



CORRELATION OF RIGHT FOOT LENGTH AND LEFT FOOT LENGTH TO BODY HEIGHT AMONG YOUNG ADULTS OF MUMUYE ETHNIC GROUP OF BALI, NORTH-EAST, NIGERIA

Izang Genesis*

Anatomy Department, Faculty of Basic Medical Sciences, College of Medicine, David Umahi Federal University of Health Sciences Uburu, Ebonyi State, Nigeria.



*Corresponding Author: Izang Genesis

Anatomy Department, Faculty of Basic Medical Sciences, College of Medicine, David Umahi Federal University of Health Sciences Uburu, Ebonyi State, Nigeria.

DOI: <https://doi.org/10.5281/zenodo.21032836>

How to cite this Article: Izang Genesis*. (2026). Correlation of Right Foot Length and Left Foot Length To Body Height Among Young Adults of Mumuye Ethnic Group of Bali, North-East, Nigeria. European Journal of Biomedical and Pharmaceutical Sciences, 13(7), 151-156.

This work is licensed under [Creative Commons Attribution 4.0 International license](https://creativecommons.org/licenses/by/4.0/).



Article Received on 25/05/2026

Article Revised on 15/06/2026

Article Published on 01/07/2026

ABSTRACT

Background: The study on correlation of right foot-length (RFL) and left foot-length (LFL) to body height (BH) among young adults of Mumuye ethnic group of Bali, North-East, Nigeria was aim to correlate right and left foot-lengths to body height for forensic identification of mutilated bodies, investigation of crime, industrial production of shoes and establishment of regression formula. **Methodology:** Anthropometric instruments were used for data collection. The total of 1500 subjects consisting of 652 males and 848 females were use for this study. The age limit of 18-36years and age range of 18-22years, 23-27years, 28-32years and 33-37years were used. Ethical approval was obtained from Ebonyi State University, Abakaliki, Nigeria. Study duration was three months. Inclusion criterial were subjects with no deformity of body parts. **Results:** Mean age of 25.86years males and 23.80years females was used. The mean foot length and body height obtained include RFL=25.68cm males, LFL=25.59cm males, BH=169.32cm males, RFL=23.86cm females, LFL=23.79cm females, and BH=161.03cm females. All parameters have small standard deviation. The correlation of foot-lengths to body height was statistically significance at the level of $P < 0.05$. 23-27years males and females had the highest population range with 330(50.61%) males out of 652 males and 442(52.1%) females out of the total 848 females subjects. Pearson correlation coefficient for LFL to RFL, LFL to BH and RFL to BH was significant at the level of $P < 0.01$. **Conclusion:** The correlation of right and left foot-lengths to body height was statistically significance at the level of $P < 0.05$. Regression formula was develop.

KEYWORDS: Correlation, Right footlength, Left footlength, Body height.

INTRODUCTION

Foot length is the distance from the heel to the longest toe of an individual while stature is the distance from the heel of the foot to the vertex of the head when in upright posture. The measurement was carried out in centimeter. In forensic science variety of parameters can be use for identification. The identification of body remains become a challenge when the lower limb is dismember from the main body and the family of a decease wish to bury the late person with complete body parts or the appearance of foot prints at the site where crime had been committed. Hence, the task of identification by forensic expert become easier if a standard parameter

values had been established for foot length and body height especially for people living in that specific geographical region where mutilated legs or foot prints where found.^[1] In Africa and Asian countries most of the people living in rural areas often walk on bare foot which may be due to socioeconomic and climatic condition. In the case where foot prints were found at the site of crime when a criminal remove his/her shoes in order to avoid noise or have a better grip while clambing the wall or entering or making an exist, the foot impression can be measured in centimeter to obtained footlength for body height correlation with already established and documented data of people living in specific

region.^{[2],[3],[4]} The aim of this study is to correlate the right and left footlengths to body height for crime investigation, identification of mutilated body, industrial production of shoes and develop regression formula for young adults of mumuye in Bali, North-East, Nigeria.

