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RESEARCH ARTICLE

Prevalence and Risk Factors of Ankle Sprain Among Male Soccer Players in Tabuk, Saudi Arabia: A Cross-Sectional Study

Hamad S. Al Amer^{1,*} and Shahul Hameed Pakkir Mohamed¹

¹Department of Physical Therapy, Faculty of Applied Medical Sciences, University of Tabuk, Tabuk 71491, Saudi Arabia

Abstract:

Background:

Ankle sprains are common among soccer players, and their risk factors are well documented in the literature. In Saudi Arabia, some healthcare and sport-related characteristics provide the necessity for investigating the prevalence and risk factors of ankle sprain in that region as well.

Objective:

To analyze the prevalence of lower limb injuries and risk factors of ankle sprains among male soccer players in Tabuk, Saudi Arabia.

Methods:

A cross-sectional study among 400 male soccer players from different sports clubs in Tabuk, Saudi Arabia was conducted. A self-structured questionnaire was used to collect data related to ankle sprains. Chi-square, Fisher's exact tests, and unpaired *t*-tests were used to test the association between variables. Univariate logistic regression analysis was used to identify the risk factors.

Results:

Ankle sprains were the most prevalent, reported by 63.8%. Previous ankle injury, lack of stretching, lack of warm-up, and not wearing bracing were identified as significant risk factors. A total of 47.9% of players preferred to go to the hospital for treatment, 15.8% selected physical therapy, while 56% had no prior education regarding injury prevention.

Conclusion:

Ankle sprain is the most prevalent lower limb injury. Risk factors include previous ankle injuries, lack of stretching, lack of warm-up, and not wearing bracing. Players have little knowledge of physical therapy measures and lack of injury prevention education. Our findings suggest that increasing the awareness of injuries and proper physical therapy measures might assist in preventing recurrence of ankle sprains among male soccer players.

Keywords: Ankle sprain, Prevalence, Risk Factors, Soccer, Physical Therapy, Saudi Arabia.

Article History

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1. INTRODUCTION

Soccer (or football) is the most popular sport in Saudi Arabia [1]. Ankle sprain is the most common lower limb injury experienced by individuals involved in physical activity, comprising approximately 80% of ankle injuries [2, 3]. Ankle sprain injuries usually occur during landing on irregular surfaces, such as the foot of another player, or incorrect foot positioning at landing, resulting from delayed reaction time of

the peroneal muscles or a tackle from the medial side [4, 5]. Recurrent ankle sprains account for approximately 16% of all ankle sprains [6]. Studies have reported that the ankle reinjury rate in soccer is between 4% and 29% [7 - 9]. One recent study from Saudi Arabia reported ankle injuries ($n = 399$) in physical education and sports among Saudi high school male students in Riyadh. The authors found that the range of prevalence of ankle injuries was 14%-34.7% [10].

Several studies found that soccer injury rates varied depending on competition level, age, and gender [11 - 13]. During the 2010 FIFA World Cup competition, ankle sprain was the most prevalent condition, and approximately 50% of

* Address correspondence to this author at the Department of Physical Therapy, Faculty of Applied Medical Sciences, University of Tabuk, Tabuk 71491, Saudi Arabia; Tel: +966144562777; Fax: +966144222202; E-mail halamer@ut.edu.sa

players were prevented from participating in the competition [14]. The recognition of risk factors leading to ankle sprain appears to be the keystone for effective ankle sprain injury prevention strategies [15]. Two types of risk factors are suggested: extrinsic and intrinsic risk factors. Extrinsic risk factors include the total amount of training and number of played games, climatic factors, pitch surface, playing field status, equipment, and rough play. Intrinsic risk factors include joint flexibility, instability, preceding injuries, and inadequate rehabilitation [16 - 18].

Previous studies reported that players with histories of ankle sprain, players wearing air-filled heel shoes, and players who did not stretch the ankle joint structure before exercising were 4.9, 4.3, and 2.6 times more likely to withstand an ankle sprain [19]. Limited dorsiflexion movement in the ankle [20], the usage of artificial turf ground while playing soccer [21], and posteriorly-positioned fibula [22] were also reported as risk factors for ankle sprains.

Previous ankle injury is one of the most common risk factors for acute ankle injuries; therefore, it is very important to recognize strategies for preventing first-time occurrence of acute ankle injuries [23, 24]. In order to prevent acute ankle injuries, some players use ankle braces during sports activities. A few systematic reviews reported that ankle bracing was effective in reducing the re-occurrence of ankle sprain among athletes [25, 26]. The benefits of taping, neuromuscular exercising, and bracing for preventing injuries during team sports have been emphasized in the literature [27, 28]. Appropriate warm-up and stretching exercises are the most commonly recommended measures for the prevention of acute sports injuries [29, 30]. A few studies suggested performing warm-up exercises prior to sports activity to reduce the risk of injury [31 - 33].

