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FOOT MORPHOLOGY AND STATURE PREDICTION AMONG THE IGBOS OF SOUTHEAST NIGERIA

Eze Chioma Paschaline[1], G.E Anyanwu[2], C.I.P Anibeze[1]

[1]Department of Anatomy, Enugu State University of Science and Technology.
[2]Department of Anatomy, University of Nigeria, Nsukka, Enugu.

*Author for Correspondence: raphaelpaschaline@gmail.com.

ABSTRACT

Stature is considered as one of the important and significant parameters for establishment of personal identity in forensic medical examination or anthropological studies. With the alarming increase in frequency of road and train accidents, floods, fire, deliberate mutilation, disfigurement and natural disasters, there is a need of studies that provide help to identify the deceased from fragmentary and dismembered human remains. In such situations, measurements of feet provide a reasonably good estimation about the stature of a person. Accidents in Igbo land today are driven largely by a dangerous combination of bad roads, reckless driving, poor vehicle upkeep, narrow single lanes, incomplete construction and absence of traffic patrols (Federal road safety corps, ministry of transportation and police). The limited availability of reliable data for estimating human stature from foot dimensions underscores the importance of this study, as it seeks to fill critical gap in forensic and anthropometric research by providing accurate, population-specific correlations between foot parameters and height. Specific Objectives: 1) Measure the foot parameters (foot length:PT1, PT2, PT3, PT4, PT5 and foot width of right foot and left foot), thigh length, leg length and height of population. 2) To establish a normogram of foot parameters of various age groups of the measured population. 3) To establish sexual dimorphism in the measured parameters. 4) To determine the foot parameters that correlates best with height. 5) To determine symmetry in the foot parameters of the sample population. 6) To correlate foot parameters with age. Scope of the Study: The data from this study was limited to only Igbos in Enugu urban. Results: Age has a weak correlation with height (R=0.379). The foot parameters that correlates best with height is the Right pterion to toe 1 (R= 0.846), followed by Left pterion toe 1 (R=0.837) and the least correlated is Foot right width (R=0.513). The differences between values of all the male and female parameter for all the age groups are statistically significant (p <0.01). From this study, determination of stature could be done with 72-85% accuracy ratio. Conclusion: The present study has established that stature can be estimated from lower limb measurements, and out of the seventeen parameters studied, pterion right toe1 showed the highest degree of correlation(r = 0.846) and right right width showed lowest degree of correlation(r = 0.513).With the regression equation established for them, this study will help in medico-legal cases in establishing identity of an individual when only some remains of the body are found as in mass disasters, bomb explosions, accidents etc. It will also help in establishing identity in certain civil cases.

Keywords: Stature estimation, Foot morphology, Forensic identification, Igbo population

INTRODUCTION

Stature or height is the distance from the vertex to the base of the feet in a human being standing erect and is considered a vital parameter in forensic medical examination (Pandhare et al. 2013; Ebeye et al. 2015). It is measured using a stadiometer, usually in centimeters when using the metric system or feet and inches when using the imperial system (Lapham and Ager, 2009). Height is fundamental for assessing growth and nutrition and calculating body surface. Before estimating stature, one must determine the race, sex, and age of the individual as stature varies with these variables. Potential stature refers to the stature of an individual who has not undergone skeletal changes associated with the aging process.

Anthropometry is an important tool of physical anthropology for obtaining different measurements like stature on the living as well as dead (skeleton and skeletal remains) of man using scientific method. Anthropometric techniques are commonly used by anthropologist and adopted by medical scientist to estimate body size for the purpose of identification. Anthropometry provides the single most portable, universally applicable, inexpensive and noninvasive technique for assessing the size, proportion and composition of the human body. It reflects both health and nutritional status and predicts performance, health and survival. As such it is a valuable, but currently underused tool for guiding public health policies and clinical decisions (Ferro et al., 1993). Physical anthropologists mainly deal with study of human origin and evolution of human beings. They also deal with study of different races in various parts of the world. Identification includes determining sex, age, race and stature of a person. Among these, the sex and stature are the most important (Zeybek, et al. 2008).

Stature estimation has a very important role to play in forensic anthropometry for personal identification. Even anatomists and anthropologists apart from forensic experts have shown keen interest in estimating the height of an individual by measuring different parts of body like hand length, foot length. Previous researchers have established a very well defined relationship between height of individuals and different parts of body like head, trunk and lengths of upper and lower limb.

Many different body parts can be used in the estimation of stature. Certain long bones & appendages can be aptly used in the calculation of height of a person. Estimating stature is one of the "big four" (identifying age, sex, stature and ancestry or race) of forensic anthropology. Using stature estimation, a forensic scientist can narrow down the pool of possible victim matches in any ongoing investigation. The stature is directly proportional to different body parts and hence, shows a definite biological and genetic relationship with each other. In forensic cases, stature (or body height) is usually estimated using 'anatomical' and 'mathematical' techniques (Krishan et al. 2012).

