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The Prevalence of Selected Intrinsic Risk Factors for Ankle Sprain Among Elite Football and Basketball Players

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Abstract

Background: Lateral ankle sprains (LAS) are among the most common sports- related injuries and the reinjury rate is very high.
Objectives: This study aimed to evaluate the prevalence of some intrinsic risk factors among professional football and basketball players with or without history of acute or recurrent ankle sprain.
Patients and Methods: One hundred and six professional football and basketball players who were referred for pre-participation examinations were recruited in this study. Prepared checklist was completed for each participant. Athletes were asked for any history of previous ankle sprain and the severity (based of self-description of signs and symptoms by the athlete), level and number of injuries in the last two years. All players were assessed for measures of foot posture index- 6, foot length and width, Beighton generalized joint laxity score, anterior drawer and talar tilt tests, star excursion and single leg balance tests and goniometric assessment of ankle plantarflexion, ankle dorsiflexion and first metatarsophalangeal dorsiflexion.
Results: Forty eight basketball players (45.3%) and 58 football players (54.7%) with mean (SD) age of 19.8 (4.5) years participated. About 58.5% and 14.2% of athletes had a history of ankle sprain and recurrent sprain in at least one extremity, respectively. Sprains were more prevalent in basketball players and in dominant leg. There was no significant difference in assessed risk factors between athletes with and without history of ankle sprain, except for positive single leg balance test which was more prevalent in athletes with history of ankle sprain and also for positive talar tilt test and decreased ankle plantarflexion range of motion in acute and recurrent injury of left ankle.
Conclusions: Some intrinsic risk factors including lateral ankle ligaments laxity, balance and ankle plantarflexion seem to be related to acute or recurrent LAS in athletes. Further research is needed to reveal the role of different arthrokinematics following lateral ankle sprain.

Keywords: Ankle Sprain, Intrinsic Risk Factors, Balance, Instability, Athletes, Joint Laxity

1. Background

The lateral part of ankle is one of the most frequently injured structures in the body and the direct and indirect annual medical cost of treating lateral ankle sprain is estimated to reach as high as billions of dollars (1). Although most lateral ankle sprains (LAS) may not cause long-term disability, an important number do not completely resolve, leading to residual symptoms and dysfunction for athletes.The rate of recurrent ankle sprain may reach as high as 40% and repeated ankle sprain is a major cause of chronic ankle instability (CAI) in athletes (2-4). Moreover, as much as 80% of patients with CAI are assumed to finally suffer from osteoarthritis and some cases require surgical interventions (5-7). Therefore, the recognition of factors which may be related to lateral ankle sprain seem to be the cornerstone of an effective ankle sprain prevention program. Despite many authors evaluating the relationship between different intrinsic factors such as anatomic characteristics (8), balance (9, 10), joint position sense (11), flexibility and range of motion (12), reaction time (13), muscle strength (13, 14), gait pattern (15), body mass index (16), ankle instability (17), generalized laxity (12) and lateral ankle sprain, no consensus has been reached on the predictive intrinsic risk factors. Consequently, the predictive intrinsic factors in LAS remain still to be defined, and further studies are needed. Additionally, while ankle stability is maintained by different parameters including bony structure, foot biomechanics, flexibility and neuromuscular control (2, 18), the majority of authors have merely focused on the neuromuscular mechanisms as an essential factor for ankle stability.

2. Objectives

This study was conducted to determine the prevalence of selected intrinsic risk factors for ankle sprain including foot posture, foot dimensions, generalized and localized joint laxity and static and semidynamic balance, ankle and first metatarsophalangeal range of motion among elite football and basketball players and recognize whether they are related to the incidence of acute or recurrent ankle sprain.

