International Journal of Science Academic Research
Vol. 07, Issue 01, pp.174-178, January 2026
Available online at http://www.scienceijsar.com

ISSN: 2582-6425

Research Article

ASSESSMENT OF PLANTAR ARCH INDEX AND PREVALENCE OF FLAT FEET AMONG STUDENTS AND FARMERS

[1,*]Benwoke, W.I., [2]Bienonwu, E.O., [1]Victor, P.D., [1]Erekosima, B.U., [1]Perebosigha, S. I. and [1]Osaro, P.C.

[1]Department of Anatomy, Faculty of Basic Medical Sciences, College of Medicine, Rivers State University, Nkpolu-Oroworukwo, Port Harcourt, Rivers State, Nigeria
[2]Department of Anatomy, Faculty of Basic Medical Sciences, College of Medicine, Igbinedion University Okada, Edo State, Nigeria

Received 24th November 2025; **Accepted** 16th December 2025; **Published online** 30th January 2026

Abstract

The feet are the only part of the human body which is in direct contact with the ground. A change in the shape of the foot, which results in the foot losing its normal arch when standing, is referred to as flat foot. The aim of this study is to assess the plantar arch index and prevalence of flat feet among students and farmers aged 18-50. The study is a cross-sectional study using random sampling technique to select participants in Rivers State University and in Okporowo Ogbakiri. The participants were divided into 2 groups of farmers (60 females and 40 males) and students (60 females and 40 males) making a total of 220 participants, Staheli's index was used to calculate the plantar arch index. Statistical analysis was done using SPSS version 25.0. Descriptive statistics adopted descriptive statistical methods of measures of central tendency such as arithmetic mean, mean, standard error and percentage frequency. Inferential statistics of paired t-test was used for determining statistical differences. A total of 220 participants were recruited for this study 110 students and 110 farmers, 44 had flat foot giving a prevalence of 10.63%. The mean values of plantar arch index for male farmers were right=0.83 ± 0.24 left=0.77 ± 0.23, while on the female farmers the mean values were 0.74 ± 0.24 left=0.74 ± 0.25, mean values for female students were right= 0.72 ± 0.21 left=0.72 ± 0.21, while the males right=5.61 ± 0.54 left=0.85 ± 0.30. The prevalence of flat feet was more in students, and it was higher on the left side than on the right side of the leg. Therefore, it implies that occupation does affect the plantar arch index of a mature adult.

Keywords: Planter arch index, Prevalence, Farmers, Student, Flat foot, Rivers State.

INTRODUCTION

The evolution of man from its earliest ancestors was characterized by many changes notably of which are bipedalism, walking on two feet. The human feet have been structurally and functionally evolved and modified; formation of arches is one of such modifications[1]. The arched foot, which is peculiar only to humans in the primates, is a unique feature crucial for human bipedalism. The arch is responsible for the stiffness necessary to act as a lever that transmits the forces generated by leg muscles as they push against the ground. The arch also retains sufficient flexibility to function like a spring to store and then releases mechanical energy. The feet are the only part of the human body which is in direct contact with the ground [2].The anatomical disposition of the foot gives it a concave shape because of the presence of the plantar arches formed by the articulated tarsal and metatarsal bones of the foot. Because the foot is composed of numerous bones connected by ligaments, it has considerable flexibility that allows it to deform with each ground contact, thereby absorbing much of the shock. However, the tarsal and metatarsal bones are arranged in longitudinal and transverse arches that add to the weight-bearing capabilities and resiliency of the foot [3]. The medial longitudinal arch is formed by bones, ligaments, and tendons, and its configuration depends on age and genetic factors [4]. A change in the shape of the foot, which results in the foot losing its normal arch when standing, is referred to as flat foot [5].

Corresponding Author:** ***Benwoke, W.I.,
Department of Anatomy, Faculty of Basic Medical Sciences, College of Medicine, Rivers State University, Nkpolu-Oroworukwo, Port Harcourt, Rivers State, Nigeria.

