International Journal of
Disabilities Sports and Health Sciences
e-ISSN: 2645-9094

RESEARCH ARTICLE

Investigation of the Foot Arch Postures of Sport Sciences Students According to Some Variables

Hasan ABANOZ[1*]

[1] Çanakkale Onsekiz Mart University, Faculty of Sport Sciences, Çanakkale / Turkey
*Corresponding author: abanoz.hasan@comu.edu.tr

Abstract
Purpose: In this study, it was aimed to investigate the foot arch structures of undergraduate students of sports sciences faculty according to some demographic characteristics. **Method:** A total of 159 volunteer participants, 34 females and 125 males aged 18-34 years, were included in the study. General information form and podoscope imaging device for foot images were used as data collection tools. Foot images were analysed according to Staheli's Arc Index. The plantar arch index status of the participants was analysed according to gender, department, sporting status, sporting age and post-training pain variables. Cross-tabulation and Fisher's exact chi-square test were used to determine the distributions between the plantar arch index categories according to the variables. Kruskal-Wallis test was used for comparisons between groups according to arch categories and Mann-Whitney-U tests were used to determine the source of the difference. **Results:** According to the plantar index scores, 53.5% of the participants had normal, 25.8% flexible, 6.3% rigid flat, and 15.5% high arches. While there was no difference in the variables of gender, height, body weight and BMI in terms of foot arch index scores ($p>0.05$), significant differences were detected in sports status, pain status and pain scores ($p<0.05$). **Conclusion**: As a result, the incidence of flexible arches was higher in active athletes, while high arches were more common in recreational athletes. In terms of post-training pain scores, it was determined that participants with flexible arch soles felt higher pain than participants with normal and rigid flat soles.

Keywords
Arc, Foot Posture, Pes Planus, Pes Cavus, Student, Sport

INTRODUCTION

As one of the most extreme organs of the human body, the foot provides contact with the ground in walking, running and standing positions. The feet are the limb that transfers the effect of the gravitational force of the earth on the body to the ground during contact with the ground and the response from the ground to the body in physical body activities. Feet fulfil important functions in physical activities such as maintaining balance in the human body, body stabilisation and walking, running and jumping (Yüksel, 2015; Smith, Lichtwark, & Kelly, 2021). Foot structure is one of the most effective factors in terms of movement efficiency and economy, especially in physical activities such as walking, running, and jumping (Buldt et al., 2018). Under ordinary conditions, the foot has a certain anatomical size and morphological structure with reference values depending on genetic characteristics. However, anatomical and morphological abnormalities may develop due to some orthopedic, clinical and physiological factors. Distortions in the foot structure may cause balance problems, deformations in the skeletal and muscular system, pain and movement limitations, especially in standing, walking and running, where the foot undertakes major functions (Nalbant, 2014). In recent scientific studies, it has been determined

Received: 18 September.2023 ; **Accepted:** 17 October 2023; **Online Published:** 25 October 2023
[1]**ORCID:** 0000-0002-4415-6723

How to cite this article: Abanoz, H. (2023. Investigation of the Foot Arch Postures of Sport Sciences Students According to Some Variables. *Int J Disabil Sports Health Sci*;2023;Special Issue 1:434-442. https://doi.org/10.33438/ijdshs.1362034

that disorders in foot posture cause secondary health problems such as excessive weight gain, type 2 diabetes, high blood pressure, cardiovascular diseases by causing a decrease in physical activity level as well as the mentioned health problems (Azhagiri et al., 2021; Stolzman et al., 2015).

Distortions in the foot structure are commonly characterised as pes planus-flat sole and pes cavus-high arch. Among these two types of foot deformities, pes planus occurs due to collapse of the medial longitudinal arch of the foot, while pes cavus occurs as a result of the medial longitudinal arch height being higher than the standard values (Statler & Tullis, 2005; Yeagerman et al., 2011). The most common problem among these foot posture disorders is pes planus (Fabry, 2010). This health problem, which occurs especially at an early age, can negatively affect the whole life by reducing physical development and quality of life (Carr, Yang & Lather, 2016). Studies conducted in our country and abroad suggest that pes planus in children and young people is a cause of physical inactivity and obesity with its physical and psychological effects (Stolzman et al., 2015; Açak, Özen, & Tan, 2023). Like pes planus, pes cavus similarly causes similar negative effects because it negatively affects the skeletal-muscular structure and restriction of movement in the lower extremities (Aminian & Sangeorzan, 2008; Troiano, Nante & Citarelli, 2017; Açak, 2020).

