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ASSESSMENT OF PLANTAR ARCH INDEX AND FLAT FOOT AMONG ADOLESCENTS OF DAWAKIN KUDU LOCAL GOVERNMENT, KANO, NIGERIA

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ABSTRACT

The arches of the feet are important in protecting the internal structures of the body from impact forces while it mainly helps in transferring the internal forces to the ground and are also involved in lifting the body weight and mainly shock absorption. With respect to the medial longitudinal arch, some prominent deformities can be observed - high arch i.e., Cavus foot and low arch i.e., flat foot also known as Pes planus. The deformities are responsible for inefficient transmission of forces leading to foot diseases. The aim of this research project is to assess the plantar arch index and flat foot among the adolescent residents in Dawakin kudu local government area, Kano. This is useful in creating awareness about the plantar arch deformities and the cause for the deformity. The parameters used in measuring the plantar arch height are Staheli's plantar arch index and arch angle. The study design was cross-sectional study and a sample size of 457 participants from Dawakin kudu local government area, Kano, was selected comprising of 204 males and 253 females, aged between 10- 19 years. Informed consent from the participants and ethical clearance from our institute was obtained. Printing Nigerian ink was applied on the soles of both the feet of each participant and dynamic footprints were obtained on A4 size papers. Analysis of the results was done. Flat foot was determined using Staheli plantar index (PI) and values ≥ 1.15 were considered flat footed. The result of the present study showed that 267 (58.4%) population were flat footed and 190 (41.6%) population were normal footed. The correlation between age, BMI, Right and Left Footprint Parameters, was observed that there was no significant relationship between all the variables except for Right with Left Planter Arch Index where a significant relationship was reported between them at ($P < 0.05$). Students' two samples - t - test was carried out to determine sexual dimorphism; it was shown that there was a significant difference between Male and Female Footprint Parameters in RPAI only with Males having a higher mean value in RPAI and females having a higher mean value in LPAI. This research project may serve as an early warning sign of structural and functional defects of the foot in a young population and can provide help for making appropriate footwear for persons with pesplanus. Also, the present study suggests that the simple ink print method is a cost-effective and easier way of diagnosing flat foot deformity clinically using PAI.

Keywords: plantar arch index, flat foot, adolescents

INTRODUCTION

Anthropology is now one of the interdisciplinary scientific fields that is gaining much attention in forensic, socio-cultural, industrial and bio-medical applications, literally meaning measurement of human body, refers to the measurement of living humans for the purpose of understanding human physical variation [1].

Anthropometry is the study of the measurement of human body in terms of dimension of bone, muscles and adipose tissue. Anthropometric studies are today conducted for numerous purposes in academics, government agencies, and by scientist in private companies [1].

Anthrometric measurement plays an important role in industrial design, clothing design, ergonomics and architecture, where statistical data about the distribution of body dimension in the population are to optimize product, changes in life styles, nutrition and ethnic composition of population lead to changes in distribution of body dimension and require regular updating of anthropometric data. Different anthropometric measures or ways of taking Anthropometric measurement exists. These includes; height, weight, length, circumference, waist circumference, hip circumference, percentage of body fat etc. anthropometric measurements are used in a remarkable wide variety of scientific and technical fields from genetics, nutrition forensics, and industrial designs. Over the years, Engineers, Designers, Architects etc. have increasingly recognized the need for the anthropometric measurements and have also incorporated it into their field of practice [2]. It is now recognized as the single most potable, university application, inexpensive and noninvasive technique for assessing the size, proportions and composition of the human body.

Flat Feet (Pes Planus) can be defined as a collapse of the medial longitudinal arch of the foot, in which there is absence of the normal concavity under the medial longitudinal arch, in addition there is bulging of the foot medial side as a medial convexity, especially on weight bearing [3].

The aim of this research is to assess the planter arch index and flat foot among the adolescent residents in Dawakin kudu local government area, Kano.

MATERIALS AND METHODOLOGY

Study Area

The study will be conducted in Dawakin Kudu Local Government area, in Kano State.

Population

Kano State is the most populous State in Nigeria with a population of over 9 millions (National population commission, *et al.*, 2010).

Study Population

The study population will comprise of all Hausa ethnic population of Kano residing within Dawakin Kudu local government area, Kano State. There are about population of 225,389 (2006 census).

Study Design

The study was a descriptive cross sectional study using closed ended questionnaire.

Sampling Technique

Simple random sampling technique was employed to select subjects for the study.

Sample Size Determination

The objects for the study were the people's residents in Dawakin Kudu local government, Kano State.

The sample size was determined using standard formula that recognizes the total population, precision level, confidence interval and standard deviation.

$$N \geq Z^2 a 2S^2/d^2$$

Where

N = Sample size

Z = Normal distribution table value

D = detection level considered to be important

S = standard deviation of the sample data, based on the previous knowledge (Bio statistic and micro-biology: A survival manual 2008).

