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Effects of Pes Planus on Foot Pain, Low Back Pain, and Static Balance in Young Adult Individuals

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ABSTRACT

Purpose: Pes planus is the reduction or complete loss of the medial longitudinal arch height of the foot. There are conflicting results in the literature explaining the relationship between pes planus and foot pain, low back pain, and balance in young adult individuals. This study aimed to determine the effects of pes planus on foot pain, low back pain, and static balance in young adult individuals.

Methods: 59 people were examined in this cross-sectional study. Considering the homogeneity of the results, 4 people were not included in the statistical analysis. According to the analysis results, a total of 55 people was included in the study, 37 with pes planus and 18 without pes planus. Feiss line test, Foot Function Index (FFI), Visual Analog Scale (VAS), and Stork Balance Test (SBT) were used to assess pes planus, foot pain, low back pain, and static balance, respectively.

Results: There was no significant difference between FFI, VAS (resting-activity), and left foot SBT values comparisons of individuals without pes planus and with pes planus ($p>0.05$), it was found that the right SBT results were significantly higher in without pes planus than in pes planus ($p<0.05$).

Conclusion: The Static Balance scores of individuals without pes planus were found to be higher than individuals with pes planus. No significant foot or back pain was observed in the participants with and without pes planus, which consisted entirely of young individuals.

Keywords: Pes planus, pain, postural balance, young adult.

ÖZET

Amaç: Pes planus, ayağın medial longitudinal ark yüksekliğinin azalması veya tamamen kaybolmasıdır. Literatürde genç erişkin bireylerde pes planus ile ayak ağrısı, bel ağrısı ve denge arasındaki ilişkiyi açıklayan çelişkili sonuçlar bulunmaktadır. Bu çalışmada pes planusun genç erişkin bireylerde ayak ağrısı, bel ağrısı ve statik denge üzerine etkilerinin belirlenmesi amaçlandı.

Yöntem: Bu kesitsel çalışmaya 59 birey dahil edildi. Sonuçların homojenliği dikkate alınarak 4 birey istatiksel analize dahil edilmedi. Analiz sonuçlarına göre 37 pes planusu olan, 18 pes planusu olmayan toplam 55 birey çalışmaya dahil edildi. Pes planus, ayak ağrısı, bel ağrısı ve statik dengeyi değerlendirmek için sırasıyla Feiss çizgisi testi, Ayak Fonksiyon İndeksi (AFİ), Görsel Analog Skala (GAS) ve Stork Denge Testi (SDT) kullanıldı.

Bulgular: Pes planusu olan ve olmayan bireylerin AFİ, GAS (istirahat-aktivite) ve sol ayak SDT değerleri karşılaştırıldığında anlamlı bir fark olmadığı ($p>0,05$), sağ SDT sonuçlarının ise pes planusu olmayanların pes planusu olanlara göre anlamlı ölçüde daha yüksek olduğu belirlendi ($p<0,05$).

Sonuç: Pes planusu olmayan bireylerin pes planusu olan bireylere göre statik denge puanlarının daha yüksek olduğu belirlendi. Tamamı genç bireylerden oluşan, pes planusu olan ve pes planusu olmayan katılımcılarda önemli bir ayak ya da bel ağrısı gözlenmemiştir.

Anahtar Kelimeler: Pes planus, ağrı, postüral denge, genç erişkin.

Pes planus (PP) can be defined as the valgus of the hindfoot while loading, the disappearance of the medial longitudinal arch in the midfoot, and the supination of the forefoot relative to the hindfoot (1, 2). Pes planus is characterized by a lowered medial longitudinal arch (MLA), an everted hindfoot, and a dorsiflexed and abducted midfoot (3). The prevalence of pes planus in the general population has been reported to be between 2% and 23%, this rate increases up to 74% (4-6).

The most important problem related with pes planus is excessive pronation of the foot during standing and walking. This leads to impaired load distribution in gait, excessive stresses in the foot and ankle joints, compressive shearing forces in the knee joint and internal rotation in the hip joint (7-9). Also, it has been reported that in individuals with pes planus, activation of the plantar intrinsic muscles and tibialis posterior is needed more to support the MLA and stabilize the foot in weight-bearing activities, and as a result, muscle fatigue and failure may occur (10).

Pes planus may cause pain, tenderness, stiffness, kinematic changes in gait patterns, and activity limitation (11-13). Biomechanical changes resulting from pes planus may cause low back, foot, and calf pain, as well as gait disorders; therefore, they affect daily activities such as doing sports, standing for a long time and walking, and physical fitness (1). Pes planus may cause foot and leg pain, fatigue, and functional limitations, especially in elderly individuals (14, 15).