Based on the theoretical framework for injury prevention, effective actions should be directed towards the adjustment of the player's attitude and behaviors regarding risk factors and prophylactic measures [34, 35]. Because of the rate of recurrence and debilitating nature of these injuries, it is critical for coaches or trainers, physical therapists, and physicians to identify leading risk factors for ankle injury. This would assist in the application of preventive measures and, in turn, would reduce the likelihood of injury occurrence and recurrence.

Tabuk region is located in the northwest part of Saudi Arabia. The Jordanian border bounds it from the north and the red sea from the west. It is known by its colder climate in comparison to other regions of Saudi Arabia. In terms of sport, Tabuk has four professional soccer clubs and one stadium that hosts local soccer competitions. There are also a number of public and private soccer fields, turfed and non-turfed, scattered all over the region. Presently, sport-related healthcare professionals are relatively less in number in the Tabuk region, and there are no specialized clinics or hospitals for athletic or sports injuries. The only available options of treatment in Tabuk for injured athletes are general medical facilities. All these healthcare and sport-related factors provide the necessity for investigating the prevalence and risk factors of ankle sprain in Tabuk region, and how these data may differ from what was reported in the literature. To date, there are insufficient studies

of ankle sprain injuries among soccer players in Tabuk and other regions in Saudi Arabia. In this study, therefore, we analyzed the prevalence of lower limb injuries and risk factors of ankle sprain among male soccer players in Tabuk, Saudi Arabia. It was hypothesized that, in male soccer players, there will be a high prevalence rate of ankle sprain among the lower limb injuries. We also hypothesized that there will be significant demographic and play-related risk factors correlated with ankle sprain rates.

2. MATERIALS AND METHODS

2.1. Participants

This cross-sectional study was conducted from February to August 2018. A total of 400 male soccer players, professionals and amateurs, from four sport clubs in Tabuk, Saudi Arabia were recruited using a convenience sampling method. This sampling method was utilized due to the limited number of sports clubs and difficulties to access the soccer players at any time. The sample size was determined using the prevalence and risk factors of ankle sprain among the soccer players in the study population. This was calculated using a power of 80% and $\alpha = 0.05$ to detect a difference of 20%. Accordingly, a total sample size of at least 400 was determined. The inclusion criteria were as follows: current soccer players (professional or amateur); between 18 and 40 years of age; and male gender (because this game is uncommon among females in Saudi Arabia). The exclusion criteria were as follows: any underlying inflammatory symptoms (*e.g.*, redness, swelling, pain, limited range of motion) assessed through taking a full history, and any ankle or foot congenital diseases or abnormalities.

2.2. Questionnaire

A self-structured questionnaire that was based on previous research [15] was used in this study. The questionnaire collects data relating to (1) basic demographics such as age, marital status, educational level, height, weight and body mass index (BMI); (2) occurrence and recurrence of ankle sprain among other lower extremity regions; and (3) potential risk factors, including play field-related characteristics, play environment, recurrence of injury, previous ankle injury and type of management taken, knowledge of physical therapy, received physical therapy treatment and education. The questionnaire is distributed among the participants and collected by the researchers on the same day, with the researchers presented all the time to answer any questions regarding the questionnaire. The items of the questionnaire were presented in a language appropriate for players. It was pilot-tested in a group of 10 players. The players faced no major difficulties and they could understand the questions and the response options.

2.3. Data Analysis

All categorical data are expressed as the frequency with percentage; continuous data are expressed as mean with standard deviation. Significance and associations between the dependent and independent variables were tested using Chi-square tests, Fisher's exact tests, and unpaired t-tests. All significant variables from the Chi-square analysis were tested further using a univariate logistic regression model. The

goodness of fit of the univariate logistic regression model was 0.789. All analyses were performed using SPSS 21.0 version. *p*-values less than 0.05 were considered significant.

3. RESULTS

A total of 400 participants with a mean age of 23.2 ± 5.9 years participated in the study. The characteristics of the participants are shown in Table 1. As illustrated in Fig. (1), ankle injury (63.8%) represented the highest percentage of complaints among all lower limb injuries. A total of 47% of the players reported injury of the right ankle, 24% of the left, and 29% in both. For those with ankle sprains in the previous year, about 42% suffered the sprain more than once, while the rest had it only one time. None of the demographic variables (age, BMI, duration of playing soccer, *etc.*) were significantly associated with the frequency of ankle sprain (one and more than one time) on Chi-square or Fisher exact or unpaired *t*-test (Table 2). The Chi-square or Fisher exact test and univariate logistic regression analysis revealed that previous ankle injury, lack of stretching, lack of warm-up and not wearing bracing were significant risk factors for ankle sprain incidence regardless of injury frequency (Tables 3 and 4). The remaining risk factors were not found to be significant (Tables 3 and 4). Of those with ankle sprains, 47.9% preferred to go to the hospital for treatment, while 33.2%, 15.8% and 3.1% chose to rest, undergo physical therapy, and other treatments, respectively. A total of 56% of players had no prior educational background regarding injury prevention.

