Gudaji and Rukayya (2023)
Biological and Environmental Sciences Journal for the Tropics 20(3) December, 2023
ISSN 0794 – 9057; eISSN 2645 - 3142
BEST JOURNAL 20(3): 39 - 48
Date received: 02/11/2023
Date accepted: 17/12/2023
https://dx.doi.org/10.4314/bestj.v20i3.4

Estimation of Stature from Foot Dimensions: A Comparative Study between Hausas and Yorubas in Bayero University, Kano, Nigeria

Gudaji, A.* and Rukayya, Z.I.
Department of Anatomy, Faculty of Basic Medical Sciences, Bayero University Kano, Nigeria
agudaji.ana@buk.edu.ng

ABSTRACT
Anthropometry is the measurement of variables such as foot height, length and width of human body. The current study was conducted to estimate stature from foot dimensions among Hausas and Yorubas of Faculty of Basic Medical Science in Bayero University, Kano. The objectives were to obtain height and foot dimensions; determine sexual dimorphism, correlation and to estimate stature. The materials used were stadiometer and a digital vernier caliper. Sampling was done randomly. The sample size was 400 subjects (200 Hausas and 200 Yorubas). Statistical significance was deemed acceptable at $p<0.05$. It was observed that all the variables have significant sexual dimorphism. Among the Hausas, all the variables correlated strongly with each other except for BMI and all foot dimensions. There was a weak negative correlation that is statistically significant between BMI and height. Among the Yorubas, weight, height and BMI correlated strongly with one other and also all foot dimensions correlated strongly with weight and height except LFB and weight where there was a weak positive correlation that is statistically significant. There was a weak positive correlation that is statistically significant between RFB and BMI while LFB and BMI correlate strongly with each other. Both foot lengths do not correlate with BMI. Significant relationship was found between the selected forensic parameters and the foot dimensions among Hausas and Yorubas of Faculty of Basic Medical Science in Bayero University, Kano.

Keywords: Estimation; Stature; Foot dimensions; Hausa; Yoruba

INTRODUCTION
Stature is the natural height of a person in an upright position (Laila *et al.,* 2009). Over the years, the development of anthropometric measurements of various anatomical structures for prediction and estimation of stature has become very useful especially when skeletal remains are often observed to be incomplete or extensively dismembered (Reddy, 2000). It is important to note that there are no universal formulae applicable for stature estimation from the length of one bone, since the bones are influenced by genes, age, sex and race (Rutihauser, 1968; Kulthanan *et al.,* 2004; Alabi *et al.,* 2016; Alabi *et al.*, 2017).

Stature is usually estimated by employing either anatomical or mathematical method. Dwight (1894) introduced the anatomical method to estimate the total skeletal height while the mathematical method makes use of bone lengths, stature tables, and regression formulae to estimate the skeletal height or living stature (Dayal *et al.,* 2008). The dimensional relationship between stature and long bones could change in a population after a very long period of time.

Dimensional relationships between the body segments and the whole body have been of interest to artists, scientists, anatomists, anthropologists and medico-legal scientists for long time (Chikhalkar *et al.,* 2010). Anthropometry refers to a technique of expressing the form of human body quantitatively as it is the systematic collection and correlation of measurement of human body.

Ascertaining sex and estimation of stature from incomplete skeletal and decomposing bodies in physical anthropology and forensic science (Daniel *et al.*,2005) has become useful in recent times due to mass disasters like plane crash, mass suicide, tsunamis, forest fires, and earth quakes (Snell, 2000). Sex differences is not in conformation with the foot per se, but rather in proportionality to the size of the body, and such has been documented by Ashizawa *et al.* (1997) among urban Japanese, in which women have smaller feet than men.

Body weight and stature tend to exhibit sexual dimorphism among populations of Ankara, Turkey (Atamturk and Duyar, 2008). The aim of the study was to estimate of stature from foot dimensions: a comparative study between Hausas and Yorubas in Bayero University, Kano, Nigeria.

MATERIALS AND METHODS

Study area

The study was conducted at the Faculty of Basic Medical Sciences, Bayero University Kano.