A study investigating the relationship between pes planus and pelvic inclination angle and the presence of low back pain reported that pes planus may cause an increase in pelvic inclination angle and low back pain in young sedentary individuals (16). In another study conducted in the same age group, no significant relationship was found between pes planus and pain in the lumbar region (17). When the studies examine the relationship between pes planus and balance in the literature, it has reached that contrasting results are reported. In a study conducted with young adults, it was reported that pes planus negatively affected balance (18). In another study conducted with participants in a similar age group, it was reported that individuals in the group with pes planus had decreased physical performance, but there was no difference between the group with pes planus and the control group (without pes planus) in terms of balance (19).

When the literature is analyzed, the relationship between pes planus and static balance and pain is not clear and there are studies with different results. The aim of our study is determining the effects of pes planus on foot pain, low back pain, and static balance in the young adult age group and to contribute to the literature on this subject.

Material and Methods

Participants and Ethic Approval

This cross-sectional research was conducted at KTO Karatay University between 30.09.2022 and 30.01.2023. Participants is selected among Physiotherapy and Rehabilitation students at the School of Health Sciences, KTO Karatay University with simple random sampling method.

Before starting the study, permission was obtained from KTO Karatay University Ethics Committee for Non-Pharmaceutical and Non-Medical Device Research (Decision date: 21.09.2022 Decision No: 2022/012). Participants were informed before inclusion in the study and a written informed consent form was obtained.

Inclusion criteria:

a. Ages of 18-30,

b. No lower extremity injury in the last 6 months,

c. Individuals who did not undergo any lower extremity surgery were included in the study.

Exclusion criteria:

a. Having systemic, neurologic, and/or degenerative diseases involving the foot,

b. Having epin calcanei, hallux valgus and hallux rigitus,

c. Individuals with any systemic and/or neurologic problems that may cause low back pain were excluded from the study.

Assessments

Demographic information of the individuals participating in the study was recorded. Participants were evaluated for pes planus, pain (low back pain and foot pain), and static balance.

Demographic Information

Demographic data (age, height, body weight, body mass index (BMI), gender, dominant side) were recorded.

Pes planus Evaluation

The "Feiss line" technique was used in the evaluation of pes planus. The "Feiss line" is the line formed by connecting the medial malleolus and the center of the 1st metatarsophalangeal joint. In a normal foot, the scaphoid tubercle of the navicular bone lies on the Feiss line. PP degrees are evaluated according to the separation of the scaphoid tubercle from this line and how close to the ground. If the tubercle falls 1/3 of the distance between the Feiss line and the ground, it is interpreted as degree 1 PP; if it falls 2/3 of the distance, it is interpreted as degree 2 PP; if it completely touches the ground, it is interpreted as degree 3 PP (20). PP was evaluated on a hard ground.

Pain Assessment

In our study, participants' foot pain and low back pain were assessed. The severity of low back pain was assessed with Visual Analog Scale (VAS). The VAS is a scale that has been validated and proven to be reliable in measuring the intensity of pain (21). The VAS is an assessment criterion that is represented by a 10-centimeter line, where 0 indicates "no pain" and 10 represents "very severe pain." In our study, the individual was asked to mark the severity of pain experienced during activity (outdoor walking, cycling, gardening…) and at rest separately on the scale (22). The pain levels were determined by measuring the place where the participants were marked.

The Foot Function Index (FFI) was used for the assessment of foot pain. The FFI is a commonly used self-administered form developed to assess the effects of foot pathologies on pain, disability, and activity limitations. Our study used only the pain-related part of the FFI scale. There is nine questions within the FFI assess pain in different time periods (morning, evening), different situations (standing, walking), and different conditions (with and without shoes). They are asked to rate each question on a scale from 0 (no pain or difficulty) to 10 (most severe pain that can be felt or too difficult to do) (23, 24).

Static Balance Assessment

The Stork Balance Test (SBT) was used for static balance assessment. In the SBT, participants stand on the floor with their shoes removed and hands on their waist. The foot of the non-tested extremity is fixed medial to the knee joint of the other extremity. The participant rises on tiptoe on the support leg and is asked to maintain the position for 1 minute and the timer is started with the command to rise. If the participant fails to maintain the position of the foot fixed medial to the knee, pulls one or both hands away from the waist and the heel of the support foot touches the ground, the stopwatch is stopped, and the time is recorded. The average of the test repeated 3 times is calculated and recorded (25).

Statistics

SPSS 22.0 program was used in the statistics analysis. Fisher's exact test was used to analyse categorical data. It was determined whether the data were normally distributed or not by examining the skewness and kurtosis values. Independent Samples t-test and Mann Whitney U test were used for normally distributed data and not normally distributed data respectively. Wilcoxon Paired t-test was used to compare the data belonging to the same individuals and those that were not normally distributed. The post hoc power analysis result was found as power $(1-\beta) = 54\%$ according to SBT-right leg (G*Power 3.1.9.7).

