

Influence of floor, shoes and body mass index in the occurrence of ankle sprains in women

Influência do piso, calçado e massa corporal na ocorrência de entorses de tornozelo em mulheres

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ABSTRACT

Objective: To evaluate ankle sprains associated with type of shoes, surface, body mass index and age. **Methods:** We analyzed 150 women with ankle sprains. Patients completed a questionnaire about the kind of shoes they were wearing at the time of the sprain, type of surface they were on, and their body mass index. Types of shoes worn at the time of the sprain were slippers, high-heels (platform shoes, high and medium heels), tennis shoes, and barefoot. We calculated the body mass index and it was classified into underweight, normal, overweight and obesity. We divided type of floor into irregular (stairs, dirt and grass) and regular (floor, concrete, asphalt, wood and rubber). Sprains were classified based on location (lateral, medial, or mixed) and degree (I, II or III). **Results:** A total of 68% of patients were young and young adults (20 to 40-year-old), 19.3% were adults (40 to 60-year-old) and 12% were elderly. Most patients, 71.3%, were under-and normal-weight, and 28.7% of them were overweight and obese. Sprains occurring in regular floor entailed 58% of the sample. Strains due to high heels (platform shoes, high and medium heels) accounted for 36.7%, with a predominance of sprains in women wearing platform type shoes (24%). Sprains due to slippers represented 29.3%, sneakers 28.7%, and barefoot 5.3%. Lateral isolated lesion was seen in 83.3%, medial lesion in 10.7% and mixed lesion in 6% of cases. Of these injuries, 10.7% occurred during exercise. **Conclusion:** No significance was observed among variables: type of floor, body mass index and age. Sprains were homogeneous in relation to type of shoes and surface in lateral lesions. Medial lesions were statistically significant in patients who were wearing slippers (68.8%, $p=0.001$). Level of evidence IV, Case Series.

Keywords:

Ankle/injuries; Sprains and strains; Shoes; Women

RESUMO

Objetivo: Avaliar as entorses de tornozelo, relacionando-as ao tipo de calçado, ao piso, ao índice de massa corporal e à idade. **Métodos:** Foram analisados 150 pacientes femininos com entorse do tornozelo. As pacientes responderam um questionário sobre o tipo do calçado que usavam no momento da entorse, o piso e o índice de massa corporal. Os tipos de calçados utilizados no momento da entorse foram: chinelos, calçados com salto (plataforma, salto alto e médio), tênis ou estavam descalças. Calculamos o índice de massa corporal, que foi classificando em baixo peso, normal, sobrepeso e obesidade. Quanto ao tipo de piso, dividimos em irregular (escada, terra e grama) e regular (piso frio, concreto, asfalto, madeira e emborrachado). As entorses foram classificadas quanto à localização (lateral, medial ou mista) e ao grau (I, II ou III). **Resultados:** Dentre as pacientes, 68% eram jovens e adultas jovens (20 a 40 anos), 19,3% adultas (40 a 60 anos) e 12% idosas. A maioria das pacientes (71,3%) apresentava peso baixo e normal, e 28,7% correspondiam à obesidade e ao sobrepeso. Ocorreram em piso regular 58% das entorses. Os sapatos de salto (plataforma, salto alto e médio) representaram 36,7% das entorses, com domínio do tipo plataforma (24%); o chinelo representou 29,3%; o tênis, 28,7%; e pés descalços, 5,3%. Lesão lateral isolada foi evidenciada em 83,3%, a medial em 10,7% e a mista em 6% dos casos. Das lesões, 10,7% ocorreram durante prática esportiva. **Conclusão:** Não houve significância entre as variáveis tipo do piso, índice de massa corporal e idade. As entorses se mostraram homogêneas em relação ao tipo de piso e de calçado nas lesões laterais. As entorses mediais foram estatisticamente significantes nas pacientes que usavam chinelos. Nível de Evidência IV, Série de Casos.

Descritores:

Tornozelo/lesões; Entorses e distensões; Sapatos; Mulheres

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Conflict of interest:
none reported.

Funding:
none reported.