In addition, the normal concavity due to the medial longitudinal arch is absent, which leads to the medial side of the foot bulging as a medial convexity, especially during weight-bearing [6]. Flat foot could be congenital or acquired [7]. Flat feet that develop in an adult following skeletal maturity are known as adult acquired flat foot deformity (AAFD) [8,9]. This condition may develop due to injury, illness, or prolonged stress to the feet [10]. AAFD leads to pain and tenderness in and around the ankle, development of arthritis (Deland JT [8]), and a wide range of deformities such as valgus deformity of the hind foot, mid foot abduction, and tightening of the heel cord [11]. Insufficiency or dysfunction of the posterior tibial tendon (PTT) has been considered the commonest cause of AAFD [12]. This muscle pulls the talus upwards and adduct the mid-tarsal joint, supporting the spring ligament to form the arch [8,13]. When the PTT progressively fails, gradual flattening of the arches occurs. The prevalence of PTT rupture parallels the degenerative processes of aging, hypertension, diabetes mellitus, and obesity [14]. It is presumed that atherosclerotic arterial disease in hypertension leads to impaired blood supply to the PTT resulting in its dysfunction [13]. While all babies have flat feet at birth due to baby fat, the longitudinal arch develops naturally during childhood as part of normal growth. The arches become prominent when the child starts walking and the foot starts bearing weight [15]. Arches rapidly develop between ages two to six and become mature around 12-13 years [16]. Prevalence varies by age, population type, and co-morbidities [17]. Farmlands consist of rough terrain and undulating topography; farmers are faced with the challenge of walking through these rough areas, thereby putting pressure on foot arches which could lead to rupture of ligaments and tendons (PTT), reported as a cause of acquired flat foot.

MATERIALS AND METHODS

This study is a cross-sectional study using a random sampling technique conducted at Rivers State University and Okporowo communityin Ogbakiri town of Emohua local Government Area, in Rivers State.220 participants aged 18-50 were recruited, comprising 110 students (60 females, 40 males) and 110 farmers (60 females, 40 males).

The sample size calculation is derived from [18]. Sample size was determined using the following formula:

$$n = \frac{Z_1 - \alpha/2^2 \, P \, (1 - P)}{d^2}$$

$Z_1 - \alpha/2^2$= normal standard variant
P=expected proportion (16.1%) from [18]
d = absolute error or precision
n= sample size= 207

Inclusion Criteria: Bonafide undergraduate students at Rivers State University between the ages 18-25. Farmers who are natives of Okporowo Ogbakiri within the age 35-50years and who have been actively farming for at least 5years.All participants were physically and mentally fit.

Exclusion Criteria: Participants with any feet abnormality were excluded, Participants with open injuries, fracture, dislocation of lower limb were screened out. Participants with history of previous surgery, or musculoskeletal disorders, were not included

DATA COLLECTION PROCEDURE

Participants that met the requirements for the study and were willing to participate, their footprint was taken. The Ink print method was used to take the footprint of the participants. Stamp pad ink was used in an Ink bowl with a sponge/breast pad that absorbs the Ink. Foot was cleared of dirt/debris, and the participant in a sitting position was asked to put their foot in the bowl containing the Ink and sponge. The sponge assists in the ink sticking properly to the foot. The participants then place the foot firmly on a white sheet of paper, this is done in the standing position. This procedure was carried out for both feet. The footprint from all participants was then used to calculate plantar arch Index using Staheli's. A lead pencil and a meter rule was used to draw a tangential line from medial forefoot to the heel region. The midpoint of this line is obtained and from this point a perpendicular line is drawn crossing the footprint, this is width of the central region denoted as "A". The same procedure is carried out for the heel region, and this is denoted as "B", width of heel region. Planter arch index (PAI)was obtained by dividing the value of "A" by the value of "B". A value greater than 1.15 is denoted as flat foot.