Regular physical activity and participation in sports since childhood cause both the development of psychomotor skills and the development of sportive abilities (Akgönül & Yıldırım, 2021; Dilekçi, 2023). Foot posture also has a significant effect on people's sportive abilities and motor skills along with its effect on physical activity and development. In this direction, foot posture analyses should be performed in terms of children's participation in sports and the development of their abilities. However, foot posture disorders, which are often ignored or unrecognised by parents, negatively affect the quality of life and general health with multiple effects in childhood and adolescence. Decreased performance in physical and sportive activities or pain and injuries also cause withdrawal from these activities (Michelson, Durant & McFarland, 2002; Açak, Özen, & Tan, 2023). The sole of the foot deformity negatively affects the quality of life and physical fitness parameters of individuals. In this direction, it is important to identify health problems related to foot posture and to initiate preventive practices at an early stage (Korkmaz et al., 2020). In this context, in this study, it was aimed to examine the foot postures in the students of the faculty of sports sciences, who are directly related to this issue both individually and professionally, and indirectly to raise awareness on this issue.

MATERIALS AND METHODS

Research Procedure

This cross-sectional descriptive study was conducted at Çanakkale Onsekiz Mart University, Faculty of Sport Sciences during the 2022-2023 academic year. The research was carried out in accordance with the Declaration of Helsinki after obtaining approval from Çanakkale Onsekiz Mart University Graduate Education Institute Scientific Research Ethics Committee. Participants were informed about the purpose and procedures of the research before the study.

Participants

At the time of the study, a total of 159 students, 34 females and 125 males, aged 18-34 years, out of approximately 650 students studying at Çanakkale Onsekiz Mart University Faculty of Sport Sciences, Departments of Coaching Education, Sport Management and Recreation, participated in the study voluntarily..

Data Collection

In the study, as a data collection tool the general information form prepared by the researcher was used and the foot images of the participants were taken using the podoscope imaging device. In addition, body mass index values were calculated by measuring the height and body weight of the participants. Foot images were analysed according to Staheli's Arc Index. The plantar arch index values of the participants were analysed according to their gender, department of study, sporting status, sporting age and pain threshold after training.

Foot Posture Analysis

Foot posture analyses of the participants were performed under laboratory conditions using the podoscope device. The participants were made to stand barefoot on the glass platform on the device with both feet and stand in the anatomical position for five seconds. After the correct

standing position was achieved, the sole of the foot was imaged and recorded on the computer. The images obtained were analysed with the Global Postural System computer software. After the analysis, the narrowest point of the arch of the foot and the widest points of the heel track were measured and the ratio of these two measurements was calculated. According to this calculation, a value of <0.3 was accepted as pes cavus, a value range of 0.3 - 0.70 as normal arch and a value of 1.01 and above as pes planus (Staheli et al., 1987).

Figure 1. Podoscope imaging device

Statistical Analysis

The research data were analysed using SPSS 21.0 statistical analysis software. Descriptive data were presented as frequency, percentage, arithmetic mean and standard deviation. The relationship between the demographic characteristics of the participants according to their plantar arch index scores was analysed by Fisher's exact Chi-Square test. Kruskal Wallis test was used to compare the arithmetic averages according to the foot analysis results of the participants because the data showed non-parametric distribution, and Mann Whitney-U tests were used to determine the source of the difference. The significance level was accepted as ($p<0.05$) in statistical analyses.

RESULTS

Table 1. General descriptive information of the participants

Variables	Min	Max	M±Sd
Age (year)	18	34	20.70±2.43
Body Height (cm)	153	193	175.1±8.83
Body Weight (kg)	47	104	69.93±12.58
BMI (kg/m^2)	17.28	33.41	22.67±2.85
training frequency (week/day)	1	7	4±2

According to Table 1, it was determined that the participants had an average age of 20.7 years in the age range of 18-34 years, an average height of 175.1 cm in the range of 153-193 cm, an average body weight of 69.9 kg in the range of 47-104 kg, and an average BMI of 22.67 kg/m2 in the range of 17-33. The training frequency of the participants; It was determined that they trained at least 1 day a week, at most 7 days a week and on average 4 days a week.

