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Anatomy

Comparative Analysis of the Morphology of the Male and Female Humeri

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Abstract | **Original Research Article**

Background: Almost every bone in the human skeleton exhibits sexual variation. The humerus, a large bone in the upper limb, is commonly used to determine sex due to its very stable condition. ***Aim of the study:*** The goal of the current study is to evaluate various measures of the humerus to determine sex. ***Methods:*** This study was conducted in Department of Anatomy, Anwer Khan Modern Medical College, Dhanmondi, Dhaka, Bangladesh, from June 2023 to June 2024. This cross-sectional study examined on 200 well ossified humeri, among them 100 were male and 100 were female humeri. Each bone was thoroughly examined to determine any obvious abnormalities. The study looked at six measurements: maximum length of the humerus (MLH), maximum diameter of the humeral head (MDH), vertical diameter of the humeral head (VDH), transverse diameter of the humeral head (TDH), condylar breadth (CB), and epicondylar breadth (EB). All data was collected, documented in a Microsoft Excel work sheet, and analyzed using descriptive statistics in SPSS 23.0. ***Results:*** Male and female participants had MLH measurements of 305.86 ± 11.19 mm and 282.88 ± 6.78 mm, respectively. Male and female MDH measurements were 42.75 ± 1.81 mm and 39.86 ± 1.62 mm, respectively. The VDH measured 41.54 ± 1.63 mm in males and 38.88 ± 1.52 mm in females, respectively. Males had a TDH of 38.28 ± 1.82 mm, while females had 35.77 ± 1.49 mm. Males and females had EBs of 54.23 ± 4.60 mm and 49.64 ± 8.27 mm. The CB measured 37.17 ± 2.22 mm in males and 34.29 ± 1.08 mm in females. A value below the stated threshold was categorized as female, while a number over it was classified as male. For example, a maximum humerus length of more than 289.6 mm is classified as male, whereas a length less than 289.6 mm is classified as female. The threshold values for MDH, VDH, TDH, EB, and CB are 42.6 mm, 41.7 mm, 39.9 mm, 55.4 mm, and 36.5 mm, respectively. ***Conclusion:*** This study found that the maximum length of the humerus and vertical diameter of the humeral head are the most accurate parameters for establishing gender from human skeletal remains.

Keywords: Morphometric, humerus, males, females.

INTRODUCTION

Almost every bone in the human skeleton shows anatomical variation. The humerus is a large bone in the upper limb that does not degrade with time, hence it is preferred for sex determination. The length of numerous bones in the human body, especially the humerus, is an excellent predictor of gender, but the vertical diameter of the head is also important in determining sex [1]. Several studies on upper-limb bone measurements, including the humerus, have been conducted using metric systems developed in Chile [2], South Africa [3], Guatemala [4], the Dart collection [5], the island of Crete [6, 7], Turkey [8], Greece [9], America [10], and the Eastern Adriatic coast [11]. Observing morphological characteristics of the entire human skeleton allows for straightforward sex estimation [12]. Accurate sex diagnosis is easier when the full skeleton is accessible. However, assessment becomes more challenging when only a section of the skeleton is available [13]. Anthropologists use bone remains to reconstruct a person's biological profile, including sex, age, and height [14]. Identifying gender is a fundamental element of assessment, as other methods of assessing age and size rely heavily on sex [15]. Sex is determined mostly by the pelvic girdle, cranium, and long bones. Missing anatomical features such as the pelvis and skull might lead to inaccurate sex classifications. Parameters for long bones, which are commonly found in the collection, need to be created [16]. This study evaluated various measures of the humerus to determine sex.