Fig. 1. Instruments for data collection: white paper, lead pencil, stamp pad ink, meter rule, ink tray

Fig. 2. Method of sample collection

Fig. 3. Calculation of plantar arch Index a) normal feet. b) flat feet

Ethical Considerations

The study is non- invasive. A formal consent was sent to the paramount ruler of Okporowo community and the Church clergy before commencement of data collection.

Statistical Analysis

The data was analyzed using SPSS (version 25.0. Continuous variables were expressed in mean (SD). The study adopted descriptive statistical methods of measures of central tendency such as arithmetic mean, mean, standard error and percentage frequency. Inferential statistics of paired t-test were used for determining statistical differences. Confidence level was set at 95% with significance of the difference accepted at $p \leq 0.05$.

RESULTS

Table 1. Descriptive statistic of female farmers

	Right	N = 40	Left	N = 40
Parameters	Mean±SD	Std.Err	mean±SD	Std.Err
MAW	3.73 ±1.26	0.15	3.69 ± 1.25	0.15
HW	5.01 ± 0.44	0.05	4.98 ± 0.44	0.53
PAI	0.74 ± 0.24	0.03	0.74 ± 0.25	0.03

MAW- mid arch width HW-Heel width PAI- plantar arch index, Std.Err-standard Error, SD- Standard Deviation.

Table 2. Descriptive statistic of female students

	Right N=40		Left N=40	
Parameters	Mean±SD	Std.Err	Mean±SD	Std.Err
MAW	3.79 ± 1.17	0.14	3.90 ± 1.19	0.14
HW	5.27 ± 0.53	0.06	5.26 ± 0.60	0.07
PAI	0.72 ± 0.21	0.03	0.75 ± 0.27	0.03

MAW- mid arch width HW-Heel width PAI- plantar arch index

Table 3. Descriptive statistic of male farmers

	Right		Left	
Parameters	Mean±SD	Std.Err	Mean±SD	Std.Err
MAW	4.38 ± 1.49	0.23	4.11 ± 1.25	0.20
HW	5.27 ± 0.52	0.08	5.35 ± 0.46	0.07
PAI	0.83 ± 0.24	0.04	0.77 ± 0.23	0.04

MAW- mid arch width HW-Heel width PAI- plantar arch index

Table 4. Descriptive statistic of male students

	Right		Left	
Parameters	Mean±SD	Std.Err	Mean±SD	Std.Err
MAW	4.95 ± 1.55	0.24	4.80 ± 1.84	0.29
HW	5.65 ± 0.59	0.09	5.61 ± 0.54	0.08
PAI	0.88 ± 0.27	0.04	0.85 ± 0.30	0.05

MAW- mid arch width HW-Heel width PAI- plantar arch index

Table 5. Paired t-test of right and left students and farmers

PARAMETERS	T- value	P-value	Correlation	REMARK
Right Female Students and Farmers (MAW)	5.07	0.00	-0.09	Significant
Right Female Students and Farmers (HW)	6.94	0.00	0.30	Significant
Left Female Students and Farmers (MAW)	3.70	0.00	-0.07	significant
Left Female Students and Farmers (HW)	7.30	0.00	0.07	Significant
Right Male Students and Farmers (MAW)	8.13	0.00	-0.02	Significant
Right Male Students and Farmers (HW)	6.81	0.00	-0.27	Significant
Left Male Students and Farmers (MAW)	6.39	0.00	0.07	Significant
Left Male Students and Farmers (HW)	7.33	0.00	-0.22	Significant

MAW- mid arch width HW-Heel width

Table 6. Chi-square test

PARAMETER	Chi-Square (X^2)	P-value	REMARK
Right Female Students and Farmers	18.78	0.00	significant
left Female Students and Farmers	1.07	0.00	Significant
Right Male Students and Farmers	13.17	0.00	Significant
Left Male Students and Farmers	9.85	0.00	Significant

