ORIGINAL ARTICLE

Prevalence of Flat Foot using Plantar Arch Index among Young Adults of Delta State, Nigeria

Eloho Nyerhovwo Igbinedion, Augustina Oghenevwaerhe Jewo, God'swill Okoro, John Chinedu Obianke

Department of Human Anatomy and Cell Biology, Faculty of Basic Medical Sciences, College of Health Sciences, Delta State University, P.M.B. 1, Abraka, Nigeria

ABSTRACT

Introduction: Traditionally, feet are classified as high, normal or low arched. Studies on flat foot (pes planus) have been conducted in different ethnic groups in Nigeria but none has been conducted among young Ika adults. This study is therefore aimed at determining the prevalence of flat foot using plantar arch index among young adults of Ika. **Methods:** A total of 384 subjects comprising 199 females and 185 males aged 18-37 years participated in the study. Foot prints of subjects were obtained using the simple ink and duplicating paper method. The Plantar Arch Index was calculated by dividing the foot prints in three equidistant regions excluding the toes. The index value was the ratio between the area of the mid foot and the total area of the foot print. Descriptive statistics for each variable included mean and standard deviation while statistical tools included independent sample t-tests and paired samples test respectively. **Results:** After data analyses, the total prevalence of flat foot was 8.6% while a total of 24(6.3%) males had flat foot on their right foot while 16(4.2%) had on their left. However, 14(3.6%) and 12(3.1%) females had flat foot on their right and left foot sides respectively. The prevalence of Pes planus was significantly higher among males ($P< 0.05$) than their female counterparts on both foot sides. Furthermore, there was a statistically significant difference between flat and normal foot on both foot sides while the difference between flat foot of the right side and that of the left was not statistically significant. **Conclusion:** Being the first of its kind in Ika, this study is therefore important to the Orthopaedist and Podiatrist in Nigeria for diagnosis and treatment choices of foot deformities amongst young adults of Ika.

Keywords: Flat Foot, Gender Differences, Ika L.G.A., Pes planus, Plantar Arch Index

Corresponding Author:
Eloho Nyerhovwo Igbinedion, MSc
Email: enogboromorie@delsu.edu.ng
Tel: +234-8133057487

INTRODUCTION

Pes planus, commonly called 'flat foot' is one of the frequently encountered orthopaedic issues in paediatrics and adult health practice. Presence of an averted rear foot, lowered medial longitudinal arch (MLA), abducted and dorsiflexed mid foot are the characteristic features of flat foot (1). Reports have shown that individuals that have flat foot suffer from foot pain, foot injury, stress fracture and even perform poorly in exercises (2). A previously conducted study revealed that an increase in age causes a decrease in the occurrence of flat foot deformity (3). Although lots of flat foot-based studies exist, none has been carried out in this part of Nigeria. Therefore, this study was aimed at determining the prevalence of flat foot using plantar arch index among young Ika adults of Delta State, Nigeria who were aged between 18 and 35 years.

MATERIALS AND METHODS

Ethics

Ethical clearance for this study was obtained from the Research and Ethics Committee of the Department of Human Anatomy and Cell Biology, Faculty of Basic Medical Sciences, College of Health Sciences, Delta State University, Abraka with reference number DELSU/CHS/ANA/18/18. In addition, informed consent was also obtained from the participants.

Study Design

The cross sectional descriptive design involving participants who were selected by using simple random sampling technique were used for the study. The total population of the Ika was 346,251 drawn from the records of the Ika Local Government Area Secretariat. Based on previous recommendation (4), 384 subjects were employed as sample size for the study. Male and female adults within ages 18 – 35 years who are pure Ika breeds and residents of Agbor, Agbor Obi, Alisime and Alihame (all of Delta State, Nigeria) and had no foot deformity were included in the study. During data

collection, subjects who had evidence of previous foot or leg surgery, foot swellings/inflammations and ulcers as well as other foot conditions that could hinder diagnosis of flat foot were excluded from the study. Thus, about 15 subjects were rejected based on the exclusion criteria. This study was conducted within six months (from November, 2018 to May, 2019).

Footprints of the subjects were obtained manually using the ink and plain paper method as described previously (5-7). Using endorsing ink, white paper (A4), plain tile, roller brush, bowl, water, liquid soap, cotton wool and acetone, the subjects were asked to place their feet on a glass tile which was impregnated with stamp ink that was spread evenly using the roller brush in order to make an impression on a plain white A4 sheet of paper. The feet were then washed using soap and water and finally cleaned using acetone.

