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PREVALENCE OF *PES PLANUS* (FLAT FOOT) AMONG THE INDIGENES OF UGEP IN YAKURR LOCAL GOVERNMENT AREA, CROSS RIVER STATE, NIGERIA

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ABSTRACT

Pes planus, also called "flat foot" is a known musculoskeletal condition characterized by a collapsed medial longitudinal arch, resulting in altered gait biomechanics and postural defects. Even though its prevalence has been documented in different populations, limited data exist for indigenous Nigerian communities, particularly in Cross River State. This study aimed to explore the prevalence of *Pes planus* among adult indigenes of Ugep, Yakurr Local Government Area, Cross River State, Nigeria, and to examine sex differences in anthropometric foot parameters. A cross-sectional study was conducted among 400 Ugep indigenes (206 males, 194 females) aged 18–62 years, selected by random sampling. Plantar footprints were obtained using the ink method. Right and left foot lengths and arch indices were measured and analyzed using descriptive statistics and independent-samples t-tests. A total of 16 participants (7 males, 9 females) were identified with pes planus, giving an overall prevalence of 4.0%. Statistically significant sex differences were observed for mean age and both foot lengths, whereas no significant differences were found for right or left arch index. The prevalence of *Pes planus* among the Ugep people is low, with females showing a slightly higher prevalence than males. These findings contribute anthropometric baseline data for this population and underscore the utility of low-cost plantar print methods in community-based foot health screening.

Keywords: *Pes Planus*, Flat Foot, Foot Length, Prevalence, Anthropometry, Ugep, Cross River State

INTRODUCTION

Pes planus, also called 'flat foot', is an anatomical condition of the foot in which the medial longitudinal arch is either reduced or absent in a weight-bearing standing position. It may affect one or both feet, with the unilateral one mostly indicating an underlying pathology (Moore and Tafti, 2026). The human foot is positioned for two cardinal functions of supporting the body weight in upright posture, and as a lever during ambulation (MacGregor and Byerly, 2023). These functions of the foot are largely dependent on the osseous, ligamentous, and muscular integrity of its architecture. The foot arches are preserved mainly by the bones and ligaments, while muscles play the supporting role. However, muscular weakness is considered to be the most recurrent clinical cause of pes planus, resulting in elongation of ligaments and even secondary bony deformity (Richie, 2020; MacGregor and Byerly, 2023).

Generally, pes planus is classified into two main types as physiological (flexible) or pathological (rigid). In flexible flat foot, the arch is normal in non-weight-bearing position, but flattens on loading. It is mostly observed in the first decade of life, and may correct spontaneously (Garcia *et al.*, 1999). On the other hand, rigid flat foot shows a fixed, collapsed arch in both weight-bearing and non-weight-bearing positions. It is always associated with underlying conditions like congenital vertical talus, tarsal coalition, or accessory navicular bone. Males, children, overweight, and obese individuals have been identified as the major risk groups, and the prevalence is reported to decline with age, from about 54% in three-year-old children to 24% in six-year-olds (Garcia *et al.*, 1999).

In adults, flat foot has been linked to some musculoskeletal conditions such as plantar fasciitis, Achilles and tibialis posterior tendinopathy, patellofemoral pain, and lower back pain, though the direct causal relationship still remains understudied (Bradley *et al.*, 2014).

Epidemiological estimation of the prevalence of flat foot varies across different populations. Didia *et al.* (1987) reported 2.22% prevalence among Nigerian school children in Port Harcourt, while Igbigbi *et al.* (2005) reported prevalence of 430 per 1,000 population in Kenya. Among adult athletes in Port Harcourt, Didia and Asomugha (2004) found an incidence of 3.5%. In southern Nigeria, Eluwa *et al.* (2009) documented higher prevalence among females than males in the Akwa Ibom population. Dare *et al.* (2012) in another study, documented higher prevalence among females than males in Bayelsa. Aenumulapalli *et al.*, (2017) also reported a higher prevalence in females in an Indian population though the difference was not statistically significant. These variations suggest that genetic, environmental, and sociocultural factors, including footwear habits and population-specific anatomy, influences foot arch characteristics.

Anthropometry of foot parameters gives an objective and cost-effective means of quantifying foot arch morphology in population studies. The foot arch index derived from plantar footprint analysis is a validated tool for classifying foot arch types (Bradley *et al.*, 2014). Even with the documented variations in the prevalence of *Pes planus* across Nigerian ethnic groups, no study has so far investigated this condition among the population of the Ugep people of Yakurr Local Government Area in Cross River State. This study is hence designed to determine the prevalence of *Pes planus* in this population, analyze sex differences in anthropometric foot parameters, and provide an ethnic-specific baseline data that is relevant for clinical screening, anthropometric profiling, and public health planning.