Researchers have established a relationship between stature and measurements of different body parts which are often represented using linear regression equations derived from them. Another important consideration here is the fact that often in forensic cases only a part of the skeletal framework is encountered. There exist many inherent population differences among the different population, thus, giving rise to the need for different formulae to be derived from different populations. (Lundy, 1985). It has been proved that stature can be estimated from a shoe left at the scene of a criminal offense. Similarly, the stature of a victim can be estimated when a part of body, such as a long bone, or hand, is all that corpse. (Santosh, et al.,2014).

MATERIALS AND METHODS

Cochran formula was used to determine the sample size for this research since our population size is unknown. From the formula we obtained the required sample size to be approximately 138, hence the data of 138 persons (72males and 66 females) were collected and used for the analysis of this work.

Anthropometric measurements of the right and left foot length (PT1, PT2, PT3, PT4, PT4 and PT5) and foot width (FW of right foot and left foot) were taken using sliding caliper and steel tape.

The length of the foot was measured from the pterion to Acropodion while the foot width was measured at the most prominent head of the first and last metatarsals.

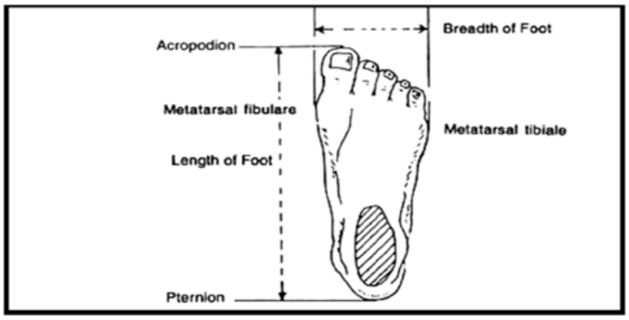

Fig. 1: Plantar view of the foot.

The statistical analysis was carried out using SPSS version (21).

RESULTS

	Frequency	% Frequency
16-20	30	21.7
21-25	95	68.8
26-30	13	9.4
Total	138	100

In table 1 above, the modal age group for the study was age group 21-25

TABLE 2: DISTRIBUTION OF SAMPLE POPULATION BY GENDER

	Frequency	% Frequency
Male	66	47.8
Female	72	52.2
Total	138	100

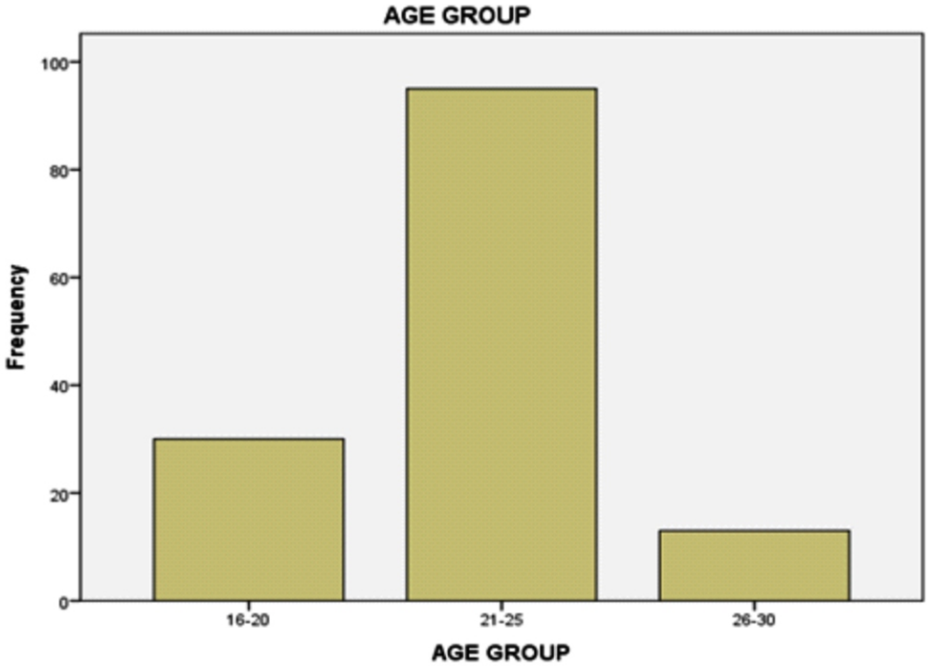

Fig 2: This figure shows the bar chart for age group.