Results

A total of 59 individuals were included in our study. The dominant side of 4 individuals was determined as left, and the dominant side of 55 individuals was determined as right. Considering the homogeneity of the results in the study, 4 individuals with the left side of the dominant were not included in the statistics. A total of 55 individuals, consisting of 43 females and 12 males, were included in the statistics. The participants diveded two group for statictical anlyses, Group 1; without pes planus and Group 2; with pes planus. The participants who have pes planus is not divided in itself according to pes planus degrees because of the insufficient participants number. The demographic information of the participants is presented in Table 1.

Table 1. Demographic Information of Participants

	Group 1 (n= 18)		Group 2 (n=37)			Total (n=55)	
Gender	Female	Male	Female	Male	p[a]	Female	Male
	13	5	30	7	0.49	43	12
	Group 1 (n= 18)		**Group 2 (n=37)**			**Total (n=55)**	
	Mean±SD		Mean±SD		p[b]	Mean±SD	
Age (year)	23.4±2.6		22±2.4		0.056	22.4±2.5	
BMI	21.9±3.1		23.7±4.5		0.14	23.1±4.2	

Group 1: without pes planus, Group 2: with pes planus, SD: standard deviation, BMI: Body Mass Index, p[a]: Fisher's exact test, p[b]: Independent Samples t-test

While 18 participants in the study did not have pes planus, it was determined that 37 participants had different degrees of flexible pes planus. Detailed information regarding the presence and degrees of pes planus in the study participants is shown in Figure 1.

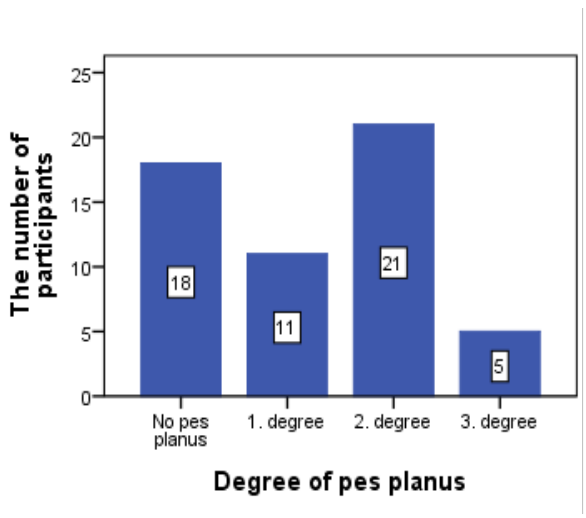

Figure 1: Pes planus evaluation results

When the pain levels of the participants in the study were assessed, no significant difference was found between individuals with pes planus and those without pes planus. Detailed information regarding the pain levels of the participants is shown in Table 2.

Table 2. Pain assessment results in individuals with and without pes planus

	Grup 1 (n= 18)	Grup 2 (n=37)	
	Mean±SD	Mean±SD	p[b]
VAS-resting	1.3±2.1	1.6±2.3	0.604
VAS-activity	1.9±2.2	2.5±2.3	0.401
	Median (Min-Max)	Median (Min-Max)	p[c]
FFI-dominant leg (right)	9 (0-44)	8 (0-52)	0.928
FFI-non-dominant leg (left)	6.5 (0-40)	8 (0-53)	0.725
FFI-total	15.5 (0-84)	16 (0-105)	0.781

Group 1: without pes planus, Group 2: with pes planus, SD: standard deviation, VAS: Visual Analogue Scale, FFI: Foot Function Index pain score, p[b]: Independent Samples t-test, p[c]: Mann Whitney U test

In the static balance evaluations of the participants in the study, it was found that individuals with pes planus had significantly lower Stork Balance Test-right results compared to those without pes planus.

There was no significant difference between the groups in the Stork Balance Test-left results. Detailed information about the results of the Stork Balance Test is shown in Table 3.

Table 3. Static balance assessment results in individuals with and without pes planus

	Group 1 (n= 18)	Group 2 (n=37)	
	Median (Min-Max)	Median (Min-Max)	p[c]
SBT-dominant leg (right) (sec)	3.0 (1.15-24.00)	2.1 (0.83-15)	**0.038**
SBT-non-dominant leg (left) (sec)	2.1 (1.05-25.33)	2.0 (1-8)	0.317

Group 1: without pes planus, Group 2: with pes planus, SBT: Stork Balance Test, sec:second, p[c]: Mann Whitney U test, Bold value indicate p < 0.05

According to the static balance evaluation results of the participants in the dominant and non-dominant legs, there was no significant difference between the static balance scores between the dominant and non-dominant sides. The static balance results in the dominant and non-dominant legs are shown in Table 4.

