Sex Determination using Femoral Head Diameters on Radiographs of Adults who visited Delta State University Teaching Hospital Oghara Nigeria

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ABSTRACT

Introduction: Estimating biological sex is critical for identifying unknown skeletal remains in modern medico-legal circumstances or bioarcheological research of previous cultures. Population-specific sexual dimorphism often affects sex estimation methodologies. The goal of this study was to determine sex using femoral head diameters.

Materials and Methods: This study adopted the retrospective cross-sectional study of the quantitative design. This study was carried out in the radiology department of Delta State University Teaching Hospital, Oghara. The radiographs selected showed hip joint, intact Shenton's lines, no fracture at the femoral necks, no pathological disorders, intact cortices at femoral heads and were of known sexes. The radiographs were those taken at a routine object-film distance of 5cm and focal film distance of 92cm in the anterior-posterior view with the two big toes touching on their medial aspects. With the aid of a certified radiographer, the measurements were taken by locating the appropriate points using a mouse-operated cursor at the defined anatomical coordinates. The distance/angle in the two points were subsequently obtained from the screen's results window in standardized units. The axes of the femoral neck and shaft and the maximum femoral headdiameterswere determined by means ofthe digital vernier caliper. The data was analyzed using the Statistical Package for the Social Sciences (SPSS) software version 23 (IBM Corp., Armonk, NY, USA).The level of statistical significance was set at P < 0.05.

Results: The means of males and females were seen to be different and these differences were statistically significant for all parameters (Right Femoral Head Vertical Diameter, Right Femoral Head Transverse Diameter, Left Femoral Head Vertical Diameter; Left Femoral Head Transverse Diameter (P<0.001).

Conclusion: Focusing on the results of this study, it was concluded that the mean values of the studied parameters are statistically and significantly different in males and females. These parameters are useful and reliable for sexual dimorphism in anthropometric and Forensic studies, especially in identifying skeletal remains.

INTRODUCTION

The femur is the human body's longest, heaviest, and most powerful bone. The pyramid-shaped neck joins the spherical head at the apex and the tubular shaft at the base at the proximal end [1,2]. The greater and lesser trochanters are two conspicuous bony bulges that connect to muscles that move the hip and knee. The angle between the neck and the shaft, in a typical adult is around 128 degrees. In contrast, the inclination angle decreases with age [3,4].

Estimating biological sex is critical for identifying unknown skeletal remains in modern medico-legal circumstances or bioarcheological research of previous cultures. Population-specific sexual dimorphism often affects sex estimation methodologies. As a result, the necessity for separate criteria for each group has long been recognized [5]. Apart from stature and ethnicity, age and gender estimation are critical characteristics in medico-legal and archaeological identification [6-10]. Identifying an unidentified body becomes easier when the entire body or skeleton remains are available. It gets difficult, however. When dismembered body parts are the sole material accessible to the investigator, which is frequently the case in most circumstances [11-13]

The neck-shaft angle (NSA) is defined as the obtuse angle generated by the intersection of two axes: the femoral shaft axis and the femoral neck axis [14-16]. This keeps the leg away from the pelvis during movement. It is broadest at birth and gradually narrows until the age of ten [17,18]. The NSA value averages 127° and fluctuates depending to temperature, clothes, lifestyle, sex, age, and side [19,20]. As a result, the NSA is subject to change. Diverse researches in diverse populations have determined normal ranges. A drop in NSA is referred to as coxa vara, whilst a rise is referred to as coxa valga. This study therefore aimed at determining sex using femoral head diameters.

MATERIALS AND METHODS

This descriptive cross-sectional study retrospectively of patients who visited the Radiological unit of the Delta State University Teaching Hospital Oghara in Nigeria between 2014 to 2021. Before the commencement of data collection, an ethical approval from the Research and Ethics Committee of the Hospital (DELSUTH/HRE/2022/068/0635) was obtained.

The populations of this study were adults (18 years to 70 years; 357 radiographs) who visited the radiology department of Delta State University Teaching Hospital, Oghara for pelvic radiography. The radiographs selected showed the hip joints, intact Shenton's lines, no fracture at the femoral necks, no pathological disorders, intact cortices at femoral heads and were of known sexes.