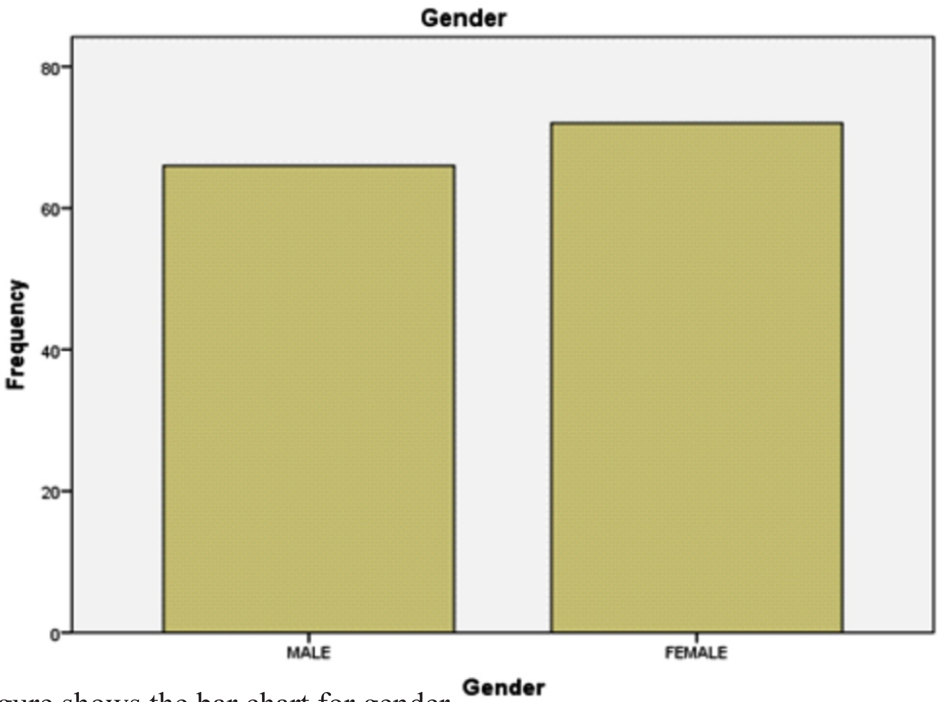

Fig 2: This figure shows the bar chart for gender.

TABLE 3: SUMMARY OF MEAN DISTRIBUTION OF THE VARIOUS FOOT PARAMETERS BY GENDER AND AGE GROUP

Foot Parameters	MALE			FEMALE		
	16-20	21-25	26-30	16-20	21-25	26-30
FRW	10.53±0.97	11.04±0.74	11.18±0.60	9.86±0.60	10.34±0.64	10.20±0.64
FLW	10.07±0.60	11.05±0.80	11.13±0.60	9.83±0.62	10.30±0.54	10.45±0.24
PLT1	26.43±1.94	28.04±0.73	28.20±0.81	25.19±1.11	25.76±1.26	25.70±1.21
PLT2	26.43±1.18	27.50±0.74	27.60±0.73	24.72±0.98	25.36±1.07	25.05±1.17
PLT3	25.15±1.08	26.36±1.01	26.63±1.03	23.80±0.80	24.44±1.02	23.13±0.93
PLT4	23.67±1.20	24.92±0.96	24.97±1.21	22.56±0.85	23.13±0.93	23.25±1.50
PLT5	21.92±0.99	22.97±0.78	23.18±1.05	20.93±0.73	21.39±0.90	21.68±1.31
PRT1	26.37±1.58	27.97±0.88	28.34±0.90	25.45±0.97	25.81±1.15	26.08±1.15
PRT2	26.15±1.60	27.47±0.89	22.94±0.89	24.78±1.20	25.26±1.19	25.15±0.94
PRT3	24.98±1.53	26.31±1.03	27.11±1.20	23.73±1.11	24.24±1.17	24.18±1.11
PRT4	23.38±1.90	24.78±1.01	25.26±1.37	22.29±1.18	22.78±1.19	22.98±1.15
PRT5	21.77±1.82	22.89±0.10	23.34±1.34	20.74±1.04	21.11±1.28	21.40±1.12

In table 3 above, the mean and standard deviation of male and female subjects of age group: 16-20, 21-25 and 26-30 was shown. It also explains that the mean values in each age group of males are higher than that of the females in all the measured parameters.