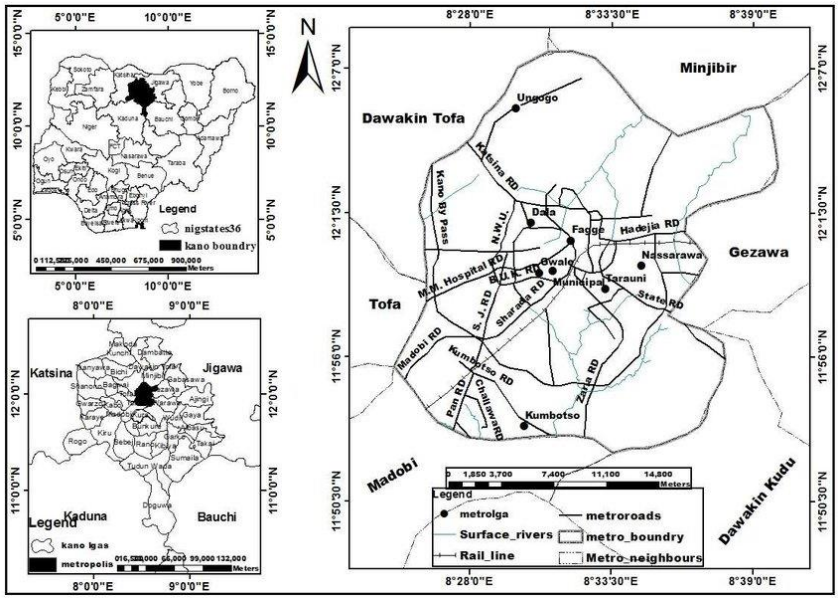

Fig I: Map of the study area: Bayero University, Kano.

MATERIALS

The instruments for taking the anthropometric measurements in this research are includes digital vernier caliper (used in taking foot dimensions), stadiometer (used in taking height and body weight). The stadiometer was improvised with a meter ruler and weighing balance.

Anthropometry

The stature of individuals was measured using the stadiometer from highest point on vertex to the foot. All subjects were asked to stand at anatomical position (erect) barefoot on a level platform against the stadiometer bar with his/her back and hips touching the bar, their feet were brought in contact with each other and the heels touching the bar with arms hanging by the side. The head of the subject was rested without any strain in the Frankfurt plane. The Foot Length (distance from the most prominent point of the heel to the most distal part of the longest toe) and Foot Breadth (distance between the most prominent point on the medial aspect of head of first metatarsal and the most prominent point on the lateral aspect of head of fifth metatarsal) were measured using digital vernier caliper.

Study Design
The study was a cross-sectional study.
Study Population and sample size
The study population represents Hausa and Yoruba students of Faculty of Basic Medical Sciences, Bayero University Kano, Nigeria
Sample Size Determination
The total number of subjects that participated in the research were calculated using the formula below:
$N=Z^2P(1-P)/d^2$
Where;
N= required sample size
Z= standard normal deviation (1.96, at 95% confidence level)
P= proportion in the target population (50%)
d= degree of accuracy desired (5%)
$n=1.96^2\times0.5\times0.5/(0.05)^2$
n=384.16 (Lwanga and Lemeshow, 1991)
According to the formula, 384 participants will be required for the study, but 400 participants were used to increase power of statistics. The 400 participants included both males and females, Hausas and Yorubas within the age range of 18 - 30 years. The sampling technique used to sample the population was a simple random sampling.

Statistical Analyses
Descriptive Statistics was adopted for the direct measured variables. Independent sample t-test was used to ascertain the difference between the two tribes while the relationship between stature and foot dimension was determined using Pearson correlation. Step wise regression analysis was done to predict stature from foot dimensions. Data analysis was carried out using Statistical Package for Service Solution SPSS (IBM Corporation) version 20.0. Significant difference was slated at $p<0.05$.

RESULTS
The results on Height, Weight, BMI, RFL, LFL, RFB and LFB was presented in Table 1. The average foot length is greater than the average foot breadth.

Table 1: Anthropometrical parameters (Height, Weight, BMI, RFL, LFL, RFB and LFB) among Hausas and Yorubas students.

