Peertechz

JOURNAL OF Biology and Medicine

DOI: https://dx.doi.org/10.17352/jbm

Adelakun SA[1]*, Ogunlade B[1], Akingbade GT[1], Olayemi OT[2], Fidelis OP[3] and Owolabi FM[3]

[1]Department of Human Anatomy, Federal University of Technology, Akure, Nigeria
[2]Department of Anatomy, Ladoke Akintola University of Technology, Ogbomoso, Nigeria
[3]Department of Biomedical Technology, Federal University of Technology, Akure, Nigeria

Received: 17 April, 2019
Accepted: 27 May, 2019
Published: 28 May, 2019

***Corresponding author:** Adelakun SA, Department of Human Anatomy, School of Health and Health Technology, Federal University of Technology, PMB 704, Akure, Ondo State, Nigeria, Tel: +2348133354835; E-mail: saadelakun@futa.edu.ng

Keywords: Athropometric measurement; Sexual dimorphism; Foot length; Foot breadth; Foot index; Oyemekun

https://www.peertechz.com

Check for updates

Research Article

Sexual dimorphism and anthropometric measurements of foot in adult Oyemekun ethnic group population in Akure, South-West Nigeria

Abstract

Background: Dismembered human remains are frequently found in cases of mass disasters and criminal mutilation. Therefore, it is of great importance to use foot dimensions for the determination of sex (gender) of an individual in order to assist in establishing personal identity. This study focused on sexual dimorphism using the anthropometric measurements of foot in adult Oyemekun ethnic population in Akure, Southwest Nigeria.

Materials and Methods: The study population consists of randomly selected 500 adult subjects (250 males, 250 females) aged 18-50 years without any foot disability within Akure North and South Local Government, Ondo State, Southwest Nigeria. After explaining the purpose and procedure of the survey and obtaining an informed consent from each participant, the foot length and foot breadth of both foot were measured using an osteometric board, recorded and subjected to statistical analysis.

Results: The male participant had an average foot length about 1cm greater than female participant and foot breadth in male was about 1cm greater as compared to female. Differences in foot length and foot breadth in male and female subject of the population were statistically significant ($p<0.05$) compared to the foot in which the length is lesser than 26cm and breadth lesser than 11cm can be suggested to be that of a female while the foot with length greater than 26cm and breadth greater than 11cm can be suggested to be that of a male.

Conclusion: Foot length, Foot breadth and foot index are higher in male compared to female. This proves sexual dimorphism of foot dimensions. Therefore, 26cm can be taken as the cut-off point for foot length and 11cm as the cut-off point for foot breadth in this locality.

Abbreviations

RFL: Right Foot Length; RFB: Right Foot Breadth; RFI: Right Foot Index; LFL: Left Foot Length; LFBL Left Foot Breadth; Left foot index; M: Male; F: Female; CM: Centimetre; SD: Standard Deviation of Mean; FREQ: Frequency

Introduction

Measurement of human size and shape for the purpose of understanding physical variation has been a long time practice [1]. Today this practice is called anthropometry. Anthropometry is a series of systematized measuring techniques that expresses quantitatively, the dimensions of the human body and skeleton [2]. Anthropometry is often viewed as a traditional and perhaps the basic tool of biological anthropology, but it has a long tradition of use in forensic sciences and it is findings is use in medical sciences especially in the discipline of forensic medicine [3]. Anthropometry is the measurement of the body dimensions such as the length, the width, and the height for the purpose of understanding human physical variations and plays an important role in ergonomics, clothing designing, prosthetics, plastic surgery, and industrial designs, where statistical data about the distribution of the body dimensions in the population are used to optimize product(s) [4]. Appropriate use of anthropometry in design may improve well-being, health, comfort, and safety [5]. In ancient times, anthropometry was used in criminology where criminals were identified by measuring parts of their body [6]. Anthropometry stems from the measurement of the whole human body to individual body parts e.g. face, nose, limb and orbit. It is highly objective and reliable in the hands of trained anthropometrists [7]. The significance of somatometry, cephalometry, craniometry and osteometry in the identification

