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Original Research Article

Morphological evaluation and clinical significance of proximal femoral dimensions among Southern Nigerian population

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ABSTRACT

Background: Anthropometric studies are vital in evaluation and description of morphological characteristics of body tissues of living individuals or dead remains. This study was done to evaluate proximal femoral dimensions and to describe sexual or bilateral dimorphism among Southern Nigerians.
Methods: This study involved 500 pelvic radiographs showing proximal aspects of right and left femurs of Southern Nigerians (including 250 males and 250 females) between ages 25 to 55 years. Measurements taken on radiographs include transverse diameter and vertical diameter of femoral head, neck diameter (ND), neck length (NL) and proximal shaft diameter. Bilateral measurements were recorded and average values evaluated. Data were analyzed using IBM-statistical package for social sciences (SPSS) (version 20) and statistical comparison was done using analysis of variance (ANOVA) with $p<0.05$ regarded as statistically significant level.
Results: Proximal femoral dimensions showed non-significant bilateral differences with right side having higher values in all parameters except NL in males and ND in females. Also, mean values for TD (5.39±0.25 and 4.28±0.21), VD (5.01±0.21 and 4.58±0.19), ND (4.03±0.22 and 3.61±0.18), NL (2.08±0.11 and 1.79±0.10) for male and females subjects respectively showed sexual dimorphism in all parameters with males having significantly ($p<0.05$) higher values than females.
Conclusions: The femur is an important bone in human body that plays crucial morphological and physiological role and offers prominent anthropometric value.

Keywords: Physical Anthropometry, Proximal femoral dimensions, Sexual dimorphism, Southern Nigeria

INTRODUCTION

Physical anthropometry is an important branch of biological anthropology that involves scientific measurements of physical dimensions, mass and strength of parts or the whole of human body with particular reference to bony, muscular and adipose tissue mass.[1-4] Anthropometric studies are therefore vital in evaluation of morphological landmarks and description of morphological characteristics of bony, dental and soft tissue components of the body of living individuals or dead remains within a given population. Also, anthropometric studies, including those of bony components, help to generate scientific results which are useful in human identification, forensic investigation, clinical diagnosis, plastic and reconstructive surgical procedures.[5,6]

Basically, sex identification and age estimation are among most important forensic procedures which are often achieved with complete skeleton but usually challenging and cumbersome with mutilated or

incomplete skeletal remains. During such forensic procedures, bone morphometry or densitometry techniques are employed to derive vital results useful for sex identification and age estimation with cranium and pelvic bones being most generally preferred.[7,8] However, the femur has been described as the most dimorphic long bone commonly used for sex identification and also to estimate age with application of multiple femoral morphometrics known to produce more efficient outcomes.[7-9]

The femoral bone is the longest and strongest bone in the human body, located between hip joint superiorly and knee joint inferiorly and thereby transmits the body weight from pelvic bone to tibial bone. Morphologically, it can be divided into three parts which include proximal end, shaft or body and distal end.[10-12] These different parts have been studied to establish their anthropometric value and the most valuable parts are components of proximal and distal ends such as head, neck and condyles. In particular, femoral head dimensions are crucial variables that have been used to demonstrate sexual dimorphism, racial variation and more importantly in the diagnosis and treatment of femoral neck fractures.[13,14] These diverse applications and clinical significance of proximal femoral morphometrics necessitated this study among the Southern Nigerian population. Therefore, the objectives of this study were to evaluate standard values of femoral head, femoral neck and proximal shaft dimensions among Southern Nigerians and to describe possible sexual and bilateral dimorphism of these proximal femoral dimensions among the study population.

METHODS

This study involved 500 plain anterior-posterior (AP) pelvic radiographs showing proximal aspects of right and left femoral bones of Southern Nigerians (including 250 males and 250 females) between ages 25 to 55 years. They were accessed from selected radiological diagnostic centers in three geo-political zones of Southern Nigeria during years 2007 to 2015 following a duly informed consent from all prospective subjects. Measurements taken on selected radiographs are femoral head dimensions (FHD) which include the transverse diameter (TD) measured as distance between two vertical lines passing through medial and lateral margins of femoral head and the vertical diameter (VD) measured as distance between two horizontal lines passing through superior and inferior margins of femoral head. In defining femoral neck dimensions (FND), three diameters were marked as distances between inferomedial and superolateral borders at proximal end, middle and distal end of femoral neck. The middle diameter represented the definitive neck diameter (ND) while distance between midpoints of proximal and distal diameters represented the neck length (NL). The proximal shaft diameter (PSD) was measured as horizontal width of femoral shaft at a point just distal to lesser trochanter. All measurements for right and left side were recorded and average values for each parameter evaluated.

Inclusion and exclusion criteria

Only radiographs showing right and left femurs in well articulated orientation with pelvic bone and with no observable fracture or pathology were included in this study. Conversely, radiographs showing pelvic or proximal femoral fractures and/or hip joint dislocation were excluded from this study.

Statistical analysis

Recorded data were analyzed using IBM-SPSS (version 20) and statistical comparison was done using analysis of variance (ANOVA) and $p<0.05$ was regarded as statistically significant level.