Looking at the % distribution of the demographic characteristics of the participants in Table 2; in terms of gender variable; 78.6% of the participants were males, in terms of department variable; 59.7% of the participants were students of the department of coaching education, in terms of sports age variable; 45.3% of the participants had a sports age in the range of 5-9 years, and

74.2% of the participants were active athletes. In the results of foot analysis according to plantar index scores; 53.5% of the participants were found to have normal soles, 25.8% flexible, 14.5% high arch and 6.3% rigid flat soles. According to the post-training pain status, it was determined that 62.9% of the participants did not feel pain and 37.1% felt pain (Table 2).

Table 2. Frequency and percentage distribution of general characteristics of the participants

Variables		f (159)	(%)
Gender			
	Female	34	(21.4)
	Male	125	(78.6)
Department			
	Choaching Education	95	(59.7)
	Sports Management	43	(27)
	Recreation	21	(13.2)
Training Age			
	1-4 year	50	(31.4)
	5-9 year	72	(45.3)
	10+ year	37	(23.3)
Athlete Status			
	Active Athlete	118	(74.2)
	Recreative	41	(25.8)
Chronic Health Problem			
	Yes	3	(1.9)
	No	156	(98.1)
Plantar Index			
	Normal foot sole	85	(53.5)
	Flexible Flatfoot	41	(25.8)
	Rigid Pes Planus	10	(6.3)
	High Arch	23	(14.5)
Post-Workout Pain			
	Yes	59	(37.1)
	No	100	(62.9)

In Table 3, it was determined that 53.5% of the participants had normal soles, 25.8% had flexible soles, 6.3% had rigid flat soles and 15.5% had high arch soles in the foot analysis results according to the plantar index scores. When the results of the sole analysis in terms of gender variable were analysed, it was determined that there was no statistically significant difference between the distribution percentages of the sole distribution of females and males (X^2= 4.870, p>0.05).

Table 3. Foot posture analysis results of participants according to gender

Variables		Female	Male	Total	X^2	*p*
Normal foot sole	f	16	69	85	4.870	.182
	%	47.1	55.2	53.5		
Flexible Flatfoot	f	12	29	41		
	%	35.3	23.2	25.8		
Rigid Pes Planus	f	0	10	10		
	%	0	8.0	6.3		
Pes Cavus	f	6	17	23		
	%	17.6	13.6	15.5		

In Table 4, when the results of the analysis of the sole in terms of the department variable according to the plantar index scores of the participants were examined; it was determined that there was no statistically significant difference between the distribution percentages of the sole of the foot of the students of the departments of coaching education, sports management and recreation (X^2=7.795, p>0.05).

Table 4. Foot posture analysis results according to participants' departments

Variables		Coaching (f:95)	Manegment (f:43)	Recreation (f:21)	X^2	*p*
Normal foot sole	f	55	22	8	7,795	0,254
	%	57.9	51.2	38.1		
Flexible Flatfoot	f	22	11	8		
	%	23.2	25.6	38.1		
Rigid Pes Planus	f	8	2	0		
	%	8.4	4.7	0		
Pes Cavus	f	10	8	5		
	%	10.5	18.6	23.8		

When the results of the sole of the foot analyses in terms of the athletic status variable according to the plantar index scores in Table 5 were examined, it was determined that there were statistically significant differences between the participants' sole of the foot distribution percentages (X^2=10.150, p<0.05).

Table 5. Foot posture analysis results according to the athletic status of the participants

Variables		Recreational Athletes (n:118)	Licensed Athletes (n:41)	X^2	*p*
Normal foot sole	f	56	29	10.150	0.017*
	%	47.5	70.7		
Flexible Flatfoot	f	37	4		
	%	31.4	9.8		
Rigid Pes Planus	f	9	1		
	%	7.6	2.4		
Pes Cavus	f	16	7		
	%	13.6	17.1		

*=p<0,05

When the results of the analysis of the sole according to the pain status after training were examined in Table 6, it was determined that there were statistically significant differences between the pain status of the participants and the distribution percentages of the sole (X^2=12.229, p<0.05).