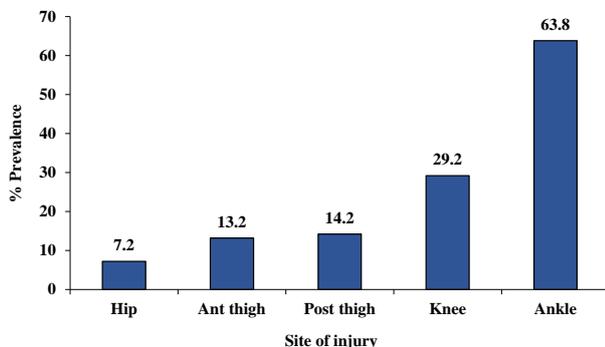


Fig. (1). Percentage of lower limb injuries. Ant: anterior; Post: posterior.

4. DISCUSSION

This study was conducted to evaluate the prevalence and risk factors of ankle sprain among male soccer players in the Tabuk region, Saudi Arabia. We hypothesized that there will be a high prevalence rate of ankle sprain among the lower limb injuries. We also hypothesized that there will be significant demographic and play-related risk factors correlated with ankle sprain rates. The results of this study partially support our proposed hypotheses in that ankle sprain was the most prevalent, reported by 255 of 400 participants (63.8%), with 58% and 42% reporting ankle sprain once and more than once within the prior 12 months, respectively. Some risk factors were found to be significant in our study, including previous ankle injury, lack of stretching, lack of warm-up, and not

wearing bracing. However, none of the examined demographic factors was found to be significantly correlated with ankle sprain incidences.

Several authors found previous ankle injury as a significant risk factor for the recurrent ankle sprain. One group reported that 60% of the ankle sprains occurred in players with a history of previous ankle sprains [4]. In another study, 9 of 13 ankle sprains (69%) were associated with a history of previous ankle sprains [36]. Soccer players having a previous history of ankle sprain injury were 4.9 times more likely to sustain a recurrent ankle sprain injury than players without previous ankle sprain injury [5]. Tropp *et al.* [37] also reported that players with a history of ankle injury are at a higher risk of future injury than players with no previous injury. These findings are consistent with those of the present study.

Most of the players acknowledged using regular stretching exercises for injury prevention; stretching exercises are commonly used for warm-up or cool-down routines [38] and are useful to increase muscle extensibility [39 - 41] and for prevention of sport-related injuries. Kaini *et al.* [42] reported that sports-specific warm-up, including dynamic stretching, could prevent injuries. In another study, it was reported that stretching exercises of certain muscles and joints for certain activities may enhance the effectiveness of these pre-exercise activities [43]. The results of these studies are consistent with those of the present study in that players who perform stretching exercises before playing have a lower risk of ankle sprain.

Warm-up exercises play an important role in the prevention of ankle sprains and their effects are well known. Warm-up is one of the most commonly suggested countermeasures for sports injury [29]. Warm-up, together with stretching exercises, enhances the flexibility of the lower extremity joints, including the ankle [44, 45]. The combination of warm-up, strength, and balance training with stretching had significant effects on the prevention of knee and ankle injuries [46 - 48]. These findings are strongly supportive of our results to the effect that a greater number of players developed ankle injury because of the poor performance of warm-up exercises.

In our study, we observed that not wearing bracing was a significant risk factor for ankle sprain. Ankle braces have been commonly used in sports to manage and prevent ankle sprains. One study reported a 69% reduction in ankle sprains in previously-injured athletes by using ankle braces [26]. Studies reported the use of ankle braces for the prevention of ankle sprains among active and healthy subjects [49 - 51]. Rovere *et al.* [52] reported that ankle stabilizers were effective in decreasing the occurrence of ankle injuries and that they must be worn whenever exposure to the risk of ankle injury is present. However, it is not advisable to play with a previous unhealed injury under the assumption that tapes and bandages will have a strong preventive effect [27]. This study's results acknowledge that the use of ankle bracing reduces the incidence of ankle sprain injuries, as well as the incidence of ankle sprain injury recurrences.