Variables	Mean	Minimum-Maximum
Weight(kg)	58.12±10.51	37.60-113.00
Height(m)	167.00±8.57	149.00-192.00
BMI(kg/m^2)	20.87±3.72	14.95-40.52
RFB(cm)	8.90±1.20	6.00-15.00
LFB(cm)	8.93±1.21	6.50-14.00
RFL(cm)	25.20±1.74	18.50-30.50
LFL(cm)	25.28±1.77	18.50-30.50

BMI= Body Mass Index, **RFB=** Right Foot Breadth, **LFB=** Left Foot Breadth, **FLR=** Right Foot Length, **LFL=** Left Foot Length, **SD.=** Standard deviation.

Ethnic differences among Hausa and Yoruba students was not significant ($p>0.05$) except for Right Foot Breadth (Table 2). In all the variables that exhibit ethnic differences, Hausas recorded higher mean value except for BMI.

Table 2: Ethnic differences in Weight, Height, BMI, FBR, FBL, FLR and FLL among Hausas and Yorubas students.

Parameters	Hausas	Yorubas	T-value	P-value
WEIGHT (Kg)	58.18±10.88	58.06±10.16	0.114	0.910
HEIGHT (cm)	167.16±8.23	166.8±8.28	0.387	0.714
BMI (Kg/m^2)	20.83±3.71	20.90±3.71	-0.199	0.843
RFB (cm)	9.03±1.31	8.77±1.06	2.125	0.034
LFB (cm)	9.02±1.33	8.83±1.08	1.604	0.109
RFL (cm)	25.30±1.82	25.10± 1.64	1..604	0.109
LFL (cm)	25.43±1.86	25.13±1.66	1.692	0.091

Mean ± Standard deviation of **BMI=** Body Mass Index, **RFB=** Right Foot Breadth, **LFB=** Left Foot Breadth, **FLR=** Right Foot Length, **LFL=** Left Foot Length at 5%.

The sexual dimorphism in foot dimensions and anthropometric variables in both Hausas and Yorubas have significant difference at $p<0.05$ (Table 3 and 4).

Table 3: Sexual dimorphism in foot dimensions and anthropometric variables among Hausas students.

Parameters	Mean ± SD		T-Value	p-value
	Males	Females		
WEIGHT (Kg)	62.46±9.03	53.90±10.92	-6.037	<0.001
HEIGHT (cm)	171±0.08	163±0.07	-7.21	<0.001
BMI (Kg/m^2)	21.44±3.67	20.22±3.72	-2.32	0.021
RFB (cm)	9.50±1.46	8.55±0.94	-5.397	<0.001
LFB (cm)	9.46±1.39	8.57±1.10	-5.011	<0.001
RFL (cm)	26.00±1.82	24.61±1.53	-5.825	<0.001
LFL (cm)	26.18±1.82	24.68±1.59	-6.164	<0.001

BMI= Body Mass Index, **RFB=** Right Foot Breadth, **RFB=** Right Foot Breadth, **LFB=** Left Foot Breadth, **FLR=** Right Foot Length, **LFL=** Left Foot Length, and **SD=** Standard Deviation.

Table 4: Sexual Dimorphism in foot dimensions and anthropometric variables among Yorubas of Faculty of Basic Medical Science in Bayero University, Kano.

Parameters	Male	Female	T-Value	p-value
WEIGHT (Kg)	62.43±9.38	53.69±8.98	-6.73	<0.001
HEIGHT (cm)	170±8.57	163±6.50	-6.162	<0.001
BMI (Kg/m^2)	21.66±3.62	20.14±3.68	-2.929	0.004
RFB (cm)	9.03±1.08	8.51±0.97	-3.539	0.001
LFB (cm)	9.12±1.06	8.53±1.02	-3.989	<0.001
RFL (cm)	25.69±1.67	24.51±1.40	-5.384	<0.001
LFL (cm)	25.74±1.69	24.52±1.4	-5.557	<0.001

Mean± SD, **BMI=** Body Mass Index, **RFB=** Right Foot Breadth, **RFB=** Right Foot Breadth, **LFB=** Left Foot Breadth, **FLR=** Right Foot Length, **LFL=** Left Foot Length, and **SD=** Standard Deviation.

