International Journal of Medicine Research
ISSN: 2455-7404; Impact Factor: RJIF 5.42
www.medicinesjournal.com
Volume 1; Issue 5; November 2016; Page No. 14-19

Estimation of sex using transverse breadth of talus in north eastern Nigerians

***[1] Eduitem S Otong, [2] Aminu A Rufai, [3] Danladi S Amaza, [4] Zainab Mustapha, [5] Tamunotonye W Jacks, [6] Sani A Bello**

[1, 2, 6] Department of Human and Clinical Anatomy, College of Medical Sciences, Abubakar Tafawa Balewa University Bauchi, Bauchi State, Nigeria

[3] Department of Anatomy, Faculty of Medicine, Kaduna State University, Kaduna State, Nigeria

[4] Department of Radiology, University of Maiduguri Teaching Hospital, Borno State, Nigeria

[5] Department of Human Anatomy, College of Medical Sciences, University of Maiduguri, Borno State

Abstract

Aim: To evaluate sexual differences using demarking points and index of sexual dimorphism of the Breadth of the talus in relation to age of males and females in north eastern Nigerians.

Methodology: Three hundred and twelve (312) radiographs of adult north eastern Nigerians (156 males and 156 females) with age ranged 20 to 69 years were measured retrospectively. Radiographs used for this study were obtained from the collection of the records unit of the Radiology Department, University of Maiduguri Teaching Hospital (UMTH) in Borno State, Nigeria. Both female and male samples were grouped into two separate subsamples (right and left talus). Samples were classified separately into five (5) age groups spanned ten years' interval. Plain antero-posterior radiographs of the ankle were used for this study. Transverse Breadth (TB) of the talus was measured as a linear distance between the most medial and lateral points on the body of talus with a meter rule in centimeters (cm).

Results: The result showed age related variation, with male TB of the talus ranging from 4.41cm at 60-69 years age group to 4.68 cm at 30-39 years age group; while the female TB of the talus ranged from 3.96 cm at 60-69 years age group to 4.19 cm at 30-39 years' age group. The means of TB of talus for males are all significantly greater than their female counterparts of the same age group. The results also show statistically significant ($p<0.001$) differences between the Breadth of talus in males and females with the values of demarking points (DP) in males higher than those in the females. Parameters of index of sexual dimorphism (ISD) are greater than 100 which suggest that males have higher value over their female counterparts.

Conclusion: It was observed that the TBs of talus are sexually dimorphic; the DPs of male parameters are all higher than those of their female Counterparts. ISD also shows that, male TBs are greater than those of the female counterparts: because the ISDs were all greater than 100 at all age groups. However, more studies are required in other part of Nigeria, so as to capture the racial variation in the country.

Keywords: sex determination, demarking point, index of sexual dimorphism, transverse breadth, talus, north-eastern Nigerians

1. Introduction

Surface or shallow burials often result in the loss of skeletal materials which can greatly impede an investigation. Unlike the skull and other long bones, the compactness and the associated soft tissues (ligaments) make the talus more resistance to taphonomic factors, thus increasing its chances of preservation and eventual field recovery. In situations requiring post-mortem identification where recovered skeletal material may be limited, this quality makes the talus an appropriate alternative for osteological analysis [1].

The field of forensic anthropology involves the building of an ante mortem profile of an individual from skeletal remains. This involves sex, race determination; age and stature estimation. Because most bones that are conventionally used for sex determination, age and stature estimation are often recovered either in fragments or incomplete state, it has become necessary to use denser bones that are often recovered intact such as the patella, calcaneus and talus [2].

Categorization of human remains by sex and age has been a challenge for the medico-legal profession. Metrical study of bones has been done by various authors [3, 4]. Advocated the DP can identify the sex of the individual with 100% accuracy [5]. Reported that even within the same general population, mean value may be significantly different in bones from different zones [6]. Showed that DP should be calculated separately for different region of population, because the mean of parameter, may differ in values. To be certain in identification, calculated ranges have to be considered, which was worked out by adding and subtracting 3 X standard deviation (SD) to and from the mean of any parameter [4]. called the limiting point of such calculated range: demarking point, which identify sex with 100% accuracy from any given population or region, hence the need for this study is to evaluate sexual differences using DPs and ISDs of the length of the talus in relation to age of males and females in north eastern Nigerians.