The radiographs were those taken at a routine object-film distance of 5 cm and focal film distance of 92 cm in the anterior-posterior view with the two big toes touching on their medial aspects. With the aid of a certified radiographer, the measurements were taken by locating the appropriate points using a mouse-operated cursor at the defined anatomical coordinates. The transverse diameter of the femoral shaft was measured at two sites to identify the longitudinal axis of the femoral shaft: one beneath the lesser trochanter and one under in diaphysis [21,22]. The midpoints of the two diameters was then determined and connected by a line, the longitudinal axis of the femoral shaft [23].

The obtuse angle (interior) of the femoral neck and shaft axes was gotten as Neck-Shaft angle and the measurements was performed by extending the lines joining the midpoints of the femoral neck and the femoral shaft until they intersected [24-26]. Vertical diameter of the femur head was measured at right angle to the long axis of the neck of femur [27]. This was gotten as the

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straight distance between the highest and deepest points of the femoral head [28] Transverse diameter of the femur head was gotten by drawing a best fit circleof the femur head [29]. And measurement taken as an extension of the femoral neck axis from the border of the circle opposite the acetabulum to the border of the circle directly underneath the rim of the acetabulum.

The data was analyzed using the Statistical Package for the Social Sciences (SPSS) software version 23 (IBM Corp., Armonk, NY, USA).The level of statistical significance was set at P < 0.05. Firstly, the general descriptive statistics for the different parameter were obtained. The independent T-tests was employed to find differences between the sexes while the paired T-test was used to determine the side difference between the right and left femoral head diameters. The sexual dimorphism ratio was calculated as: (male mean/female mean) × 100. Lastly, stepwise and direct discriminant function analyses were performed to discriminate between sexes [Figures 1 and 2].

RESULTS

Table 1 showed the means of the different parameters within age group 18-27 years. The means of males and females were seen to have variations and these variations were statistically significant for all parameters. The sex differences observed in RFHVD, RFHTD, LFHVD and LFHTD were highly statistically significant with P-Value of P<0.001.

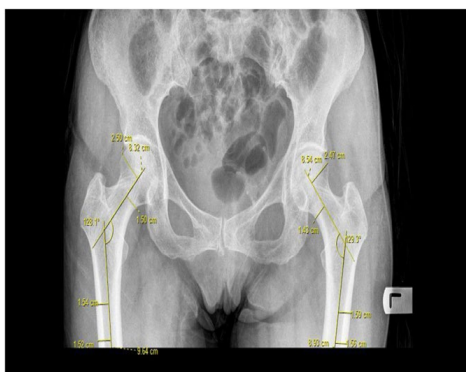The means of the different parameters within age group 28-37 years were

Figure 1) *Pelvic Radiograph Showing the Femoral Head Diameters (DELSUTH, 2023).*
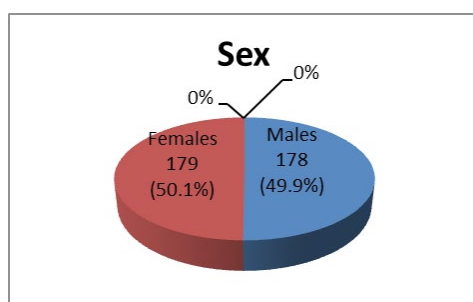

Figure 2) *Sex Distribution.*

Table 1) *Descriptive Statistics.*

	N	Minimum	Maximum	Mean	Std. Deviation
Age (years)	357	18	70	43.33	14.632
Right femoral head vertical diameter(cm)	357	3.81	5.22	4.7137	0.25936
Right femoral head transverse diameter(cm)	357	3.78	5.19	4.6562	0.25366
Left femoral head vertical diameter(cm)	357	3.79	5.2	4.6573	0.25975
Left femoral head transverse diameter(cm)	357	3.7	5.12	4.5975	0.25029

observed. There was statistically significant sex difference for all parameters. The sex differences observed in RFHVD, RFHTD, LFHVD and LFHTD were highly statistically significant with P<0.001 [Table 2].

Table 3 showed the means of the different studied parameters. The table revealed that the study comprised of 178 males and 179 females whose means showed statistically significant sex differences for all parameters (P<0.001).

Stepwise discriminant function analysis was developed for all variables and is presented in Table 4. The LFHVD was found to be most dimorphic followed by RFHVD, RFHTD and LFHTD. This classification was based on their Eigen, Canonical correlation, Wilk's Lambda and Chi-square values. Those with the highest values of Eigen, Canonical correlation and Chi-square values were said to be more dimorphic while the lower the Wilk's Lambda value the more dimorphic the variables [30,31]. The table also showed that these values were statistically significant with P < 0.001.

