

## Research Article

**Foot and Head Anthropometry of 18-30 Years old Nigerian Polytechnic Students**S.N. Onuoha<sup>a\*</sup> M.C. Okafor<sup>a</sup> and O. Oduma<sup>b</sup><sup>a</sup>Department of Agricultural and Bio-environmental Engineering Technology, Auchi Polytechnic, Auchi, P.M.B.13, Auchi, Edo State, Nigeria.<sup>b</sup>Department of Mechanical Engineering, Ministry of Works and Transport, Abakaliki, Ebonyi State, Nigeria.

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**Abstract**

Human body compositions change with age and other related factors, and as such the anthropometric dimensions developed from one region may not be appropriate to be used when designing machines and fittings for people living in another region. This study presents the anthropometric data of Nigerian polytechnic students, which helps to develop and modify foot and head protective and wears suitable for the people of the region. Seven anthropometric data useful for the design of foot and head protective were selected and measured from 800 (400 male and 400 female) subjects within the age of 18-30 years. Data obtained was analyzed using independent samples *t*-test by SPSS (version 18.0). The measurements were compared between two genders and among other ethnic populations of the world. The results showed that male were larger in all the mean dimensions and significant difference was only noticed on foot length dimension for both genders at ( $p < 0.05$ ). The results also indicate differences among various foot and head dimensions while comparing with other ethnic populations of the world. It is recommended that the study should be extended to different tertiary institutions in our country in order to generate design database for efficient production of foot and head facilities and fittings for Nigerian polytechnic students.

**Keywords:** Foot and head; protective wears; male and female; polytechnic students; anthropometric dimension.

**1. Introduction**

Many studies have shown a mismatch between anthropometric dimensions and protective wears produced for foot and head in many countries of the world. New materials and design techniques allow for the creation of more sophisticated foot and head protective equipment that has the potential for providing significant improvement in protection level. But in order to maximize the advantages offered by these new products, it is essential to have an understanding of the anthropometric variability of the population that must be protected. Hsiao and Halperin (1998) confirmed that inadequate fit of personal protective equipment can expose workers to injury devices which cannot guarantee the health and safety of workers.

Wearing unfitted shoes lead to foot disorders, mental impacts, dexterity and comfort reduction, increasing energy consumption and decreasing the subject efficiency of performing tasks (Simon, 2004). Zhizhong et al. (2007) discovered differences in body dimensions of elderly Chinese and the Japanese. They found out that the elderly Japanese had larger head dimensions and extremities than their Chinese counterparts; whereas there is larger dimension of body trunks for the Chinese elderly compared to Japanese elderly.

At present, helmets and foot wears are playing vital roles on our bodies not only for beauty wearing but also for safety. 1<sup>st</sup> January, 2009, Nigerian government came up with white elephant project of passing the bill of wearing helmets by bike users into law without considering the anthropometric head measurements of the target users. The law could not be effective because the helmets being used were not produced with the anthropometric head dimensions of the target users. Most at times these helmets cause discomfort, headache and burden to the users. Head contains the brain which is the centre of reasoning and for this cause; every step should be taken to ensure that head dimensions are included in the design of head protective to ensure that burden is reduced to barest minimum.

Up to now there has not been any special foot and head anthropometry research in Nigeria. Existing anthropometric data on foot and head of Nigeria population is woefully scanty. Millions of workers in Nigeria including students rely on protective equipment to reduce the risk of occupational diseases and injuries on workshops and farms. The ability to achieve proper foot and head fittings for Nigerian population is essential for providing adequate protection to workers. Xiao et al. (1998) measured 41 head and face dimensions on 393 Chinese adults. From the collected data, they were able to create regression equations to predict head and face dimensions from seven basic measurements collected in

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1998. Quamra et al. (1980) also generated regression equation for estimation of stature from foot length. The inspection of the equations reveals that for a given foot length, men are predicted to be taller than women, and hence foot length is greater relative to stature in women than in men.