2. Materials and Methods

This retrospective study used radiographs obtained from the collection of the Records Unit over a period of five years (2005-2010) from Radiology Department University of Maiduguri Teaching Hospital (UMTH) in Maiduguri, Borno State, Nigeria. The distance between the cassette and the X-ray tube was short; hence magnification obtained was 0.1 mm (0.01 cm). Only radiographs that were reported by a consultant radiologist as

normal without any bone defect were used for this study. Plain antero-posterior X-ray radiographs of the ankle for three hundred and twelve (312) subjects (156 males and 156 females) with age ranged from 20 to 69 years were measured. Both female and male samples were grouped into two separate subsamples (right and left talus). Samples were classified based on their ages which spanned ten years interval (Table 1). Each patient's age and sex were taken directly from the film jackets. Radiographic viewing box, erasable maker, calibrated meter rule was used for the measurements. The viewing box was connected to a light source which gave good illumination.

Table 1: Distribution of Subjects According to Age Groups

Age Group (years)	Males		Females		Total
	Right	Left	Right	Left	
20-29	16	16	16	16	64
30-39	15	15	15	15	60
40-49	17	17	17	17	68
50-59	15	15	15	15	60
60-69	15	15	15	15	60
Total	78	78	78	78	312

Transverse Breadth (TBs) in centimeters was taken on each talus. Erasable marker was for noting the points of measurements while a calibrated meter rule was used for the measurements. Each measurement was taken three times and an average was computed. The methods adopted for the measurements were a modification from [7]. The X-ray films were mounted on a viewing box. The margins of the talus were well outlined and the most medial and the most lateral points on the body were marked by erasable marker. Then the linear distance between the two points were measured by a transparent calibrated meter rule in centimeter as TB (Figure 1). All the measurements were taken directly on the radiographs [8, 9].

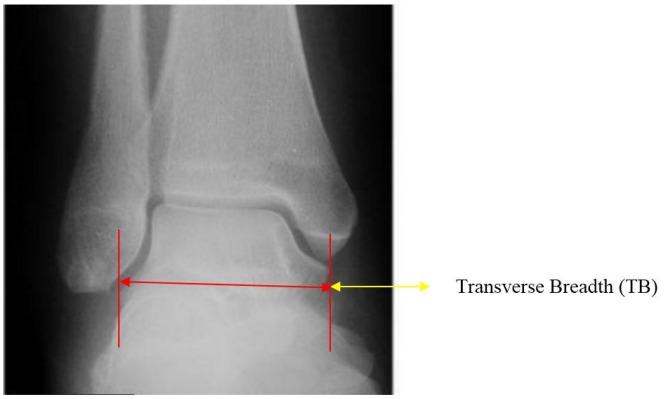

Fig 1: Antero-posterior Radiograph of the Ankle showing Transverse Breadth (red line): [10].

Statistical Analysis

Data obtained from the measurements were entered directly into the data sheet and analyzed using Graph pad InStat3 [11]. The average taken from all the variables measured were grouped into right and left sides and were used in the analysis. The mean and standard deviation were determined using two-way analysis of variance (ANOVA) and differences between mean diameters of both sexes. The significance of differences in the means of the parameters and indices reported were determined using paired sample student t- test and a p value of <0.05 (two tailed) was considered significant. However, a probability level of less than 0.001 ($p<0.001$) was considered extremely significant; $p<0.01$ was very significant; $p<0.05$ was significant while $p>0.05$ was not significant. Indices of sexual dimorphism were also calculated for both sexes using the formula male mean/female mean x 100%. Demarking points were calculated for males and females from the formula: mean ± 3 standard deviation, which gave calculated ranges for both males and females. From the calculated range (CR), the demarking points were obtained.
Values for Index for Sexual Dimorphism (ISD) were obtained using the formula

$$ISD = \frac{\text{Male Mean}}{\text{Female Mean}} \times 100\% \quad [12].$$

Values for CR and DP were obtained using the formula = mean ± 3 x Standard Deviation

3. Results and Discussion

3.1 Analysis of Results for Transverse Breadth of the Right Talus in Males and Females

The TB of right talus between male and female was compared. It was observed that male value ranged from 4.38 cm at 60-69 years age group to 4.69cm at 30-39 years age group: while female mean value ranged from 3.95cm at 60-69 years age group to 4.19cm at 30-39 years age group. There are statistically significant differences among males and females ($p<0.001$) (Table 2).

