams from 2001 to 2008, Ekstrand et al.[13] noted a markedly lower rate of head injuries, with 34

concussions recorded over the 7-year period, accounting for 0.76% of total injuries. The authors attributed the lower incidence of concussions primarily to a failure of athletes to consistently self-report symptoms of head injuries and concussions. As the external manifestations of concussions are often masked, these injuries in soccer athletes often go undiagnosed and under-reported despite several studies showing concussion rates in soccer athletes to be comparable to those in athletes participating in football and hockey.[28-31]

Recently, new rules and standardized protocols for head injuries and concussions in soccer athletes have been proposed. The Fédération Internationale des Associations de Footballeurs Professionnels (FIFPro) and the Union of European Football Associations (UEFA) have both sought the passage of new guidelines when treating players sustaining head injuries.[32] Regulations, including evaluation of concussions by a neutral team doctor and allowing temporary substitutions to enable examination without player disqualification, has encouraged the self-reporting of injuries during game play. Furthermore, the International Football Association Board (IFAB) elected to introduce trials for concussion substitutes in collaboration with FIFA during the 2021 Olympic Games in Tokyo.[33] The increasing awareness of concussion injuries in soccer athletes has likely resulted in a growing number of concussions reported during tournament matches. Namely, during the 1998 World Cup, 1 concussion (1% of all injuries) was recorded throughout the duration of the tournament.[20] In comparison, during the 2014 World Cup in Brazil, the number of concussions was recorded at 5% of all injuries (n = 5) sustained. The elevated rate of concussions and head injuries noted during the 2019 Gold Cup may demonstrate a continuation of this trend as concussion protocols and rule changes take effect.

Limitations

This study is not without limitations. Although the survey response rate was 80%, it is likely that a subset of injuries was not recorded, leading to an underestimation of the total incidence of actual injuries occurring during the 2019 Gold Cup. The reasons for nonresponse in 20% of matches is unclear but is likely related to the surveys not being completed and submitted at the end of each respective match. Furthermore, the survey questionnaire may under-report injuries owing to the overlap of definitions of injuries and inconsistencies in reporting between teams. Finally, this study highlights injuries sustained during a men's soccer tournament, and it should be noted that there may be a difference in injury prevalence among female soccer players.

Conclusions

During the 2019 CONCACAF Gold Cup, injuries were recorded in 7% of athletes (27 of 368), with 89% of injuries recorded as occurring during match play, primarily consisting of injuries involving strains to the thigh.

Disclosures

The authors declare the following financial interests/personal relationships which may be considered as potential competing interests: J. Chahla is a member of *Arthroscopy* Editorial Board. All other authors (B.F., D.M.K., D.K-S., J. Chang, C.B., C.H., A.K., O.L-G., G.C., B.R.M.) declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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