Received on:
July 16, 2016

Accepted on:
October 31, 2016

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INTRODUCTION

Ankle sprains can be caused by mechanisms of direct injury or, more often, by indirect rotational, translational, axial, or combined trauma. Any change in joint congruence significantly interferes with the biomechanics of movements and with ankle load distribution, which may lead to a sprain.⁽¹⁾

The estimated frequency of ankle inversion injuries is one injury per 10,000 people per day.⁽²⁾ Belangero et al. presented data for the city of São Paulo, with an estimated population of about 10 million individuals, showing that one thousand lateral ankle sprains occur daily.⁽³⁾

There are intrinsic and extrinsic factors that increase the risk of ankle sprains in women. In addition to predisposing anatomical alterations, the main intrinsic risk factors include lower limb length discrepancy, ligament laxity, tibiofibular joint disorders, calcaneal varus, forefoot valgus, and clubfoot. Extrinsic factors include type of shoe, type of surface, sports involving impulsion/jumping movements and running.^(4,5)

In view of the above, the objective of this study was to assess ankle sprains in women, relating them to the type of shoe, surface, body mass index and age.

METHODS

We analyzed 150 patients with ankle sprains admitted to the Pronto-Socorro Municipal de Taubaté (municipal emergency department) and to the private clinic of one of the authors between July and December 2011. This study was previously authorized and registered by the Institutional Review Board of the Universidade de Taubaté under protocol 444/11.

Female gender and established diagnosis of ankle sprain not associated with fracture were the inclusion criteria. The patients answered a questionnaire about the type of shoe they were wearing at the time of the trauma, the surface where the sprain occurred, weight and height (to calculate body mass index) and activity at the time of the injury.

We used the traditional grading system for ankle ligament injuries, which were divided into grade I (mild), II (moderate) and III (severe or serious).⁽⁶⁾ In this study we also classified sprains based on location as lateral, medial or mixed. The types of shoe were divided into barefoot, flat sandals (flip-flops), heeled shoes (wedge/platform, high heel, mid heel) and tennis shoes. We calculated the body mass index (BMI) adopted by the World Health Organization,⁽⁷⁾ used to diagnose overweight and obesity, as measured by the formula: weight divided by height square. Below

18.5=malnutrition, between 18.5 and 24.5, normal weight, between 25.0 and 29.9, overweight, between 30.0 and 39.9, obesity and above 40.0, morbid obesity.

We classified the patients in two groups: underweight and of normal weight, and overweight and obese. We divided the types of surface at the time of injury into uneven (stairs, earth and grass) and even (tiled, concrete, asphalt, wood and rubber flooring).

The significance level of 0.05 ($\alpha=5\%$) was adopted in all the statistical tests used and the Statistical Package for Social Science (SPSS), version 15.0 for Windows was used for all the statistical analyses.

RESULTS

Table 1 shows the results related to the variables age, weight, shoe, surface, classification and location of the lesion, and presence of previous sprains.

Sixty percent of ankle sprains occurred between the ages of 20 and 40 years; 19.3% between the ages of 40 and 60 years; and 12% in patients over 60 years of age.

In terms of weight, 71.3% were in the low and normal weight range, and 28.7% were overweight and obese.

Twenty-nine point three percent of patients were wearing flat sandals at the time of the sprain; 5.3% were barefoot; 28.7% wore tennis shoes; and in the majority of cases (36.7%), the patients were wearing heeled shoes, with platform type footwear predominating (24%).

There was no statistical significance in terms of the type of surface studied, with 87 sprains occurring on an even surface (58%) and 63 on an uneven surface (42%).

Table 2 shows the comparison between groups of types of lesion.

The groups were homogeneous in terms of the type of surface on which the sprain occurred ($p=0.775$).

In analyzing the type of shoe used at the time of the sprain, there was a statistically significant difference for patients wearing flat sandals and presenting with medial ligament injuries compared to the other types of shoe and the location of the sprain. We emphasize the high rate of lateral ligament complex injuries in patients wearing high heels (39.2%).

Table 3 shows the cross referencing of data between the lateral injuries with the type of surface and shoe.

The groups were homogeneous in terms of the type of surface ($p=0.477$).