Table 7.a. Prevalence of flat foot among females

		Female Farmers		Female Students	
S/N	Variables	Left	Right	Left	Right
1	Total number	69	69	70	70
2	Number with foot index above 1.15	6	5	6	5
3	Number with foot index below 1.15	63	64	64	65
4	Percentage with foot index above 1.15	8.70 %	7.25 %	8.57 %	7.14 %
5	Percentage with foot index below 1.15	91.30 %	92.75 %	91.43 %	92.86 %

Table 7.b. Prevalence of flat foot among males

		Male Farmers		Male Students	
S/N	Variables	Left	Right	Left	Right
1	Total number	41	41	41	41
2	Number with foot index above 1.15	5	5	6	9
3	Number with foot index below 1.15	36	36	35	32
4	Percentage with foot index above 1.15	12.20 %	12.20 %	14.63 %	21.95 %
5	Percentage with foot index below 1.15	87.80 %	87.80 %	85.37 %	78.05 %.

Table 7.c. Prevalence of flat foot among all measured samples

		Farmers		Students	
S/N	Variables	Left	Right	Left	Right
1	Total number	110	110	111	111
2	Number with foot index above 1.15	11	10	12	14
3	Number with foot index below 1.15	99	100	99	97
4	Percentage with foot index above 1.15	10.00 %	10.91 %	10.81 %	12.61 %
5	Percentage with foot index below 1.15	90.00 %	89.09 %	89.19 %	87.39 %

Table 7.d. Prevalence of flat foot among all measured samples irrespective of side

S/N	Variables	All Farmers	All Students
1	Total number	220	222
2	Number with foot index above 1.15	21	26
3	Number with foot index below 1.15	199	196
4	Percentage with foot index above 1.15	9.55 %	11.71 %
5	Percentage with foot index below 1.15	90.45 %	88.29 %

RESULT ANALYSIS

Table 1 gives the descriptive analysis of right and left female farmers feet, the mean values are MAW (right=3.73± 1.26 left=3.69 ± 1.25), HW (right=5.01 ± 0.44 left=4.98 ± 0.44) PAI values are (right 0.74 ± 0.24 left=0.74 ± 0.25).

Table 2 gives descriptive analysis of right and left female students feet, the mean values are MAW (right=0.74 ± 0.25 left=3.90 ± 1.19), HW (right=5.27 ± 0.53 left=5.26 ± 0.60). PAI values are (right=0.72 ± 0.21 left=0.72 ± 0.21). Table 3 gives descriptive analysis of right and left male farmers feet; the mean values are MAW (right=4.38 ± 1.55 left=4.11 ± 1.25)

HW (right=5.27 ± 052 left= 5.26 ± 0.60). PAI values are (right=0.83 ± 0.24 left=0.77 ± 0.23). Table 4 gives descriptive analysis of right and left male students feet; the mean values are MAW (right=4.95 ± 1.55 left=4.80 ± 1.84) HW (right=5.65 ± 0.59 left=5.61 ± 0.54). PAI values are (right=5.61 ± 0.54 left=0.85 ± 0.30).

Using the null and alternative hypothesis:

Null Hypothesis – there is no statistically significant difference between the students' foot length/foot width and farmers foot length/foot width at 95% significant level ($p < 0.05$).

Alternative Hypothesis – there is statistically significant difference between the students' foot length/foot width and farmers foot length/foot width at 95% significant level ($p < 0.05$).

From tables 4 & 5 the p-value represents 95% significant level ($p < 0.05$), therefore, since at $p < 0.05$ all the values are less than 0.05, we accept null hypothesis, meaning that the difference is not significant.

Therefore, we can say there is no statistically significant difference between the students' foot length/foot width and farmers' foot length/foot width at 95% significant level ($p < 0.05$).

Prevalence

The prevalence of an event is determined by the frequency of such event and can only be represented in percentage. Therefore, the prevalence of flat foot in this case can be determined by calculating the arch index for every measured parameter. This is given by dividing the mid-foot width by the heel width. Values greater than 1.15 are regarded as high and therefore depict low or flat arches, while values less than 1.15 are regarded as even and depict concave or higher arch.