Citation: Adelakun SA, Ogunlade B, Akingbade GT, Olayemi OT, Fidelis OP, et al. (2019) Sexual dimorphism and anthropometric measurements of foot in adult Oyemekun ethnic group population in Akure, South-West Nigeria. J Biol Med 3(1): 027-030. DOI: http://dx.doi.org/10.17352/jbm.000009

of human remains has been described by a new term, 'forensic anthropometry'. Forensic podiatry deals with the study of foot dimensions for human identification [8]. The human foot, the foundation of bipedal locomotion, is a highly complex multi bone structure with 26 bones and numerous articulation [9]. Identification is often required in medico-legal practice. The problem mainly arises when the body is recovered in advanced stage of decomposition, mutilated state and skeletonized state. Sometimes, fragments of soft tissues are found disposed-off in the open, in ditches, or rubbish dumps and this material is brought to forensic pathologist for examination. Over the last few decades, studies have been largely conducted on human foot for both ergonomic shoe design and forensic purposes [10]. Anthropologists continue to use anthropometric data to study the differences between various groups of people, though they no longer do so with the goal of promoting racial superiority. Measuring people can also provide information about how humans are changing, with such measurements being used by people who develop prosthesis, clothing, furniture, and other consumer goods which are dependent on average user size. Measurements can include length and breadth measurements of various aspects of the body, ranging from overall height to individual fingers as well as body weight. Measurements are also taken to learn more about the internal structure of the body, such as density measurements [11]. Sex determination is a very vital part of the analysis of human remains. Lots of researches are on-going for assessing stature, sex, race, etc. from anthropometric measurements of different parts of the body for identification purpose [12]. This study focused on sexual dimorphism from the anthropometric measurements of the foot in adult Oyemekun ethnic population in Akure southwest Nigeria.

Materials and Methods

The study was conducted among the people of Akure North and South local government. 500 healthy subjects (250 males and 250 female) age bracket of 18-50 years were surveyed. This is because most people attain their maximum growth within this age bracket. The study was conducted between October and December 2018 among randomly selected volunteers at the Basic Health Centre, Itaogbolu, Akure North Local Government and the Basic Health Centre, Orita-obele, Akure South Local Government within Oyemekun ethnic group in Akure. The purpose and procedure of the survey was properly explained to the participants in English and Vernacular and an informed consent was obtained from each participant. None of the participants in this study was coerced in any way or provided with an inducement for their involvement. All the subjects were barefooted at the time of recording the measurements. All the measurements for the study were taken with the subjects standing erect in an anatomical position. Subjects less than 18 and above 50 years of age as well as those with apparent foot anomalies, inflammation, trauma, deformities, etc. were excluded because of their possible influence on the precision and accuracy of the result.

The following measurements were taken;

Foot Length: - The foot length was measured as a straight distance between the most posteriorly projecting point of the heel (pternion) and the most anteriorly projecting point on the head of the first or second toe (akropodion), whichever is longer, when the subject stood erect on flat surface. This measurement excluded any nail extending over the end of the toe.

Foot Breadth: - The foot breadth was measured as a straight distance from the medial border of the head of first metatarsal to the lateral border of the head of the fifth metatarsal.

Foot Index: - The foot index was calculated using equation 1.

$$Foot\ Index = \frac{Foot\ breadth}{Foot\ length} x100 \quad (1)$$

Measurements were taken twice and the average of both measurements was recorded in centimetres (cm). All measurements were according to the protocols recommended by the International Society for the Advancement of Kinanthropometry.

Data presentation and statistical analysis

The numerical data was collated and analyzedusing Microsoft Excel (version 2010) and IBM Statistical Packages for Social Sciences (SPSS), version 21.

Results

In this study, anthropometric measurements were carried out on 250 males and 250 females from Oyemekun ethnic group population and the result of the data analysis is required to measure changes in foot morphology in relation to sex is presented in [Table 1]. The overall mean of the right foot length was 26.96cm in male and 25.03cm in female, the overall mean of the right foot breadth was 11.32cm in male and 10.33cm in female. The overall mean of the left foot length was 26.99cm in male and 25.01cm in female, the overall mean of the left foot breadthwas11.27cm in male and 10.32cm in female. The results obtained indicate a sexual dimorphism with statistical significant difference between male and female which was significantly higher values of all the parameters in males compared to the females as shown in [Table 1].