We also investigated post-injury treatment measures chosen by the players. Almost half of them preferred to go to

the hospital, possibly because of the severity of the injury. On the other hand, only 15.8% selected physical therapy treatment. The explanation involved a lack of physical therapy experts available in the sports field in Saudi Arabia, mainly in the Tabuk region, as well as lack of physical therapy awareness among the soccer players. Furthermore, Saudi Arabia's healthcare system prevents patients from direct access to physical therapy services, also contributing to this finding. Analysis of injury prevention strategies among the players

showed that more than half of them had never received education regarding injury prevention. Increased awareness of the mechanisms of ankle injury among soccer players, in addition to more frequent instruction and education about injury avoidance and prevention, should be addressed by trainers and team physicians. This may play an important role in reducing the incidence rate of ankle sprains in soccer players.

Table 1. Characteristics of the Participants (n = 400).

Age, mean \pm SD (y)	23.2 \pm 5.9
BMI, mean \pm SD (kg/m ²)	23.1 \pm 4.2
Marital Status	
Single	332 (83.0)
Married	68 (17.0)
Education level	
PhD	1 (0.2)
Master	9 (2.2)
Bachelor	165 (41.3)
Diploma	67 (16.8)
School	158 (39.5)
Duration of playing football (y)	
1-5	37 (14.5)
5-10	88 (34.5)
>10	130 (51.0)
Frequency of playing per week	
1 time	44 (17.3)
2 times	98 (38.4)
More than 2 times	113 (44.3)
Professional football player	87 (33.6)

Note. Values are given as number (percentage) unless otherwise indicated. SD indicates standard deviation.

Table 2. Demographic risk factors for ankle sprain (n = 255).

Risk Factors	Frequency of Ankle Sprain		P value
	1 time (n = 148)	More than 1 Time (n = 107)	
Age, mean \pm SD (y)	23.5 \pm 5.4	23.2 \pm 6.1	0.689
BMI, mean \pm SD	23.0 \pm 4.3	22.8 \pm 4.2	0.767
Marital Status, n (%)			
Single	119 (80.4)	93 (86.9)	0.171
Married	29 (19.6)	14 (13.1)	
Education level			
PhD	4 (2.7)	1 (0.9)	0.235
Master	4 (2.7)	2 (1.9)	
Bachelor	56 (37.8)	51 (47.7)	
Diploma	26 (17.6)	14 (13.1)	
School	58 (39.2)	39 (36.4)	
Duration of playing football (y)			
1-5	28 (18.9)	12 (11.2)	0.239
5-10	47 (31.7)	39 (36.4)	
>10	73 (49.4)	56 (52.3)	
Frequency of playing per week			
1 time	31 (20.9)	14 (13.1)	0.316
2 times	52 (35.2)	43 (40.2)	
More than 2 times	65 (43.9)	50 (46.7)	
Professional football player (Yes)	49 (33.1)	36 (33.6)	0.258

Note. Data are expressed as mean \pm standard deviation or number (percentage) and were analyzed for the association between the demographic variables and the frequency of ankle sprain using chi-square or Fisher exact tests for categorical data and unpaired *t*-test for continuous data. BMI indicates body mass index.

Table 3. Play-related risk factors for ankle sprain (n = 255).

Risk Factors	Frequency of Ankle Sprain		P value
	1 time (n = 148)	More than 1 time (n = 107)	
Type of playground			
Turf	100 (67.6)	81 (75.7)	0.225
Non-turf	48 (32.4)	26 (24.3)	
Footwear while play (No)	18 (12.2)	12 (11.2)	0.817
Previous ankle injury (Yes)	32 (21.6)	18 (16.8)	0.003*
Surgery (Yes)	30 (20.3)	14 (13.1)	0.119
Functional activity (No)	85 (57.4)	66 (61.7)	0.216
Warm up (No)	80 (54.1)	51 (47.7)	0.023*
Stretching (No)	28 (18.9)	33 (30.8)	0.034*
Strengthening (No)	115 (77.7)	86 (80.4)	0.680
Bracing (No)	123 (83.1)	101 (94.4)	0.017*
Taping (No)	134 (90.5)	99 (92.5)	0.440
Shoe-in-soles (No)	141 (95.3)	107 (100)	0.669

Note. Data are expressed as number (percentage) and were analyzed for the association between the potential risk factor variable and the frequency of ankle sprain by using chi-square or Fisher exact tests.

*Significant at $p < 0.05$ level

Table 4. Univariate logistic regression analysis.

Risk Factor		B	P-value	OR	95% CI
Previous ankle injury	Yes	1.128	0.042*	1.230	0.454 to 2.033
	No	Reference group	-	-	-
Stretching	Yes	Reference group	-	-	-
	No	0.778	0.019*	1.569	1.212 to 3.215
Warm-up	Yes	Reference group	-	-	-
	No	1.159	0.011*	1.406	1.092 to 2.919
Bracing	Yes	Reference group	-	-	-
	No	1.450	0.006*	2.163	1.219 to 2.979

Note. OR indicates odds ratio; CI indicates confidence interval.

*Significant at $p < 0.05$.

