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Original Article

The relationship between footwear fit and foot deformities, musculoskeletal disorders and physical activity level

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Abstract

Aim: To determine the relationship between footwear fit and foot deformities, musculoskeletal disorders, and physical activity level.
Material and Methods: One hundred physically healthy individuals were included in the study. Footwear fit was examined via the footwear assessment score, foot deformities were examined via the Total Foot Deformity Scoring and musculoskeletal disorders were evaluated with Cornell Musculoskeletal Discomfort Questionnaire. The physical activity level of the individuals was measured by the International Physical Activity Questionnaire. Spearman correlation coefficient was used to determine the relationship between variables.
Results: No statistically significant relationship was found between footwear fit and right foot deformity scores ($p > 0.05$). However, there was a weak negative correlation between the participants' footwear fit and left foot pes planus ($r = -0.242$, $p = 0.015$), pes cavus ($r = -0.245$, $p = 0.014$), and total deformity scores ($r = -0.208$, $p = 0.038$). There was no statistically significant relationship between footwear fit and musculoskeletal disorders and physical activity levels ($p > 0.05$).
Conclusion: There was no relationship between footwear fit and musculoskeletal pain and physical activity level in the study population. However, it was found that proper footwear use was associated with foot deformities. It is considered that the present study can be used in the future as a reference in studies conducted with populations with certain pathologies.

Keywords: Foot; foot deformities; shoes; musculoskeletal pain; physical activity.

INTRODUCTION

Similar to the foot, footwear also acts as a connection between the body and ground and provides somatosensory input to the body through the tactile and proprioceptive systems (1,2). The quality of these inputs alters muscle activation in the feet and legs and affects both the lower extremity kinematics and the skeletal alignment of the individual (1,3). Footwear, as off-the-shelf soles, patient-specific insoles, or orthoses, can be used as a non-pharmacological treatment for pathological conditions (4). In recent publications, there is evidence that footwear reduces pain and improves function in pathologies such as the 1st metatarsal pain, gout, and ankle arthritis (3,5,6).

On the other hand, effects of footwear in healthy individuals have been investigated with duration of short and instant effects only, such as the effects of high heels on balance. There are publications in the literature on the effects of different sole materials on gait and involving elderly population. These publications often involve observing the person's momentary kinetic or kinematics while wearing footwear with sole materials having varying intensities (7–10). However, individuals' long-term behaviors affect their susceptibility to deformities (11). There are limited publications investigating the relationship between footwear habits and physical activity in healthy populations (12). Therefore, it is important to associate foot deformities with possible risk factors.

The aim of the present study was to define footwear habits in healthy young individuals, and to investigate the relationship between footwear fit and foot deformities, physical activity, and musculoskeletal pain. To this end, the hypothesis of the present study is that there is a relationship between footwear fit and foot deformities, musculoskeletal disorders, and physical activity level.

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MATERIAL and METHODS

Volunteer college students without any health problems were participated in the study. According to the power analysis, with 80% power and 5% type 1 error level, the number of people to be included in the study was calculated as 98. The inclusion criteria were: being a volunteer in an age range of 18-35 years without any discomfort preventing ambulation.

Individuals with a history of lower extremity surgery, fracture, and neurological problems were not included in the study. Subjects were informed about the study and signed consent forms were obtained from volunteers (Adnan Menderes University Ethics Committee Date and Number: 20/12/2018-E.73327).

First, the age, height, footwear size, and body weights of the participants were recorded. In addition, participants' foot type and footwear habits were recorded (13). To investigate the presence of foot deformities, Total Foot Deformity Scoring (TADS), which is a semi-structured method based on a separate total score for both feet according to the number of deformities seen in each foot, was used. In this scoring; pes planus, pes cavus, hallux valgus, low transverse arch, hammer finger, claw finger, syndactyly, polydactyly, pes equinovarus, and metatarsus primus varus deformities were questioned. The presence of each deformity was scored. Separate TADS scores were calculated for each foot (12).

