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## **Midshaft diameter of humerus and its accuracy in sex determination of south Indian population**

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**Abstract**---Background: Humerus is one of the long bones generally favoured in osteometric studies as it appears to yield highest level of classification accuracy in sex determination. Aim: To study the midshaft diameter of humerus and its accuracy factor in sex determination. Methods: A total of 100 (Male - 72, Female - 28) dry human humeri were collected from the Department of Anatomy as well as from the under graduate students of Santhiram Medical College, Nandyal. The maximum midshaft diameter of humerus was measured from absolute greatest diameter without regard to the vertical or transverse plane. The minimum midshaft diameter of humerus was measured from absolute least diameter in the middle without regard to any plane or maximum diameter Results: The mean maximum mid shaft diameter of humerus in male bones was  $1.953\pm 0.027$  and in female bones was  $1.75\pm 0.030$ . The mean minimum midshaft diameter of humerus in male was  $1.657\pm 0.0211$  and in female was  $1.485\pm 0.026$  in the present study Conclusion: The mid shaft diameter can be considered as one of the sex determinations factors due to its higher accuracy in males than females with other predictive variables of humerus.

**Keywords**---humerus, shaft, sex determination.

## Introduction

The determination of sex in the human skeleton is not a simple task. It can be quite problematic in the early childhood years. Percentage of accurate sex determination was 93% by assessing humerus bone alone, but with inclusion of radius and ulna the accurate sex determination was 95% when compared to other bones of the body [1]. Many bones have been previously used for the identification of sex, and such studies emphasize that sexual dimorphism starts to appear after puberty [2]. The humerus often remains in good condition and is especially favourable for metric sex determination [3]. The humerus has rarely been tapped as a site for sex determination, though it has often demonstrated an even greater accuracy than other long bones such as the femur [4,5]. The size and shape of the humerus may vary among human groups as well other body parts [6]. The reason for these differences is genetic and environmental factors such as dietary patterns and occupation [7,8].

## Materials and Methods

A total of 100 (Male - 72, Female - 28) dry human humeri were utilized to measure the midshaft diameter and its accuracy factor in sex determination. The dry humerus bones were collected from the Department of anatomy as well as from the under graduate students of Santhiram Medical College, Nandyal. Maximum midshaft diameter of humerus was measured at absolute greatest diameter without regard to the vertical or transverse plane. The middle of the bone should be marked as calculated by measurement of maximum length. It lies usually a few millimetres above the lower margin of deltoid tuberosity. The minimum midshaft diameter of humerus was measured at absolute least diameter in the middle without regard to any plane or maximum diameter. Both the parameters were measured by using sliding callipers (Figure-1&2). The Student's t test was used to determine the mean standard deviation (SD), standard error (SE) and the variance for each variable in both the sexes. The t' and P values were estimated and the level of significance was set at 0.05. The data were also statistically analysed by using the SPSS 11.0 version.

## Results

We measured the midshaft diameter of the humerus in 100 dry humeri by maximum midshaft diameter and minimum midshaft diameters for all the bones. The mean maximum mid shaft diameter of humerus in male bones was  $1.953 \pm 0.027$  and in female bones was  $1.75 \pm 0.030$ . The mean minimum midshaft diameter of humerus in male was  $1.657 \pm 0.0211$  and in female was  $1.485 \pm 0.026$  [Table 1&2]. The t-test showed that the measurements were significantly higher in men compared to women ( $P < 0.05$ ) which is indicating that mid shaft diameter of the humerus can be considered as one of the major sex determination parameters in the present study [Table -3].

## Discussion

The humerus is one of the strongest long bones of the skeleton which even in a fragmented state is likely to be recorded in a forensic case [9]. The mean values of