Table 6. Foot posture analysis results according to participants' post-training pain status

Variables		Pain (n:59)	No Pain (n:100)	X^2	*p*
Normal	f	24	61	12.229	0.007*
	%	28.2	71.8		
Flexible Flatfoot	f	24	17		
	%	58.5	41.5		
Rigid Pes Planus	f	2	8		
	%	20	80		
Pes Cavus	f	9	14		
	%	39.1	60.9		

*=p<0,05

Table 7. Analysis of the difference in physical characteristics of the participants according to their Plantar Arch Index Scores

Variables	Group	M±Sd	$f_{(3,155)}$	p	Post-Hoc
Body Height (cm)	1) Normal foot sole	176.1±8.86	3.687	0.227	N.S
	2) FlexibleArch	173±9.42			
	3) Rigid Pes planus	174.5±3.17			
	4) Pes Cavus	175.5±9.07			
Body Mass (kg)	1) Normal	70.81±1.46	3.034	0.386	N.S
	2) FlexibleArch	67.01±1.60			
	3) Rigid Pes planus	74.90±4.14			
	4) Pes Cavus	69.61±2.59			
BMI (kg/m^2)	1) Normal	22.69±3.04	3.034	0.475	N.S
	2) FlexibleArch	22.32±2.26			
	3) Rigid Pes planus	24.56±3.97			
	4) Pes Cavus	22.41±2.31			

N.S: Not Significant

When the physical characteristics of the participants were analysed according to the Plantar Arch Index scores in Table 7, it was determined that there was no statistically significant difference between the height, body weight and BMI averages of the participants with normal, flexible, rigid flat feet and high arch feet in terms of foot postures ($p>0.05$).

Table 8. Analysis of participants' pain scores according to Plantar Arch Index Scores

Variables	Group	M±Sd	X^2	p	Post-Hoc
Pain Score	1) Normal foot sole	1.45±1.94	9.052	0.029*	1<2 3<2
	2) FlexibleArch	2.73±2.60			
	3) Rigid Pes planus	1.10±2.42			
	4) Pes Cavus	2.04±2.38			

*=p<0,05

When the post-training pain scores of the participants according to the results of foot analysis in Table 8 were analysed; it was determined that the participants with flexible arch soles had a statistically significant higher mean pain score than the participants with normal and rigid flat soles ($p<0.05$).

DISCUSSION

In the study, according to the results of foot posture analysis of 34 female and 125 male students between the ages of 18-34 who were undergraduate students at Çanakkale Onsekiz Mart University, Faculty of Sports Sciences, significant differences were determined in the status of doing sports, pain status and post-training pain scores ($p<0.05$).

According to the general distribution of the results of foot posture analysis, 53.5% of the participants had no problem, 25.8% were flexible, 6.3% were rigid flat and 15.5% had high arch. In terms of general population studies, it can be stated that the rate of foot posture disorder is higher than predicted. When compared with the literature examples, Açak et al. (2023) examined the foot postures of 252 secondary school students aged 10-14 years in Ezine district of Çanakkale and determined that 39% of the participants had foot posture disorder according to Staheli's Arch Index scores. In the study conducted by Kazdal-Kabakulak (2015) on 733 children aged 8-11 years in Fatih district of Istanbul, 16.8% of the children had foot posture disorder according to Staheli's Arc Index scores. In a study conducted by Mølgaard, Lundbye-Christensen, and Simonsen (2010) on 2100 adults in Denmark, it was reported that 17.9% had pes planus and pes cavus problems. When the results of our study and the literature samples are compared, it can be stated that the prevalence of foot posture disorders in the students of the faculty of sport sciences, which constitute the research sample, is quite high.

When foot posture disorders were analysed in terms of gender in the study, flexible sole were found in 35.3% and pes cavus was detrmined in

the 17.6% of females, respectively. In males, these rates were 23.2% and 13.6%, respectively. The remarkable result was that pes planus was not seen in women, while pes planus was detected in 8% of men. Although some descriptive differences were observed in terms of foot posture disorder, it was determined that these proportional differences were not significant in statistical analysis. When the literature samples were examined, in the study conducted by Açak et al. (2023), although foot posture disorder was more common in male children compared to females, no statistically significant difference was determined in the analysis results similar to our study. In the study conducted by Özçadırcı et al. (2021) in which foot posture analysis was performed in pre-adolescent swimmers; it was stated that there was no difference between foot posture conditions in terms of gender. In the study conducted by Carvalho et al. (2017), it was stated that foot posture disorders were more common in young women, especially due to wearing high-heeled shoes. In this direction, our research findings are consistent with the literature.