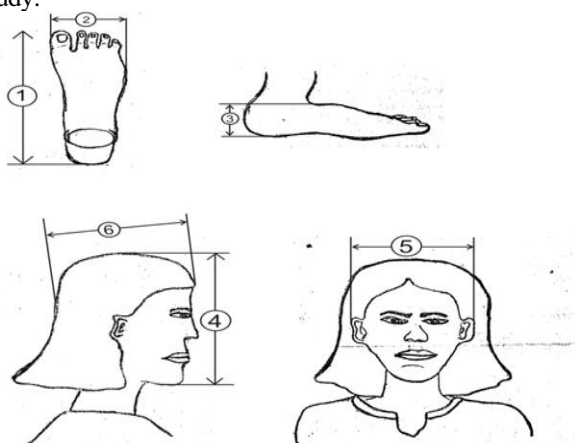
Left and right feet have almost one quarter of the bones in the body making it an integral part of the body. These bones are joined together to form joints which are firmly held together with the layers of 126 muscles and ligaments (Kanaani et al; 2010). When these muscles become overstretched possibly due to the variability in footwear design techniques, might cause repetitive motion injuries that can further weaken the ankles and muscles.

The objectives of this study are to develop foot and head anthropometric database for Nigerian polytechnic students for better design, determine the level of statistical significance of mean anthropometric dimensions of male and female Nigerian polytechnic students, and compare the differences in foot and head bodily proportions among four ethnic populations of the world.

**2. Materials and methods**

*2.1. Sample*

The sampling strata consisted of 800 students of Auchi, Ogwashi-uku, Ozoro and Bori Polytechnics in Edo, Delta and Rivers states respectively. A group of 100 male and 100 female students within the age range of 18 – 30 years were selected across each of the four polytechnics based on their willingness and readiness to participate in this study.



**Fig.1** Selected Anthropometric Variables

- (1) Foot length (2) Foot breadth (3) Foot height
- (4) Head height (5) Head breadth (6) Head length

*2.2 Instruments*

Traditional anthropometric instruments were used and these included anthropometer, a steel measuring tape, digital venier caliper, caliper and digital height gauge. The anthropometer, calipers and digital height gauge were

manufactured by GPM in Switzerland. The tape is manufactured by Lufkin in the United States.

*2.3 Anthropometric Variables Considered*

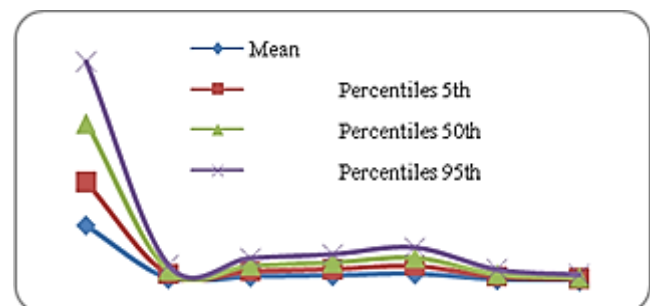
Seven anthropometric variables were considered and collected in this study as shown in Fig. 1. The variables selected were related to head, foot and stature of human body. Stature was taken because it forms a set of useful basic body descriptors allowing this data set to be compared to others. Accuracy and reliability of the measurements were achieved by undergoing through a specific training with a certified anthropometrics specialist and practice in performing measurements at the pilot study carried out previously.

*2.4 Data Analysis*

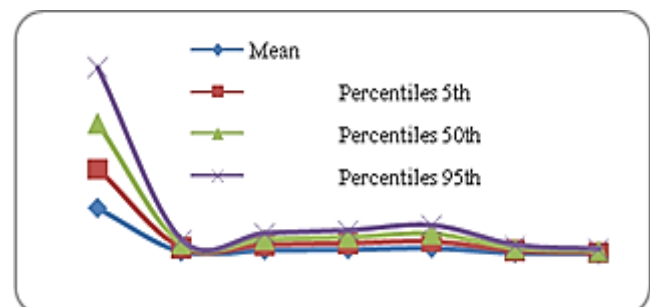
The data were examined using SPSS analysis to determine the descriptive statistics (mean, standard deviation, standard error of mean, minimum, maximum, 5<sup>th</sup>, 50<sup>th</sup> and 95<sup>th</sup> percentiles). The data obtained from male and female students were compared for both genders using simple t-test (2-tailed) at 5% level of significance

**3. Results and discussion**

The foot and head anthropometric variables of 800 Nigerian Polytechnic students; 400 males and 400 females are measured and the comparative disclosure has been presented in Fig. 2 and 3.



