

Anthropometric Sexual Dimorphism of Hand Length, Breadth and Hand Indices of University of Port-Harcourt Students

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Abstract: Forensic anthropometry incorporates most of the techniques originating from the analysis of human skeletal material from archaeological sites. Hand index which is derived from hand dimensions can be used to estimate differences related to sex, age and race in forensic and legal sciences. This study estimated the sex of Nigerian student from hand measurements. Three hundred students (150 males and 150 females) from University of Port-Harcourt Nigerian with age ranges of 18-30 years were used. The hand breadth and length of these subjects were measured using an automatic sliding caliper. The hand index was calculated as percentage of hand breadth over the hand length. The statistical analysis of the data obtained showed that male hand dimension was significantly higher than those of the females at $p < 0.05$. In general the left hand length was obviously higher than the right hand length while in the breadth there was a reverse. The male data revealed a mean right hand length and breadth of 19.02 ± 0.08 and 8.58 ± 0.03 , with a mean left hand length and breadth of 19.09 ± 0.07 and 8.43 ± 0.03 . On the other hand, the female mean right hand length and breadth was 17.62 ± 0.07 and 7.69 ± 0.03 with a mean left hand length and breadth of 17.69 ± 0.07 and 7.58 ± 0.03 . The hand index obtained showed higher value for male than female with right and left mean value of 45.16 ± 1.9 and 44.21 ± 1.7 as compared to female mean right and left hand index of 43.68 ± 0.19 and 42.90 ± 0.19 . The average hand indices of left and right hand for both male and female are 44.68 ± 0.13 and 43.29 ± 0.14 , respectively. The results of the hand index suggest that the population studied belong to two groups of hand dimension, the dolichocheir and the mesocheir group.

Key words: Hand Length, hand Breadth, hand Index, sex and identification

INTRODUCTION

The need for determination of sex from skeletal remains in living and non-living population for genetic, anthropological, odontologic and forensic purposes has been documented by several researchers. Anthropological measurements of the skeleton and the comparison with existing standard data must then be applied and may help to differentiate between male and female (Vandana *et al.*, 2008). This has become useful in recent times due to mass disasters like plane crash, mass suicide, forest fires, and earth quakes

However, the hand bones have been documented as good anthropometric parameters and had proven to exhibit great sexual dimorphism. Bhatnagar *et al.* (1984), estimated stature of Punjabi male using three anthropometric measurement of the left and right hands separately. Similarly, Abdel-Malek *et al.* (1990) also estimated the stature of Egyptian subjects using two anthropometric measurement of the hand.

A study of sexual dimorphism in hand and foot length, indices, stature-ratio and relationship to height in

Nigerians has been reported (Barnabas *et al.*, 2008). The morphometric parameters of the hand show considerable sexual dimorphism in the Indian population while the hand and palm index were poor sex indicator (Kanchan and Rastogi, 2009). Agnihotri *et al.* (2005) in their study of determination of sex of Mauritius Population from hand measurement reported that hand index more than 44 is suggestive of male and less than 44 is suggestive of a female. The anthropometric study of a convenience sample of 51 female and 50 male adults of Bangladeshi origin living in the United State, but spent most of their lives in Bangladeshi showed significant difference in palm and finger lengths, breadths and depths (Imrhan *et al.*, 2008). To the best of our knowledge there is paucity of information on hand dimension of Nigeria population in correlation to sex.

Although this has been reported by several researchers but the obvious truth remains that standards of morphological and morphometric sex differences in the skeleton may differ with the population sample involved especially with reference to dimensions and indices and thus cannot be applied universally (Krogman and Iscan,

1986). This study therefore aimed at investigating hand length, hand breadth and hand indices of University of Port-Harcourt student with reference to sex.