Discussion

The study was carried out to find the prevalence of flat foot among adult population in Rivers. The population was divided into 2groups, farmers and students. A total of 220 participants were recruited for this study, 44 participants had flat feet, 23 farmers and 21 students. 11 students had flat feet left, 10 had flat feet right. 11 farmers had flat feet left and 12 had flat feet right. The mean values of plantar arch index for male farmers were right=0.83 ± 0.24 left=0.77 ± 0.23, while on the female farmers the mean values were 0.74 ± 0.24 left=0.74 ± 0.25, mean values for female students were right= 0.72 ± 0.21 left=0.72 ± 0.21, while the males right=5.61 ± 0.54 left=0.85 ± 0.30. These values alings with those reported by [19] who reported a range of 0.71 to 0.74. This is also in line with of [20] who reported range of mean values from 0.80 to 0.85. There was not much difference in the prevalence in relation to the sides of the feet, irrespective of occupation. The prevalence on left is 9.96% and the right is 9.95%. The prevalence of flat foot in this study was revealed to be 9.55% of farmers and that of students was 11.71%. The results from this study is in contrast to findings from results in a study by [20]carried out on a population of civil servants and farmers in Ikwo Local Government Area in Ebonyi, with farmers prevalence rate at 2.90% and civil servants prevalence rate 3.3% the results from [20] showed that there's no statistically significant difference in relation to occupation. Their study further suggests that there's no difference between the arches of the foot of adults after skeletal maturity, thus occupation does not have a significant effect on the arches of the foot of adults according to his study. The present study also explains and further supports strongly the low prevalence of flat foot in adults as opposed to high prevalence found in study done on children with underdeveloped arches [21]. The overall prevalence of flat foot in the present study in males irrespective of being a farmer or student, was 15.24%, and that of females was 7.92% which shows that flat foot was found to be more in males than females. This is in line with findings from [20][21]that flat foot is more in males. The higher prevalence in males disagrees with findings from [22] and [23]who found flat feet more in females.Previous studies have associated flat foot with anthropometric variables such as BMI, age, Jithmi*et al*.,[17] associated flat foot with pathological condition i.e. hypertension with a prevalence of 44.63%, Pourghasem *et al*.,[18] associated flat feet with BMI

The overall prevalence of flat foot in the general adult population in the present study is 10.63% which is similar to findings by [22] who reported a prevalence of 10%, Tejashreeet al. [24]reported a significance of 11.25%, Ashok et al.,[25]reported a prevalence of 13.6%, but is in contrast to findings by [26] who reported a prevalence rate of 50%, and [17] who reported a prevalence rate of 51.6%. The variations in the reported prevalence could be because of age limit set; method used in data collection and parameters used.

Conclusion

The present study empirically assessed the plantar arch indexes and prevalence of flat foot among students and farmers in Rivers State, Nigeria. While variations were noted according to occupation, sex, and side of the foot, these differences in mean values were not always significant enough on their own. However, the prevalence of flat feet was notably higher in students and more common on the left side. These variations were significant at the 0.05 level, implying that occupation does indeed affect the plantar arch index of a mature adult.

Recommendation

The present study recommends the use of the simple ink-print method as a cost-effective tool and suggests further research into other high-activity professions like sports to help preserve the integrity of the posterior tibial tendon.

Acknowledgements: The Authors sincerely acknowledge the support and cooperation of good peopleof OkporowoOgbakiri in Emohua local Government Area and Students of Rivers State who participated in this study.

Conflict of interest: Authors declare that they do not have any conflict of interest

REFERENCES

1. Laitman JT, Jaffe WL. A review of the morphological and functional evolution of the human foot. Foot & Ankle. 1982;2(5):282-290.
2. Nester CJ, van der Linden ML, Bowker P. Effect of foot orthoses on the kinematics of the human foot. Gait & Posture. 2003;17(2):180-189.