Finally, it should be mentioned that to prevent ankle sprains, it is important to employ a multi-disciplinary team approach, involving sports trainers, coaches, physicians, and physical therapists, as well as the players. Raising awareness of the complexity of the situation and improving individual compliance under the supervision of trainers and physical therapists are essential factors. All these factors are important in implementing ankle sprain prevention strategies.

4.1. Limitations

To the best of authors' knowledge, this is the first study to analyze the prevalence and risk factors of ankle sprain among amateur and professional male soccer players in Tabuk in particular and Saudi Arabia in general. The findings of this study can be expected to contribute to guiding medical and support staff in soccer clubs regarding how to reduce the prevalence of ankle sprain among players. However, this study has some limitations which should be discussed. One limitation is that we did not record the frequency of injury in the dominant side versus the non-dominant side. These recordings could have added important information to the study's results with respect to the difference in injury occurrence and recurrence between the two sides [53]. Yet, we believe that this

limitation does not affect the significance of the major findings of the study about the prevalence and risk factors of an ankle sprain. Another limitation is that the study sample was limited to male soccer players. However, this could have a minimum effect on the generalizability of the results because soccer is uncommonly played among females in Saudi Arabia. Finally, the sample was drawn from a single region in Saudi Arabia, which may also affect the generalizability of the results. However, we believe this study could lead to future studies in other regions of Saudi Arabia.

CONCLUSION

Ankle injuries are the most prevalent among lower limb injuries in Saudi Arabian male soccer players, particularly in the Tabuk region. Previous ankle injuries, lack of stretching, lack of warm-up, and not wearing bracing were the highest risk factors for the occurrence of an ankle sprain. Players had little knowledge of injury prevention and education. Our findings suggest the importance of increasing the awareness of 1) injuries and 2) the proper physical therapy measures. This might assist in reducing the likelihood of recurrence of ankle sprain injuries among male soccer players.

LIST OF ABBREVIATION

BMI = Body Mass Index.

ETHICS APPROVAL AND CONSENT TO PARTICIPATE

The study was approved by the Research Ethics Committee of the University of Tabuk, Tabuk, Saudi Arabia (Approval No. UT-73-21-2018).

HUMAN AND ANIMAL RIGHTS

No animals were used for this study. All research procedures in this study were performed in accordance with the ethical standards of the responsible committee on human experimentation (institutional and national).

CONSENT FOR PUBLICATION

Written informed consent was obtained from each participant.

STANDARD OF REPORTING

Strobe guidelines and methodologists were followed.

AVAILABILITY OF DATA AND MATERIALS

The datasets generated and/or analyzed during the current study are available from the corresponding author on reasonable request.

FUNDING

None.

CONFLICT OF INTEREST

The author declares no conflict of interest, financial or otherwise.

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SUPPORTIVE/SUPPLEMENTARY MATERIAL

Self-Structured Questionnaire.