The plantar arch index (PAI) was then calculated by dividing the obtained footprint in three equidistant regions using the pencil and metre rule: fore foot (A), mid foot (B) and rear foot (C), excluding the toes in accordance with previous methods (5-7) (Fig. 1). The index value which was calculated as the ratio between the area of the mid foot to the total area of the toeless foot is shown to be: PAI = B / (A+B+C).

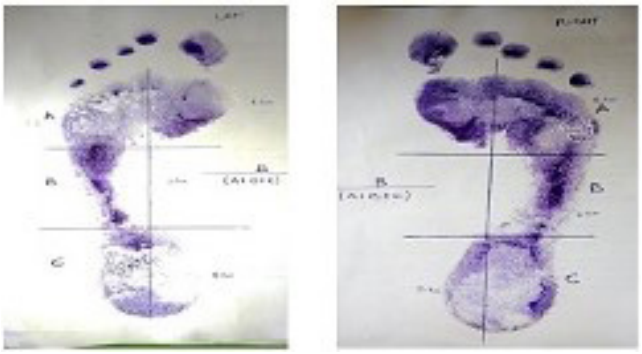

Figure 1: Photograph showing the foot prints and the calculations. After obtaining the foot prints, plantar arch index (PAI) was then calculated by dividing the obtained footprint in three equidistant regions using the pencil and metre rule: fore foot (A), mid foot (B) and rear foot (C), excluding the toes. The index value which was calculated as the ratio between the area of the mid foot to the total area of the toeless foot is shown to be: PAI = $\frac{B}{A+B+C}$

After obtaining the index values for right and left feet of both genders, the foot types were classified into; high arched foot or pes cavus (arch index < 0.21), normal foot (0.21 ≤ arch index < 0.26) and flat foot (arch index ≥ 0.26) based on previous classification methods (8-9).

Data Analysis

The data were analysed using Statistical Package for Social Sciences (SPSS) version 22. The results were also presented in tables and chart and the statistical tool used was independent sample t-test for ascertaining gender differences while paired sample test was used to test for differences between flat and normal foot as well as right and left foot sides where P value lesser than 0.05 was considered significant.

RESULTS

A total of three hundred and eighty four (384) subjects aged 18-37 years comprising 185 (48.2%) males and 199 (51.8%) females participated in the study. The age range for the study included: 18-21yrs (65 subjects), 22-25yrs (136 subjects), 26-29yrs (118 subjects), 30-33yrs (51 subjects) and 34-37yrs (14 subjects).

The foot of each subject was classified into various foot types based on plantar arch index on both foot sides. On the right side, it was observed that 261 subjects (68.0%) had pes cavus or high arch while 85 subjects (22.1%) had normal foot and 38 subjects (9.9%) had pes planus or flat foot. However, on the left side, it was observed that 280 subjects (72.9%) had pes cavus while 76 subjects (19.8%) had normal foot and 28 subjects (7.3%) had pes planus (see Fig. 2).

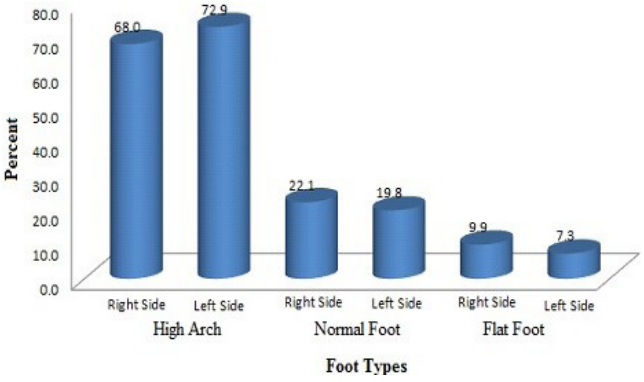

Figure 2: Classification of the foot types. The foot of each subject was classified into various foot types (High Arch, Normal Foot and Flat Foot) based on plantar arch index for both right and left foot sides.