A statistically significant difference was found between the type of footwear at the time of the sprain with medial

Table 1 | Characterization of the sample of patients

Variables	n (%)
Age (years)	
12-20	42 (28.0)
20-40	61 (40.7)
40-60	29 (19.3)
>60	18 (12.0)
Body mass index	
Low weight	26 (17.3)
Normal	81 (54.0)
Overweight	25 (16.7)
Obesity	18 (12.0)
Type of surface	
Uneven	63 (42.0)
Even	87 (58.0)
Type of shoe	
Flat sandal	44 (29.3)
Barefoot	8 (5.3)
High heels	55 (36.7)
Tennis shoes	43 (28.7)
Edema	
1+	57 (38.0)
2+	63 (42.0)
3+	24 (16.0)
4+	6 (4.0)
Pain	
Mild	38 (25.3)
Moderate	91 (60.7)
Intense	21 (14.0)
Injury	
Grade I lateral	68 (45.3)
Grade I lateral/grade I medial	5 (3.3)
Grade II lateral	49 (32.7)
Grade II lateral/grade I medial	1 (0.7)
Grade II lateral/grade II medial	2 (1.3)
Grade III lateral	8 (5.3)
Grade III lateral/grade II medial	1 (0.7)
Grade I medial	13 (8.7)
Grade II medial	1 (0.7)
Grade III medial	2 (1.3)
Type of injury	
Lateral	125 (83.3)
Lateral/medial	9 (6.0)
Medial	16 (10.7)
Lateral	134 (89.3)
Medial	25 (16.7)
Grade of lateral injuries	n=134
I	73 (54.5)
II	52 (38.8)
III	9 (6.7)
Grade of medial injuries	n=25
I	19 (76.0)
II	4 (16.0)
III	2 (8.0)
Previous injuries	
Não	115 (76.7)
Sim	35 (23.3)
Ecchymosis	
No	107 (71.3)
Yes	43 (28.7)
Sport	
No	134 (89.3)
Yes	16 (10.7)

injury ($p=0.001$), highlighting the proportion of grade I injuries while wearing low sandals (63.2%), a significantly higher proportion than in grade II (25.0%) and grade III (0%) medial injuries. Other differences were found to be

Table 2 | Association of the type of injury with the type of surface and shoe

Variables	Injury			p-value
	Lateral (n=125) n (%)	Lateral + medial (n=9) n (%)	Medial (n=16) n (%)	
Type of surface				
Uneven	51 (40.8)	4 (44.4)	8 (50.0)	0.775
Even	74 (59.2)	5 (55.6)	8 (50.0)	
Type of shoe				
Flat sandal	31 (24.8)	2 (22.2)	11 (68.8)	0.001*
Barefoot	6 (4.8)	0 (0.0)	2 (12.5)	
High heels	49 (39.2)	4 (44.4)	2 (12.5)	
Tennis shoes	39 (31.2)	3 (33.3)	6 (37.5)	

* Statistical significance

Table 3 | Association of the degree of lateral injury with the type of surface and shoe

Variables	Lateral injury			p-value
	Grade I (n=73) n (%)	Grade II (n=52) n (%)	Grade III (n=9) n (%)	
Type of surface				
Uneven	30 (41.1)	22 (42.3)	3 (33.3)	0.878
Even	43 (58.9)	30 (57.7)	6 (66.9)	
Type of shoe				
Flat sandal	19 (26.0)	13 (25.0)	1 (11.1)	0.111
Barefoot	2 (2.7)	3 (5.8)	1 (11.1)	
High heels	28 (38.3)	19 (36.5)	6 (66.6)	
Tennis shoes	24 (32.9)	17 (32.7)	1 (11.1)	

Table 4 | Association of the degree of medial injury with the type of surface and shoe

Variables	Medial injury			p-value
	Grade I (n=19) n (%)	Grade II (n=4) n (%)	g3 (n=2) n (%)	
Type of surface				
Uneven	8 (42.1)	3 (75.0)	1 (50.0)	0.477
Even	11 (57.9)	1 (25.0)	1 (50.0)	
Type of shoe				
Flat sandal	12 (63.2)	1 (25.0)	0 (0.0)	0.001*
Barefoot	0 (0.0)	0 (0.0)	2 (100.0)	
High heels	6 (31.6)	0 (0.0)	0 (0.0)	
Tennis shoes	1 (5.3)	3 (75.0)	0 (0.0)	

* Statistical significance

important: the higher proportion of grade II injuries while wearing tennis shoes and the higher proportion of grade III injuries when barefoot.