Table 5 showed strong correlation of anthropometrical parameters among Hausas except for BMI and foot dimensions while similar trend was also observed in Yorubas (Table 6).

Table 5: Correlation of the parameters among Hausas students

Variables	Weight (Kg)	Height (cm)	BMI (Kg/m^2)	RFB (cm)	LFB (cm)	RFL (cm)	LFL (cm)
Weight (Kg)	1						
Height (cm)	0.401**	1					
BMI (Kg/m^2)	0.834**	-0.163*	1				
RFB (cm)	0.224**	0.454**	-0.028	1			
LFB (cm)	0.229**	0.439**	-0.011	0.90**	1		
RFL(cm)	0.323**	0.665**	-0.50	0.485**	0.519**	1	
LFL (cm)	0.299**	0.659**	-0.70	0.527**	0.581**	0.907**	1

BMI= Body Mass Index, RFB= Right Foot Breadth, LFB= Left Foot Breadth, FLR= Right Foot Length, LFL= Left Foot Length.

Table 6: Correlation of the parameters among Yorubas students

Variables	Weight (Kg)	Height (cm)	BMI (Kg/m^2)	RFB (cm)	LFB (cm)	RFL (cm)	LFL (cm)
Weight (Kg)	1						
Height (cm)	0.307**	1					
BMI (Kg/m^2)	0.832**	0.285**	1				
RFB (cm)	0.228**	0.190**	0.16*	1			
LFB (cm)	0.338*	0.249**	0.185**	0.874**	1		
RFL (cm)	0.239**	0.566**	-0.088	0.405**	0.374**	1	
LFL (cm)	0.249**	0.587**	-0.091	0.431**	0.436**	0.882**	1

BMI= Body Mass Index, RFB= Right Foot Breadth, LFB= Left Foot Breadth, RFL= Right Foot Length, LFL= Left Foot Length.

Table 7 and 8 indicated that there are significant difference (P<0.005) between the Foot Length and Foot Breadth stature among Hausas students.

Table 7: Prediction (Regression) of Stature from foot dimensions among Hausas students.

Equation (DV = B x IV +constant)	R^2	F-value	p-value
Height (cm) = 3.055 x RFB (cm)+ 139.59	0.206	51.38	<0.001
Height (cm) = 2.926 x LFB (cm)+ 140.757	0.193	47.38	<0.001
Height (cm) = 3.240 x RFL (cm) + 85.173	0.446	159.13	<0.001
Height (cm) = 3.129 x LFL (cm) + 87.6	0.434	151.95	<0.001

Table 8: Prediction (Regression) of Stature from foot dimensions among Yorubas students.

Equation (DV = B x IV +constant)	R^2	F-value	p-value
Height (cm) = 1.486 x FBR (cm) + 153.81	0.036	7.416	0.007
Height (cm) = 1.914 x FBL (cm) + 149.94	0.062	13.09	<0.001
Height (cm) = 2.84 x FLR (cm) + 95.39	0.32	93.20	<0.001
Height (cm) = 2.925 x FLL (cm) + 93.34	0.345	104.24	<0.001

DISCUSSION

The human foot is a complex structure, playing an important role in the locomotion processes of the lower extremity, therefore analysis of foot anthropometry is important to the study of ergonometrics, orthotics designing and forensic science (Shaifaly *et al.,* 2013). The study showed that males have significant higher mean value of total stature than females. It can therefore be inferred that males are generally taller than females, which agrees with previous studies on stature estimation in Nigeria (Danborno and Elukpo, 2008; Danborno *et al.,* 2008; Ebite *et al.,* 2009; Numan *et al.,* 2013; Ibegbu *et al.,* 2014; Oria*et al.,* 2016).