3. Patients and Methods

In a cross- sectional study, elite basketball and football players were recruited. Inclusion criteria were as follows: 1, history of at least one year of experience in professional sports and at least 3 to 5 training sessions in a week within last 6 months; 2, male gender; 3, age 15 to 40 years; 4, lack of history of orthopedic surgery in lower extremities, any malalignment and spinal deformity. Exclusion criterion was patient's request to leave the study. The study protocol was approved by the ethics committee of Tehran University of Medical Sciences. All samples were asked to sign an informed consent form prior to participating in the study.

During the preseason period, a prepared checklist was completed for 106 elite basketball and football players who were referred to sports medicine clinic of Sports Medicine Research Center affiliated to Tehran University of Medical Sciences (TUMS) for pre-participation examinations (PPE). All players underwent baseline measurements and were asked for any history of previous ankle sprain and severity, quality and number of injuries in the last two years. Athletes were assessed for measures of foot posture index-6, foot length and width, Beighton generalized joint laxity score, anterior drawer and talar tilt tests, star excursion and single leg balance tests and goniometric assessment of ankle plantarflexion, ankle dorsiflexion and first metatarsophalangeal dorsiflexion. Each measurement was performed by a single well experienced physician in a station-based model.

LAS was defined as an ankle injury with an inversion mechanism that caused the player feel pain or discomfort in the lateral side of ankle, regardless of missing or not missing a game or practice.

Recurrent LAS was defined as the multiple ankle injury with a low energy inversion mechanism and less than three months interval between two injuries.

Data collection was performed using researcher-designed checklist. Demographic data and risk factor assessments were registered in this checklist considering both lower extremities. All measurements were performed by sports medicine specialists. Baseline measurements included foot posture assessment (using FPI-6), foot characteristics (length, width and length to width ratio), generalized joint laxity (using Beighton and Horan score), lateral ankle ligaments laxity (measured by anterior drawer test and talar tilt test), static and semi-dynamic balance (measured by single-leg balance test and star excursion balance test), and goniometric measurement of ankle plantarflexion, ankle dorsiflexion and first metatarsophalangeal dorsiflexion. To address the inter-rater variability of the subjective assessments, each examination was performed by a sports medicine expert in a separate station.

Detailed description of all measurements are as follows:

3.1. Foot Posture Index-6

This easy to implement clinical assessment tool has good face validity and evaluates the multisegmental nature of foot posture in all three planes and does not require the use of specialized equipment. The FPI is a 6-item assessment tool performed during relaxed stance, with each item scoring between -2 and +2 to give a sum between -12 (highly supinated) and +12 (highly pronated). Items include talar head palpation, curves above and below the lateral malleoli, calcaneal angle, talonavicular bulge, medial longitudinal arch, and forefoot-to-rearfoot alignment (19, 20).

3.2. Foot Dimensions

Anterior- posterior distance from heel to toe was defined as the foot length and the widest part of the foot in the forefoot was considered as the foot width.

3.3. Generalized Joint Laxity

The Beighton and Horan joint mobility index (BHJMI) (21) as a widely used simple system for enumerating joint laxity and hypermobility was used in this study to measure generalized joint laxity. Based on this method, a simple 9 point system is used in which the higher the score, the higher the laxity. The threshold for joint laxity in a young adult begins from 4 and a score above 6 most probably indicates hypermobility or generalized joint laxity. Reliability of the BHJMI was good to excellent in screening for generalized joint laxity (22).

3.4. Lateral Ankle Ligaments Laxity

Anterior drawer test and talar tilt test were used in this study to determine lateral ankle ligaments laxity. To perform anterior drawer test, the athlete was asked to sit with their knee bent and their ankle in a slightly plantar flexion. Then the physician stabilized the distal tibia with one hand, while keeping the heel with the other hand and applying an anterior force to the heel. This test was performed for both ankles to compare the differences in anterior translation. The test was considered positive if the examiner felt laxity or poor endpoint on forward translation compared with contralateral side. Sensitivity and specificity of the anterior drawer test is estimated to be 0.58 and 1.00 respectively (23).