Furthermore, the average right foot length across all age groups in the female ranges between 24.77cm to 25.29 cm while in the male the figures range between 26.62 cm to 27.21cm. Those of right foot breadth ranges between 10.20cm to 10.53cm in female and 11.07cm to 11.61cm in male. The left foot length in female ranges between 24.81cm to 25.24cm while in male it ranges from 26.58cm to 27.29cm, while those of left foot breadth in female ranges between 10.16cm to 10.55cm and from 11.04cm to 11.57cm in male. For analysis of age-related and sex-related variations in the foot morphology, the effect of age and sex were observed on all the variables which were measured. Sex had statistical significant effect on all the variables measured while age had no significant effect on the variables (Figure 1).

Discussion

The human foot is a complex adaptation that moves

Citation: Adelakun SA*, Ogunlade B, Akingbade GT, Olayemi OT, Fidelis OP, et al. (2019) Sexual dimorphism and anthropometric measurements of foot in adult Oyemekun ethnic group population in Akure, South-West Nigeria. J Biol Med 3(1): 027-030. DOI: http://dx.doi.org/10.17352/jbm.000009

Table 1: Descriptive statistics (Mean±SD) for Foot length, Foot breadth, and Foot index in both sexes and for right and left side.

AGE	FREQ.	SEX	RFL	RFB	RFI	LFL	LFB	LFI
18 -21	31	M	26.62±1.38	11.30±1.14	42.45±0.83	26.58±1.41	11.15±1.01	41.95±0.72
	31	F	25.01±1.09	10.39±0.77	41.54±0.71	24.89±1.08	10.34±0.73	41.54±0.68
22-25	31	M	27.03±1.35	11.31±0.86	41.84±0.64	27.06±1.45	11.21±0.80	41.43±0.55
	31	F	24.82±1.31	10.53±0.75	42.43±0.57	24.90±1.31	10.55±0.80	42.37±0.61
26-29	31	M	27.21±1.52	11.31±1.01	41.57±0.66	27.29±1.44	11.31±1.03	41.44±0.72
	31	F	25.13±1.04	10.35±0.61	41.18±0.59	25.05±1.03	10.35±0.64	41.32±0.62
30-33	31	M	26.94±1.07	11.07±0.67	41.09±0.63	26.94±1.06	11.04±0.61	40.98±0.58
	31	F	25.00±1.20	10.21±0.84	40.84±0.70	25.03±1.20	10.27±0.85	41.03±0.71
34-37	31	M	27.14±1.35	11.29±0.59	42.70±0.44	27.12±1.36	11.27±0.56	41.56±0.41
	31	F	25.29±1.24	10.39±0.57	41.08±0.46	25.24±1.25	10.39±0.57	41.16±0.46
38-41	31	M	26.98±1.55	11.61±0.84	43.03±0.54	27.04±1.58	11.57±0.80	42.79±0.51
	31	F	24.77±1.06	10.24±0.67	41.34±0.63	24.81±1.09	10.23±0.67	41.23±0.61
42-45	31	M	27.07±1.50	11.53±0.92	42.59±0.61	27.11±1.54	11.48±0.90	42.35±0.58
	31	F	25.26±1.23	10.31±0.61	40.81±0.50	25.24±1.22	10.27±0.60	40.69±0.49
46-50	33	M	26.71±1.33	11.17±0.58	41.82±0.44	26.82±1.39	11.12±0.68	41.46±0.49
	33	F	24.97±1.40	10.20±0.69	40.85±0.49	24.91±1.43	10.16±0.66	40.77±0.46
p value b/w sides	-	-	0.865	0.501	-	0.669	0.622	-
p value b/w sex	-	-	<0.001 *	<0.001 *	<0.001 *	<0.001 *	<0.001 *	<0.001 *

*Student t test - p value of < 0.05 indicates significance difference between groups.

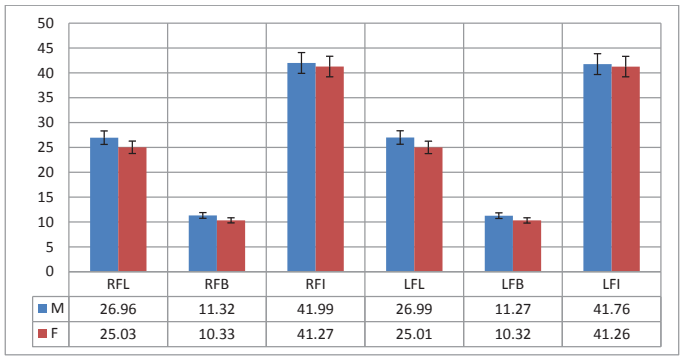

Figure 1: Bar chart of over all average of measured foot parameters (Mean± SD).