Inclusion criteria

The following subjects are included in the research:

1. The subject must be within Dawakin kudu local government area, Kano.
2. Subjects between 10 to 19 years age (adolescence population)
3. Physically health subjects with normal lower limbs (No deformity).

Exclusion Criteria

The following are excluded in the research:

1. Subjects from other non Dawakin Kudu local government area are excluded.
2. Subjects below 10 years of age or above 19 years of age are excluded (Non adolescence)
3. Subject with deformity, lower limbs diseases and injury or any kind of pathological changes.

Ethical Approval

A letter of introduction will be collected from the Department of Human Anatomy Yusuf Maitama Sule University, Kano. Was used to seek for permission at selected school, for approving of conducting the experiment.

Then the aim and objective of the study were explained to the committee and their permission were obtained, and the explanations of the procedure as well as the intended use of the research were properly addressed to the subjects and their consent for the participation was obtained.

Ethical clearance will be sought from the faculty of Basic Medical Sciences' Ethical committee.

METHODOLOGY

(Step 1)

Sample size and participant

A total of 457 participants of students comprised of (204 Male and 253 Female) of Dawakin kudu local government area, Kano. Particularly from Dawakin kudu local government areas were selected randomly for the research study. The participants are adolescents range in age of 10 to 19 years. Research study was conduct in Dawakin kudu L.G.A only. Each participant was required to fill in a questionnaire contain basic demographic profile (e.g. sex, age, ethnicity, etc.). Participant were giving information regarding the research study and measurement, procedure and were assure about the confidentiality of the date, they provide and are require to a sign consent form before participant in the study. Participants with any lower limb deformity or injury were excluding from the research study.

(Step 2)

On arrival to the scene the participant was asked to sit comfortably in a chair and asked him/her to take off the shoes.

(Step 3)

A clear cotton wool dabbed in methylated spirit was used to clean the planter surface of the feet.

(Step 4)

The cyclostyling ink was spread on smooth plank.

(Step 5)

The ink was evenly distributed on the smooth plank using an ink roller.

(Step 6)

The participant was asked to stand and step the foot on the smooth plank and then stamp the foot on a plain sheet of paper.

(Step 7)

The outline of the foot print was determined; each foot print was obtained in the standing position with the limb bearing about 50% of the body weight [4].

(Step 8)

The footprints were then used to calculate the planter arch index (PI). Using a lead pencil, a line was drawn tangent to the medial forefoot edge and the heel region. The midpoint of this line was determined. From this point, a perpendicular line was drawn crossing the footprint [5]. The same procedure was repeated for the heel tangency point. The perpendicular distance (A; the perpendicular line representing the width covered by the ink from the medial edge to the lateral edge of the mid-foot) was measured. Also, a second perpendicular distance (B; the perpendicular line representing the width covered by the ink from the medial edge

to the lateral edge of the rear foot) was measured. The PI was then calculated by dividing the value of A by the value of B (PAI = A/B) [5]. An individual was considered to have flat foot, if his/her PI value was >1.15 [6]. This is a well validated method of measuring the PI [7].

Statistical analysis

The data obtained was processed from Microsoft application (word and excel) and will be expressed in mean and ±SD (descriptive analysis). Maximum and minimum values of the Right and Left variables were determined. Sexual dimorphism in footprint parameters measured in (cm) was also calculated. Correlation between Right and Left footprint parameters were also calculated. Tow samples – t – tests between right and left footprints parameters were also determined. The statistical analysis of the study was performed using SPSS (statistical package for social science) version 20.0 and value of P < 0.05 in all the variables was considered as the level of significant.

Results

Table 1: Descriptive Statistics of Footprint Parameters among Adolescent of Dawakin Kudu Local Government, Kano

Variable (cm)	Minimum	Maximum	Mean± SD
RPAI	1.15	1.82	1.44±0.13
LPAI	1.10	1.41	1.41±0.15
BMI	14.40	32.80	21.12±4.51

Table 2: Correlation between Age BMI, Right and Left Footprint Parameters among Adolescent of Dawakin Kudu Local Government, Kano

Variables	Right Planter Arch Index	Left Planter Arch Index
Age	-0.054	-0.084
Right Planter Arch Index		0.353**
Left Planter Arch Index	0.353**	
BMI	0.049	0.083

Table 3: Difference between Right and Left Feet Parameters among Adolescent of Dawakin Kudu Local Government, Kano

Variables	Mean ± SD		t-value	p-value
	Right	Left		
PAI	1.40±0.34	1.32 ±0.34	2.40	0.018