DISCUSSION

There are few epidemiological studies of ankle sprains related to the type of surface, shoe, and body mass index in women. Studies of sprains in women were only found in sports activities and in military training.⁽⁸⁻¹¹⁾

Ankle sprains, especially of the lateral complex, should be viewed as a frequent, debilitating, and costly injury. Approximately one lateral ankle sprain occurs per 10,000 people each day, with sprains predominating in the economically active population.⁽³⁾ This result is consistent with the present study, in which we found that 60% of ankle sprains occurred in the population considered economically active (aged 20 to 40 years), with special emphasis on the high rate of injuries of the lateral ligament complex while wearing high heels (39.2%).

In our study, the rate of grade I injuries was higher than those of greater severity. This result was also obtained by Tyler et al.⁽¹²⁾ However, despite this high frequency, the diagnosis and management of ankle sprains still represent a challenge, as the evaluation of the severity of the injury is hard to establish definitively in the initial stages of the trauma. In this scenario, sprain management still leads to differences of opinion verified in recent publications.^(3-5,9)

Women are different from men in terms of bone structure and biomechanics, having implications for adjustment of the foot to the female shoe. The female foot tends to be narrower in the hindfoot than in the forefoot, and is of a smaller size overall than the male foot.⁽⁴⁾ During the collection of data, the greater occurrence of sprains in female patients was significant, according to the study by Frey.⁽⁴⁾ In this study, high heel shoes were associated with 32% of the sprains, representing a higher rate of sprains with the use of this type of shoe.

Sprains were also frequent in patients who wore flat sandals (flip-flops), occurring in 29.3% of the sample; however, we did not find comparative studies for these variables. The use of this type of footwear is common in our population, perhaps because of the Brazilian climate.

Tennis shoes were associated with 28.7% of sprains, many of which were directly related to sports. Tennis/athletic shoes are the footwear of choice among sportsmen/women, and there is a high rate of sprains in all types of sports.⁽¹³⁻¹⁶⁾ Due to the association of tennis shoes (footwear) with sports, we expected to find a higher rate of sprains.

However, we must take into account the fact that this study was conducted in an emergency department. Many sports injuries are diagnosed and promptly treated at the site of the training session or game.

High BMI did not appear to be a risk factor for ankle sprains, diverging from the studies of Tyler et al.⁽¹²⁾ However, our results proved consistent with other studies, in which the BMI was not a significant risk factor for ankle sprains.⁽¹⁶⁻¹⁸⁾ The discordance existing between studies ratifies the need for more data and new studies to associate the variable BMI with the risk factors.

Isolated deltoid ligament injuries are very rare. In a series of 281 acute ankle injuries studied by Brostroem, only 3% were on the medial side.⁽¹⁹⁾ Almost all the injuries of the medial side were partial tears of the deltoid ligament. Harper showed that all complete deltoid ligament tears of the 42 patients studied were associated with other injuries, corroborating the rarity of isolated injuries in the medial region of the ankle.⁽²⁰⁻²¹⁾ However, we observed statistically significant rates of medial sprains in patients wearing flat sandals (flip-flops). The sprain mechanism caused by the use of flat sandals (flip-flops) may have accompanied the three major features of the mechanisms of injury of the deltoid ligament, which occur due to pronation-abduction, pronation-external rotation and supination-external rotation of the foot.⁽²¹⁻²²⁾

Acute ankle injuries are widely studied as common sports injuries, and the resulting recovery time is significant. However, we draw attention to an audience that is seldom studied in relation to ankle sprains and that presented high rates of this pathology. Fortunately, functional treatment has provided good results in most cases, and the period of inactivity has been minimized.

Research suggests that the etiology of ankle sprain is multifactorial, justifying the difficulty encountered in this study with the large number of variables that can be assessed and/or be related to ankle sprains.⁽²¹⁻²²⁾

This investigation is one of the few focusing on the risk factors for ankle sprains that allowed conclusions to be drawn on the main extrinsic factors responsible for such an injury.

CONCLUSION

Ankle sprains did not show significance in relation to two variables: body mass index or age. The groups were homogeneous in terms of the variable 'surface', with no evidence of a statistical difference between even and uneven surfaces, in relation to the number and severity of sprains.

The sprains were homogeneous in terms of the type of surface and shoe in lateral ankle injuries. In the patients wearing flat sandals and flip-flops, the rate of medial ankle sprains was higher, with statistical significance, than lateral sprains. Differences noted included the higher proportion of grade II injuries in patients wearing tennis shoes.

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