The total prevalence of each foot type among adult male and female subjects were also determined. Fig. 3 shows that the total prevalence of pes cavus was 70.4% while

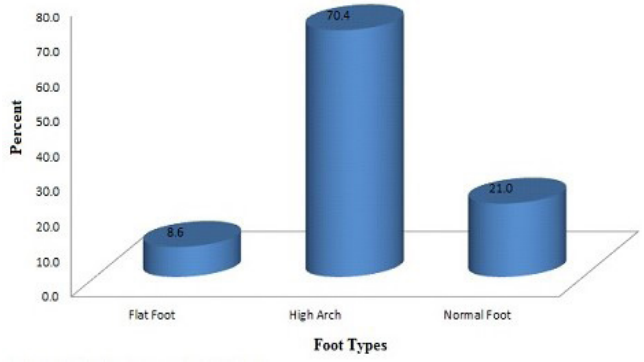

Figure 3: Total prevalence of flat foot. The total prevalence of each foot type among adult male and female subjects were also determined. The study showed that the total prevalence of pes cavus was 70.4% while it was 21.0% and 8.6% for normal foot and pes planus respectively.

it was 21.0% and 8.6% for normal foot and pes planus respectively. Thus, the most prevalent foot type in the study population was pes cavus.

The prevalence of each foot type was determined across the age groups. The foot type with the highest prevalence amongst all the age range was pes cavus while the least was pes planus on both foot sides as shown in table I. Based on gender, the most prevalent foot type among both genders was pes cavus on both foot sides while the least among both genders was pes planus on both foot sides (Table I).

Gender difference was determined based on the various foot types. It was observed that the men flat foot for males (0.21±0.05) was significantly higher than that of females (0.19±0.05) on the right foot side ($p<0.05$). Moreover on the left foot side, the mean flat foot for males (0.19±0.05) was higher than their female counterparts (0.18±0.05) and the difference was also statistically significant ($p\leq0.05$) (Table II).

The study showed that there was a negative correlation between age and flat foot on both foot sides as shown in table III. This therefore implies that flat foot decreases with an increase in age and vice versa.

The relationship between flat foot and normal foot was also ascertained using paired sample tests. Table IV shows that there is a statistically significant difference between flat and normal foot for both the right and left foot sides. The difference between flat foot of right and that of left foot was also determined. There was no statistically significant difference between flat foot of the right foot side and that of the left.

DISCUSSION

The current study showed that the most common

Table II: Gender differences based on Pes planus

Foot Sides	Gender	N	Mean	Std. Dev.	t	df	*p* - value
Right	Male	185	0.21	0.05	3.056	382	0.002
	Female	199	0.19	0.05			
Left	Male	185	0.19	0.05	1.934	382	0.054
	Female	199	0.18	0.05			

Table III: Relationship between Age and Flat Foot

Paired Samples	N	Mean	Std. Dev.	r	*p* - value
Age	384	2.51	1.04	-0.058	0.255
Right foot	384	0.20	0.05		
Age	384	2.51	1.04	-0.081	0.113
Left foot	384	0.19	0.05		

Table IV: Difference between Flat and Normal foot

Sides	Foot Types	N	Mean	Std. Dev.	t	df	*p* - value
Right	Flat foot	38	0.310	0.03	21.020	121	<0.0001
	Normal foot	85	0.232	0.01			
Left	Flat foot	28	0.299	0.02	20.292	102	<0.0001
	Normal foot	76	0.231	0.01			

Table I: Prevalence of Foot Types based on Age and Gender

Foot Side	Age	Pes Cavus (%)	Normal Foot (%)	Pes Planus (%)	Gender	Foot Side	Pes Cavus (%)	Normal Foot (%)	Pes Planus (%)
Right	18-21	10.4	4.7	1.8	Male	Right	28.9	13	6.3
Left		11.2	4.2	1.6					
Right	22-25	26	6.8	2.6		Left	32.3	11.7	4.2
Left		27.9	4.9	2.6					
Right	26-29	20.6	6.3	3.9		Right	39.1	9.1	3.6
Left		21.6	6.5	2.6					
Right	30-33	8.3	3.6	1.3	Female	Left	40.6	8.1	3.1
Left		9.4	3.4	0.5					
Right	34-37	2.6	0.8	0.3					
Left		2.9	0.8	0					