REFERENCES

- [1] Sadat-Ali M, Sankaran-Kutty M. Soccer injuries in Saudi Arabia. *Am J Sports Med* 1987; 15(5): 500-2. [http://dx.doi.org/10.1177/036354658701500513] [PMID: 3674274]
- [2] Fong DT, Hong Y, Chan LK, Yung PS, Chan KM. A systematic review on ankle injury and ankle sprain in sports. *Sports Med* 2007; 37(1): 73-94. [http://dx.doi.org/10.2165/00007256-200737010-00006] [PMID: 17190537]
- [3] Woods C, Hawkins R, Hulse M, Hodson A. The Football Association Medical Research Programme: An audit of injuries in professional football: An analysis of ankle sprains. *Br J Sports Med* 2003; 37(3): 233-8. [http://dx.doi.org/10.1136/bjism.37.3.233] [PMID: 12782548]
- [4] Kofotolis ND, Kellis E, Vlachopoulos SP. Ankle sprain injuries and risk factors in amateur soccer players during a 2-year period. *Am J Sports Med* 2007; 35(3): 458-66. [http://dx.doi.org/10.1177/0363546506294857] [PMID: 17218660]
- [5] Fong DT, Chan YY, Mok KM, Yung PS, Chan KM. Understanding acute ankle ligamentous sprain injury in sports. *Sports Med Arthrosc Rehabil Ther Technol* 2009; 30:1:14 [http://dx.doi.org/10.1186/1758-2555-1-14]
- [6] Swenson DM, Collins CL, Fields SK, Comstock RD. Epidemiology of U.S. high school sports-related ligamentous ankle injuries, 2005/06-2010/11. *Clin J Sport Med* 2013; 23(3): 190-6. [http://dx.doi.org/10.1097/JSM.0b013e31827d21fe] [PMID: 23328403]
- [7] Cloke DJ, Spencer S, Hodson A, Deehan D. The epidemiology of ankle injuries occurring in English Football Association academies. *Br J Sports Med* 2009; 43(14): 1119-25. [http://dx.doi.org/10.1136/bjism.2008.052050] [PMID: 19106152]
- [8] Jain N, Murray D, Kemp S, Calder J. Frequency and trends in foot and ankle injuries within an English Premier League Football Club using a new impact factor of injury to identify a focus for injury prevention. *Foot Ankle Surg* 2014; 20(4): 237-40. [http://dx.doi.org/10.1016/j.fas.2014.05.004] [PMID: 25457658]
- [9] Waldén M, Hägglund M, Ekstrand J. Time-trends and circumstances surrounding ankle injuries in men's professional football: An 11-year follow-up of the UEFA Champions League injury study. *Br J Sports Med* 2013; 47(12): 748-53. [http://dx.doi.org/10.1136/bjsports-2013-092223] [PMID: 23813486]
- [10] Almalki MA, Alowaimi NA, Alanazi AM, *et al.* Prevalence of ankle injuries in physical education and sports classes among Saudi high school male students in Riyadh, Saudi Arabia. *J Musculoskelet Surg Res* 2018; 2: 16-20. [http://dx.doi.org/10.4103/jmsr.jmsr_24_17]
- [11] Söderman K, Alfredson H, Pietilä T, Werner S. Risk factors for leg injuries in female soccer players: A prospective investigation during one out-door season. *Knee Surg Sports Traumatol Arthrosc* 2001; 9(5): 313-21. [http://dx.doi.org/10.1007/s001670100228] [PMID: 11685365]
- [12] Faude O, Junge A, Kindermann W, Dvorak J. Injuries in female soccer players: A prospective study in the German national league. *Am J Sports Med* 2005; 33(11): 1694-700. [http://dx.doi.org/10.1177/0363546505275011] [PMID: 16093546]
- [13] Tegnander A, Olsen OE, Moholdt TT, Engebretsen L, Bahr R. Injuries in Norwegian female elite soccer: A prospective one-season cohort study. *Knee Surg Sports Traumatol Arthrosc* 2008; 16(2): 194-8. [http://dx.doi.org/10.1007/s00167-007-0403-z] [PMID: 17899007]
- [14] Dvorak J, Junge A, Derman W, Schweltnus M. Injuries and illnesses of football players during the 2010 FIFA World Cup. *Br J Sports Med* 2011; 45(8): 626-30. [http://dx.doi.org/10.1136/bjism.2010.079905] [PMID: 21257668]
- [15] Zech A, Wellmann K. Perceptions of football players regarding injury risk factors and prevention strategies. *PLoS One* 2017; 12(5):e0176829 [http://dx.doi.org/10.1371/journal.pone.0176829] [PMID: 28459845]
- [16] Inklaar H. Soccer injuries. II: Aetiology and prevention. *Sports Med* 1994; 18(2): 81-93. [http://dx.doi.org/10.2165/00007256-199418020-00002] [PMID: 9132922]
- [17] Taimela S, Kujala UM, Osterman K. Intrinsic risk factors and athletic injuries. *Sports Med* 1990; 9(4): 205-15. [http://dx.doi.org/10.2165/00007256-199009040-00002] [PMID: 2183329]
- [18] Dvorak J, Junge A. Football injuries and physical symptoms. A review of the literature. *Am J Sports Med* 2000; 28(5)(Suppl.): S3-9. [http://dx.doi.org/10.1177/28.suppl_5.s-3] [PMID: 11032101]
- [19] McKay GD, Goldie PA, Payne WR, Oakes BW. Ankle injuries in basketball: Injury rate and risk factors. *Br J Sports Med* 2001; 35(2): 103-8. [http://dx.doi.org/10.1136/bjism.35.2.103] [PMID: 11273971]
- [20] de Noronha M, Refshauge KM, Herbert RD, Kilbreath SL, Hertel J. Do voluntary strength, proprioception, range of motion, or postural sway predict occurrence of lateral ankle sprain? *Br J Sports Med* 2006; 40(10): 824-8. [http://dx.doi.org/10.1136/bjism.2006.029645] [PMID: 16920769]
- [21] Orchard JW, Powell JW. Risk of knee and ankle sprains under various weather conditions in American football. *Med Sci Sports Exerc* 2003; 35(7): 1118-23. [http://dx.doi.org/10.1249/01.MSS.0000074563.61975.9B] [PMID: 12840631]
- [22] Eren OT, Kucukkaya M, Kabukcuoglu Y, Kuzgun U. The role of a posteriorly positioned fibula in ankle sprain. *Am J Sports Med* 2003;