Table 2: Descriptive Statistics for Transverse Breadth of Right Talus in Males and Females

	Male		Female	
Age GP (YRS)	Mean ± SD (cm)	95% CL (cm)	Mean ± SD(cm)	95% CL (cm)
20 -29	4.62±0.23	4.50-4.73	4.16±0.22***	4.04-4.27
30 -39	4.69±0.15	4.61-4.78	4.19±0.14***	4.11-4.27
40 -49	4.60±0.22	4.49-4.72	4.09±0.20***	3.99-4.19
50 -59	4.51±0.33	4.34-4.68	4.05±0.05***	3.95-4.16
60 -69	4.38±0.21	4.26-4.50	3.95±0.17***	3.86-4.05

SD=Standard Deviation; CL=Confidence Limit; GP=Group; P=Probability; CM=Centimeter, *** = P<0.001

3.2 Analysis of the Results for Transverse Breadth of the Left Talus in Males and Females

The TB of left talus between male and female was compared. It was observed that male value ranged from 4.44cm at 60-69 years age group to 4.66cm at 30-39 years age group: while female mean value ranged from 3.97cm at 60-69 years age group to 4.18cm at 30-39 years age group. There are statistically significant differences ($p<0.001$) among males and females (Table 3).

Table 3: Descriptive Statistics for Transverse Breadth of Left Talus in Males and Females.

Age GP (Yrs)	Males (n = 16)		Females (n = 16)	
	Mean ± SD (cm)	95% CL (cm)	Mean ± SD (cm)	95% CL (cm)
20-29	4.59±0.17	4.50-4.68	4.10±0.19***	4.00-4.20
30-39	4.66±0.16	4.57-4.75	4.18±0.14***	4.10-4.26
40-49	4.58±0.22	4.47-4.69	4.08±0.18***	3.99-4.17
50-59	4.52±0.32	4.36-4.69	4.04±0.17***	3.95-4.13
60-69	4.44±0.27	4.29-4.59	3.97±0.16***	3.88-4.06

SD=Standard Deviation; CL=Confidence Limit; GP=Group; P=Probability; CM=Centimeter *** = P<0.001

3.3 Analysis of the Results for TB of Right and Left Talus in Males

The TB of the right and left talus in male was compared. It was observed that right mean value ranged from 4.38 cm at 60-69 years' age group to 4.69cm at 30-39 years' age group: while left mean value ranged from 4.44 cm at 60-69 years' age group to 4.66cm at 30-39 years' age group. There are no statistically significant differences (p>0.05) between right and left talus in males (Table 4)

Table 4: Descriptive Statistics for TB of Right and Left Talus in Males

Age GP (Yrs)	Right (n = 16)		Left (n = 16)	
	Mean ± SD (cm)	95% CL (cm)	Mean ± SD (cm)	95% CL (cm)
20-29	4.62±0.23	4.50-4.73	4.59±0.17 NS	4.50-4.68
30-39	4.69±0.15	4.61-4.78	4.66±0.16 NS	4.57-4.75
40-49	4.60±0.22	4.49-4.72	4.58±0.22 NS	4.47-4.69
50-59	4.51±0.33	4.34-4.68	4.52±0.32 NS	4.36-4.69
60-69	4.38±0.21	4.26-4.50	4.44±0.27 NS	4.29-4.59

SD=Standard Deviation; CL=Confidence Limit; GP=Group; P=Probability; CM=Centimeter; NS= Not Significant

3.4 Analysis of the Results for the TB of Right and Left Talus in Females

The TB of the right and left talus in female was compared. It was observed that right mean value ranged from 3.95cm at 60-69 years' age group to 4.19cm at 30-39 years' age group: while left mean value ranged from 3.97cm to 4.18cm at the same age group respectively. There are no statistically significant differences (p>0.05) between right and left talus in females (Table 5).