Table 4.4: Sexual Dimorphism in Footprint Parameters among Adolescent of Dawakin Kudu Local Government, Kano

Variables	Mean ± SD		t-value	p-value
	Female	Male		
RPAI	1.429 ± 0.138	1.458 ± 0.141	-2.249	0.025
LPAI	1.421 ± 0.176	1.417 ± 0.120	0.288	0.774

Table 5: Percentage of Footprint Parameters among Adolescent of Dawakin Kudu Local Government, Kano

Variables	Frequency	Percentage (%)
Normal foot	190	41.6
Flat Foot	267	58.4
Total	457	100.0

DISCUSSION

The anatomy and shape of an individual's medial longitudinal arch dictates the types of injuries that person is susceptible to. The height of a person's arch is determined by

the height of the navicular bone and collapse of this arch result in flat feet. Pesplanus (flat foot) is the most common foot pathology not only in patients of all

ages in general but in pediatric, orthopedic practice in particular [8].

In the Present study, Plantar Arch Index (PI) method has been used for evaluation of the footprints. The Right Planter Arch Index (RPAI), Left Planter Arch Index (LPAI), and Basic Metabolic Index (BMI). In (kg/m²). The mean RPAI was 1.44±0.13 while the minimum and maximum values for RPAI were 1.15 and 1.82 respectively. The mean LPAI was 1.41±0.15 while the minimum and maximum values for LPAI were 1.10 and 1.41 respectively. The mean BMI was 21.12±4.51 while the minimum and maximum values for BMI were 14.40 and 32.80 respectively. The plantar arch index (PI) correlates foot central region, also called arch region, to the heel region, and has also been used by some other authors [8]. The relationship between the areas of these regions was used by Cavanagh and Rodgers [9].

The Result of correlation showed correlation between age, BMI, Right and Left Footprint Parameters among Adolescent of Dawakin Kudu Local Government, Kano, it was observed that there was no significant relationship between all the variable except for Right Planter Arch Index with left Planter Arch Index were significant relationship was reported between them.

Also the result of sexual Dimorphism in Footprint Parameters among Adolescent of Dawakin Kudu Local Government, Kano, it was observed that there was significant difference between Male and Female Footprint Parameters in RPAI only with Males having higher mean value in RPAI and females having higher mean value in LPAI

Our present study showed the prevalence of flat feet to be 58.4% percentage in adolescent population aged from 10-19 years old, which is comparatively higher

compared to a study done by Martin Pfeiffer *et al* [10] where the prevalence of flat feet was 44% in a group of 3-6 year old children. Also Ezema *et al.* [11] were he reported higher prevalence of flat foot among Nigerian children as compared to figures from many developed countries.

The present study was showed that the PAI method we studied is suitable for the diagnosis of flatfoot in the adolescent's population and has high sensitivity. Furthermore, simple ink print method is cost effective and easier method of diagnosing flat feet compared to other techniques like radiography. It is, in fact, simple, easier to apply, and portable. This method is also non-invasive and does not involve radiation and hence can be applied to any kind of people immaterial of their age, conditions like pregnancy, etc. Thus, it could be used clinically to diagnose flat feet.

Footprints can be used for studies as they are simple, easily available, low-cost, and non-invasive, and without radiation [12]. Although there are people who consider footprint as a poor evaluation approach, there is almost an unaccountable number of authors who advocate it use: Cavanagh and Rodgers [9]) The correlation between X-ray studies and footprint shows that the footprint is effective for individual studies and population-based investigations (Mathieson *et al.*, 2004), for large-scale studies (population-based), its practical application is more cumbersome. Any method showing a clear and homogenous footprint is, at first, worthy for assessing it. Cavanagh and Rodgers, have mentioned several cases [9].

Eluwa *et al.* [13] found a higher incidence of flat foot among females compared with males. Our results come in contrast with [14], who conducted a study on (2083)

Taiwanese children aged between 7 years and 12 years, and another study of 5866 Greek children aged between 6 years and 17 years. The current study showed that the weight and BMI status were not significantly associated with flat foot. Although, a strong significance between flat foot and high BMI in children was reported by [15].

CONCLUSION

The study was concluded that the prevalence of flat foot among Adolescent of Dawakin Kudu Local Government, Kano. In a population of 10 to 19 years old was found that 58.4% has flat foot deformity, and 190 (41.6%) population were normal footed. The correlation between age, BMI, Right and Left Footprint Parameters, was observed that there was no significant relationship between all the variable except for Right with left Planter Arch Index were significant relationship was reported. Students' the determination of sexual dimorphism was showed the significant difference between Male and Female Footprint Parameters in RPAI only with Males having higher mean value in RPAI and females having higher mean value in LPAI. The result of this research was provided the useful information to identified individuals with normal and flat foot, based on the anatomical characteristics.

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