In the study, it was determined that there was no significant difference between the height, body weight and BMI averages of the participants grouped according to the arch index scores in terms of anthropometric characteristics. In literature studies, the general opinion is that individuals with rigid flat feet have excessive body weight and high BMI scores (Atak, Özbek & Algun, 2016; Aktan & Kutlay, 2022). In this research group, this predicted difference may not have emerged because the students of the faculty of sport sciences who do more physical activity and sports than the general population were examined. Confirming this result, it was found that foot posture deformity was less common in participants who were active in sports with a rate of 29.3%, while 52.5% of those who were engaged in recreational sports activities had foot posture disorder. In this respect, it can be said that doing active sports is beneficial for the protection of foot posture health. In addition, it was determined that there was no proportional difference in the foot posture conditions of the participants in terms of the department they studied in sports sciences.

In the study, when the pain conditions of the participants after sportive training and activities were analysed according to their foot posture conditions; it was determined that participants with flexible feet had more pain complaints than other groups. In the studies on foot posture and pain in the literature, Mølgaard, Lundbye-Christensen, and Simonsen (2010) examined Danish adults between the ages of 18-80 years; it was stated that the prevalence of lower extremity pain was higher in individuals with foot deformity. However, unlike our study, this sample included both older age and sedentary people, so there is a reasonable difference. The fact that the participants in our study were both younger and engaged in more physical activity may be the reason for the absence of pain. The fact that more pain is seen in individuals with flexible soles is thought to be due to the fact that tendons and muscles cause pain due to more stretching of the feet in movements such as running and jumping in sportive activities. In the study conducted by Aktan and Kutlay (2022), it was reported that those with foot posture disorder among sedentary individuals in the 18-30 age range also had pain complaints. In this respect, it is clinically expected that flexible flat soles experience post-activity pain due to foot posture disorder in physical activities.

Conclusion

As a result of the study, it was determined that the rate of foot posture disorder was higher in students studying at the faculty of sport sciences compared to the general population. While there was no difference in terms of gender, height, body weight and BMI values, the rate of foot posture disorder was lower in active athletes. When the pain conditions of the participants after physical activity and training were examined, it was observed that the pain complaints of those with flexible flat feet were more. In this context, it can be said that participation in regular physical activity and training will help to reduce complaints related to foot posture disorders.

Foot health has an important place in the context of protecting and improving health, quality of life and increasing work efficiency or sportive performance. However, when the literature is examined, it is seen that the prevalence of studies on the subject is limited. Therefore, it is thought that there is a need for clinical research on more participants with different demographic characteristics and that such research will contribute to the field by filling an important gap.

Conflict of interest

There is no conflict of interest for the authors in this study. In addition, no financial support was received from any institution or organisation for the study.

Ethics Committee

This research was conducted with the approval of Çanakkale Onsekiz Mart University, Institute of Graduate Education Scientific Research Ethics Committee (Approvel Nummer: E-84026528-050.01.04-2300214054).

Author Contributions

The preparation of this study, design of the topic, collection of data, statistics, findings, discussion, conclusion and added references were done by the researcher. The author has read and accepted the published version of the article.

REFERENCES

Açak, M., Özen, G. & Tan, E. (2023). Investigation of foot posture and body composition in 10-14 years old children: The Case of Çanakkale Ezine District. *Iğdır University Journal of Sport Sciences*, 6(1), 45-56.

Açak, M. (2020). The effects of individually designed insoles on pes planus treatment. *Scientific Reports*, 10(1), 19715.

Akgönül, E. K., & Yıldırım, U. C. (2021) Investigation of the relationship between anthropometric characteristics and strength values of star cyclists. *Sporty Overview: Journal of Sport and Education Sciences*, 8(3), 391-408.

Aktan, A. K., & Kutlay, Ö. (2022). The relationship between body mass index and pes planus, balance, quality of life and pain levels in sedentary women and men. *Value in Health Sciences*, 12(1), 58-64.

Aminian, A., & Sangeorzan, B. J. (2008). The anatomy of cavus foot deformity. *Foot and ankle clinics*, *13*(2), 191-198.