Table 5: Descriptive Statistics for the TB of the Right and Left Talus in Females

Age GP (Yrs)	Right		Left	
	Mean ± SD (cm)	95% CL (cm)	Mean ± SD (cm)	95% CL (cm)
20-29	4.16±0.22	4.04-4.27	4.10±0.19 NS	4.00-4.20
30-39	4.19±0.14	4.11-4.27	4.18±0.14 NS	4.10-4.26
40-49	4.09±0.20	3.99-4.19	4.08±0.18 NS	3.99-4.17
50-59	4.05±0.21	3.95-4.16	4.04±0.17 NS	3.95-4.13
60-69	3.95±0.17	3.86-4.05	3.97±0.16 NS	3.88-4.06

SD=Standard Deviation; CL=Confidence Limit; GP=Group; P=Probability; CM=Centimeter; NS= Not Significant

3.5 DP and ISD for TB of the Right Talus for Male and Female

DP for the male TB of the right talus ranged from >4.46cm at 60-69 years' age group to >4.82cm at 20-29 years' age group: while the DPs for the female ranged from <3.52cm at 50-59 years' age group to <4.24cm at 30-39 years' age groups. ISD at 20-29 years' age group was 111.06, 30-39 years' age group was 111.93, 40-49 years' age group was 112.47, 50-59 years' age group was 111.36 and 60-69 years' age group was 110.89 (Table 6).

Table 6: The DP and ISD for APL of the Right Talus for Male and Female

Age GP (Yrs)	Male			Female		D.P (cm)	ISD
	Mean ± SD (cm)	CR (cm)	D.P(cm)	Mean ± SD (cm)	CR (cm)		
20-29	4.62±0.23	3.93-5.31	>4.82	4.16±0.23	3.50-4.82	<3.93	111.06
30-29	4.69+0.15	4.24-5.14	>4.61	4.19±0.14	3.77-4.61	<4.24	111.93
40-49	4.60±0.22	3.94-5.24	>4.69	4.09±0.20	3.49-4.69	<3.94	112.47
50-59	4.51±0.33	3.52-5.50	>4.68	4.05±0.21	3.42-4.68	<3.52	111.36
69-69	4.38±0.21	3.75-5.01	>4.46	3.95±0.17	3.44-4.46	<3.75	110.89

SD=Standard Deviation; DP=Demarking Point; ISD=Index of Sexual Dimorphism; CM=Centimeter; YRS= years; GP= Group; CR=Calculated Range

3.6 The DP and ISD for TB of the Left Talus for Male and Female

DP for the male TB of the left talus ranged from >4.45cm at 60-69 years' age group to >4.67cm at 20-29 years' age group: while the DPs for the female ranged from <3.56cm at 50-59 years' age group to <4.18cm at 30-39 years' age group. ISD at 20-29 years' age group was 111.95, 30-39 years' age group was 111.48, 40-49 years' age group was 112.25, 50-59 years' age group was 111-88 and 60-69 years' age group was 111.84 (Table7).

Table 7: The DP and ISD for TB of the Left Talus for Male and Female

Age GP (Yrs)	Male			Female		D.P (cm)	ISD
	Mean ± SD (cm)	CR (cm)	D.P (cm)	Mean ±SD (cm)	CR (cm)		
20-29	4.59±0.17	4.08-5.10	>4.67	4.10±0.19	3.53-4.67	<4.08	111.95
30-39	4.66±0.16	4.18-5.14	>4.60	4.18±0.14	3.76-4.60	<4.18	111.48
40-49	4.58±0.22	3.92-5.24	>4.62	4.08±0.18	3.54-4.62	<3.92	112.25
50-59	4.52±0.32	3.56-5.48	>4.55	4.04±0.17	3.53-4.55	<3.56	111.88
60-69	4.44±0.27	3.63-5.25	>4.45	3.97±0.16	3.49-4.45	<3.63	111.84

SD=Standard Deviation; D.P=Demarking Point; ISD=Index of Sexual Dimorphism; CM=Centimeter; YRS= years; GP= Group; CR=Calculated Range

3.7 Comparison of the Transverse Breadth (TB) in both sexes among 20-29 and other age groups.

The TB of the talus in both sexes was compared among 20-29 and other age groups. It was observed that the difference was significant at 60-69 years age group in males: while in females, the differences was significant at 50-59 years age group and above. (Table 8)

Table 8: Descriptive Statistics for TB in both sexes among 20-29 and other Age Groups (Yrs).