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TABLE 4: PAIRED SAMPLE TEST FOR ALL THE FOOT PARAMETERS

		Paired Differences					T	df	Sig.-(2 tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference Lower	Upper			
Pair 1	Foot Right Width-Foot Left Width	.02899	.36412	.03100	-.03231	.09028	.935	137	.351
Pair 2	Left Pterion to toe 1 - Right Pterion to toe 1	-.04275	.48914	.04164	-.12509	.03958	- 1.027	137	.306
Pair 3	Left Pterion to toe 2 - Right Pterion to toe 2	.02174	.43877	.03735	-.05212	.09560	.582	137	.562
Pair 4	Left Pterion to toe 3 - Right Pterion to toe 3	.06667	.61077	.05199	-.03614	.16948	1.282	137	.202
Pair 5	Left Pterion to toe 4 - Right Pterion to toe 4	.21667	.63540	.05409	.10971	.32362	4.006	137	.000
Pair 6	Left Pterion to toe 5 - Right Pterion to toe 5	.15652	.66552	.05665	.04450	.26855	2.763	137	.007
Pair 7	Left Thigh - Right Thigh	.17372	2.23713	.19113	-.20425	.55170	.909	136	.365
Pair 8	left leg - right leg	-.05290	2.30212	.19597	-.44041	.33462	-.270	137	.788

From the table above, pair1, 2, 3, 4, 6, 7, and 8 are not significantly different. But pair 5 is significantly different (p-value<0.05).

TABLE 5: CORRELATION OF AGE AND HEIGHT WITH RIGHT AND LEFT FOOT PARAMETERS

Foot Parameters	Age		Height (R=Coefficient of Pearson correlation)	
	Right	Left	Right	Left
			0.379	0.379
Foot width	0.340	0.385	0.513	0.569
Pterion-toe1	0.436	0.409	0.846	0.837
Pterion-toe2	0.416	0.409	0.806	0.786
Pterion-toe3	0.439	0.408	0.810	0.731
Pterion-toe4	0.437	0.427	0.788	0.734
Pterion-toe5	0.434	0.468	0.738	0.738

(P-value<0.01)

From the table above, it shows that the foot parameters that correlates best with height is Right pterion to toe 1 (**R= 0.846**), followed by Left pterion to toe 1 (**R=0.837**) and the least correlated is Foot right width (**R=0.513**).

The regression equations are given as

Height = 31.42 – 0.23(FRW) + 5.33(PRT1)

Height = 38.37 + 1.24(FLW) + 4.50(PLT1)

where

FRW = Foot Right Width

FLW = Foot Left Width

PRT1 = Right Pterion to Toe1

PLT1 = Left Pterion to Toe1

DISCUSSION

The total number of persons in the age group of 16-20 is 30 with the percentage of 21.7 while 21-25 is 13 with a percentage of 68.8 and lastly 26-30 is 13 with a percentage of 9.4. The number of males in the sample population is 66 with the percentage of 47.8 while the total number of females is 72 with the percentage of 52.2. The mean values in each age group of males are higher than that of the females in all the measured parameters. Arif, et. al. (2015), agreed with this study stating that males exhibited higher mean value in all the parameters studied than that of females. The values of mean and standard deviation of height in male subjects (in cm) were 178.31±7.87 while female subjects (in cm) were 165.38±6.10. The differences between values of all the male and female parameter for all the age groups are statistically significant ($p < 0.01$). This implies that there is sexual dimorphism in the measured parameters of the subjects. Paired sample test for all the foot parameters shows that pair1, 2, 3, 4, 6, 7, and 8 are not significantly different. But pair 5 is significantly different ($p<0.05$). This implies that pair 5, which is the right and left pterion to toe 4 is significantly different from each other. Moorthy and Asogan, (2016) disagreed with this result, stating that there is existence of left sided asymmetry. Worthy of note also was the correlation between age and the measured parameters. This revealed that age has a weak correlation with height (R=0.379) which means that a persons age does not determine his height since some of the subjects of this work have past their age of growth. The foot parameters that correlates best with height is the Right pterion to toe 1 (R= 0.846), followed by Left pterion to toe 1 (R=0.837) and the least correlated is right foot width (R=0.513). The findings of this study is similar to that of Sonali and Ashish, (2012) which states that foot length in both sexes depicts higher correlation coefficients with stature (R=0.850) than any of the measured parameter. Modibbo, et al. (2009) stated in their study that among the measured parameters from hand and foot measurements, that hand breadth was found to be the best estimate of stature among upper limb parameters (R=0.62), and foot length (R=0.75) was also found to be the best estimate of stature among the lower limb parameters, and from their result, they concluded that foot length had the highest overall r value (R=0.75). Sen and Ghosch (2008) conducted a study on estimation of stature from foot length and foot breadth among the Rajbanshi: An indigenous population of North Bengal. It was shown that among the lower limb parameters, foot length had the highest correlation value with stature among the 350 adult Rajbanshi and 100 adult Meche individuals aged 18– 50 year, while foot breadth had the least value. This implies that foot length is the best estimate of stature among the measured parameters; these findings were in agreement with the present study. Furthermore, Patel and Shah (2007), conducted a study based on the measurements of foot length and body height (stature) among 502 students between the ages of 17 to 22 years, they found that foot-length showed the highest degree of correlation with height of an individual. The present study also highlights a strong correlation between Stature and foot-length.

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