MATERIALS AND METHODS

Three hundred students (150 males and 150 females) devoid of gross anatomical pathology were randomly selected from the University of Port-Harcourt Rivers State, Nigeria in 2009. The age of subjects used ranged from ages 18-30 years, because at this age range most people had attained their maximum growth and therefore their maximum hand length and breadth. The subjects' hand is extended, with the palm in a supine position and a sliding caliper was used. The hand length was measured as a straight distance between the distal crease of the wrist joint and the most anterior projecting point (the middle finger) (Fig. 1). The hand breadth was

$$\text{Hand index} = \frac{\text{Hand breadth}}{\text{Hand length}} \times 100$$

measured as a straight distance from the most laterally placed point on the hand of the 2nd metacarpal to the most medially placed point located on the hand of the 5th metacarpal (Fig. 2). The hand index indicates the change in a value when compared with the level of that value. Hand index was calculated by dividing the hand breadth by the hand length and multiplying by 100.

The result obtained was considered based on length-breadth index 1 standard by Krogman hand indices in which five classes of hand indices are introduced.

- Hyperdolichocheri (hdch) <40.9
- Dolichocheri (dch) 41.0-43.9
- Mesocheri (mch) 44.0-46.9
- Brachycheri (bch) 47.0-49.9
- Hyperbrachycheri (hbch) 50.0-x



Fig. 1: Measurement of hand length



Fig. 2: Measurement of hand breadth

Table 1: Summary of hand length value of both sexes of n = 150 each

Male	Minimum	Maximum	Mean
Right	17.02	23.06	19.02±0.08
Left	17.14	21.89	19.09±0.07
Female			
Right	15.60	20.78	17.62±0.07
Left	15.71	20.82	17.69±0.07

Table 2: Summary of hand breadth value for both sexes (n = 150)

Male	Minimum	Maximum	Mean
Right	7.52	9.70	8.58±0.03
Left	7.44	9.58	8.43±0.03
Female			
Right	6.76	8.92	7.69±0.03
Left	6.28	8.92	7.58±0.03

Table 3: Summary of hand dimension (Length, Breadth, Indices) for both sexes

Sex	Average mean length	Average mean breadth	Average hand index
Male	19.05±0.95	8.50±0.42	44.68±0.19
Female	17.65±0.91	7.96±0.34	43.29±0.19

RESULTS AND DISCUSSION

Table 1 represents the mean, maximum and minimum values of hand length for male and females. Table 2 represents the mean, maximum and minimum values of hand breadth for male and females. Table 3 represents the summary of average hand dimension (hand length, breadth and indices) of both sexes. The average hand length for males was 19.05±0.95 and 17.65±0.91, while the average hand breadth was 8.50±0.42 for males and was 7.96±0.34 for females. The average hand indices of left and right hand for both male and female were 44.68±0.13 and 43.29±0.14, respectively. Table 4 and 5 represent the age wise distribution of hand dimension of both sexes.

The human hand which is the most used and versatile part of the body is of great scientific importance to investigators in the field of anthropometry, forensic pathology, Orthopedic Surgery and ergonomics. The present study investigated the hand length, hand breadth and hand index of university of Port-Harcourt students in correlation to sex. Authorities appear to agree that no part of the human body has been as neglected as has the hand (Ashley, 1931; Wilder, 1920). The assessment of the physical dimensions of the human hand provides a metric description to ascertain human-machine compatibility (Fraser, 1980; Freivalds, 1987) in the design of manual systems for the bare and gloved hand (e.g., design of hand tools, knobs and controls, personal equipment, consumer appliances in the home and industry). Ducharme (1977) observed that soldering tools, pliers and wire strippers caused frequent complaints in women workers, due to dimensional incompatibility and improper usage of tools. In adults, sexual differences are evident in hand length measurements and in hand width to length ratios (McFadden and Shubel 2002).