Sex	20-29 Years		30-39 Years	
	Mean ± SD (cm)	95%CL (cm)	Mean ± SD (cm)	95%CL (cm)
Males	4.61±0.02	4.41-4.80	4.68±0.02^{NS}	4.48-4.87
Females	4.13±0.04	3.75-4.51	4.19±0.01^{NS}	4.12-4.25
	20-29 Years		**40-49 Years**	
Males	4.61±0.02	4.41-4.80	4.59±0.01^{NS}	4.46-4.72
Females	4.13±0.04	3.75-4.51	4.09±0.01^{NS}	4.02-4.15
	20-29 Years		**50-59 Years**	
Males	4.61±0.02	4.41-4.80	4.52±0.01^{NS}	4.45-4.59
Females	4.13±0.04	3.75-4.51	4.05±0.01*	3.98-4.11
	20-29 Years		**60-69 Years**	
Males	4.61±0.02	4.41-4.80	4.41±0.04**	4.03-4.79
Females	4.13±0.04	3.75-4.51	3.96±0.01**	3.83-4.09

SD=Standard Deviation; CM=Centimeter; TB=Transverse Breadth, *** = P<0.001, ** = P<0.01, * = P<0.1 and NS = Not Significant

3.8 Comparison of the Transverse Breadth (TB) in both sexes among 30-39 and other age groups.

The TB of the talus in both sexes was compared among 30-39 and other age groups. It was observed that the difference was significant at 50-59 years age group and above in males: while in females, the differences was significant at 40-49 years age group and above (Table 9)

Table 9: Descriptive Statistics for TB in both sexes among 30-39 and other Age Groups (Yrs).

Sex	*30-39 Years*		*40-49 Years*	
	Mean±SD (cm)	95%CL (cm)	Mean±SD (cm)	95%CL (cm)
Males	4.68±0.02	4.48-4.87	4.59±0.01^{NS}	4.46-4.72
Females	4.19±0.01	4.12-4.25	4.09±0.01*	4.02-4.15
	30-39 Years		**50-59 Years**	
Males	4.68±0.02	4.48-4.87	4.52±0.01**	4.45-4.59
Females	4.19±0.01	4.12-4.25	4.05±0.01**	3.98-4.11
	30-39 Years		**60-69 Years**	
Males	4.68±0.02	4.48-4.87	4.41±0.04***	4.03-4.79
Females	4.19±0.01	4.12-4.25	3.96±0.01***	3.83-4.09

SD=Standard Deviation; CM=Centimeter; APL=Transverse Breadth, *** = P<0.001, ** = P<0.01, * = P<0.1 and NS = Not Significant

3.9 Comparison of the Transverse Breadth (TB) in both sexes among 40-49, 50-59 and other age groups.

The TB of the talus in both sexes was compared among 40-49 and other age groups. It was observed that the difference was significant at 60-69 years age group in both sexes. Also between 50-59 and 60-69 years age group in both sexes (Table 10)

Table 10: Descriptive Statistics for APL in both sexes among 40-49 and other Age Groups (yrs).

Sex	*40-49 Years*		*50-59 Years*	
	Mean ± SD (cm)	95%CL (cm)	Mean ± SD (cm)	95%CL (cm)
Males	4.59±0.01	4.46-4.72	4.52±0.01^{NS}	4.45-4.59
Females	4.09±0.01	4.02-4.15	4.05±0.01^{NS}	3.98-4.11
	40-49 Years		**60-69 Years**	
Males	4.59±0.01	4.46-4.72	4.41±0.04**	4.03-4.79
Females	4.09±0.01	4.02-4.15	3.96±0.01**	3.83-4.09
	50-59 Years		**60-69 Years**	
Males	4.52±0.01	4.45-4.58	4.41±0.04**	4.03-4.79
Females	4.05±0.01	3.98-4.11	3.96±0.01**	3.83-4.09

SD=Standard Deviation; CM=Centimeter; APL=Transverse Breadth, *** = P<0.001, ** = P<0.01, * = P<0.1 and NS = Not Significant