To perform talar tilt test, the athlete was in the seated position, with their knee bent and foot in a neutral or slightly dorsiflexed position. The examiner stabilized the distal tibia with one hand while applying an inversion force to the foot. This test was performed bilaterally to compare for differences. The test was considered positive if the examiner felt laxity or poor endpoint on translation compared with contralateral side. It was found that the sensitivity and specificity of the medial talar tilt stress test was 0.50 and 0.88 respectively (23).

3.5. Balance

Single-Leg balance (SLB) test and star excursion balance test (SEBT) were used in this study to determine the balance of the samples. For single-leg balance test, the athlete was instructed to stand on one leg without support of the upper extremities or bracing of the unweighted leg against the stance leg. The player began the test with the eyes open, practicing twice on each side with his gaze fixed straight ahead. The sample was then instructed to close his eyes and maintain balance for 10 seconds. Termination or a failed test was recorded if the foot touched the support leg, hopping occurred, the foot touched the floor, or the arms touched something for support. The test was considered positive even if a failed test was recorded only for one leg. The SLB test is a reliable and valid test for predicting ankle sprains (24).

The Star excursion balance test (25) is a functional test that includes a single-leg stance on one leg while trying to reach as far as possible with the other leg. The test was performed in this study with the athlete keeping a single-leg stance while reaching with the contralateral leg. The aim was to reach as far along the 3 directions (anterior, postero-medial, postero-lateral) as possible to touch the furthest point on the line as gentle as possible to avoid using the reach leg for support. The subject then returned to the centre of the grid on both feet whilst maintaining balance. Each subject performed 3 rounds of the SEBT. Each circuit consisted of 3 reaches (trials) in each of the 3 directions. Subjects were given a 5 second rest between each reach. Trials were failed if the examiner felt that the athlete lifted the stance foot from the ground, athlete lost his or her balance or athlete did not touch the line with the reach foot while continuing to fully weight bear on the stance leg. SEBT is a reliable and predictive measure of lower extremity injury in high school basketball players (26, 27).

3.6. Ankle Plantarflexion and Dorsiflexion

Maximal ankle dorsiflexion and plantarflexion was measured in a non-weight-bearing position while the ankle joint was in a plantigrade (90 degrees) and neutral position respectively using a standard goniometer with 2° increments.

3.7. First Metatarsophalangeal Dorsiflexion

Maximal first metatarsophalangeal dorsiflexion was measured in a non-weight-bearing and neutral position of first metatarsophalangeal joint using a standard goniometer with 2° increments.

3.8. Statistical Analysis

Quantitative variables are described as mean (standard deviation) and categorical variables are presented as frequency (percentage). The between- groups differences were assessed using Chi-square and Fisher exact test. Independent sample t-Test and One Way ANOVA were used to detect association between quantitative and descriptive parameters. Using SPSS version 17 and STATA version 10, the level of significance was set to $P < 0.05$.

4. Results

A total of 106 participants [48 basketball players (45.3%) and 58 football players (54.7%) with mean (SD) age of 19.8 (4.5) years participated in this study. The descriptive information is shown in Tables 1, 2.

Sixty two (58.5%) athletes had a history of sprain and 15 athletes (14.2%) reported history of recurrent sprain in at least one extremity (Table 2). Acute and recurrent ankle sprain both were more prevalent in basketball players ($P = 0.002$ and $P = 0.018$, respectively).

There was no relationship between acute or recurrent ankle sprain and FPI-6, foot dimensions and generalized joint laxity in athletes ($P > 0.05$). There was a relationship between acute as well as recurrent ankle sprain and some aspects of ankle joint laxity (Table 3).