- 31(6): 995-8.
[http://dx.doi.org/10.1177/03635465030310064101] [PMID: 14623669]
- [23] van Rijn RM, van Os AG, Bernsen RMD, Luijsterburg PA, Koes BW, Bierma-Zeinstra SMA. What is the clinical course of acute ankle sprains? A systematic literature review. *Am J Med* 2008; 121(4): 324-331.e6.
[http://dx.doi.org/10.1016/j.amjmed.2007.11.018] [PMID: 18374692]
- [24] Yeung MS, Chan KM, So CH, Yuan WY. An epidemiological survey on ankle sprain. *Br J Sports Med* 1994; 28(2): 112-6.
[http://dx.doi.org/10.1136/bjism.28.2.112] [PMID: 7921910]
- [25] Handoll HH, Rowe BH, Quinn KM, de Bie R. Interventions for preventing ankle ligament injuries. *Cochrane Database Syst Rev* 2001; 3(3)CD000018
[PMID: 11686947]
- [26] Dizon JMR, Reyes JJB. A systematic review on the effectiveness of external ankle supports in the prevention of inversion ankle sprains among elite and recreational players. *J Sci Med Sport* 2010; 13(3): 309-17.
[http://dx.doi.org/10.1016/j.jsams.2009.05.002] [PMID: 19586798]
- [27] Verhagen EA, Bay K. Optimising ankle sprain prevention: A critical review and practical appraisal of the literature. *Br J Sports Med* 2010; 44(15): 1082-8.
[http://dx.doi.org/10.1136/bjism.2010.076406] [PMID: 21047837]
- [28] Hübscher M, Zech A, Pfeifer K, Hänsel F, Vogt L, Banzer W. Neuromuscular training for sports injury prevention: A systematic review. *Med Sci Sports Exerc* 2010; 42(3): 413-21.
[http://dx.doi.org/10.1249/MSS.0b013e3181b88d37] [PMID: 19952811]
- [29] Hedrick A. Physiological responses to warm-up. *Natl Strength Cond Assoc J* 1992; 14(5): 25-7.
[http://dx.doi.org/10.1519/0744-0049(1992)014<0025:PRTWU>2.3.CO;2] [PMID: 1621533]
- [30] Ekstrand J, Gillquist J, Möller M, Oberg B, Liljedahl SO. Incidence of soccer injuries and their relation to training and team success. *Am J Sports Med* 1983; 11(2): 63-7.
[http://dx.doi.org/10.1177/036354658301100203] [PMID: 6846683]
- [31] Bixler B, Jones RL. High-school football injuries: Effects of a post-half-time warm-up and stretching routine. *Fam Pract Res J* 1992; 12(2): 131-9.
[PMID: 1621533]
- [32] Wedderkopp N, Kalfot M, Lundgaard B, Rosendahl M, Froberg K. Prevention of injuries in young female players in European team handball. A prospective intervention study. *Scand J Med Sci Sports* 1999; 9(1): 41-7.
[http://dx.doi.org/10.1111/j.1600-0838.1999.tb00205.x] [PMID: 9974196]
- [33] Olsen OE, Myklebust G, Engebretsen L, Holme I, Bahr R. Exercises to prevent lower limb injuries in youth sports: Cluster randomised controlled trial. *BMJ* 2005; 330(7489): 449-52.
[http://dx.doi.org/10.1136/bmj.38330.632801.8F] [PMID: 15699058]
- [34] Van Tiggelen D, Wickes S, Stevens V, Roosen P, Witvrouw E. Effective prevention of sports injuries: A model integrating efficacy, efficiency, compliance and risk-taking behaviour. *Br J Sports Med* 2008; 42(8): 648-52.
[http://dx.doi.org/10.1136/bjism.2008.046441] [PMID: 18400875]
- [35] Lund JALE. Accident prevention. Presentation of a model placing emphasis on human, structural and cultural factors. *Saf Sci* 2004; 42: 271-324.
[http://dx.doi.org/10.1016/S0925-7535(03)00045-6] [PMID: 18400875]
- [36] Arnason A, Gudmundsson A, Dahl HA, Jóhannsson E. Soccer injuries in Iceland. *Scand J Med Sci Sports* 1996; 6(1): 40-5.
[http://dx.doi.org/10.1111/j.1600-0838.1996.tb00069.x] [PMID: 8680943]
- [37] Tropp H, Ekstrand J, Gillquist J. Stabilometry in functional instability of the ankle and its value in predicting injury. *Med Sci Sports Exerc* 1984; 16(1): 64-6.
[http://dx.doi.org/10.1249/00005768-198401000-00013] [PMID: 6708781]
- [38] Ebben WP, Hintz MJ, Simenz CJ. Strength and conditioning practices of Major League Baseball strength and conditioning coaches. *J Strength Cond Res* 2005; 19(3): 538-46.
[PMID: 16095401]