Furthermore, stature is an anatomical complex that is form by head, neck, trunk, pelvise, vertebral column and lower limb. Genetic and environmental factors are the main determinant factors of individual height and footlength. Foot ossification and maturation occurred earlier in life than in long bones, making the possibility of stature estimation more accurate with foot than long bones.^[5] Their finding was in consonant with this study. The body height of an individual is one of the most important and useful anthropometric parameter which can be used to determine the physical identity of an individual. The identification of the stature of an unknown person using footlength obtained from foot prints is the main task of forensic investigators.^[6] The present study examine 1500 subjects consisting of 652 males and 848 females within the age limit of 18-36years and correlate their footlength to stature. The study conducted by Srinivasulu K and his team on cross sectional study of stature estimation from footlength in Telangana, concluded that both right and left footlengths of subjects have good correlation reliability to stature.^[7] Their study was in agreement with this study because Mumuye footlengths also correlate to stature with good significant value at $P < 0.05$. The study conducted by Anamul Haque and his team on estimaton of stature from hand and foot of Nalanda district of Bilar shows that footlength correlate better than hand.^[8] Anamul 2023, study was in agreement with this study. Ankit Agrawal and his team study the reliability of stature estimation from footlength and concluded that the foot length of students in North India have good correlation to their stature.^[9] Their study was in agreement with this research. This study is original and had not been published or submitted to any journal at the time of this submission.

MATERIALS AND METHODS

Materials: The materials used as instrument in this study include anthropometer, head piece, vernier caliper, exercise book and writing pen.

METHODOLOGY

Anthropometric Technique Measurement of Stature

Only the young adults of Mumuye in Bali, North-East, Nigeria were allow to participate in this study willingly. The volunteer subject was told to remove his/her shoes and stand on an anthropometer made up of meter rule with a movable head piece and a platform stand. The examiner ensure that the subject occipital protuberance touches the meter rule while in upright posture with the vertebral column and gluteus maximus touching the meter rule which project in between the right and left subject legs. The examiner then adjust the movable head

piece to align with the highest point of the subject head known as the vertex and immediately take reading with the help of head piece pointer on the calibrated meter rule measure in centimeter. The result was recorded in an exercise book with help of a writing pen by the examiner. The same procedure was repeated on all the volunteers who participated in the study.

Anthropometric Technique measurement of Foot Length

Only the young adults of Mumuye in Bali, North-East, Nigeria were allow to participate in this study willingly. The examiner instructed the subject to remove his or her shoes and place the right foot length on the vernier caliper place on a flat ground surface. The instrument has a movable and fixed part. When the movable part was adjusted the subject place his/her foot on the vernier caliper so that the heel touches the fixed part of the caliper while the adjustable moving part of the vernier caliper was made to slightly touch the longest toe of the subject then clamp by tightening the screw. The examiner take reading of the foot length from the heel to the longest toe by the help of a pointer touching the vernier caliper calibration measure in centimeter and recorded in an exercise book with the help of a writing pen. The same procedure was repeated on all the subjects who willingly participated in this study.

Ethical Approval: Ethical approval was obtained from the research and ethics committee of Ebonyi State University Abakaliki and was used to take permission from the community head of Bali, North-East, Nigeria.

Study Population: The study population was indigenes of Bali local government area of Taraba State, Nigeria.

Study Age Limit: The selected age limit of this study ranges between 18-36years only.

Duration of Study: The duration of this study was three months (1/12/2025-28/2/2026).

Inclusion Criteria: Only people with no deformity of head, vertebral column, neck upper and lower limbs were selected for the study base on their willingness.

Sampling Technique: Random sampling technique was used to sample the study population.

Study Statistic Used: Comparative statistic was used to direct measurement of study parameters.

Study Design: Comparative study design was adopted for this research work.

Data Analysis: The collected data were analyzed using statistical package for social science version 20.



Figure 1: Showing Image of Foot Length Measurement (Courtesy of Izang Genesis 2026 Free Hand Sketching).

RESULT

Table 1: Shows the Parameters of Age, Foot Lengths and Body Height of Young Adults of Mumuye Ethnic Group of Bali, North-East, Nigeria.

Parameters	Males (n=652)		SEM	Females (n=848)		SEM	t-values	P-values
	Mean	SD		Mean	SD			
Age (years)	25.86	2.65	0.78	23.80	1.90	0.64	1.12	0.931
RFL (cm)	25.68	1.20	0.36	23.86	1.30	0.42	10.50	<0.05
LFL (cm)	25.59	1.23	0.44	23.79	1.25	0.49	9.85	<0.05
BH (cm)	169.32	12.22	3.26	161.03	11.40	2.62	2.94	<0.05

n: Number, SD: Standard deviation, SEM: Standard error in mean, t-values: Test value, RFL: Right foot length, LFL: Left foot length, BH: Body height, P-values: Probability values

Table 2: Shows Mean Age Range and Percentage Population of Males and Females of Mumuye Ethnic Group of Bali, North-East, Nigeria.