The positive Single Leg Balance Test was related to acute LAS (P=0.035) but not to recurrent LAS. Also, no correlation

Table 1. The Quantitative Descriptive Characteristics of Players

Variable	Mean (SD)	Range
Age, y	19.8 (4.5)	15 - 40
Height, cm	183.7 (10.1)	165 - 212
Weight, kg	76.9 (12.8)	53 - 120
FPI-6		
Right foot	5.1 (3.2)	-6 - 11
Left foot	5.2 (3.4)	-6 - 11
Beighton score	1.6 (1.2)	0-7
Ankle plantarflexion, Degrees		
Right foot	43.6 (6.7)	30 - 58
Left foot	44.1 (7/5)	27 - 60
Ankle dorsiflexion, Degrees		
Right foot	16.3 (4.4)	6 - 30
Left foot	15.1 (4/1)	7 - 27
First MTP joint dorsiflexion, Degrees		
Right foot	75.4 (12)	28 - 92
Left foot	73.8 (11.9)	28 - 90
Foot length, c		
Right foot	25.5 (1.9)	21.5 - 32.5
Left foot	25.5 (1.9)	21.5 - 32.5
Foot width, cm		
Right foot	9.5 (0.8)	7 - 11
Left foot	9.5 (0.8)	7 - 11
Star Excursion Balance Test		
Anterior displacement		
Right foot	72.2 (7.5)	55 - 90
Left foot	72.4 (8)	51 - 91
Posteromedial displacement		
Right foot	104.5 (10.1)	77 - 138
Left foot	104.9 (10.8)	71.5 - 129
Posterolateral displacement		
Right foot	104.7 (10.7)	72 - 128.5
Left foot	104 (9.4)	77 - 134

was detected between the SEBT and acute or recurrent LAS. No relationship was found between dorsiflexion of ankle as well as the first metatarsophalangeal joint and acute or recurrent LAS. However plantarflexion of the left ankle was related to acute ($P = 0.009$) and recurrent ($P = 0.02$) LAS.

5. Discussion

This study showed that some intrinsic risk factors including ankle joint laxity, impaired Single Leg balance test and decreased ankle plantarflexion are more prevalent in athletes with history of acute or recurrent LAS.

Based on this study the positive anterior drawer and talar tilt tests seem to be more common in athletes with acute as well as recurrent LAS. Of course, due to the cross

Table 2. The Qualitative Descriptive Characteristics of Players[a]

Variable	Right Foot	Left Foot
Dominant leg	87 (82.1)	19 (17.9)
History of previous ankle injury		
One injury	19 (17.9)	18 (17)
Two injuries	16 (15.1)	6 (5.7)
More than two injuries	9 (8.5)	10 (9.4)
History of recurrent previous injury	7 (6.6)	8 (7.5)
Positive Anterior Drawer Test	30 (30)	21 (21)
Positive Talar Tilt Test	14 (14)	16 (16)
Positive Single-Leg Balance Test	28 (26.4)	24 (22.6)
FPI-6		
Normal	52 (52)	46 (46)
Excessive pronation	44 (44)	51 (51)
Excessive supination	4 (4)	3 (3)

[a]Values are expressed as No. (%).

sectional nature of this study, results can merely demonstrate the higher prevalence and these significant differences may not represent a causal effect.

According to the published prospective studies, using the anterior drawer and talar tilt tests to predict occurrence of LAS in athletes present conflicting results.While some authors demonstrated that the anterior drawer and talar tilt tests did not predict ankle sprains, (17) others reported a higher incidence of LAS in athletes with positive talar tilt and anterior drawer tests (13, 28). Through a retrospective study, Denegar et al. (29) reported that significant differences in joint laxity are found between injured and uninjured ankles based on the anterior drawer and talar tilt tests. This finding is in accordance with the result of the present study. Also, in this study like many previous projects (8, 9, 12), no association was detected between generalized joint laxity and LAS.