Our study showed that the male hand length, breadth and indices were higher than the female. The difference in

Table 4: Age group distribution of hand dimensions in male

Age groups	No. in each groups	Hand length mean	Hand breadth mean	Hand index mean
18- 19				
Right hand	16	18.66±0.28	8.38±0.13	44.99±0.68
Left hand		18.73±0.29	8.29±0.12	44.34±0.67
20				
Right hand	13	18.68±0.29	8.55±0.09	45.90±0.70
Left hand		8.81±0.27	8.39±0.09	44.70±0.60
21				
Right hand	5	18.66±0.49	8.46±0.24	45.48±2.0
Left hand		18.72±0.44	8.27±0.16	44.49±1.2
22				
Right hand	19	18.92±0.17	8.57±0.08	45.43±0.49
Left hand		19.09±0.17	8.47±0.08	44.35±0.51
23				
Right hand	21	18.99±0.18	8.49±0.01	44.66±0.47
Left hand		19.09±0.18	8.34±0.09	43.69±0.38
24				
Right hand	26	19.10±0.18	8.67±0.06	45.59±0.51
Left hand		19.14±0.17	8.49±0.07	44.69±0.49
25				
Right hand	22	19.11±0.16	8.72±0.08	46.22±0.77
Left hand		19.17±0.17	8.56±0.07	45.15±0.72
26 to 30				
Right hand	28	19.37±0.23	8.59±0.08	44.99±0.83
Left hand		19.35±0.19	8.42±0.09	44.23±0.67

Table 5: Age group distribution of hand index in females (n = 150)

Age groups	No. in each groups	Hand length mean	Hand breadth mean	Hand index mean
18- 19	19			
Right hand		17.60±0.18	7.70±0.09	43.90±0.55
Left hand		17.58±0.17	7.65±0.09	43.57±0.56
20	21			
Right hand		17.18±0.29	7.68±0.12	44.75±0.65
Left hand		17.22±0.31	7.63±0.12	44.37±0.63
21	18			
Right hand		17.40±0.21	7.83±0.01	45.03±0.75
Left hand		17.44±0.25	7.75±0.01	44.46±0.87
22	26			
Right hand		17.79±0.19	7.72±0.07	43.43±0.45
Left hand		17.83±0.21	7.59±0.09	42.63±0.51
23	34			
Right hand		17.57±0.23	7.64±0.09	43.66±0.54
Left hand		17.62±0.22	7.55±0.09	42.90±0.42
24	18			
Right hand		17.56±0.26	7.78±0.13	44.38±0.63
Left hand		17.66±0.28	7.59±0.13	43.06±0.76
25	6			
Right hand		16.93±0.46	7.54±0.48	44.67±1.4
Left hand		17.28±0.17	7.49±0.17	43.47±1.2
26 to 30	8			
Right hand		17.79±0.29	7.80±0.09	43.89±0.90
Left hand		17.93±0.30	7.75±0.09	43.10±0.98

Table 6: Comparison of the Male hand dimension means from various population

Hand dimension	Mauritius (Agnihotri <i>et al.</i> , 2005)	Sri Lankan (Isurani <i>et al.</i> , 2009)	France (Dean, 2006)	Vietnamese (Imrhan <i>et al.</i> , 1993)	Bangladesh (Imrhan <i>et al.</i> , 2006)	Mexican (Imrhan and Contreras, 2005)	Jordanian (Nabeel, 2008)	Nourthern Nigeria (Barnabas <i>et al.</i> , 2008)	Present study
Average (HandLength)	189 mm	19.01±0.86	190.8 mm	177 mm	174 mm	185.5 mm	191.2 mm		19.05±0.95
RHL								19.85±0.86	19.02±0.08
LHL								19.93±0.93	19.09±0.07
Average (Hand Breadth)	84 mm	NA	87.3 mm	NA	NA	NA	NA		8.50±0.42
RHB								8.90±0.95	8.58±0.03
LHB								8.68±0.92	8.43±0.03

hand dimension between male and female could be explained as part of genetic expression of male being larger than female. The general analysis of both sides

within the groups showed that the mean left hand length values were consistently higher than the right hand except in age group 18-19 in females and age group 26-30 in