through extensive remodeling of the hind appendage of the human arboreal primate forebears and the foundation for bipedal locomotion [13]. The normal human foot shows great individual variation in length, breadth in males and female [14]. Sex determination from Foot dimensions has major role in personal identification [8]. The present study was carried out to determine the sexual dimorphism in the foot dimension among adults of Oyemekun ethnic group in Akure, to provide base line data for population, for design and manufacture of shoes for correct shoe fit. In this study, the average foot length of males was found to be significantly greater than that of females while foot breadth in males was found to be significantly greater as compared to females in all age groups ($p< 0.001$). Thus, the study indicates a positive correlation between an individual's foot measurements and gender. This is in accordance with earlier studies and proves sexual dimorphism in foot length and foot breadth [15]. The study conducted by Agnihotri *et al.*,[11] on 250 students (125 males, 125 females), age group 18-30 years, concluded that the average foot length was found to be 3cm greater in males as compared to females and average foot breadth of males was about 1cm broader than females. Sen *et al.*,[16] attempted to estimate sex from foot length, foot breadth and foot index among 350 adult Rajbangsi (175 men, 175 women) individuals, likewise Tyagi *et al.*, [17]. They all concluded that foot dimensions show a significant sex difference which supports the present study. Bob-Manuel and Didia [18], established in their study that the mean value of right foot length in males and females were 26.92±1.02 and 25.00±1.33 and the mean value of right foot breadth for males and females were 9.87±0.53 and 9.14±0.58. The mean values for the left foot length of males and females were 26.92±0.13 and 24.75±0.17 respectively. The mean value for the left foot breadth of males and females were 9.75±0.07 and 8.92±0.08 respectively. Males had significantly higher values of foot length and foot breadth than females. Singla *et al.*, [19], established in their study among the Haryanvijats and North Indian mixed population that Haryanvi males had an average foot length about 2cm greater than females and foot breadth in males was about 1cm greater in males as compared to females while in North Indian mixed population males had an average foot length about 3cm greater than females and the average foot breadth in males was about 1cm greater than in females. Our findings in this study therefore agree with their submissions. These variations could be due to differences in community and environmental factors. In our study males had higher Foot index than females. This is in agreement with the earlier studies who observed that Foot index is higher in males than in females [8,15]. Our study is comparable with the study by Sen et al.,[16], on Bengali Rajbanshi population on 175 males and 175 females who reported a foot index of 41.3 in males and 40.5 in females on both right and left side [16]. These variations could be due to the fact that anatomic structures of foot shows ethnic and regional variations owing to genetic background, climatic factors, physical activities, socio-economic status, nutritional conditions and practice of using different footwear [20,21].

Citation: Adelakun SA*, Ogunlade B, Akingbade GT, Olayemi OT, Fidelis OP, et al. (2019) Sexual dimorphism and anthropometric measurements of foot in adult Oyemekun ethnic group population in Akure, South-West Nigeria. J Biol Med 3(1): 027-030. DOI: http://dx.doi.org/10.17352/jbm.000009

Conclusion

Foot length, foot breadth and foot index are higher in males compared to females. This proves sexual dimorphism of foot dimensions. This study provides a useful tool for forensic science researchers in forensic identifications in cases of mass disasters and criminal mutilation, assisting investigators and legal experts in sex determination of a person (victim). Therefore, foot with length lesser than 26cm and breadth lesser than 11cm can be suggested to be that of a female while any foot with length greater than 26cm and breadth greater than 11cm can be suggested to be that of a male. Thus, 26cm can be taken as the cut-off point for foot length and 11cm as the cut-off point for foot breadth in this locality.

Acknowledgment

We are grateful to the study subjects from the Akure community for their participation in the study.