The relationship between balance and LAS is the main subject of many previous studies. Different methods have been used in the previous studies to assess the balance in athletes. However the Single-leg balance test and the star excursion balance test are the two most commonly used methods in the previous surveys to assess balance of the athletes. According to this study, only the positive single leg balance test was related to acute LAS while no association was found between the SEBT and LAS. Since the majority of previous surveys (24, 30-32) established that balance deficits could predict ankle injury susceptibility in athletes and as the present study was not able to show the causality between different variables, it is not rational to draw conclusions that the SEBT cannot be used to predict LAS in athletes. Besides, the lack of relationship between the SEBT and LAS in the present study is not supported by a recent study where Doherty et al. (33) showed that acute first-time LAS was associated with impaired SEBT. However, this study was performed on samples who suffered from acute first-time LAS, while the players with a history of acute or recurrent LAS during past 2 years were included in the present study. On the other hand, the lack of association between LAS and static and especially semidynamic balance measurements may be explained by this fact that injured athletes may perform the balance and proprioceptive training more vigorously compared with other athletes to continue their professional career and therefore, may not show any difference.

Another finding in this study was the relationship between decreased left ankle plantarflexion and acute or recurrent LAS, while no relationship was found between dorsiflexion of ankle as well as the first metatarsophalangeal joint and LAS. This finding is nearly in accordance with the result of a previous study where Denegar et al. (29) reported that ankle dorsiflexion was mainly restored following LAS.

Static measurements of foot features are mainly performed to determine the relationships between the anatomy as well as biomechanics of foot and LAS (34). Based on this study, none of the foot characteristics including foot length, foot width and Foot Posture Index were related to LAS. However, among different foot characteristics, cavovarus deformity, increased foot width, and increased calcaneal eversion range of motion are reported as the most commonly parameters which have been related to LAS (34). Regarding the relationship between FPI-6 and LAS, the findings of the present study are not supported by previous surveys (34-37), where they reported that having an under-pronated to supinated foot type is associated with an increased risk of ankle injury. This difference may be due to prospective design of the mentioned studies.

The limitations of this study were as follows: First, the surveys like this study, by nature, lend to information bias as participants may not recall their experiences, properly. However, as these events may significantly affect the professional career of these elite athletes, this problem may not apply in this group. Secondly, although cross-sectional studies can be a useful method in gathering general information about samples, it is difficult to evaluate causality. Lastly, due to difficult access to the elite athlete, we were obliged to use conventional sampling and therefore, results of this study may not be generalized to all football and basketball players. Furthermore, the biomechanical differences between football and basketball may impact

Table 3. The Results of Anterior Drawer Test and Talar Tilt Test Among Athletes With or Without History of Acute and Recurrent LAS

Injury	Anterior Drawer Test			Chi-Square Tests	Talar Tilt Test			Chi- Square Tests
	Negative	Positive	Total	P Value	Negative	Positive	Total	P Value
Acute right ankle injury				0.037				0.056
Positive	24	17	41		32	9	41	
Negative	46	13	59		54	5	59	
Acute left ankle injury				0.001				0.017
Positive	17	14	31		22	9	31	
Negative	62	7	69		62	7	69	
Recurrent right ankle injury				0.133				0.692
Positive	2	3	5		4	1	5	
Negative	68	27	95		4	13	95	
Recurrent left ankle injury				0.015				0.044
Positive	3	4	7		4	3	7	
Negative	76	17	93		80	13	93	

on some intrinsic factors such as the ankle range of motion and may be considered as a potential confounding factor.

5.1. Conclusion

Some intrinsic risk factors including ankle joint laxity, impaired single leg balance test and decreased ankle plantarflexion seem to be more prevalent in athletes with history of acute or recurrent LAS. More prospective studies are required for better recognition of intrinsic risk factors of ankle injuries.

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Footnotes

Authors' Contribution: Farzin Halabchi and Mohammad Hosein Pourgharib conceived the project; Farzin Halabchi, Mohammad Hosein Pourgharib and Maryam Mirshahi assisted with acquisition of data; Farzin Halabchi, Mohammad Ali Mansourn, Mohammad Hosein Pourgharib and Maryam Mirshahi were involved in analysis and interpretation of data; Farzin Halabchi, Hooman Angoorani and Maryam Mirshahi wrote the first draft of the manuscript; Farzin Halabchi wrote the final drafts of this.

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