METHODOLOGY

This study was conducted in Department of Anatomy, Anwer Khan Modern Medical College, Dhanmondi, Dhaka, Bangladesh, from June 2023 to June 2024. This cross-sectional study examined on 200 well ossified humeri, among them 100 were male and 100 were female humeri. Each bone was thoroughly examined to determine any obvious abnormalities. The study focused on six measurements: maximum length of the humerus (MLH), maximum diameter of the humeral head (MDH), vertical diameter of the humeral head (VDH), transverse diameter of the humeral head (TDH), condylar breadth (CB), and epicondylar breadth (EB). The maximum length of the humerus was defined as the distance between the peak of the humeral head and the lowest point on the trochlea. The vertical diameter was calculated as the distance between the highest and lowest places on the articular surface of the humeral head. The transverse diameter was determined by measuring the distance between the most anterior and posterior places on the articular surface of the humeral head. Finally, epicondylar breadth was defined as the distance between the two most laterally extended spots on the humerus's lateral epicondyles. The six variables maximum length of the humerus (MLH), maximum diameter of the humeral head (MDH), vertical diameter of the humeral head (VDH), transverse diameter of the humeral head (TDH), condylar breadth (CB), and epicondylar breadth (EB) were compared between genders using suitable statistical methods. All data was collected, documented in a Microsoft Excel work sheet, and analyzed using descriptive statistics in SPSS 23.0.

RESULT

Males had a maximum length of the humerus (MLH) of 305.86 ± 11.19 mm, while females had 282.88 ± 6.78 mm. Male and female maximum diameter of the humeral head (MDH) measurements were 42.75 ± 1.81 mm and 39.86 ± 1.62 mm, respectively. The vertical diameter of the humeral head (VDH) measured 41.54 ± 1.63 mm in males and 38.88 ± 1.52 mm in females, respectively. Males had a transverse diameter of the humeral head (TDH) of 38.28 ± 1.82 mm, while females had 34.77 ± 1.49 mm. Males and females had epicondylar breadth (EB) of 54.23 ± 4.60 mm and 49.64 ± 8.27 mm, respectively. The condylar breadth (CB) measured 37.17 ± 2.22 mm in males and 34.29 ± 1.08 mm in females. A value below the stated threshold was categorized as female, while a number over it was classified as male. Males have humerus lengths greater than 289.6 mm, whereas females have lengths less than 289.6 mm. The threshold values for maximum diameter of the humerus (MDH), vertical diameter of the humeral head (VDH), transverse diameter of the humeral head (TDH), epicondylar breadth (EB), and condylar breadth (CB) are: 42.6 mm, 41.7 mm, 39.9 mm, 55.4 mm, and 36.5 mm, respectively.

Table-1: Variable comparison between male and female

Variable	Male	Female
MLH (mm)	305.86 ± 11.19	282.88 ± 6.78
MDH (mm)	42.75 ± 1.81	39.86 ± 1.62
VDH (mm)	41.54 ± 1.63	38.88 ± 1.52
TDH (mm)	38.28 ± 1.82	34.77 ± 1.49
EB (mm)	54.23 ± 4.60	49.64 ± 8.27
CB (mm)	37.17 ± 2.22	34.29 ± 1.08

Table -2: Demarking point for males and females

Variable	Demarking point	Wilks' lambda
MLH (mm)	F< 289.6	0.512
MDH (mm)	F<42.6	0.531
VDH (mm)	F<41.7	0.487
TDH (mm)	F<39.9	0.603
EB (mm)	F<55.4	0.617
CB (mm)	F<36.5	0.744

DISCUSSION

Sex estimation is the first criterion used to identify human bones. Human skeletal measures can identify an individual's sex. Anthropometry is the study of measuring the human body's proportions, size, and weight [17]. In early investigations on sex identification, the pelvis and skull were shown to be the most varied bones between genders [18]. When the human body is weakened, such as during wars or calamities, the pelvic and skull bones may sustain damage. Several investigations were conducted to determine sex using different bones. This study evaluated various humerus measures for determining sex [19, 20]. Males had an MLH of 305.86 ± 11.19 mm while females had 282.88 ± 6.78 mm. Male and female MDH measurements were 42.75 ± 1.81 mm and 39.86 ± 1.62 mm, respectively. The VDH measured 40.54 ± 1.63 mm in males and 37.88 ± 1.52 mm in females, respectively. Males had a TDH of 38.28 ± 1.82 mm, while females had 34.77 ± 1.49 mm. Males and females had EBs of 54.23 ± 4.60 mm and 49.64 ± 8.27 mm, respectively. The CB measured 37.17