Age Range	Males	Percentage	Females	Percentage
18-22years	160	24.54	200	23.60
23-27years	330	50.61	442	52.10
28-32years	100	15.34	126	14.90
33-37years	62	9.51	80	9.40
Total	652	100	848	100

Table 3: Shows How Body Height, Left Foot Length and Right Foot Length Correlate to each other Among Mumuye Ethnic Group of Bali, North-East, Nigeria.

Variables (cm)	P-value	r
LFL-RFL	<0.01	0.701
LFL-BH	<0.01	0.601
LFL-BH	<0.01	0.892

P-value=Probability value, r=Pearson correlation coefficient, RFL=Right footlength, LFL=Left footlength, BH=Body height. Correlation significance is at the level $P<0.01$.

Regression Formula

BH=RFL/2X10+40.92 males and **BH=LFL/2X10+41.37 males**

BH=RFL/2X10+41.73 females and **BH=LFL/2X10+42.08 females**

DISCUSSION

The result in table 1, shows the parameter values of foot length and body height of young adults of Mumuye ethnic group of Bali, North-East, Nigeria. The age limit used in this study was 18-36years with the mean age 25.86years males and 23.80years females. With the different of 2.06years the males were older than the females of this study. Footlength and body height parameters include, RFL=25.68cm males, RFL=23.86cm females, LFL=25.59cm males, LFL=23.79cm females, BH=169.32cm males, and BH=161.03cm females. The different between the right and left foot length of males and females are 0.09cm and 0.07cm respectively. Males right foot length (RFL) was longer than females with 1.82cm while 1.8cm left footlength (LFL) of males was longer than that of females. In medico-legal autopsies, predicting personal identity of victims was often required. Stature estimation from footlength and other parts of lower extrimities play important role in identifying body remains for forensic examination.^[10]

The study conducted by Krishna SSM and his team on stature estimation on foot length of 400 medical students age 20-25 years of Andhra medical college, India concluded that the individual footlengths prove useful for stature estimation with males footlength longer than that of females offering crucial support to forensic experts.^[11] Mumuye mean body height parameters includes 169.32cm males and 161.03cm females. The findings show that males footlength were taller than females by 8.29cm. This study was in agreement with the work of Krishan SSM, 2024. The standard deviation and standard error in mean of all the parameters were small showing that there was a good correlation between footlength to body height of individual Mumuye young adult involve in this study. The findings made by Sarah R and her team on estimation of stature from static and dynamic foot prints clearly shows that foot length can be obtained from both static and dynamic foot prints for stature estimation and concluded that footlengths have good correlation to body height prediction and enhance forensic investigation of crime when committed on bare foot.^[12] This study made by Sarah R, 2011 was in agreement with this research since the footlength of Mumuye correlate to body height even though Sarah 2011 made use of foot prints but from foot prints foot length may be obtain for forensic investigation. Therefore the footlengths of Mumuye have similarity to foot prints length of the work of Sarah R and her team. The independent research work of Krishan K, on estimation of stature from foot prints and foot outline dimension in Gujjar of North India and concluded that footlength have good correlation to stature and can be use for crime investigation by law enforcement agency and forensic science expert.^[2] Krishan 2008 study was in agreement with this study because in taking measurement for foot dimension, footlength was often considered as one of the parameter value for the prediction of body height.

Furthermore, table 1 also shows that the P-values of RFL, LFL and BH of Mumuye ethnic group of Bali in North-East, Nigeria was statistically significant at the level of $P < 0.05$, proving that both right and left foot length correlate with stature and can be use for identification of mutilated body when the lower limb was dismembered from the whole body cause by plane crash and vehicle accident and for forensic investigation of crime when committed on bare foot to avoid noise and enhance wall clambing. The standard values obtained in this study will help shoes industries to produce large quantities of quality shoes for young adult of Mumuye living in Bali, North-East, Nigeria with the aim of maximizing profit. The study conducted by Viral NC and Kumar SV with their independent teams on estimation of stature from foot length shows that foot have good correlation for stature prediction with low standard deviation and significant P-values.^{[13],[14]} Their finding was in agreement with this study because the standard deviation of Mumuye obtained was also low with significant P-value. The finding of Nataraja Moorthy and

his team on estimation of stature base on foot length of Malayi in Malaysia, shows the existence of good correlation between footlength and stature and concluded that stature can be predicted from foot length to aid identification of mutilated body and in crime investigation.^[15] Their study was in agreement with this study since Mumuye footlength can be correlated to body height just as that of the Malayi study conducted by Nataraja Moorthy 2011. The correlation coefficient between stature and foot length were found to be statistically significant with high reliability and accuracy in the estimation of stature from foot lengths of males and females.^{[16],[17]} This study was in consonant with the work of Krishan K, 2013 and Mahk AR, 2015 since in this study the pearson correlation coefficient of left footlength to body height, right footlength to body height and left footlength to right footlength were statistically significance at the level of $P < 0.01$ of Mumuye young adults of Bali, North-East, Nigeria.