RESULTS

According to findings of this study, proximal femoral dimensions of male subjects showed non-significant bilateral variation with the right side having slightly higher values in all parameters except femoral neck length that showed opposite outcome (Table 1). Similar result was observed among the female subjects with the right side having values for all proximal femoral dimensions except the femoral neck diameter (Table 2). However, comparison across gender showed prominent sexual dimorphism in all parameters of this study with male subjects having significantly ($p<0.05$) higher values than their female counterparts (Table 3).

Table 1: Mean values of right and left femoral head, femoral neck and proximal shaft dimensions among males Southern Nigerians.

	FHD				FND					
	TD		VD		ND		NL		PSD	
	Right	Left	Right	Left	Right	Left	Right	Left	Right	Left
Mean	5.42	5.27	5.08	4.96	4.08	3.93	2.09	2.13	4.05	3.97
SEM	0.27	0.19	0.29	0.18	0.21	0.17	0.11	0.09	0.21	0.19
SD	0.86	0.88	0.93	0.89	0.76	0.88	0.58	0.54	0.91	0.89
Range	1.25	1.15	1.45	1.35	1.25	1.15	0.85	0.90	1.15	1.15

Table 2: Mean values of right and left femoral head, femoral neck and proximal shaft dimensions among females Southern Nigerians.

	FHD				FND					
	TD		VD		ND		NL		PSD	
	Right	Left	Right	Left	Right	Left	Right	Left	Right	Left
Mean	4.92	4.77	4.63	4.54	3.59	3.66	1.82	1.69	3.76	3.67
SEM	0.22	0.15	0.27	0.19	0.16	0.19	0.10	0.08	0.19	0.13
SD	0.87	0.82	0.76	0.71	0.63	0.58	0.43	0.51	0.77	0.83
Range	1.25	1.10	1.25	1.30	1.15	1.25	0.75	0.80	1.05	0.95

Table 3: Mean values of femoral head, femoral neck and proximal shaft dimensions among males and females Southern Nigerians.

	FHD				FND					
	TD		VD		ND		NL		PSD	
	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
Mean	5.39	4.82	5.01	4.58	4.03	3.61	2.08	1.79	4.02	3.69
SEM	0.25	0.21	0.21	0.19	0.22	0.18	0.11	0.10	0.23	0.16
SD	0.72	0.85	0.77	0.65	0.54	0.62	0.49	0.52	0.66	0.71
Range	1.20	1,15	1.35	1.25	1.15	1.15	0.85	0.80	1.15	1.05

DISCUSSION

Generally, anthropometric measurements are reliable and significant markers of morphological variation within a given human population or across different populations either within the same or different sexes.[15] In particular; identification of sex is a vital forensic procedure in biological anthropology which is carried out to establish biological profile of an individual. It is often achievable by using anthropometric parameters derived from anonymous skeletal structures that readily showed sexual dimorphism.[16,17]

Based on the results of this study, proximal femoral dimensions showed non-significant bilateral differences with the right side having higher values in all parameters of study except femoral neck length in males (Table 1) and femoral neck diameter in females (Table 2). The results further showed prominent sexual dimorphism in all parameters of study with the males having significantly ($p<0.05$) higher values than their female counterparts (Table 3).

Accordingly, the mean±SEM values for the transverse diameter of femoral head were 5.39±0.25 and 4.28±0.21 while the vertical diameter of femoral head was 5.01±0.21 and 4.58±0.19 for male and female subjects respectively. The mean±SEM values for the femoral neck diameter were 4.03±0.22 and 3.61±0.18 while the femoral neck length were 2.08±0.11 and 1.79±0.10 for male and females subjects respectively. The mean±SEM values for the proximal shaft diameter were 4.02±0.23 and 3.69±0.16 for male and female subjects respectively.

The finding from this study revealed conformity with previous studies carried out in South-East, South-West and North-East regions of Nigeria wherein proximal femoral dimensions showed significant sexual dimorphism among the Nigeria population resident in those regions.[14,18-20] Further comparison showed that results of this study were significantly similar to those independently reported among Eastern and Western parts of Southern Nigeria but vary from those of Northern Nigerian population.

Furthermore, in similarity with the results of this study, findings from studies among Thai, Japanese, Portuguese and Nepalese populations showed femoral morphometric parameters such as epicondylar breadth, transverse head diameter, vertical head diameter and neck diameter as most significant femoral morphometric variables that demonstrated sexual variation.[7,8,21,22]

Another crucial application of bone morphometry or densitometry (including those involving femoral bone) is estimation of age of individual at death or from skeletal remains as well as determination of physical fitness, health status and performance levels of different individuals.[23-26] Accordingly, the results of this study, which revealed standard values of proximal femoral dimensions of adult male and female Southern Nigerians, are of great value during forensic investigative procedures such as age estimation among the study population. This is in line with previous studies that have reported the application of femoral morphometrics during important pathological procedure like age estimation for

individuals from different populations or during mass death.[27-30]

CONCLUSION

Based on the findings of this study, proximal femoral morphometrics are among the significant anthropometric indicators of sexual variation within the study population. In addition, the results of this study also present crucial anthropometric data useful in wide-range of applications. Therefore, the femoral bone is an important bone in human body that exhibits crucial morphological usefulness, plays important physiological role and offers prominent anthropometric value.

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