Footwear habits and footwear fit of the individuals were evaluated using the Footwear Assessment Score (FAS), whose Turkish validity and reliability were established. FAS is an objective method of assessing footwear fit in children, and evaluates several factors such as footwear material, footwear heel metatarsal distance, footwear width, finger box height, footwear's unintentional coming out of the foot during walking, heel height, footwear style, heel wear, and toe spacing. The full score for eligible footwear is 15 (14).

The participants' physical activity levels were determined with the International Physical Activity Questionnaire (IPAQ), whose Turkish validity and reliability were established. The short form of this self-report questionnaire, which includes the previous seven days, was used to assess the level of physical activity. This short form includes seven items, and provides information about sitting, walking, moderately severe and severe activities as well as the frequency of and the time spent in these activities. The evaluation of all activities is based on the assumption that each activity is performed for at least 10 minutes at a time. In calculating energy consumption for physical activities, the weekly duration of each activity (minutes) was multiplied by the metabolic equivalents (METs) developed for the IPAQ. Thus, energy consumption for each individual in terms of walking activity; vigorous, moderate and total physical activities was obtained in MET-min / week (15,16).

The Cornell Musculoskeletal Discomfort Questionnaire (CMDQ) was used to evaluate the musculoskeletal discomforts of the participants. The questionnaire, whose Turkish validity and reliability were established, assesses pain in 20 different regions under three main headings: frequency, severity, and deformity. According to the scoring system, 0-90 points are obtained for each region. Higher results indicate an increase in musculoskeletal disorders (17). In this study, the part of the questionnaire regarding the lower back, upper back and lower extremities was used.

Statistical Analysis

The suitability of the variables to normal distribution was examined using visual (histogram and probability charts) and analytical methods (Kolmogorov-Smirnov test). Categorical data were represented by percentages of distribution and the numerical data obtained by measurement were shown by mean and standard deviation values. Correlation coefficients and statistical significance were calculated using the Spearman correlation coefficient for relationships between variables which was not normally distributed or between ordinal variables. For statistical significance, type-1 error level was set as 5%.

RESULTS

The study included 100 healthy individuals, 80 women (80%) and 20 men (20%) with a mean age of 28.5 ± 10.7 years, of whom 95 were right-dominant and 5 were left-dominant (Table 1).

Table 1. Demographic data of individuals (N=100)

	X±SD
Age (years)	28.5±10.7
Height (cm)	150.0±50.1
Weight (kg)	66.0±15.6
Foot length (cm)	
Right	45.9±64.9
Left	46.0±65.1
Duration of shoe usage (month)	14.4±16.7
	N
Gender (Female/Male)	80/20
Dominant side (right/left)	95/95
Shoe size (min-max)	35-45

min-max: minimum-maximum

The distribution of the individuals based on their foot type and footwear habits are given in Table 2. It was observed that the participants mostly had normal foot type, and they preferred sneakers with thick soles (Table 2). It was observed that the individuals were similar in terms of foot type and footwear preference.

The distribution of foot deformity scores observed in individuals is shown in Table 3. The subheadings and total score of the FAS assessment is shown in Table

4. The results of the examination of the relationship between footwear scores, as determined by FAS, and foot deformities are shown in Table 5.

Table 2. Foot type and shoe use habit of individuals

	N (%)
Foot Type	
Wide Foot	20 (20)
Normal Foot	63 (63)
Narrow foot	17 (17)
Shoe usage habits	
Sneakers with thin sole	21 (21)
Sneakers with thick sole	57 (57)
Leathery based shoe	3 (3)
Rubber based shoe	5 (5)
Thick based boats	12 (12)
Rubber/thin based boats	2 (2)

Table 3. The subheading results of the Foot Deformity Scoring (TFDS) were calculated separately for for right, left feet of individuals. Bilateral incidence of deformities is indicated as number (N)