The result of table 2, shows the mean age range and percentage population of males and females Mumuye ethnic group of Bali, North-East, Nigeria. The age range adopted for data collection includes, 18-22 years, 23-27 years, 28-32 years and 33-37 years. The age range with the highest population of males was 23-27 years consisting of 330(50.61%) males out of the total 652(100%) Mumuye males used in this study. The research work carried out by Singh B and his team on stature estimation from different combination of foot measurement using linear and multiple regression analysis in North India, shows good correlation of foot length to stature and the establishment of regression formula aid forensic profession.^[18] This study made by Singh 2019 was in agreement with this study. Likewise the study conducted by Devi TP and his team on stature estimation from foot length in males indigenous population of Assam region, shows that footlength correlate to stature with good significant values that can be documented for futuristic use by forensic experts in the identification of individual.^[19] The study of Devi TP, 2021 was in consonant with this study because the footlength of Mumuye also correlate with stature with good significant values of $P < 0.05$ and $P < 0.01$. The result of table 2, also show the age range 23-27 years had the highest population of females consisting of 442(52.10%) females out of the total 848(100%) Mumuye females while the age range 33-37 years females carried the lowest females population consisting of 80(9.4%) females out of the total population of 848(100%) Mumuye females. Observation had shown that both males and females of this study have their highest population within 23-27 years and lowest population within 33-37 years. It was because of the high population trace within 23-27 years that makes the possibility of obtaining the mean age of males as 25.86 years males and 23.80 years females. The finding made by Uhrova P and his team on stature estimation from various foot dimension among Sloval population shows that stature can be estimated from foot length with good correlation

reliability^[20] Uhrova 2013. Their finding is in consonant with this study.

Table 1, shows that the right foot length of both males and females Mumuye correlate with their body height at a significant level of $P < 0.05$. Also the left foot length of both males and females of this study correlate with body height at a significant level of $P < 0.05$. The study conducted by Amit Magadum and his team on the role of foot length to stature estimation in the population of Belagavi region shows that the right and left foot length have good correlation to stature with small standard deviation.^[21] Their study was in agreement with this research work. Regression formula was establish for stature estimation from foot length of Mumuye tribe in North-East, Nigeria and will be keep in data bank for future use in investigation of crime or in identification of crime. The research conducted by Kenwal Kamboj and his team on correlation between foot length and height of individual and derivation of regression formula concluded that height correlate with foot length and derive a regression formula for stature estimation from foot length of males and females.^[22] This study conducted by Kenwal K, 2018 was in support of the present study since footlengths of Mumuye correlate to stature and a regression formula was use for predicting body height using available footlength established for males and females of this study.

CONCLUSION

The right and left foot length of Mumuye ethnic group of Bali, North-East, Nigeria correlate with their body height at a significant level with small standard deviation. The standard parameter values obtained will be documented and use for crime investigation, identification of mutilated bodies and industrial production of shoes.

RECOMMENDATION

The author recommend that the study should be carry out in all the ethnic group of North-East region of Nigeria to aid forensic profession.

Author Contribution: The author of this study contributed in the design for data collection, collection of data, analysis of data, writing of manuscript, typing of manuscript, review of literature, editing of manuscript and funding of the study.

Funding of Study: The author had declare that their was no financial support receive for this research work from any individual or organisation.

Conflict of Interest: The author declare that there was no conflict of interest associated with this study.

Acknowledgement: The author wish to acknowledge with thanks the support of the community head of Bali and the volunteers who participated in this study, your willingness was highly appreciated and worth acknowledgement.