± 2.22 mm in males and 34.29 ± 1.08 mm in females. Chaudhary RS *et al.,* (2017) [21] studied upper limb bone measurements to identify sexual dimorphism and create accurate metric criteria for sex determination. The study was place over two years at Teerthanker Mahaveer Medical College & Research Centre in Moradabad, Uttar Pradesh, India. The study included 91 adult human cadavers ranging in age from 38 to 91 years (mean +/- S.D. 70.8 +/- 12.2). All measurements were taken with calipers or measuring tapes. The variables studied included the maximum length of the clavicle (distance between acromial end and sterna end), the circumference of the middle shaft of the clavicle, the maximum length of the humerus (distance between trochlea and the proximal extremity of the humeral head), the maximum diameter of the humeral head, the epicondylar and condylar breadth of the humerus, and the transverse diameter of the humerus. Statistical analysis was performed using SPSS program. Male values were consistently greater than female values. The maximum clavicle length was 149.4 +/- 7.4 mm for males and 137.2 +/- 9.9 mm for females. Males' maximum humerus length was 301.8 +/- 15.4 mm, while females' was 279.9 +/- 16.2 mm. The maximum ulna length was 248.4 +/- 11.9 mm in males and 226.3 +/- 15.2 mm in females. Gender is defined as female if the discriminant score is less than the demarcation point, and male if the score exceeds the demarcation. If the maximum length of the clavicle is less than 143.2 mm, the specimen is deemed female; if it exceeds this amount, it is male. The diameter of the humerus head was a better predictor of sex than its length. The circumference of the midpoint of the shaft of the clavicle was the worst predictor of sex (60.4% accuracy). The study found that upper limb measures are a viable technique for estimating a specimen's sex. Khan MA et al. (2020) [22] examined various humerus measures to determine sex. This cross-sectional study was undertaken at Department of Anatomy, Anwer Khan Modern Medical College, Dhanmondi, Dhaka, Bangladesh, from June 2023 to June 2024. Six measurements were taken for 100 male and 100 female humeri, including MLH, MDH, VDH, TDH, epicondylar breadth, and CB. The variables were compared between genders using the student's t-test. Wilk's lambda test was used. The demarking point for all variables was determined by averaging male and female measurements. Correctly recognized instances were calculated for the male, female, and overall study groups. Data analysis was conducted using SPSS v.23.0 (IBM Corp, Armonk, NY). $P>0.05$ was not statistically significant. There were significant differences in maximum length of the humerus (MLH), maximum diameter of the humerus (MDH), vertical diameter of the humeral head (VDH), transverse diameter of the humeral head (TDH), epicondylar breadth (EB) and condylar breadth (CB) between the two genders ($p<0.001$). Maximum length of the humerus (MLH) achieved an accuracy of 85% across the population. Maximum diameter of the humerus (MDH), vertical diameter of the humeral head (VDH) and transverse diameter of the humeral head (TDH) had accuracy rates of 76%, 85%, and 76% for the entire population, respectively. Both epicondylar breadth (EB) and condylar breadth (CB) accurately recognized 75% and 78% of the bones, respectively.

Limitation of the study:

The study featured a single focus point and minimal sample sizes. As a result, the study's conclusions may not completely reflect the entire situation.

CONCLUSION & RECOMMENDATION

This study discovered that the maximum length of the humerus and the vertical diameter of the humeral head are the most accurate characteristics for determining gender in human skeletal remains.

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