This study showed that the mean transverse breadth of talus was significantly greater in males than their females counterpart in all the age groups; with average value of 4.60 cm for the males but 4.05 cm for the females. These values follow a similar pattern with that observed by Torres (2010) [1], who noticed a significant difference between the male transverse breadth and female transverse breadth of the talus. The higher values in males further confirm that male bones are heavier and more robust than female bones which make males to be more physically stronger than their females counterpart. Degenerative changes in bone are observed earlier in females than in males due to earlier decrease in steroid hormones in females [13]. This earlier decrease in steroid hormones is as a result of menopause that takes place in females at about 50 years of age. Occupationally, some males are involved in hard jobs such as bricklaying, welding, carpentry which are rarely seen in females. These types of work make male bones to develop and remain healthier for a long time than that of their female counterpart [13]. The study also observed that the mean transverse breadth of the talus changed with age. The differences between the age group were statistically significantly in some age group, but insignificant in others. Between the 30-39 and 60-69 years' age groups, the differences were highly significant (P<0.001) in both sexes This difference can be attributed to the fact that bones grow from birth to early adulthood, reaches it maturity at about 30 years, they maintain this state of maturity for about 20 years, before undergoing some degenerative changes which normally start around 60 years in male, but earlier in females. Other factors that affect bone growth are: genetic factors, environmental factors such as dietary patterns and occupation together with hormonal factors like growth hormones, estrogens for females and testosterone for male tends to reduce in quantity in the body system at old age [14]. Aging has two main effects on the skeletal system: Bones become more brittle and lose mass. Bone brittleness results from a decrease in the rate of protein synthesis and in the production of human growth hormone, which diminishes the production of the collagen fibers that give bones strength and flexibility [14]. As a result, inorganic minerals gradually constitute a greater proportion of the bone extracellular matrix. Loss of bone mass results from demineralization which usually begins after age 30 in females, accelerate greatly around age 45 as levels of estrogens decrease and continues until as much as about 30% of the calcium in

bones is lost by age 70 years [14]. Once bone loss begins in females, about 8% of bone mass is lost every decade [14]. In males, calcium loss from bone typically does not begin until after about 60 years, and about 3% of bone mass is lost every decade [14]. The loss of calcium from bones is one of the problems in osteoporosis. Loss of bone mass also leads to bone deformity, pain, stiffness, some loss of height, and loss of teeth [1].

The present study indicated that the right transverse breadths of the talus were slightly greater than the left transverse breadth of the talus in both sexes, but the differences were statistically insignificant which correlate with similar study by [15]. The study indicated that the average right transverse breadth was 4.64cm in males and 4.08cm in females compared to the average left transverse breadth which was 4.61cm in males and 4.03 cm in females. These values are comparable with the result reported by [16]: who observed that talus has no significant side differences (P>0.05). However, [7] noted a significant side differences in the transverse breadth of the talus. This is contrary to the present study which showed a slight but insignificant difference between the right and left talus (P>0.05). The mean transverse breadth of the talus in both sexes on both sides was highest from the 30-39 years' group but lowest at the 60-69 years' group. It increased slightly from 20 years to 40 years, but maintained a close range as the value decreased down to the last age group. It was also observed that the transverse breadth was sexually dimorphic, as the demarking points of the male transverse breadth were all higher than those of the female. Index of sexual dimorphism confirmed that male transverse breadths of the talus were all greater than female transverse breadth of the talus as the index of sexual dimorphism were all greater than 100 in all the age groups. DPs showed a similar trend of increase in male parameters over their female counterparts of the same age group. The results also showed age related variation for all the parameters which increased from 20-29 year through 30-39-years age groups, followed by a decrease to 60-69years age group in both sexes. This evidence suggests that the talus undergoes continuous changes throughout the age ranged studies. It was also observed that radiographic measurements of bones from Nigeria population was found to be higher than the morphometric study using dry bones from other parts of the world; which includes talus. Factors contributing to the measured differences between bone specimen and the X-rays and can be hypothesized as due to partial volume effects, that may be responsible for these differences which result to greater values in the radiological study than the direct bone measurement. In plain radiographs, magnification factor can only be roughly estimated; besides X-ray measurements have the common limitation of two dimensional structures. Bone specimen observations has the usual benefit of the three-dimensional presentation. On the other hand, the fact that some dry bone properties differ from the in vivo bones was the main limitation. It is known that the average male skeleton is longer and more robust than the average female, although the magnitude of the difference varies from population to population. This sex difference can be as a result of genetic and environmental factors affecting growth and development (nutrition, physical activities, hormones and pathologies), or the interaction of these factors [9]. These parameters placed talus as a useful bone in sex determination among adult north-eastern Nigerians particularly where other bones commonly used for sex determination of individual from skeletal remains such as pelvic and skull are not found. The measurements of the talus for identification of sex by several researchers is not applicable to all regions, because of variations as observed by [17] in culture, diet, heredity, climate and other geographical conditions. [18] Also stated that the human body dimension can be affected by cultural, geographical, gender and age factor.