Table 4. Results of static balance assessment in dominant (right) and non-dominant (left) leg

	n=55	
	Median (Min-Max)	p[d]
SBT- Dominant leg (right) (sec)	2.3 (0.8-24.0)	0.836
SBT- Non-dominant leg (left) (sec)	2.0 (1.0-25.3)	

SBT: Stork Balance Test, p[d]: Wilcoxon Paired t-test, sec:second

DISCUSSION

The results of the study were examined, it was found that pes planus affected static balance negatively in young adults while did not cause low back and foot pain.

As a result of our assessments, it was found that the scores of low back pain and foot pain in the group without pes planus and in the group with pes planus were similar. In many activities such as standing, walking, and running, a kinetic chain is formed along the lower extremity and pelvis. For this reason, pes planus not only negatively affects the alignment and biomechanics of the structures in the foot but also has the potential to disrupt the alignment and biomechanics of the structures and joints located above, such as the upper body (26). Disruptions in joint alignment and biomechanics may cause pain in these areas. In a study conducted on this subject, it was reported that while there was a relationship between anterior knee pain and low back pain in individuals with moderate and severe pes planus, there was no relationship between mild pes planus and pain (27). One reason why there was no significant difference in pain parameters between individuals with pes planus and those without pes planus in our study may be that individuals with pes planus were not separated according to their degree of pes planus. Another study in the literature found that there is no relationship between pes planus and low back pain (17). In this study, the idea that the pain parameter does not cause a difference between individuals with pes planus and those without pes planus is presented because the individuals are at a young age and the possible degenerations that may cause pes planus have not yet occurred. We think that the reasons why pes planus did not cause a difference in the pain parameter in our study may be that the mild, moderate and severe degrees of pes planus were considered under one heading and the effect of degenerative changes was not sufficiently revealed due to the young age of the participants.

In our study, there was no statistically significant difference between the static balance scores of the dominant and non-dominant legs. A review study investigating the role of the dominant leg in balance assessment stated that balance performance did not change significantly between the dominant leg and the non-dominant leg (28). The result of our study is consistent with previous literatüre (28). Upon detailed examination of the results related to static balance in our study, it was found that there was a statistically significant higher balance score in individuals without pes planus in the right foot, while there was no statistically significant difference in the left foot. In a study examining the relationship between pes planus and balance in athletes from various sports disciplines, it was concluded that pes planus negatively affected balance, especially on the dominant side, but a detailed explanation for this effect was not provided (29). The results of our study are similar to this study. It has been shown in the literature that pes planus leads to postural deviations, particularly causing shortening of the gastrocnemius muscle and weakness in the tibialis posterior muscle (30). In addition, many changes such as a decrease in the cross-sectional area of the intrinsic muscles of the foot and an increase in the cross-sectional area of some eccentric muscles occur (3). We think that these pathological changes that develop as a result of pes planus also affect static balance negatively. However, in our study, the negative effect of pes planus on static balance was shown only in the dominant (right) leg. We have previously stated that there is no statistically significant difference between the static balance scores on the dominant and non-dominant legs. However, although it is not statistically significant, the balance scores in the dominant (right) leg are higher than the balance scores in the non-dominant (left) leg. The low balance scores on the non-dominant (left) leg may have limited the effect of the factors explained above that negatively reflect on balance.

The most important limitation of our study is the small number of participants. Due to the limited number of participants, the groups were formed only from individuals with and without pes planus. If the number of participants could be increased enough to allow the grouping of individuals with pes planus among themselves, more detailed results could be achieved. Another limitation of the study was that the number of participants in the group with and without pes planus was not equal. Lastly, another limitation of our study was the lack of evaluation of additional factors such as physical activity level, muscle strength, and footwear choice, which may potentially affect the pain levels of the participants.

Conclusion

According to the results of our study, the presence of pes planus negatively affects the static balance in university students between the ages of 18-30, but does not affect the levels of foot pain and low back pain.

Declerations

Funding

None.

Conflicts of Interest/Competing Interests

None.

Ethics Approval

KTO Karatay University Ethics Committee for Non-Pharmaceutical and Non-Medical Device Research (Decision date: 21.09.2022 Decision No: 2022/012).

Availability of Data and Material

Available on request

Authorship Contributions:

Conceived and designed the analysis: E.B.; B.P.; M.S.; O.K.
Collected the data: E.B.; B.P.; M.S.
Contributed data or analysis tools: O.K.; K.Y.
Performed the analysis: O.K.; K.Y.
Wrote the paper: E.B.; B.P.; M.S.; O.K.; K.Y.
Other contribution: K.Y.

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