different humeral segments help in forensic and anthropometric practice and are very useful to determining the humerus segment [10]. The mean values of the male humeri were significantly higher than those of the female humera in the present study. A combination of the minimum midshaft diameter and epicondylar breadth gave the highest rate of accuracy (88%) and this seemed to be the most reliable one [11,12]. This was followed by a combination of the maximum length and the minimum midshaft diameter, with an accuracy rate of 88%. The two measurements with the greatest sex differences were the maximum humeral length and the maximum diameter at midshaft. The findings in our study are in agreement with previous literature [12,13,14]. The values for the transverse and antero-posterior diameter of the three sections of the shaft were found to be slightly greater on the right side but the difference is insignificant. The mean circumferences of the three sections of the shaft were found to be slightly greater on the right side but the difference is not significant [6,15]. The transverse diameter in the mid shaft of the humerus is greater in an Istanbul population as compared with North Indians which may probably be due to the fact that they measured the bones in radiographs and /or the racial difference[15].The race and the and genetical factors may be the reasons for the difference in our findings compared with the previous literature[6,16].The sex discrimination rate was 93.2% using vertical diameter of the head and other variables were like vertical diameter of the head and maximum humerus length[17]. Third most successful variable for sex allocation was right-left diameter at midshaft with 73.2% correct discrimination. In the present study, we observed significant mean diameters at mid shaft level and these findings are in supportive of the previous literature in determination of accuracy of sex [11,13,16,17].

### **Conclusion**

The mid shaft diameter can be considered as one of the sex determinations factors due to its higher accuracy in males than females along with other predictive variables of humerus.

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### **References**

1. Abo Samak A.M, El-Hanafy M.M.A, Attia M.M, Mishriki E.S. Identification of sex from Patella in Egyptians. *Mansoura J. Forensic Med. Clin. Toxicol.* VII (2). 1999; 43-55.
2. Akman, S., D.; Karakas, P. & Bozkir, M. G. The morphometric measurements of humerus segments. *Turk. J. Med. Sci.* 2006; 36(2):81-5.
3. Albanese J, Cardoso H.F.V, Saunders S.R. Universal methodology for developing univariate sample & specific sex determination methods: an example using the epicondylar breadth of the humerus. *J Arch Sci.* 2005; 32:143-152.

4. Anudeep Singh, Mahindra Nagar, and Anil Kumar. An Anthropometric Study of the Humerus in Adults. *RRJMHS*.2014;3(3):77-82.
5. Atamtürk D. Estimation of sex from the dimensions of foot, foot prints, and shoe. *Anthrop Anz*.2010; 68:21-29.
6. Duyar İ, Özener B. Çocuk işçiler: çarpık gelişen bedenler. Ankara: Utopya.2003.
7. Duyar İ. Growth patterns and physical plasticity in adolescent laborers. *Coll Antropol*.2008; 32:403-412.
8. Girish patil, Sanjeev Kolagi, Umesh Ramadurg. Sexual dimorphism in the Humerus: A study on South Indians. *Journal of Clinical and Diagnostic Research*. 2011.5(3):538-541.
9. Iscan M.Y, Loth S.R, King C.A, Shihai D, Yoshino M. Sexual dimorphism in the humerus: a comparative analysis of Chinese, *Japanese and Thai*.*For.sci.inter*. 1998; 98(1):17-29.
10. Knight B. Forensic Pathology. Edward Arnold, Division of Hodder & Stoughton, London, 1997: 95-132.
11. Mall, G.; Hubig, M.; Büttner, A.; Kuznik, J.; Penning, R. & Graw,M. Sex determination and estimation of stature from the long bones of the arm. *Forensic Sci. Int*.2001; 117(1-2):23-30.
12. Polochocki JH. Bilateral variation in limb articular surface dimensions. *Am J Hum Biol*. 2004; 16(3); 328-33.
13. Sembiring, S. M. B. (2021). The effectiveness of buzz group discussion on knowledge and attitudes about pranal sex in adolescents at vocational school of pencawan medan. *International Journal of Health & Medical Sciences*, 4(1), 56-60. <https://doi.org/10.31295/ijhms.v4n1.775>
14. Seo Y, Uchiyama T, Shimizu K, Takahama K. Identification of remains by sequencing of mitochondrial DNA control region. *The Am. J. for. Med. Pathol*. 2000; 20(3):138-143.
15. Sing S, Singh G, Singh P. Identification of sex from Ulna. *Indian J Med Res*.1974;62(5):731-735.
16. Suryasa, I. W., Rodríguez-Gámez, M., & Koldoris, T. (2022). Post-pandemic health and its sustainability: Educational situation. *International Journal of Health Sciences*, 6(1), i-v. <https://doi.org/10.53730/ijhs.v6n1.5949>
17. Williams, P. L.; Warwick, R.; Dyson, M. & Bannister, L. H. *The humerus*. In: *Gray's anatomy*. 37th Ed. Edinburgh, Churchill Livingstone, 1989. p.406.
18. Wright LE, Vasquez MA. Estimation the length of incomplete long bones: Forensic standards from Guatemala. *Am J Phys Anthropol*. 2003;120: 233-251.
19. Wu L. Sex discriminant analysis of long bones of upper limb. *Acta Anthropol. Sinica* (Chinese with English abstract), 1989; 8:231-239.