4. Conclusion

The result of the present study showed that, parameters of TB of talus were all greater in males than females ($p<0.001$). It was also observed that the TB changed with age, and the changes differ significantly between some age groups. ISD were also calculated, and it was observed that all parameters were found to be greater than 100. This showed that male had higher values over their female counterparts of the same age group. Hence the study of bones morphology is of used from region to region, because of these numerous factors in sex determination. Further work on the talus is required on the southern and other parts of Nigeria and this may be the reason why population specific standards must be developed for sex differentiation in Nigeria.

5. Ethical Approval

All authors hereby declare that all radiographs and measurement protocol have been examined and approved by the ethical committee of the University of Maiduguri Teaching Hospital (UMTH) and have therefore been performed in accordance with the ethical standards laid down in the 1964 Declaration of Helsinki."

6. Competing Interests

Authors have declared that no competing interest exist.

7. References

1. Torres B. Population and Sex Determination Based on Measurements of the Talus. Journal of Biological Anthropology. 2010; 2:1.
2. Bidmos M, Dayal M, Asala S. Sex determination from the Talus of South African Whites by Discriminate Function Analysis. The American Journal of Forensic Medicine and Pathology. 2003; 24(4):322-328.
3. Davivongs V. The Pelvic Girdle of the Australian Aborigines; Sex difference and Sex Determination. American Journal of Physical Anthropology.1963; 21:443-445.
4. Jit I, Singh S. Sexing of the adult Clavicle. Indian Journal of Medical Research. 1966; 54:551-571.
5. Singh S, Gangrade K. Sexing of adult Clavicle Verification and Applicability of Demarking point. Journal of Indian Academy of Forensic Science. 1968; 7:20-30.
6. Singh P, Singh S. Identification of Sex from the Humerus. Indian Journal of Medical Research. 1972; 60:1061-1066.
7. Ari I, Kafa M. Bone Length Estimation of Calcaneus and Talus. Coll. Antropol. 2009; 33(2):613-618.
8. Kumar A, Tyagi A, Aggarwal N. Sex determination by morphology of talus bone. Journal of Forensic Medicine and Toxicology. 2008; 25:1.
9. Kafa M, Liker M, Liknur A. Bone length estimation and population specific feature of talus of the late Byzantine. Forensic Science international. 2009; 2:613-618.
10. Ryan S, Michelle N, Stephen E. Anatomy for Diagnostic Imaging 2nd ed. Toroto. 2005, 609-615.

11. In Stat 3 Graph pad Graphpad software, inc. San Diego California USA. 2003.
12. Marin V, Jelena D, Zeljko D, Dair M. Determination of sex by discriminant function analysis of mandibles from two Croatian archaeological sites. Acta Stonatology of Croatia. 2006; 40(3):263-277.
13. Giles E, Elliot O. Sex determination by discriminant function analysis of crania. American Journal of Physical Anthropology. 1963; 21:53-68.
14. Kipper G. Determination of sex from femora. Forensic Sci. International. 2002; 113:315-321.
15. Eduitem SO, Aminu AA, Danladi SA, Zainab M, Jacks TW, Martha A. Estimation of Sex using antero-posterior dimension of talus in northeastern Nigerians. British Journal of Medicine and Medical Research. 2016; 14(3):1-8.
16. Oygulu O, Wafa M, Ragaa M. Pelvic girdle assessment: sex determination from skeletal remains of Indian population. Forensic Science International. 2007; 125:134-136.
17. Steele D. The estimation of sex on the basis of the talus and calcaneus American Journal of Physical Anthropology. 2005; 45:581-588.
18. Asala SA, Mbajiorgu FE, Papandro BA. A Comparative Study of Femoral Head Diameters and sex differentiation in Nigerians. Acta Anatomica. 1998; 162:232-237.