	Right Foot (Present/None)	Left Foot (Present/None)	Bilateral (Present/None)
Pes Planus	47/53	44/56	43/57
Pes Cavus	1/99	6/94	2/98
Hallux valgus	26/74	24/76	20/80
Transvers arch collapse	5/95	7/93	6/94
Hammer toe	7/93	9/91	7/93
Claw toe	6/94	5/95	4/96
Syndactyly	0/100	0/100	0/100
Polydactyly	0/100	0/100	0/100
Clubfoot	0/100	0/100	0/100
Metatarsus Primus Varus	0/100	0/100	0/100

Table 4. Subheadings and total results of the FAS assessment score (N=100)

	Variables	N
Shoe material-top	Leather/Not	35/65
Shoe material-sole	Rubber/Not	78/22
Twist point of the shoe	Proper/Not	95/5
Shoe weidth	Proper/Not	87/13
Fingerbox height suitability	Proper/Not	77/23
Slackness of the shoe during walking	Present/Not	94/6
Heel height suitability	Less than 25mm/greater than 25mm	74/26
Wear on heel of the shoe	Less than 5mm/more than 5mm	92/8
Gap between fingertip and shoe	11-20mm/6-11mm/less than 5mm	7/38/55
Total score (X±SD)		12.0±2.1

The total deformity scores obtained from the participants showed that 47 out of 100 individuals had pes planus in the right foot, 44 in the left foot, and 43 had bilateral pes planus. Of the 100 participants, 26 had hallux valgus in the right foot and 24 in the left foot, and 20 had bilateral hallux valgus (TFDS: right, left, and bilateral) (Table 3). There was no statistically significant correlation between footwear fit and right foot deformity scores (p> 0.05) (Table 5). However, there was a weak negative correlation between footwear fit and left foot pes planus (r = -0.242, p = 0.015), pes cavus (r = -0.245, p = 0.014), hammer toe (r = -0.233, p = 0.020), and total deformity scores (r = -0.208, p = 0.038) (Table 5).

Table 5. The correlation coefficients and p values for footwear scores, as determined by FAS and foot deformities. Spearman Correlation Coefficient was used for statistical analysis

		Results of FAS footwear scores	
		r	p
Pes Planus	Right	-0,156	0,121
	Left	**-0.204**	**0.041***
	Bilateral	**-0,224**	**0,025***
Pes Cavus	Right	0.047	0.642
	Left	**-0.226**	**0.024***
	Bilateral	-0.034	0.724
Halluks valgus	Right	0.051	0.614
	Left	-0.080	0.428
	Bilateral	0.045	0.657
Transvers arch collapse	Right	0.086	0.396
	Left	-0.075	0.456
	Bilateral	0,018	0.859
Hammer Toe	Right	-0.075	0.526
	Left	**-0.233**	**0.020***
	Bilateral	-0.075	0.456
Claw toe	Right	0.039	0.703
	Left	0.042	0.676
	Bilateral	0.144	0.153
Total (X±SD)	Right	-0.046	0.652
	Left	**-0.296**	**0.003***

* p<0.05

Table 6. The correlation coefficients and p values for footwear scores, as determined by FAS, and Cornell Musculoskeletal Disorders Score. Spearman correlation coefficient was used for statistical analysis

	FAS footwear scores	
	r	p
Cornell upper back	0.125	0.214
Cornell lower back	0.150	0.135
Cornell hip (right)	0.117	0.247
Cornell hip (left)	0.062	0.543
Cornell upper leg (right)	0.118	0.243
Cornell upper leg (left)	0.118	0.243
Cornell knee (right)	0.704	0.100
Cornell knee (left)	0.067	0.508
Cornell lower leg (right)	0.102	0.313
Cornell lower leg (left)	0.080	0.429
Cornel foot (right)	-0.122	0.226
Cornell foot (left)	-0.106	0.293

Table 7. The correlation coefficients and p values for footwear scores, as determined by FAS, and Physical Activity Score results for each subdomain. Spearman correlation coefficient was used for statistical analysis

	FAS footwear score result	
	r	p
IPAQ walking	0.064	0.524
IPAQ moderate	-0.014	0.887
IPAQ vigorous	-0.030	0.768
IPAQ total score	-0.001	0.989

According to the results of the present study, no statistically significant correlation was found between footwear fit and musculoskeletal disorders (p> 0.05) (Table 6).