REFERENCES

1. Mansur DI, Haque MK, Sharma K, Karki RK, Khanal K, Karna R. Estimation of stature from foot length in adult Nepalese population and its clinical relevance. Kathmadu University Medical Journal, 2012; 37(1): 16-25.
2. Krishan K. Estimation of stature from foot prints and foot outline dimension in Gujjar of North India. Forensic Science International, March 5, 2008, 175: 93-101.
3. Hairunnisa MAK, Nataraja MT. Stature estimation from the anthropometric measurement of foot outline in adult indigenous Melanau ethnics of East Malaysia by regression analysis. Srilanka Journal of Forensic Medicine, Science and Law, 2013; 4(2): 27-35.
4. Gunti D, Nishat AS. Estimation of stature from foot prints measurement by linear regression on analysis in South Indian population. Indian Journal of Forensic Medical Pathology, 2020; 13(1): 94-101.
5. Rameswarapu SB, Deepika V, Potturi BR. Estimation of stature from foot length. International Journal of Pharmacy and Biological Science, 2013; 3(3): 255-270.
6. Edibamode EI, Udoaka AI, Okoh PD, Umunna NE. Foot arch pattern and stature estimation from foot print using students of the University of Port Harcourt. Scientia Africa, 2014; 13(1): 43-51.
7. Srinivasulu K, Nakkala S, Sai SR, Jupaka OS. Cross sectional study on estimation of stature from foot length I Talangana. Indian Journal of Forensic Medicine and Toxicology, 2022; 16: 4.
8. Anamul HMD, Ashok KS, Rekha K, Mamta K, Javed A, Priyanka R, Jawed Amd. Estimation of stature from measurement hand and foot in the population of Nalanda district of Bihar. International Journal of Medicine and Pharmacy, 2023; 5(1): 724-729.
9. Ankit A, Vinod G, Harshita A. Estimation of stature from foot length in Indian students population in North India. International Journal of Pharmaceutical and Clinical Research, 2024; 16(12): 2580-2583.
10. Krishan K, Sharma A. Estimation of stature from dimension of hands and feet in North Indian population. Journal of Clinical Forensic Medicine, 2007; 14: 327-332.
11. Krishna SSM, Boddepalli D, Shanawaz Md, Mohit KM, Amrutha R, Anamika S, Ganesh Y, Roshini K, Kattamreddy AR. Estimation of from foot length: An anthropometric study. Nation Board of Examination- Journal of Medical Science, 2024; 2(4): 335-349.
12. Sarah R, Simon R, Wesley V, Patrick D. Estimation of stature from static and dynamic foot prints. Forensic Science International, 09 Dec. 2011; 219(1-3): 283.e1-5
13. Viral NC, Sunil MD, Mangal HM, Viral JA, Prince JM, Raghurajsinh DV. Estimation of stature from foot length in population of Rajkot region, Gujarat. Indian Journal of Forensic Medicine and Pathology, 2017; 10(1): 37-41.

14. Kumar SV, Shruth K, Anand PB, Tejas J. Across sectional descriptive study for estimation of stature from foot length in South Indian population. *Jiafm*, 2023; 45(2): 146-154.
15. Nataraja MP, Mazidah K, Hadzri M. Estimation of stature base on foot length of Malays in Malaysia. *Australian Journal of Forensic Science*, 2011; 43(1): 13-23.
16. Krishan K, Kanchan T. Foot length is a functional parameter for assessment of height. *The Foot*, 2013; 23(1): 54-59.
17. Mahk AR, Akhter N, Ali R, Farrukh R, Aziz K. A study on estimation of stature from foot length. *Prof Med J.*, 2015; 22: 632-641.
18. Singh B, Krishan K, Kaur K, Kanchan T. Staure estimation from different combination of foot measurement using linear and multiple regression analysis in North Indian males population. *Forensic Legal Medicine*, 2019; 62: 25-33.
19. Devi TP, Kumar P, Pratim KP, Chandravanshi LP, Chauhan M. Estimation of stature from foot length in males population indigenous population of Assam region. *Foot (Edinb)*, 2021; 49(101840): 101840. <http://dx.doi.org/10.1016/j.foot.2021.101840>
20. Uhrova P, Benus R, Masnicova S. Stature estimation from various foot dimension among Sloval population. *Journal of Forensic Science*, 2013; 58: 448-499. <https://doi.org/10.1111/1556-4029.12059>.
21. Amit A, Sangeeta SK, Asha S, Sheetal VP. Predictive role of foot length to estimate stature in the population of Belagavi region. *African Journal of Biomedical Research*, 2024; 27(45): 13823-13827 <https://doi.org/10.53555/AJBR.v27i4s.6572>.
22. Kenwal K, Iram K, Kuldeep P. A study on the correlation between foot length and height of an individual and to derive regression formulae to estimate the height from foot length of individual. *International Journal of Research in Medical Science*, 2018; 6(2): 528-532. <https://doi.org/10.18203/2320-6012.ijrms.20180292>