MATERIALS AND METHODS

Ethical Clearance for the Study

The protocol, methodology, and design of this research study were formally reviewed and approved by the Research Ethics Committee of the Department of Anatomy, Faculty of Basic Medical Sciences, Baze University, Abuja and a Research Reference Code: **BU/URES/ANA/10015**) was issued. The

study was conducted in strict compliance with the ethical standards outlined in the 1964 Declaration of Helsinki and its subsequent amendments for biomedical research involving human participants. Prior to the commencement of data collection within the community, administrative clearance and logistical approval were sought and obtained from the Traditional Leadership/Community Council of Ugep through physical meetings and elaborate discussions. Community leaders were fully briefed on the non-invasive nature, scope, and public health relevance of the anthropometric survey to ensure cultural alignment and community cooperation.

Informed Consent

Participation in this study was entirely voluntary. Before any physical measurements or ink-print assessments were conducted, the objectives, procedures, and potential minimal risks (such as mild skin staining from the ink) were thoroughly explained to each participant in English and the local dialect where necessary. Participants were assured of confidentiality and anonymity throughout the study. No identifying personal information was disclosed, and all data collected were used strictly for academic and research purposes only. Participants were also informed of their right to decline participation or withdraw from the study at any stage without any penalty or loss of benefits.

Study Design and Study Area

This study employed a descriptive cross-sectional survey design, conducted in Ugep, the headquarters of Yakurr Local Government Area, in the Central Senatorial District of Cross River State, Nigeria.

Sample Size and Sampling Technique

The sample size was calculated using Yamane's (1967) formula:

$$n = \frac{N}{1 + N(e)^2}$$

Where N is the total population of Ugep (estimated at 140,000), n is the required sample size, and e is the margin of error (0.05). This yielded a minimum sample of 400 participants. A total of 400 Ugep indigenes (206 males, 194 females) aged 18 - 62 years were recruited by random sampling from within the community.

Procedures

Before measurement (data collection), each participant's lower extremities were visually inspected for deformities, wounds, or fractures. Plantar footprints were obtained using the ink method (Antonuk, 1975). Textile ink was poured onto a spreading tray, and each participant was asked to step onto the ink-coated tray and then onto a clean sheet of A4 paper to make a plantar print. Bilateral prints were obtained for each participant.

Two anthropometric parameters: Foot length (FL), measured from the most posterior point of the calcaneus to the tip of the longest toe; and Arch index (AI), calculated by dividing the foot (excluding the toes) into three equal regions - forefoot (A), midfoot (B), and hindfoot (C) - and computing the ratio B / (A + B + C) were taken from each print. An arch index of 0.11 - 0.26 was classified as normal, 0.00 - 0.11 as high-arched (*pes cavus)*, and greater than 0.26 as flat foot (*Pes planus).*

Statistical Analysis

Data generated from this study were analyzed using the Statistical Package for the Social Sciences (SPSS), IBM version 25.0. Descriptive statistics, including means, standard deviations (SD), standard errors of the mean (SEM), and variances, were computed for all continuous variables. Sex differences in measured parameters were evaluated using independent-samples t-tests. Statistical significance was set at $p<0.05$ with 95% confidence intervals (CI) reported for all comparisons.

Inclusion Criteria

i. Individuals within the age of eighteen and above were included for the experiment
ii. Males and females whose parents and grandparents are from ugep in Yakurr local government area of Cross River State were regarded as indigenes and accepted for the study.

Exclusion Criteria

i. Children or teenagers below 18years were excluded.
ii. Individuals with a cut or a sore around the foot were excluded.
iii. Individuals with a fracture in the leg were excluded.
iv. Individuals from other local government areas and villages as well as non-Nigerians were not accepted

RESULTS AND DISCUSSION

Prevalence of *Pes planus*

Among the sampled 400 participants in this study, 16 were identified with *Pes planus*, representing an overall prevalence of 4.0%. In the male population (n = 206), 7 individuals (3.4%) were identified with flat foot, while 9 out of 194 females (4.6%) had flat foot as shown in Table 1. Thus, females had a marginally higher prevalence of pes planus among Ugep indigenes than males.

Table 1: Prevalence of *Pes planus* among Male and Female Ugep Indigenes (N = 400)

Gender	Normal Foot (n)	Normal Foot (%)	Flat Foot (n)	Flat Foot (%)	Total
Male	199	96.6	7	3.4	206
Female	185	95.4	9	4.6	194
Total	384	96.0	16	4.0	400

Descriptive Statistics of Anthropometric Foot Parameters

As presented in Table 2, male participants showed a mean age of 33.23±9.66 years with a mean foot length (right and left) of 25.33±1.47 cm, and a mean arch index (right and left) of 0.311±0.040. Female participants had a mean age of 28.15±8.93 years with a mean foot length (right and left) of 24.49±1.68 cm, and a mean arch index (right and left) of 0.304±0.044.