References

1. Ese A, Mabel OE, Dennis EOE, Ogheneyeseno A (2011) Anthropometric study of the nasal parameters of the Isokos in Delta State of Nigeria. Annals of Biological Research 2: 408-413. Link: https://tinyurl.com/y2rycq23

2. Krishan K (2008) Determination of stature from foot and its segments in a North Indian Population. American journal of Forensic medicine and pathology 29: 297–303. Link: https://tinyurl.com/yxul3r7h

3. Krishan K (2007) Anthropometry in Forensic Medicine and Forensic Science 'Forensic Anthropometry'. The internet journal of forensic science 2: 1-8. Link: https://tinyurl.com/y5pfvgrz

4. Pheasant S (1998) Body space Anthropometric Ergonomics and the Design of Work. 2nd edition, Taylor and Francis, London.

5. Moudi MA (1996) Anthropometric Engineering. Medical Sciences University of Mazandaran, Mazandaran, Iran. 21-45.

6. Franciscus RG, Long JC (1991) Variation in human nasal height and breadth. Am J Phys Anthropol 85: 419-427. Link: https://tinyurl.com/yylw5tnq

7. Krishan K, Sharma A (2007) Estimation of Stature from Dimensions of Hands and Feet in a North Indian Population. Journal Forensic Legal Med 14: 327-332. Link: https://tinyurl.com/yynutcfr

8. Bindurani MK, Kavyashree AN, Asha KR, Lakshmiprabha S (2017) Determination of Sex from foot Dimensions. Int J Anat Res 5: 4702-4706. Link: https://tinyurl.com/yyp4qye2

9. Dupartius A, Dupartius CW, Casey AE (1972) Physical anthropology of young adult females in Slieve Loughter, South West Island. AMJ Phys Anthropol 37: 435.

10. Singla R, Bedi M, Biswas M (2012) Sex estimation from foot anthropometry in haryanvijats and north indian mixed population. J Punjab Acad Forensic Med Toxicol 12: 13-16. Link: https://tinyurl.com/y5qnxlak

11. Agnihotri AK, Purwar B, Googoolye K, Agnihotri S, Jeebun N (2007) Estimation of stature by foot length. J Forensic and Legal Med 14: 279–283. Link: https://tinyurl.com/y4avmz4g

12. Agnihotri AK, Shukla S, Purwar B (2007) Determination of sex from the foot measurements. The Internet Journal of Forensic Science 2: 1-4. Link: https://tinyurl.com/y52lmhgm

13. Walia S, Shankar modi B, Puri N (2016) Sexual dimorphism from foot dimensions and foot prints in Haryanvi jat population. Int J Anat Res 4: 2142-2147. Link: https://tinyurl.com/y3p9kln4

14. Snell Richards-Clinical Anatomy for medical students 6th ed. London: Lippincott Williams and Wilkins. 468-470.

15. Danborno B, Flukpu A (2008) Sexual dimorphism in hand and foot length, Indices, statureratio and Relationship to height in Nigerians. The internat journal of Forensic science 3: 1-5. Link: https://tinyurl.com/yy7kq5vf

16. Sen J, Kanchan T, Ghosh S (2011) Sex estimation from foot dimensions in an Indigenous Indian population. J Forensic Sci 56: 48-53. Link: https://tinyurl.com/y62evwd7

17. Tyagi AK, Rani M, Kohli A (2004) Sexing by foot index (2000-2001). Journal of Forensic Medicine and Toxicology 21: 10-11. Link: https://tinyurl.com/y4u7xeb7

18. Bob-Manual I, Didia B (2008) Sexual dimorphism in foot dimensions among adult Nigerians. The Int J Bio Anthropol 3: 1-6. Link: https://tinyurl.com/y2429nyx

19. Singla R, Bedi M, Biswas M (2012) Sex estimation from foot anthropometry in Haryanvi jats and North Indian mixed population. J Punjab Acad Forensic Med Toxicol 12: 13-16. Link: https://tinyurl.com/y5kl7ol7

20. Ahmed AA (2013) Estimation of sex from the lower limb measurements of Sudanese adults. Forensic Science International 299: 169. Link: https://tinyurl.com/yyy8xrgk

21. Case DT, Ross AH (2007) Sex determination from hand and foot bone lengths. Journal of Forensic Sciences 52: 264–270. Link: https://tinyurl.com/y5da9smz

Citation: Adelakun SA*, Ogunlade B, Akingbade GT, Olayemi OT, Fidelis OP, et al. (2019) Sexual dimorphism and anthropometric measurements of foot in adult Oyemekun ethnic group population in Akure, South-West Nigeria. J Biol Med 3(1): 027-030. DOI: http://dx.doi.org/10.17352/jbm.000009