

Original Research Article

Morphological evaluation of the humeral length and application as indicator of sexual dimorphism among Southern Nigerian children

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ABSTRACT

Background: This study was carried out to evaluate humeral length among children in Southern Nigeria and to describe its sexual dimorphism among study population.

Methods: This study involved 450 children (230 males and 220 females) between 3-14 years old in Southern Nigerian. The humeral length was measured as distance between lateral epicondyle distally palpated when elbow was flexed to 90 degrees and acromion proximally palpated lateral end of clavicle. Definitive right and left humeral lengths (RHL and LHL) were derived by subtracting 2.5 mm from measured length. Average values of RHL and LHL were evaluated as morphological humeral length (MHL) for each subject. Data were analyzed using IBM-SPSS version 20 and statistical comparisons done using t-test with $p < 0.05$ regarded as level of significant difference.

Results: In all age groups, non-significant bilateral variation was observed with the RHL higher than the LHL among both male and female subjects. In addition, the results showed significant ($p < 0.05$) sexual dimorphism in all age groups with mean \pm SEM of MHL among 3-6 years old higher in females (19.45 ± 0.81) than in males (18.63 ± 0.83). However, the reverse was observed among higher age groups with mean \pm SEM of MHL in 7-10- and 11-14-years old males (24.43 ± 0.95 and 28.75 ± 0.94) significantly higher than in 7-10 years old and 11-14 years old females (22.85 ± 0.91 and 26.73 ± 0.84) respectively.

Conclusions: Based on findings of this study, humeral morphometrics particularly the humeral length can be applied as a significant indicator of sexual dimorphism among the study population.

Keywords: Anthropometry, Humeral length, Nigerian children, Sexual dimorphism

INTRODUCTION

Anthropometry refers to scientific techniques used in the evaluation and description of morphological characteristics of the whole or parts of human body which can in turn be employed in wide-range of applications.¹⁻³ Typically, human body morphometrics are influenced by variety of factors such as age, sex, geographical location and racial affiliation.⁴⁻⁶ In essence, anthropometric studies are conducted to evaluate body morphometrics that can be used to assess sexual

variation, in a given age categorization or with increasing age, within the same or across different populations.^{7,8}

Among the major body structures involved in anthropometric studies are the bony components which include long bones such as the humerus. The humerus is the longest and largest bone of upper limb which superiorly articulates with the scapula at shoulder joint and distally with the radius and ulna at elbow joint.⁹ Morphologically, the humerus can be divided into three parts which include the proximal part composed of head, neck, greater and lesser tubercles, the middle part also

known as shaft or body and the distal part composed of medial and lateral epicondyles.¹⁰ These parts possess notable morphometric characteristics that are useful in forensic and various clinical procedures.¹¹

Specifically, the humeral length is an most important humeral anthropometric features used to morphologically characterize human population with reference to sex differentiation and height estimation.^{12,13} In addition, morphometrics of bicipital groove and supratrochlear foramen are vital in selection and design of shoulder prosthetics and during pre-operative planning for distal humeral fractures respectively.^{14,15}

Others notable humeral morphometrics covering all the three morphological parts include transverse and vertical diameters of humeral head, surgical neck circumference, shaft circumference, epicondylar breadth, trochlear length and width, capitulum length and width, length, width and depth of olecranon fossa, length, width and depth of coronoid fossa, length, width and depth of radial fossa and many more.¹⁶⁻¹⁸

Due to diverse anthropometric and clinical applications of humeral morphometrics, this study was carried out to evaluate the humeral length among male and female children in Southern Nigeria and to establish whether the humeral length demonstrate sexual dimorphism among the study population.

METHODS

This study involved 450 children (230 males and 220 females) between ages of 3-14 years and bi-parentally belonged to major tribes in Southern Nigerian. They were randomly selected from elementary and high schools in Ondo City in Ondo State and Benin City in Edo State in the South-West and South-South regions of Nigeria respectively. In this study, the measurements were taken after an informed consent granted by all participating subjects or their wards. The humeral length was measured by placing subjects in standing position with

the elbow flexed to make an angle of about 90 degrees and the lateral epicondyle was palpated and marked while proximally, acromion point was identified at lateral end of clavicle and marked. The distance between the two markings was measured using spreading caliper and recorded. The acromion point is usually about 2 to 3 mm proximal to humeral head hence, definitive right humeral length (RHL) and left humeral length (LHL) for this study was derived by subtracting 2.5 mm from the measured length for all subjects.^{19,20} Also, average value of RHL and LHL were evaluated to represent the morphological humeral length (MHL) for each subject.

Inclusion criteria

Only prospective subjects with no observable defects of upper limbs were included in this study.

Exclusion criteria

Conversely, prospective subjects with observable upper limb defects or deformities were excluded.

Statistical analysis

Data obtained and recorded in this study were subjected to statistical analysis using Statistical Package for Social Sciences (IBM-SPSS) version 20 software for windows. The mean, standard error of mean (SEM), standard deviation (SD) and range of humeral length were evaluated, statistical comparisons were done using analysis of variance (ANOVA) with the statistically significant level set at $p < 0.05$.

RESULTS

The results of this population-based study showed that mean±SEM value of RHL (18.72±0.83) among 3-6 years old male children was higher than that of LHL (18.35±1.04). Similarly, among 3-6 years old female children, mean±SEM value of RHL (19.58±1.11) was higher than that of LHL (19.31±0.78) (Table 1).

Table 1: Statistical results of right and left humeral length among Southern Nigeria male and female children between ages 3-6 years.