**Fig.2:** Comparative presentation of different head and foot dimensions of male students



**Fig.3:** Comparative presentation of different head and foot dimensions of female students

**Table 1:** T-Test Analysis of male and female anthropometric data of Nigerian polytechnic students

Body Dimensions	Mean Male	Mean Female	N	Tcal	Df	sig.(2-tailed)	Decision p<0.05
Standing Height(stature)	167.3	157	800	0.84	799	0.42	NS
Head Breadth	13.1	12.5	800	-1.798	799	0.088	NS
Head Length	18.2	17.8	800	-1.143	799	0.267	NS
Head height	20.8	20.6	800	0.432	799	0.671	NS
Foot Length	25.7	25.1	800	-0.901	799	0.379	NS
Foot Breadth(Balls of Foot)	9.1	8.5	800	2.038	799	0.056	S
Foot Height	5.6	4.8	800	1.6	799	0.154	NS

Note: All dimensions in cm except mentioned

**Table 2:** Comparison of mean of foot and head proportions to the mean stature for present study and other ethnic population of the world

Measurement(cm)	Nigeria		Malays		Chinese		Indians	
	(Present study)		(Karmegam,et al;2011)		(Karmegam,et al;2011)		(Karmegam,et al;2011)	
	Male	Female	Male	Female	Male	Female	Male	Female
Head breadth	0.0834	0.07472	0.0856	0.0982	0.0909	0.0921	0.0882	0.0913
Head length	0.1159	0.1064	0.102	0.1146	0.1064	0.1117	0.1079	0.1168
Head height	0.1243	0.1312	0.1367	0.1454	0.1448	0.1417	0.1366	0.1389
Foot length	0.1536	0.1599	0.1519	0.1466	0.1497	0.1459	0.1526	0.1497
Foot breadth	0.0544	0.0541	0.0556	0.0553	0.0571	0.0545	0.0571	0.0552

Body dimensions which also include foot and head measurements are reported to change due to age, nutritional intake, race, gender among others (Agrawal et al; 2010). To investigate these differences, statistical t–test analysis were used to compare anthropometric variables of male and female gender at 0.05 significance and the results are provided in Table 1.

The results of t– test analysis for both genders demonstrate differences between males and females foot and head dimensions. Male were larger in all the dimensions. Furthermore, significant difference was only noticed between the male and female foot breadth dimensions at (P<0.05). Thus, designers and manufacturers of foot and head protective of this population groups should give consideration to data generated when designing.

The mean foot length of male and female students were 25.7cm and 25.1cm respectively, which is useful in the design of accelerator pedal, clutch pedal, brake pedal and similar other foot-operated controls. For efficient and effective design of helmets and other related head wears, the mean head breadth of 13.1cm, head length of 18.2cm and head height of 20.6cm for male polytechnic students and mean head breadth of 12.5cm, head length of 17.8cm and head height of 20.8cm for female polytechnic students respectively should be considered.

The comparison of bodily proportion among four ethnic populations of the world is shown in Table 2. The present study (Nigerian) has the lowest foot breadth, head breadth and head height but the largest foot length. The result also shows that the present study (Nigerian) has largest head length among males and relatively lowest head length among females. More so, the Chinese male has the greatest head breadth followed by Indian males whereas among females, Malays have the largest head breadth followed by Chinese. However, Chinese males have similar foot breadth with Indian males but among females, Malays has the largest foot breadth. The Chinese females generally tend to be smallest in both foot length and head length whereas Indian females have the largest head length among the ethnic populations. Head height of Chinese male was observed to be largest followed by Malays and Indians with close similarities in values. Among females, Malays has the highest values of head height followed by Chinese and Indians; Nigerians (present study) being the least.

The study presents compilation of foot and head anthropometric data of male and female Nigerian Polytechnic students that would be used as a guide for designing and modifying of accelerator pedals, clutch pedals, brake pedals, helmets and foot operated controls and other similar products for foot and head protections.

#### 4. Conclusion and recommendations

According to the research findings in this study, the following details were concluded. The comparison of foot and head anthropometry between male and female students of Nigerian Polytechnics, could be concluded that male students have highest values in all foot-and-head sizes more than their female counterpart; with only foot breadth been statistically significant at ( $P < 0.05$ ).

The characteristics of bodily proportion among the four different ethnic populations of the world for both genders are not similar. Significant differences exist among them. These anthropometric variables can be utilized in the design of foot and head protective, pedal for accelerators, clutch pedals, brake pedals, foot wears, caps and other foot and head fittings and facilities. It is recommended that extensive surveys for both male and female students of south south Nigerian Polytechnics be extended to other tertiary institutions of the country in order to generate design database for safe and efficient production of foot wears, foot operated machines, head protection facilities and fittings for Nigerian students.

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