A significant sexual dimorphism was observed in the foot dimensions which are in line with previous studies (Danborno and Elukpo 2008). Foot lengths are sexually dimorphic (Ashizawa *et al.*, 1997). Adelekan *et al.* (2019) and Egwu *et al.* (2012) reported similar result on sexual dimorphism in foot length and breadth among Nigerian population, which is also in consonance with the findings of Uhrova *et al.,* 2015, among Slovak population. The expression of the sexual dimorphism among Hausas and Yorubas students may suggest possible universality of sexual dimorphism across different ethnic groups within the age and spectra in the study area. Sex determination can be done from foot index, foot shape and foot bones. Although bilateral symmetry is a feature seen in humans, there is asymmetry in the foot length without gender or handedness bias (Grivas *et al*., 2008) and body mass index (BMI) of adults and adolescents were reported to be sexually dimorphic (Amoo-Tella, *et al*., 2017).

The present findings on sexual dimorphism in height was also in accordance with that of Egwu*et al.,* 2012). In the study of a Slovak population, stature was found to have significant sexual dimorphism (Uhrova*et al.,* 2015), which is also in agreement with the present study. Similar trend on height and weight were reported on sexually dimorphic among population in Ankara, Turkey (Atamturk and Duyar, 2008), and sexual dimorphism in height (Adamu *et al.,* 2013). Young male adults residing in Calabar State of Nigeria reported to have significantly higher values in height (Igiri *et al.,* 2009). These proved that the height is an important tool for determination of sexual dimorphism of an individual irrespective of age, ethnicity and population. It was evident that the adult weight was significantly sexually dimorphic (Shen, 2009).

A significant relationship was found to exist between height and foot dimensions among both males and females, this was supported by (Ozden*et al.,* 2004; Sanli *et al.,* 2005) in a study conducted among Turkish adults aged 17 to 23 years. Relationship between foot length and height is strongly significant (Danborno*et al.,* 2008; Okoro *et al.,* 2009). Krishan and Sharma (2007) studied the estimation of stature from dimensions of hand and feet in an Indian population and showed that the highest correlation coefficient and the lowest standard error of estimate were between stature and foot length.

Sexual dimorphism in body mass index, was also evident among Turkish population (Ergul, 2019), and this supports the present study on sexual dimorphism in BMI. The larger foot dimension of males in this study in comparison with females is in agreement with the findings by Ashizawa *et al.* (1997) and (Sexena, 1984; Wunderlich *et al.,* 2002; Obikili *et al.*,(2009). in their various study on the Nigerian population that found males to have broader and longer foot dimensions than females.

CONCLUSION

Significant relationship was found between stature and foot dimensions among Hausas and Yorubas students in Bayero University, Kano.

The findings in the present study showed that there was a strong correlation between stature and foot dimensions and in view of this, stature of an individual can be predicted using foot dimensions without any hindrance from age, race, ethnicity, genetic make-up and nationality.

Conflict of interest: None declared

Acknowledgement: The consent of the participants to participate in the study was highly appreciated and duly acknowledged.

REFERENCES

Adamu, L., Asuku, A.Y., Datti, S., Imam, A., Taura, M.G., and Tela, I.A. (2013). Neck circumference: An upcoming tool of adiposity indices. *Nigerian Journal of Basic and Clinical Sciences*, **10** (2), 82-85. https://doi.org/10.4103/0331-8540.122766.

Adelakun, S.A., Ogunlade, B., Akinghade, G. T., Olayemi, O. T., Fidelis, O. P., and Owolabi, F. M. (2019).Sexual dimorphism and anthropometric measurements of foot in adult Oyemekun ethnic group population in Akure, south-west Nigeria.*Journal of Biology and Medicine*, **3**(1), 021-026. https://doi.org/10.17352/jbm.000009

Ajeet, J. (2011). Anthropology: Historical Background. Retrieved December 12, 2022 from http://anthropologicalstudy.blogspot.com.

Alabi, A.S., Oladipo, G.S., Didia, B.C., and Aigbogun, (Jr) E.O. (2017). Regression equations for stature prediction in Nigerian Hausas, Igbos and Yorubas from toe length and toe-length ratios. *Anthropology*.**5**(1): 176-181.

Alabi, S.A., Didia, B.C., Oladipo, G.S., and Aigbogun, (Jr) E.O. (2016).Evaluation of sexual dimorphism by discriminant function analysis of toe length (1T-5T) of adult Igbo populace in Nigeria.*Journal of the Nigeria Medical Association*.**57**(4): 226-232.