Table-1: Mid shaft diameters of the male humeri

Bone No	Maximum midshaft diameter	Minimum midshaft diameter	Bone No	Maximum midshaft diameter	Minimum midshaft diameter
1	2	1.8	38	1.9	1.6
2	1.5	1.4	39	2.1	1.9
3	2	1.8	40	2	1.7

4	2	1.8	41	1.5	1.2
5	2.2	1.9	42	2.1	1.8
6	1.8	1.6	43	1.6	1.4
7	1.8	1.6	44	2	1.6
8	2.1	1.8	47	1.6	1.4
9	1.9	1.6	46	2	1.8
10	1.9	1.6	47	1.7	1.6
11	1.8	1.5	48	2.9	2.1
12	1.9	1.7	49	2.3	1.9
13	2.3	1.8	50	1.6	1.5
14	2	1.6	51	1.8	1.6
15	2	1.6	52	1.8	1.6
16	2.3	1.8	53	1.6	1.4
17	2.1	1.7	54	1.7	1.6
18	2.1	1.7	55	2.1	1.8
19	1.9	1.4	56	1.8	1.6
20	2.2	1.9	57	2.2	2.1
21	1.7	1.5	58	2.1	1.9
22	2.1	1.9	59	2.1	1.7
23	1.8	1.6	60	2.1	1.8
24	2	1.6	61	1.8	1.3
25	1.8	1.5	62	2.1	1.8
26	2.2	1.8	63	2.2	1.9
27	2	1.8	64	2.2	1.7
28	1.9	1.6	65	2.2	1.5
29	1.9	1.6	66	1.6	1.5
30	1.9	1.7	67	1.9	1.3
31	2	1.7	68	1.8	1.5
32	2.2	1.8	69	1.9	1.5
33	1.8	1.6	70	1.8	1.6
34	1.9	1.7	71	1.7	1.6
35	2.1	1.8	72	2	1.6
36	1.7	1.4	Mean	1.9535	1.6577
37	1.8	1.6	Sd	0.2286	0.1786

Table-2: length and mid shaft diameters of the female humeri

Bone No	Maximum midshaft diameter	Minimum midshaft diameter
1	2.1	1.6
2	1.9	1.7
3	1.8	1.6
4	1.6	1.4
5	1.8	1.6
6	1.6	1.4

7	1.7	1.6
8	1.7	1.5
9	1.5	1.3
10	1.9	1.5
11	1.8	1.3
12	1.9	1.5
13	1.8	1.4
14	1.5	1.3
15	1.6	1.4
16	1.6	1.4
17	1.7	1.4
18	1.9	1.7
19	1.7	1.4
20	1.9	1.7
21	1.9	1.5
22	1.7	1.6
23	2	1.7
24	2	1.7
25	1.5	1.3
26	1.6	1.3
27	1.6	1.4
28	1.7	1.4
Mean	1.7500	1.4857
Sd	0.1644	0.1407

Table -3: Statistical Analysis

Parameter	Mean $\pm$ SEM (Males =72 )	Mean $\pm$ SEM (Females =28 )	t value	P value
Maximum midshaft diameter of Humerus	1.953 $\pm$ 0.027	1.75 $\pm$ 0.030	4.362	<0.0001*
Minimum midshaft diameter of humerus	1.657 $\pm$ 0.0211	1.485 $\pm$ 0.026	4.640	<0.0001*

P\* < 0.01 (Significant)

**Legends**

Figure-1: Measuring Midshaft diameter of Humerus by using sliding callipers



Figure-2 : Measuring shaft length of humerus by osteometric board