Table 2: Descriptive Statistics of Anthropometric Variables by Sex

Variable	N	Min	Max	Mean±SD	SEM	Variance	
Age (yrs)	206	18.00	60.00	33.23±9.66	0.673	93.27	Males
Right Foot Length (cm)	206	20.10	28.00	25.33±1.47	0.102	2.155	
Left Foot Length (cm)	206	20.10	28.00	25.33±1.47	0.102	2.155	
Right Arch Index	206	0.20	0.40	0.311±0.040	0.003	0.002	
Left Arch Index	206	0.20	0.40	0.311±0.040	0.003	0.002	
Age (yrs)	194	18.00	62.00	28.15±8.93	0.641	79.76	Females
Right Foot Length (cm)	194	21.30	28.90	24.49±1.68	0.120	2.183	
Left Foot Length (cm)	194	21.30	28.90	24.49±1.68	0.120	2.183	
Right Arch Index	194	0.21	0.46	0.304±0.044	0.003	0.002	
Left Arch Index	194	0.21	0.46	0.304±0.044	0.003	0.002	

SEM = Standard Error of the Mean.

Sex Differences in Foot Parameters

Table 3 shows the Independent-samples t-test results for various anthropometric parameters measured in this study. Statistically significant sex differences were observed for age ($t = 5.451$, $df = 398$, $p<0.001$), right foot length ($t = 5.326$, $df = 398$, $p<0.001$), and left foot length ($t = 5.326$, $df = 398$, $p<0.001$). No significant sex differences were found for right arch index ($t = 1.565$, $df = 398$, $p = 0.118$) and left arch index ($t = 1.681$, $df = 398$, $p = 0.093$) respectively.

Table 3: Independent-Samples T-Test Results for Sex Differences in Foot Parameters

Parameter	F	Sig.	T	Df	p-value	Mean Diff.	95% CI Lower	95% CI Upper
Age (yrs)	1.810	0.179	5.451	398	0.000*	5.079	3.247	6.910Males
Right Foot Length	4.986	0.026	5.326	398	0.000*	0.838	0.529	1.147
Left Foot Length	4.986	0.026	5.326	398	0.000*	0.838	0.529	1.147
Right Arch Index	0.785	0.376	1.565	398	0.118	0.007	-0.002	0.015
Left Arch Index	0.751	0.387	1.681	398	0.093	0.007	-0.001	0.015
Age (yrs)	1.810	0.179	5.464	383	0.000*	5.079	3.246	6.905Females
Right Foot Length	4.986	0.026	5.305	383	0.000*	0.838	0.529	1.147
Left Foot Length	4.986	0.026	5.305	383	0.000*	0.838	0.529	1.147
Right Arch Index	0.785	0.376	1.560	383	0.120	0.0065	-0.002	0.015
Left Arch Index	0.751	0.387	1.677	383	0.094	0.0067	-0.001	0.015

** Significant at p<0.05. CI = Confidence Interval; Mean Diff. = Mean Difference.*

Discussion

The observed overall prevalence of *Pes planus* (flat foot) of 4.0% among the indigenes of Ugep in Yakurr Local Government Area aligns with a broader pattern of low, localized flat foot prevalence across several southern Nigerian cohorts. This low rate is consistent with the early findings of Didia *et al.* (1987) and Didia and Asomugha (2004), who reported regional baseline prevalence of 2.22% and 3.5%, respectively.

However, the slight female predominance noted in the Ugep population corroborates regional anthropometric trends. Eluwa *et al.* (2009) in Akwa Ibom State and Ummuna *et al*., (2021) in the eastern part of Nigeria similarly reported higher female-to-male ratios for flat foot. This presentation can be explained through anatomical and musculoskeletal variations. As originally postulated by Richie (2020) and supported by modern podiatric biometrics, adult females typically possess a smaller overall bony framework and less bulky intrinsic foot musculature. Consequently, the dynamic stabilizers of the medial longitudinal arch (such as the *tibialis posterior* tendon and the *calcaneonavicular* (spring) ligament) experience higher mechanical strain per unit area in females under weight-bearing conditions, lowering the structural threshold for arch flattening.