Am, J.A (1905). Studies of the Development of the Human Skeleton., **4**:265. Retrieved December 21, 2022 from www.musculoskeletalkey.com

Amanda, B. (2021). What factors influence a person's height?. Medically reviewed by Michelle L.Griffith,MD. Medical News Today.Retrieved January 25, 2022 from medicalnewstoday.com.

Amoo-Tella, S.,Danborno, B., Akuyam, H. and Adebisi, S. (2017). "Gender-and age-related differences in anthropometric and body composition parameters in Nigerians, Zaria, Nigeria." *Journal of Experimental and Clinical Anatomy*, **16**(2): 137.

Ashizawa, K., Kumakura, C., Kusumoto, A.,andNarasaki, S. (1997). Relative foot size and shape to general body size in Javanese, Filipinas and Japanese with special reference to habitual footwear types. *Annals of Human Biology*,**24**(2), 117-129. https://doi.org/10.1080/03014469700004862.

Atamturk, D., and Duyar, I. (2008).Age-related factors in the relationship between foot measurements and living stature and body weight. *Journal of Forensic Sciences*, **53**(6),1296-1300. https://doi.or/10.1111/j.1556-4029.2008.00856.x

Baba, K. (1975).Foot measurement for shoe construction with reference to the relationship between foot length, foot breadth, and ball girth.*Journal of Human Embryology*, **3**:49-156.

Carol, D. (2021). Feet (Human Anatomy).Bones, Tendons, Ligaments, and More-WebMD.Retrieved December 12, 2022 from https://www.webmd.com.

Charnalia, V.M. (1961). Anthropological study of the foot and its relationship to stature in different castes and tribes of Pondicherry state.*Journal of Anatomical Society of India*, **10**:26-30.

Chikhalkar, B.G., Mangaonkar, A.A., Nanandkar, S.D and Peddawad, R. G. (2010).Estimation of Stature from Measurements of Long Bones, Hand and Foot Dimensions.*Journal of Indian Academy and Forensic Medicine*.**32** (4) 329-33.

Danborno, B., and Elukpo, A. (2008).Sexual dimorphism in hand and foot length, indices, stature-ratio and relationship to height in Nigerians.*The Internet Journal of Forensic Science*, **3**(1).https://doi.org?10.5580/379.

Danborno, B., Adebisi, S.S., Adelaiye, A.B., and Ojo, S.A. (2008). Sexual Dimorphism and Relationship between Chest, Hip and Waist Circumference with 2D, 4D and 2D:4D in Nigerians. *The Internet Journal of Biological Anthropology*.**1**(2)

Daniel, M.T.F., Kevin, J.H., and Roshni, D.L. (2005).'Sexual dimorphism in foot length proportionate to stature.'*Annals of Human Biology*; **32**(1): 4459.

Dayal, M.R., Steyn, M. and Kukendall, K.L., (2008).Stature Estimation from Bones of South African Whites.*South African Journal of Science*, **104**:124-28.

Dupertius, C.W., and Hadden, J.A., Jr. (1951). On the reconstruction of stature from long bones.*American Journal of Physical Anthropology*, **9**(1), 15-54.

Dwight (1894) in Estimation of stature from measurement of hand and feet in tribal population.2010-11.

Ebite, L.E., Ozoko, T.C., Eweka, A.O., Otuaga, P.O. and Oni, A.O. (2009). Height: Ulna Ratio: a method of stature estimation in a rural community in Edo state, Nigeria. *The Internet Journal of Forensic Science*, **3**(1).

Egwu, O. A., Nto, N. J., Bello, E. F., Egwu, E. O., Ukoha, U. U. and Aiah, D. (2012). Stature estimation from foot dimensions of an adult Nigerian population. *Anatomy College in Karnataka*,**6**(2), 8-12.

Ergul-Erkec, O. (2019). Relationships between the 2D:4D digit ratio, waist circumference, hand preferences, weight, height, waist-to-height ratio and BMI in a Turkish population. *International Journal of Morphology*, **37**(4), 1299-1304. https://doi.org/10.4067/s0717-95022019000401299

Fogel, R.W., Engerman,S,L., Trusell, J.,Floud, R.., Pope, C.L. and Wimmer, L.T. (1978). "The Economics of Mortality in North America, 1650-1910: A Description of a Research Project "Historical Methods: *A Journal of Quantitative and Interdisciplinary History*, **11**(2): 75-108.