Variables	Male		Female	
	Right	Left	Right	Left
Number of subjects (n)	75	75	75	75
Mean (cm)	18.72	18.35	19.58	19.31
SEM (cm)	0.83	1.04	1.11	0.78
SD (cm)	3.98	4.05	3.87	4.13
Range (cm)	4.50	5.00	5.50	5.50

Among 7-10 years old children, mean±SEM values of RHL - 24.58±0.99 and 22.97±0.93 were higher than those

of LHL - 24.37±0.78 and 22.62±0.78 in males and females respectively (Table 2). Similar outcomes among

11-14 years old showed that mean±SEM values of RHL - 28.83±1.03 and 26.82±1.06 were higher than those of LHL - 28.46±0.92 and 26.48±0.73 in males and females children respectively (Table 3).

In addition, assessment across gender showed that mean±SEM value of MHL among 3-6 years old was higher in female children (19.45±0.81) than in male children (18.63±0.83).

Table 2: Statistical results of right and left humeral length among Southern Nigeria male and female children between ages 7-10 years.

Variables	Male		Female	
	Right	Left	Right	Left
Number of Subjects (n)	75	75	75	75
Mean (cm)	24.58	24.37	22.97	22.62
SEM (cm)	0.99	0.78	0.93	0.78
SD (cm)	3.55	3.72	3.68	2.99
Range (cm)	5.00	4.50	4.00	4.00

Table 3: Statistical results of right and left humeral length among Southern Nigeria male and female children between ages 11-14 years.

Variables	Male		Female	
	Right	Left	Right	Left
Number of Subjects (n)	75	75	75	75
Mean (cm)	28.83	28.46	26.82	26.48
SEM (cm)	1.03	0.92	1.06	0.73
SD (cm)	3.53	4.77	3.95	3.86
Range (cm)	7.50	7.50	6.00	5.50

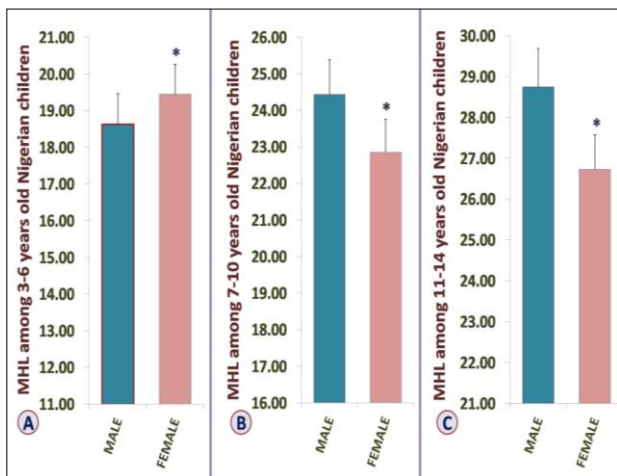


Figure 1: Mean values of morphological humeral length (MHL) among Southern Nigeria male and female children between ages 3-6 years (A), 7-10 years (B) and 11-14 years (C). (*indicate significant difference from male MHL at p<0.05).

However, mean±SEM values of MHL in 7-10 years old males (24.43±0.95) and 11-14 years old males (28.75±0.94) were significantly higher than those in 7-10 years old females (22.85±0.91) and 11-14 years old females (26.73±0.84) respectively (Figure 1).

DISCUSSION

The humerus is an important long bone which typically exists bilaterally in the upper limbs of the human body. It has been widely studied in different populations due to its numerous morphological, forensic and anthropometric importances.²¹ The bilateral occurrence of the humerus, like some other bilaterally-occurring structures or bones, may imply bilateral variation of its morphometrics. According to results of this study, mean values of RHL were non-significantly higher than those of LHL among both male and female children in all the age groups of study (Tables 1-3). This non-significant bilateral difference of humeral length, with higher value on the right humerus, is in conformity with findings reported by some previous studies in other populations including the Turkish, Indian, Nepalese and Caucasian populations.²¹⁻²⁷

Furthermore, the results of this study showed significant sexual dimorphism in all the age groups of study. Among 3-6 years old children, mean value of MHL was significantly (p<0.05) higher among females (19.45±0.81) than in males (18.63±0.83). However, reverse trend was observed in the other two age-groups wherein the mean±SEM value of MHL in 7-10 years old males (24.43±0.95) was significantly (p<0.05) higher than that of 7-10 years old females (22.85±0.91) and the mean±SEM value of MHL in 11-14 years old males

(28.75±0.94) was significantly ($p<0.05$) higher than that of 11-14 years old females (26.73±0.84) (Figure 1).

The findings of this study especially in higher age groups also showed conformity with humeral morphometrics reported by previous studies among other populations. The study among the Iranian population showed sexual variation in the upper arm length with mean value among males (33.72±2.30) significantly higher than that of females (30.12±2.29).¹⁹ The study among adult Indian population reported sexual differences with male Indians (30.98±2.43 and 30.92±2.44) having significantly higher values than female Indians (28.27±1.92 and 28.12±1.93) in both right and left humeral length.²⁰ According to study among Malaysian population, the humeral length showed sexual variation with males MHL (30.66±1.72) significantly higher than female MHL (27.71±1.74).²⁸ The study among the Egyptian population showed that the total length of humerus exhibit sexual variation with mean value among males (32.42±0.81) significantly higher than that of females (30.32±0.81).²⁹ Similar findings were reported in a cross-sectional study of humeral morphometrics among the South African population.³⁰ According to the findings of their study, the humeral length showed sexual variation among White, mixed-race and indigenous black populations with the males having significantly higher values than the females.

CONCLUSION

Generally, significant and population-independent sexual variation has been demonstrated by quantitative derivations from different anthropometric studies of many body structures including bony components such as humerus. Based on the findings of this study, humeral morphometrics particularly the humeral length can be applied as a significant indicator of sexual dimorphism among the population of study.

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