DISCUSSION

In forensic anthropology and bioarchaeology, sex estimation is one of the steps to characterize and/or achieve a successful identification of unknown individuals. For the Sexual Dimorphism of the human bones, the male bones are more massive and heavier than female bones. The crests, ridges, tuberosities, and lines of attachment of muscles and ligaments are more strongly marked in males. However, the femur remains by far the masterpiece of skeletal specimen in establishing sex. In this study 357 pelvic radiographs were used (males=178 and females-179) to determine sex and ascertain the percentage of accuracy.

From this study it was found that for all the parameters, the mean for the males were more than the means for the females and this was in agreement with Igbigbi and Msamati [32]. Tahir et al [33]. Abdul-Rafik et al [34]. And Kumar et al [35]. who found out that the femoral head diameters, collodiaphysial angles and all measured parameters respectively were greater in males than in females.

From this study, it was observed that generally, all the parameters have a strong positive correlation with their opposite side with the femoral head vertical diameter having the highest (0.974). It was also revealed that this correlation was highly statistically significant with P < 0.001. This was in accordance with Barnali et al [36]. But was inconsistent with Prabha et al [37]. Who reported that there was no statistically significant association between the right and left side of the femoral head diameters? Discrepancies in this finding may be due to differences in methodology and genetic variations.

Identification points (IP) are levels of femoral head diameters above which values are those of male bones and below which are female bones. According

Table 2) *Sex Differences of Studied Parameters within Age Group 18-27 Years.*

Parameters	Gender	N	Mean	Std. Deviation	P-Value
RFHVD (cm)	M	35	4.7740	0.19090	<0.001
	F	32	4.3072	0.20073	
RFHTD (cm)	M	35	4.7014	0.16714	<0.001
	F	32	4.2581	0.20628	
LFHVD (cm)	M	35	4.7283	0.17606	<0.001
	F	32	4.2550	0.20304	
LFHTD (cm)	M	35	4.6549	0.16008	<0.001
	F	32	4.2134	0.23076	

Table 3) *Sex Differences of Studied Parameters.*

Parameters	Gender	N	Mean	Std. Deviation	P-Value
RFHVD (cm)	M	178	4.8985	0.16484	<0.001
	F	179	4.5299	0.19842	
RFHTD (cm)	M	178	4.8337	0.16213	<0.001
	F	179	4.4798	0.19944	
LFHVD (cm)	M	178	4.8452	0.15739	<0.001
	F	179	4.4706	0.19987	
LFHTD (cm)	M	178	4.7684	0.16065	<0.001
	F	179	4.4274	0.20330	

Table 4) *Stepwise Discriminant Function Analysis for Sex Determination from Femoral Head Diameters.*

Variables	Eigen	Cannonical Correlation	Wilk's Lambda	Chi-Square	Df	Significance
RFHVD	1.026	0.712	0.493	250.368	1	<0.001
RFHTD	0.952	0.698	0.512	237.160	1	<0.001
LFHVD	1.090	0.722	0.479	261.245	1	<0.001
LFHTD	0.870	0.682	0.535	221.950	1	<0.001
All Variables	1.832	0.804	0.353	366.425	6	<0.001

to Igbigbi and Msamati [32] the identification point for the different parameters were derived from the range of their values (minimum and maximum values) and this was adopted in this study. In this study, the male identification point was derived as the maximum value of the female femoral head diameters, while the identification point for the female was derived as the minimum value of the female femoral head diameters. The identification point of the right femoral head transverse diameter had the highest identification point (5.12 cm) in femoral head diameters in males.

This suggests that any value below 5.12 cm for the right femoral head transverse diameter is considered a female. While in females, the identification point of the right and left femoral head vertical diameter had the highest identification point (4.30 cm each) in femoral head diameters. This study revealed that the identification points for the males are generally greater than those of the females and this was in unison with Igbigbi and Msamati [32].

CONCLUSION

Focusing on the results of this study, it was concluded that the mean values of the studied parameters are significantly higher in males than females. These parameters are useful and reliable for sexual dimorphism in anthropometric and Forensic studies, especially in identifying skeletal remains.

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