- [39] Morse CI, Degens H, Seynnes OR, Maganaris CN, Jones DA. The acute effect of stretching on the passive stiffness of the human gastrocnemius muscle tendon unit. *J Physiol* 2008; 586(1): 97-106.
[http://dx.doi.org/10.1113/jphysiol.2007.140434] [PMID: 17884924]
- [40] Nakamura M, Ikezoe T, Takeno Y, Ichihashi N. Effects of a 4-week static stretch training program on passive stiffness of human gastrocnemius muscle-tendon unit *in vivo* *Eur J Appl Physiol* 2012; 112(7): 2749-55.
[http://dx.doi.org/10.1007/s00421-011-2250-3] [PMID: 22124523]
- [41] Nakamura M, Ikezoe T, Takeno Y, Ichihashi N. Time course of changes in passive properties of the gastrocnemius muscle-tendon unit during 5 min of static stretching. *Man Ther* 2013; 18(3): 211-5.
[http://dx.doi.org/10.1016/j.math.2012.09.010] [PMID: 23294911]
- [42] Kiani A, Hellquist E, Ahlqvist K, Gedeberg R, Michaëlsen K, Byberg L. Prevention of soccer-related knee injuries in teenaged girls. *Arch Intern Med* 2010; 170(1): 43-9.
[http://dx.doi.org/10.1001/archintermed.2009.289] [PMID: 20065198]
- [43] Worrell TW, Perrin DH. Hamstring muscle injury: The influence of strength, flexibility, warm-up, and fatigue. *J Orthop Sports Phys Ther* 1992; 16(1): 12-8.
[http://dx.doi.org/10.2519/jospt.1992.16.1.12] [PMID: 18796769]
- [44] Hubley CL, Kozey JW, Stanish WD. The effects of static stretching exercises and stationary cycling on range of motion at the hip joint. *J Orthop Sports Phys Ther* 1984; 6(2): 104-9.
[http://dx.doi.org/10.2519/jospt.1984.6.2.104] [PMID: 18806373]
- [45] Wiktorsson-Möller M, Oberg B, Ekstrand J, Gillquist J. Effects of warming up, massage, and stretching on range of motion and muscle strength in the lower extremity. *Am J Sports Med* 1983; 11(4): 249-52.
[http://dx.doi.org/10.1177/036354658301100412] [PMID: 6614296]
- [46] Ekstrand J, Gillquist J, Liljedahl SO. Prevention of soccer injuries. Supervision by doctor and physiotherapist. *Am J Sports Med* 1983; 11(3): 116-20.
[http://dx.doi.org/10.1177/036354658301100302] [PMID: 6346912]
- [47] Hewitt TE, Lindenfeild TN, Riccobene JV, Noyes FR. The effects of neuromuscular training on the incidence of knee injury in female athletes. *Am J Sports Med* 1999; 27: 699-704.
[http://dx.doi.org/10.1177/03635465990270060301] [PMID: 10569353]
- [48] Wedderkopp N, Kalfot M, Lundgaard B, Rosendahl M, Froberg K. Prevention of injuries in young female players in European team handball. A prospective intervention studies. *Scand J Med Sci Sports* 2003; 13: 371-5.
[http://dx.doi.org/10.1046/j.1600-0838.2003.00336.x] [PMID: 14617058]
- [49] Papadopoulos ES, Nicolopoulos C, Anderson eg, Curran M, Athanasopoulos S. The role of ankle bracing in injury prevention, athletic performance and neuromuscular control: A review of the literature. *Foot* 2005; 15: 1-6.
[http://dx.doi.org/10.1016/j.foot.2004.07.002] [PMID: 15699058]
- [50] Thacker SB, Stroup DF, Branche CM, Gilchrist J, Goodman RA, Weitman EA. The prevention of ankle sprains in sports. A systematic review of the literature. *Am J Sports Med* 1999; 27(6): 753-60.
[http://dx.doi.org/10.1177/03635465990270061201] [PMID: 10569362]
- [51] Ubell ML, Boylan JP, Ashton-Miller JA, Wojtys EM. The effect of ankle braces on the prevention of dynamic forced ankle inversion. *Am J Sports Med* 2003; 31(6): 935-40.
[http://dx.doi.org/10.1177/03635465030310063201] [PMID: 14623660]
- [52] Rovere GD, Clarke TJ, Yates CS, Burley K. Retrospective comparison of taping and ankle stabilizers in preventing ankle injuries. *Am J Sports Med* 1988; 16(3): 228-33.
[http://dx.doi.org/10.1177/036354658801600305] [PMID: 3132864]
- [53] Ekstrand J, Gillquist J. Soccer injuries and their mechanisms: A prospective study. *Med Sci Sports Exerc* 1983; 15(3): 267-70.
[http://dx.doi.org/10.1249/00005768-198315030-00014] [PMID: 6621313]