right and left foot type in majority of the respondents was high arch (pes cavus), next to normal arch, while the least was flat foot (pes planus). This could be as a result of the age group used for the study. The low flat foot prevalence confirms an established report that flat footedness decreases with an increase in age (10). This finding corroborates a previous Indian study (11) that had high arch as the most prevalent foot type. Moreover, other studies (10, 12-15) that had either flat foot or normal arch as being prevalent contradict this finding.
Also, it was observed that the overall percentage of flat foot in the current study was as low as 8.6%. However, the total prevalence of flat foot was 9.9% on the right foot side with a prevalence of 6.3% among males and 3.6% among females while on the left foot side, the total prevalence of flat foot was 7.3% with a prevalence of 4.2% among males and 3.1% among females. This study is therefore compliant with the established normal range as it has been said that, flat foot is estimated to affect approximately 3.0-25.0% of the adult population globally (16). Other previous studies that reported low or lower percentages of flat foot included Nigerian, African and Asian studies (9-10, 13, 17-25) while those that reported higher percentages were few (11, 26-28). These findings were not in line with a previous study (17) which determined the prevalence of pes planus among people of Akwa Ibom State of Southern Nigeria, with an overall prevalence of pes planus as 13.4% (a prevalence of 5.8% among males and 7.6% among females) and another (19) that determined the prevalence of pes planus among people of Ebonyi with an overall prevalence of pes planus as 4.2% on the right foot and 2.5% on the left foot (a prevalence of 3.7% among males and 2.5% among females). There were also other previous studies (29-33) with discrepancies from the present study. These variances could be ascribed to use of different footprint methods. While the current study used simple ink and paper method, some of the previous studies used other methods like direct foot scans using hp photo scanner with scanning software. Also, differences in sample size, method of data analysis and of course, ethnicity could also be possible factors.

Also, it was shown that there was a statistically significant difference between flat and normal foot for both the right and left foot sides. However, the difference between flat foot of the right foot side and that of the left was not statistically significant. Furthermore, high arch and normal foot were more prevalent on the right and left foot sides of males and females. Moreover, all these differences were statistically significant ($p<0.05$). It was observed that male and female residents do more of trekking or cycling to their various farms and businesses. The fact that physical activities (such as trekking), everyday habits such as frequency of sport activity (cycling in this case), shoe wearing habits (such as low slippers worn while trekking and cycling) as well as personal characteristics (body mass index and age) could affect the foot morphology of adults as stated in a previous study (34) have been confirmed in this study. This finding does not agree with findings of some previous studies (12-14, 17, 23) who reported that majority of the subjects had flat foot and normal arch respectively. Use of different index methods for flat foot determination, reduced sample size and of course, ethnic differences as shown in the aforementioned previous studies could account for these differences.

Based on gender, the most prevalent foot type among both genders was pes cavus on both foot sides while the least among both genders was pes planus on both foot sides and as shown in the current study, the mean flat foot for males (0.21 ± 0.05) was significantly higher than that of females (0.19 ± 0.05) on the right foot side ($p<0.05$). Moreover on the left foot side, the mean flat foot for males (0.19 ± 0.05) was higher than their female counterparts (0.18 ± 0.05) and the difference was also statistically significant ($p\leq0.05$). As stated in a previous study (35), flat footedness in males is probably due to a thicker plantar fat pad in the medial midfoot which further suggests that the development of the medial longitudinal arch may be progressively slower in males than in females. Also, overweight males (even though not studied) may be assumed to be the reason for this finding in the current study. This therefore confirms the statement that overweight add more stress load to the feet, thus making the muscles, tendons and ligaments that hold up the arch to become weaker and more stretched (36). This result is similar to some previous studies (9-10, 19, 25, 37) but dissimilar to others (22, 24, 29, 34). These differences could be ascribed to use of different software package for data analysis, use of different index method for flat foot determination, occupation and again, ethnic differences.

The study showed that there was a negative correlation between age and flat foot on both foot sides. This therefore implies that flat foot decreases with an increase in age and vice versa. As previously stated, this study has further confirmed that flat foot decreases with an increase in age (10).

CONCLUSION

This study showed that the most common right and left foot type in majority of the respondents of Ika was high arch while flat foot was the least foot type observed. This study is therefore of importance to Orthopedists and Podiatrists in Nigeria for diagnosis and treatment choices of foot deformities amongst young adults of Ika. It is therefore recommended that further research on flat foot amongst adolescents and older population of Ika be carried out putting the effects of obesity into consideration.

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