Similarly, no statistically significant correlation was found between footwear fit and physical activity level (p> 0.05) (Table 7).

DISCUSSION

In this study, statistically significant no correlation was detected between footwear fit and right foot deformity, musculoskeletal disorders, and physical activity level. However, it was found that there was a relationship between footwear fit and left foot pes planus, pes cavus, hammer toe and total deformity scores. The results of the inquiry regarding foot type and footwear habits along with the demographic data of the participants showed that the distribution of the foot type was concentrated in the normal foot type, and that the participants preferred sneakers with thin or thick soles. This result showed that the individuals included in the study were homogeneous in terms of foot type and footwear preference.

Scores obtained using the FAS, which was developed to test the suitability between footwear and the feet, were obtained for the footwear frequently used by the individuals. There was a negative correlation only between the footwear habits of the individuals and the left foot pes planus, pes cavus, and total deformity scores. This result indicates that pes planus, pes cavus, and total deformity scores increase as the suitability of the footwear decreases. The present study agrees with previous studies. Menant et al (18). showed that heel height, sole thickness, and sole stiffness affect balance. In addition, it is stated that these properties of the footwear will affect the balance, and they can be preparatory factors for foot deformities by disrupting the balance of load distribution in the foot in time. Similarly, Güçhan et al (12) showed a relationship between heel height and sole material and the total deformity score. The results of the present study reveal the importance of footwear fit for foot health.

Particular attention was paid to lower extremity, back, and low back pain, which may be related to footwear fit in CMDQ, in which musculoskeletal disorders are evaluated. According to the prevalence study conducted by Kuru et al (19) 92.8 % of the adults experienced musculoskeletal disorders and musculoskeletal pain occurring most commonly in the spine. In addition, when the presence of musculoskeletal disorders was compared according to the physical activity level, only knee pain and physical activity level were found to be correlated. In another study, it was shown that the use of unstable footwear affects spine kinetics and kinematics and is a risk factor for low back pain (20). In the compilation study of Kurup et al (21), it was determined that by choosing suitable footwear; the development of foot arch structure was supported in children. At the same time, proper footwear decreases the risk of knee osteoarthritis and low back pain in women.

In the present study, no correlation was found between footwear fit and musculoskeletal disorders. This can be explained by the fact that the age range of the study population was low, and the study was administered in a single location. Aging is known to be a risk factor for the incidence of foot deformities (22). It is considered that studies conducted in different populations may yield different results. In addition to this, the fact that the participants frequently used sneakers may have contributed to this conclusion. This result can be used as a reference value for comparisons of different pathologies.

There are studies showing the relationship between footwear suitability and physical activity level in different sample groups (12,23,24). There are studies showing that footwear suitability affects running economy (23) in runners and physical activity level in healthy individuals by affecting performance tests (12). Roman et al (24) reported that footwear fit affects physical activity level in older women by affecting gait parameters. In a study conducted by Bac et al (25), no relationship was found between physical activity level and footwear preference among physically active university students. Similarly, no correlation was found in the present study between footwear fit and physical activity scores.

One of the limitations of the present study is that participants only consist of a healthy group. Another limitation is that the assessment methods used were subjective. Unfortunately, there a lack of usable questionnaire in the literature to evaluate shoe suitability. However, this study considered to be important because it gives an insight into the relationship between footwear suitability and foot deformities, musculoskeletal disorders, and physical activity levels.

As a result, no significant relationship was found between footwear habits of the individuals and the suitability of the footwear they often use, musculoskeletal disorders, and physical activity level. However, in this study, it was found that there was a relationship between footwear deformity and footwear fit. Further studies are required to show this association in different pathologic conditions.

CONCLUSION

As a result, no significant relationship was found between footwear habits of the individuals and the suitability of the

footwear they often use, musculoskeletal disorders, and physical activity level. However, in this study, it was found that there was a relationship between footwear deformity and footwear fit. Further studies are required to show this association in different pathologic conditions.

Competing interests: The authors declare that they have no competing interest.
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