Ibegbu, A.O., Danjuma, Z.C., Hamman, W.O., Umana, U.E., Ikyembe, D. and Musa S.A. (2014). Association of the index (2^{nd}) and ring (4^{th}) digit ratios with some physical attributes in Ebira ethnic group of Nigeria. *Applied Technologies and Innovations,***7**:46-54.

Igiri, A., Ekong, M., and Odey, P. (2009). Anthropometric measure and sexual dimorphism in young adult Nigerians resident in Calabar.*The Internet Journal of Biological Anthropology*, ***2***(2).https://doi.org/10.5580/ba

Kachan, T., Krishan, K., Sharma, A., and Menezes, R.G. (2008). A study of correlation of hand and foot dimensions for personal identification in mass disasters. Forensic Science International 2010; 199:112-e6. *Forensic Science International*; **179**:241. E1-e5.

Krishan, K. (2007). Anthropometry in Forensic Medicine and Forensic Science-'Forensic Anthropometry'.*The Internet Journal of Forensic Science*, **2**(1):1-17.

Krishan, K. 2008. Determination of stature from foot and its segments in a north Indian population.Am*Journal of Forensic Medicine and Pathology*. **29**:297-303.

Krishan, K. and Sharma, A. (2007).Estimation of stature from dimensions of hands and feet in a North Indian population.*Journal of Forensic Legal Medicne*, **14**:327-32.

Kulthanan, T., Techakampuch, S. and Bed, N.D. (2004). A study of foot prints in athletes and non-athletic people. *Journal Medical Association of Thailand*.**87**(7):788-793.

Laila, S.Z.H., Ferdousi, R., Nurunnobi, A.B.M., Shafiqul, I., Holy, S.Z.H. and Yasmin, F. (2009). Anthropometric measurements of the hand length and their correlation with the stature of Bengali adult muslim females. *Banglaesh Journal of Anatomy*, **7**(1): 10-13.

Lwanga, S., and Lemeshow, S. (1991). Sample size determination in health studies; A practical manual. World Health Organization, Genera.

Moore, K.L. (2008) The Developing Human Clinically Oriented Embryology. 8th ed. Philadelphia: Saunders;Pp 365-70.

Nandy, M.E. (2010). Stature estimation from footprint dimensions in an adult Nigerian student population.

Numan, A.I., Idris, M.O., Zirahei, J.V., Amaza, D.S. and Dalori, M.B. (2013). Prediction of stature from hand anthropometry: A comparative study in three major ethnic groups in Nigeria. *British Journal of Medicine and Medical Research*, **3**:1062-1073.

Obikili, E.N. and Didia B.C. (2009). Foot Dimensions of young adult Nigerian population. In press.

Oria, R.S., Igiri, A.O., Egwu, O.A. and Nandi, M.E. (2016). Prediction of stature from hand length and breadth: Anthropometric study on an adult Cross River State population. *Annals of Biological Anthropology*, **4**:12-16.

Ozden, H; Balci, Y., Demirustu, C., Turgut, A. and Ertugrul, M. (2005). Stature and Sex estimate using foot and shoe dimensions. *Forensic Science International*; **147**:181-84.

Peter, H.A., Johannes, M.B. and Jonathan, D.S. (2008). McMinn's Clinical Atlas of Human Anatomy Sixth Edition. Page 310-312.

Philip, T.A. (1990). Formula for estimating stature from foot size by regression method.*Journal of Indian Academy of Forensic Medicine*; **12**:57–62.

Reddy, K.S.N. (2000).The Essentials of Forensic Medicine and Technology, 30th Edition. Hyderabad: Devi K, Suguna. Page 51.

Rutihauser, I.H. (1968). Prediction of height from foot length: Use of measurement in field surveys. *Archives of Disease in Childhood*.**43**(229):310-312.