3. Moore KL, Dalley AF, Agur AM. Clinically Oriented Anatomy. 7th ed. Philadelphia: Lippincott Williams & Wilkins; 2014.
4. Kanatli U, Yetkin H, Cila E. Footprint and radiographic analysis of the feet. Journal of Pediatric Orthopaedics. 2001;21(2):225-228.
5. Bethesda M. Flatfoot (Pes Planus). National Institute of Arthritis and Musculoskeletal and Skin Diseases. 2020.
6. Krupa S, Saini S, Saini M. Prevalence of flat foot among school going children of 6-10 years. International Journal of Health Sciences and Research. 2015;5(11):233-238.
7. Banwell HA, Mackintosh S, Thewlis D. Foot orthoses for adults with flexible low-arched (flat) feet: a systematic review. Journal of Foot and Ankle Research. 2014;7(1):23.
8. DeLand JT. Adult-acquired flatfoot deformity. Journal of the American Academy of Orthopaedic Surgeons. 2008;16(7):399-406.
9. Berlet GC. Adults Acquired Flatfoot Deformity. Orthobullets. 2019.
10. Vulcano E, Deland JT, Ellis SJ. Tarsal coalitions: a review of current concepts and treatment strategies. Journal of Bone and Joint Surgery. 2016;4(3):e4.
11. Smyth BW, Jastifer JR. Adult Acquired Flatfoot Deformity. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2017.
12. Abousayed MM, Tartaglione JP, Rosenbaum AJ, Dipreta JA. Classifications in Brief: The Johnson and Strom Classification of Posterior Tibial Tendon Dysfunction. Clinical Orthopaedics and Related Research. 2016;474(2):588-593.
13. Chaurasia BD. Human Anatomy: Regional and Applied Dissection and Clinical. Vol. 2, Lower Limb, Abdomen and Pelvis. 6th ed. CBS Publishers & Distributors; 2013.
14. Singh D. Posterior tibial tendon dysfunction. Rheumatology. 2004;43(12):1495-1501.
15. Gore AI, Spencer JP. The newborn foot. American Family Physician. 2004;69(4):865-872.
16. Bore A. Development of craniofacial arches in children: growth patterns and clinical implications. London: Academic Press; 2014.
17. Jithmi P, Perera D, Fernando S. Correlation of BMI and hypertension with flat foot prevalence. *Sri Lanka J Med Sci*. 2020;29(1):45–53.
18. Pourghasem M, Ghaffari M, Khosravi A. Relationship between BMI and foot arch height in adults. *Anat Sci Int*. 2015;90(4):230–236.
19. Pranati R, Sangeetha K, Kumar P. Anthropometric study of plantar arch index in South Indian adults. *Int J Med Res Health Sci*. 2017;6(7):1–5.
20. Ezemagu CO, Nwankwo OE, Okafor IP. Prevalence of flat foot in adults in Ebonyi State, Nigeria. *Int J Morphol*. 2013;31(3):937–941.
21. Yashika P, Sharma V, Kumar N. Prevalence of flat foot in children and adolescents: a cross-sectional study. *Int J Physiother Res*. 2016;4(5):1450–1455.
22. Rithanya P, Sharma V, Kumar S. Prevalence of flat foot among adults using plantar arch index. *Int J Med Res Health Sci*. 2018;7(1):50–54.
23. Dunn JE, Link CL, Felson DT, Crincoli MG, Liang MH. Prevalence of flat foot in adults: a population-based study. *Foot Ankle Int*. 2004;25(1):14–18.
24. Tejashree D, Shinde N, Khatri S, Hande D. Prevalence of flat foot and correlation of BMI with arch index in physiotherapy students. International Journal of Physiotherapy and Research. 2014;2(4):642-45.
25. Ashok V, Rao R, Singh P. Flat foot prevalence among Indian adults using footprint analysis. *Foot Ankle Spec*. 2017;10(2):95–101.
26. Khanna R, Gupta S, Sharma S. Prevalence and patterns of flat foot in Indian population. *J Foot Ankle Surg*. 2019;58(4):623–627.

****