Atak, E., Özbek, H., & Algun, Z.C. (2016). The effect of body weight gain on foot posture and knee pain in healthy sedentary individuals. *Journal of Exercise Therapy and Rehabilitation*, 3(2), 66-71.

Azhagiri, R., Malar, A., Hemapriya, J., & Sumathi, G. (2021). The cause and frequency of PES Planus (Flat Foot) problems among young adults. *Asian Journal of Medical Sciences*, 12(7).

Buldt, A. K., Allan, J. J., Landorf, K. B., & Menz, H. B. (2018). The relationship between foot posture and plantar pressure during walking in adults: A systematic review. *Gait & posture*, 62, 56–67.

Carr, J. B., Yang, S., & Lather, L. A. (2016). Pediatric pes planus: a state-of-the-art review. *Pediatrics*, 137(3).

Carvalho, B. K. G., Penha, P. J., Penha, N. L. J., Andrade, R. M., Ribeiro, A. P., & João, S. M. A. (2017). The influence of gender and body mass index on the FPI-6 evaluated foot posture of 10- to 14-year-old school children in São Paulo, Brazil: A cross-sectional study. *Journal of Foot and Ankle Research*, 10, 1.

Dilekçi, U. (2023). *Conceptual Foundations of Sport-8: Physical Fitness-Physical Development* 29-42. Istanbul: Efe Akademi Publishing. E-ISBN: 978-625-6504-56-1

Fabry, G. (2010). Clinical practice. Static, axial, and rotational deformities of the lower extremities in children. *Eur J Pediatr*. 169(5), 529-34.

Korkmaz, M. F., Acak, M., Duz, S., & Bozduman, O. (2020). Prevelance of flatfoot in secondary school students and its relationship with obesity. *Medicine*, 9(2), 298-304.

Kazdal-Kabakulak, H. (2015). Investigation of pes planus prevalence in primary schoolchildren of Fatih district (Published medical speciality thesis). Istanbul University Cerrahpaşa Faculty of Medicine, Department of International Medicine and Rehabilitation. Istanbul, 91p, (in Turkish).

Michelson, J. D., Durant, D. M., & McFarland, E. (2002). The injury risk associated with pes planus in athletes. *Foot & ankle international*, 23(7), 629-633.

Mølgaard, C., Lundbye-Christensen, S., & Simonsen, O. (2010). High prevalence of foot problems in the Danish population: a survey of causes and associations. *The foot*, 20(1), 7-11.

Nalbant, A. (2014). Investigation of the effect of daily activities on foot posture and plantar pressure (Published master thesis), Dokuz Eylül University Institute of Health Sciences, İzmir, 48p, (in Turkish).

Özçadırcı, A., Öztürk, F., Cinemre, A., & Kınıklı, G. İ. (2021). Does foot posture differ according to gender and lower extremity muscle strength in pre-adolescent swimmers?. *European Journal of Human Movement*, 46, 95-102.

Smith, R. E., Lichtwark, G. A., & Kelly, L. A. (2021). The energetic function of the human foot and its muscles during accelerations and decelerations. *The Journal of experimental biology*, 224(13),jeb242263..https://doi.org/10.1242/jeb.242263.

Staheli, L. T., Chew, D. E., & Corbett, M. (1987). The longitudinal arch. *J Bone Joint Surg Am*, 69(3), 426-428.

Statler, T. K., & Tullis, B. L. (2005). Pes cavus. *Journal of the American Podiatric Medical Association*, 95(1), 42-52.

Stolzman, S., Irby, M. B., Callahan, A. B., & Skelton, J. A. (2015). Pes planus and paediatric obesity: a systematic review of the literature. *Clinical obesity*, 5(2), 52-59.

Troiano, G., Nante, N., & Citarelli, G. L. (2017). Pes planus and pes cavus in Southern. *Annali dell'Istituto superiore di sanita*, 53(2), 142-145.

Yeagerman, S. E., Cross, M. B., Positano, R., & Doyle, S. M. (2011). Evaluation and treatment of symptomatic pes planus. *Current opinion in pediatrics*, 23(1), 60-67.

Yüksel, H. B. (2015). Investigation of foot posture, functions and physical activity level in young individuals. (Published master thesis), Istanbul Medipol University Institute of Health Science, Istanbul, 105p, (in Turkish).