Interestingly, these low adult findings contrast with other coastal South-South Nigerian studies. For instance, Dare *et al.*, (2012) observed an adult *Pes planus* prevalence of 25.3% in a native Bayelsa population, while a study by Benwoke and Karibi (2026) in Rivers State among a cohort of adult farmers and students revealed an overall prevalence of 10.63%. These discrepancies indicate that even within geographical zones like the Niger Delta and South-South Nigeria, distinct sub-ethnic genetic architectures, local topography, occupational loading, and lifestyle differences heavily influence structural foot morphology.

The marginal differences between the 4.0% prevalence in this study and the lower rates previously recorded in Port Harcourt (e.g., 2.22% by Didia *et al.*, 1987) are largely due to variances in sample age composition and physical demographic types. The present study investigated an adult population ranging from 18 to 62 years, capturing individuals who have experienced decades of occupational, biomechanical, and age-related wear on the plantar fascia. Conversely, the historical reference studies predominantly evaluated school children and active athletes, populations where the transient, flexible flat foot of childhood or the highly toned musculature of active sports players alters the diagnostic landscape.

When comparing these findings to international datasets, the geographical divergence becomes even more distinct. For example, Igbigbi *et al.* (2005) documented a high prevalence of 430 per 1,000 (43%) in Kenya, while Chang *et al.* (2010) reported a 49% to 67% prevalence rate among Taiwanese school children. This contrast highlights the distinct morphological adaptations found within separate global populations.

The markedly lower prevalence of adult flat foot observed in Ugep relative to East African or Asian cohorts highlights the protective role of barefoot or minimalist shoe ambulation during early developmental years. As suggested by Kolhe *et al*., (2024), developmental barefoot walking (a common

practice in rural and semi-urban Nigerian communities like Ugep) promotes the natural development of the medial longitudinal arch. Without the restrictive stiff soles of modern footwear, the intrinsic musculature of the foot is forced to actively contract to absorb ground reaction forces, building muscular strength and stiffening the plantar fascial framework.

This structural development explains why paediatric rates can appear misleadingly high before skeletal maturity. For example, Umar and Paul (2010) reported a 25% prevalence of *Pes planus* among Yoruba children aged 9 to 14 years. In children, this higher rate frequently represents a physiological, flexible flat foot characterized by a benign fat pad beneath the medial arch, which naturally resolves as the child ages and ambulates. By the time a population reaches the 18-to-62 age bracket examined in Ugep, the arch has fully consolidated, resulting in a stable, lower adult baseline prevalence.

The independent-samples t-test analyses revealed significant sex differences in age and bilateral foot length, confirming the presence of clear sexual dimorphism in foot morphology. The finding that males possess consistently longer feet than females align with normative anthropometric standards established by Deneau *et al*., (2018) and Arikpo *et al*., (2025) and closely matches modern regional data from Rivers State (Benwoke and Karibi, 2026), which demonstrated significantly higher mean foot lengths in adult males compared to females.

Despite these distinct variations in foot length and width, the lack of a statistically significant sex difference in the arch index requires careful interpretation.

This statistical parity indicates that the proportional geometry of the arch remains symmetric between the sexes within this population, even though females exhibit a higher overall flat foot prevalence. This apparent paradox indicates that the absolute threshold at which a foot structurally collapses into clinical or pathological pes planus may be governed by different soft-tissue elastic limits in men and women. Alternatively, because the total number of individuals presenting with flat feet in this sample was small, the statistical power to detect subtle, sex-based changes in the arch index may have been mathematically limited.

Some observed limitations in this study should be noted to assist future research:

i. Sampling Restrictions: The study population was strictly limited to indigenes of Ugep, which restricts the generalizability of these findings to other diverse ethnic groups across Cross River State or Nigeria at large.
ii. Methodological Variations: The ink-print method, while validated, affordable, and widely used for field epidemiology, is vulnerable to manual errors. Variations in ink application, paper thickness, and weight-bearing positions can alter the print quality and subtly affect the calculated index.
iii. Uncontrolled Confounders: Crucial secondary factors such as historical footwear habits, current Body Mass Index (BMI), and occupational loading (e.g., farming vs. sedentary work) were not systematically controlled for. As demonstrated by Olarenwaju (2017), BMI status correlates significantly with pes planus changes at ($p = 0.039$). To build on these findings, future anthropometric studies should use multi-community sampling frameworks to increase statistical power, incorporate digital plantar pressure mat analysis, and systematically track BMI and occupational patterns to fully untangle the complex causes of adult *Pes planus*.

CONCLUSION

This study shows a very small prevalence of *Pes planus* (flat foot) among adult Ugep indigenes in Yakurr Local Government Area of Cross River State, Nigeria, with female participants exhibiting a higher prevalence than males. Significant sex differences were observed for foot length but not for arch index. These findings provide ethno-specific anthropometric baseline data for the Ugep people and support the utility of the low-cost ink-print method for community-based flat foot screening.

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