Sanli S.G., Kizilkanat E.D., Boyan N., Ozsahin E.T., Bozkir M.G., Soames R., et al (2005). Stature estimation based on hand length and foot length. Clinical Anatomy: *The Official Journal of the American Association of Clinical Anatomists and the British Association of Clinical Anatomists*, **18**(8):589-96

.Saxena S.K. (1984). A study of correlations and estimation of stature from hand length, hand breadth and sole length. *Anthropologischer Anzeigner*; **42**:271–276.

Schultz, A.E. and Lavenda (1998) R.H. Anthropology A Perspective on the Human Condition. 2nded.California:.Mayfield Publishing Company; Page 4-6.

Shaifaly, M. R., Patmaik, W. G., and Sanjeev, T. (2013). A Study of Foot Anthropometry in Right Footed Indian Population.*Medico-legal journal*, **1**: 130-135.

Sharma, A. and Krishan, K. (2007). Estimation of stature from dimensions of hands and feet in a North Indian population.*Journal of Forensic Legal Medicne*, **14**:327-32.

Shen, W., Punyanitya, M., Silva, A. M., Chen, J., Gallagher, D., Sardinha, L. B., Allison, D. B., and Heymsfield, S. B. (2009). Sexual dimorphism of adipose tissue distribution across the lifespan: A cross-sectional whole-body magnetic resonance imaging study. *Nutrition and Metabolism*, **6**(1), 17-26. https://doi.org/10.1186/1743-7075-6-17.

Singh, I.P. and Bhasin, M.K. Anthropometry (1968). 1st ed. Delhi: Kamal-Raj Enterprises; page 3-7.

Snell, R. (2000). Clinical Anatomy for medical students, 6th Ed., Lippincott Williams and Wilkins, Philadelphia. Page 91, 591-595.

Snowdon, B. and Komlos, J. (2005).“Measures of Progress and Other Tall Stories: From income to anthropometrics- World Economics”.*World Economics*: **6** (2): 87-136.

Stuart, J. (2020) Development of the Limbs. TeachMe Anatomy: 3D Human Body. Teachmeanatomy.info.

Tanner, J.M. (1981). A history of the study of human growth.Cambridge University Press.ISBN 9780521134026.OCLC 755936888.

Trotter, M., and Gleser, G.C. (1952).Estimation of stature from long bones of American Whites and Negroes.*American Journal of Physical Anthropology*, **10**(4), 463-514.

Trotter, M., and Gleser, G.C. (1958).Are-evaluation of estimation of stature based on measurements of stature taken during life and of long bones after death. *American Journal of Physical Anthropology*, **16**(1), 79-123.

Uhrová, P., Beňuš, R., Masnicová, S., Obertová, Z., Kramárová, D., Kyselicová, K., Dörnhöferová, M., Bodoriková, S.,and Neščáková, E. (2015). Estimation of stature using hand and foot dimensions in Slovak adults. *Legal Medicine*, **17**(2), 92-97. https://doi.org/10.1016/j.legalmed.2014.10.005m

Vidyullatha, V.S. (2015). “Estimation of Stature Based on Foot Length”. *Journal of Evidence Based Medicine and Healthcare*, **2**(4): 440-445.

Vinod, K.P., MD, FACS, FAOA, FABOS and FAAOS (2015) Foot Bone Anatomy.Emedicine.medscape.com.

Wilbur, A.K. (1998). The utility of hand and foot bones for the determination of sex and the estimation of stature in a prehistoric population from westcentral Illinois.International *Journal of Osteoarchaeology*.**8:** 180-191.

Wunderlich, R.E. and Cavanagh, P.R. (2002). Gender differences in adult foot shape: Implications for shoe design. *Medicine and Science in Sports and Exercise*, **33**(4):605-611.

Yankuba, C. (2015) Presentation on Clinical Research Anthropometric Measurement. Medical Research Council Unit.The Gambia Unit MRC.Anthropometric field assistant.Senior Secondary School. Retrieved January 25, 2022 from researchgate.net DOI:10.13140/RG.2.1.4354.9606

Zorab, P.A. Prime, F.J., and Harrison, A. (1963).Estimation of height from tribal length.*Lancet*, **1** :195.