Table 7: Comparison of the female hand dimension means from various population

Hand dimension	Mauritius (Agnihotri <i>et al.</i> , 2005)	Sri Lankan (Isurani <i>et al.</i> , 2009)	France (Dean, 2006)	Vietnamese (Imrhan <i>et al.</i> , 1993)	Bangladesh (Imrhan <i>et al.</i> , 2006)	Mexican (Imrhan and Contreras, 2005)	Jordanian (Nabeel, 2008)	Northern Nigeria (Barnabas <i>et al.</i> , 2008)	Present study
Average(HL) Hand length	172 mm	17.62±0.93	173.5 mm	165 mm	167 mm	171.8 mm	171.27 mm	17.65±.91	17.65±.91
Right							18.51±0.66		18.52±0.72
Left							17.62±.07		17.69±.07
Average(HB) Hand breadth	74 mm	NA	77.0 mm	NA	NA	NA	NA	7.96±.34	7.96±.34
Right							7.82±0.49		7.69±.03
Left							7.72±0.46		7.58±.03

RHL: Right Hand Length; RHB: Right Hand Breadth; LHL: Left Hand Length; LHB: Left Hand Breadth; NA: Not available

males, while the mean right hand breadth values were higher than the left hand breadth. When sex differences are noted, they are generally larger for the right hand than the left in humans (McFadden and Shubel, 2002). These observations in side differences contradict with the above investigation in hand length but agree with them in hand breadth although the reason for this is uncertain. Also, our values were slightly lower when compared with the values from Barnabas *et al.* (2008) in the same population but different ethnic group. However, this is in agreement with (Davies *et al.*, 1980; Kanchan and Rastogi, 2009) which shows that there are ethnic differences in the anatomical dimensions and its relation to sex. It has also been emphasized that differences in body dimension among population and ethnic origins are as a result of differences in nutrition and levels of physical activity (Malina, 1994). The mean value of male hand length, breadth and indices is higher than that from a study done on Mauritian population by Agnihotri *et al.* (2005), which revealed an average length of an adult male hand of 189mm, while the average length of an adult female hand is 172mm. The average hand breadth for adult males and females is 84 and 74 mm, respectively. Our study revealed an average length of an adult male hand of 19.05 ± 0.94 with average hand breadth of 8.5 ± 0.41 , while the average length of adult hand is 17.66 ± 0.05 with average hand breadth of 7.63 ± 0.02 . The results of our mean hand length is in agreement with that done by Isurani *et al.*, (2008) with a male mean hand length of 19 ± 0.86 and female mean hand 17.62 ± 0.93 . The hand index which is a percentage expression of the breadth over the length suggested that adult Nigerians falls to mesocheir and dolichocheir groups according to Wechsler hand classification (Ethel *et al.*, 1995) (Table 6, 7).

CONCLUSION

This study has succeeded in establishing standard values of hand dimensions for this population which will not only serve as a useful tool in forensic investigation and clinical practice, but also relevance in ergo-design applications of hand tools and devices.

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REFERENCES

- Abdel-Malek, A.K., A.M. Ahmed, S.A.A. Sharkawi and N.M.A. Hamid, 1990. Prediction of stature from hand measurements. *Forensic Sci. Int.*, 46: 181-187.
- Agnihotri, A., B. Purwar and N. Jeebun, 2005. Determination of sex by hand dimensions. *The Internet J. Forensic Sci.*, 1: 2.
- Ashley-Montagu, F.M., 1931. On the primatethumb. *Am. J. Phys. Anthropol.*, 16(2): 291.
- Barnabas, D. and A. Elupko, 2008. Sexual Dimorphism in Hand and Foot Length, Indices, stature-ratio and Relationship to Height in Nigerians. *Internet J. Forensic Sci.*, 3: 1.
- Bhatnagar, D.P., S.P. Thapar and M.K. Batish, 1984. Identification of personal height from the somatometry of the hand in Punjabi males. *Forensic Sci. Int.*, 24: 137-141.
- Davies, B.T., A.K. Benson, A. Courtney and I. Minto, 1980. A comparison of hand anthropometry of females in the three ethnic groups. *Ergonomics*, 23: 183-184.
- Ducharme, R.F., 1977. Women workers rate male tools inadequate. *Hum. Factors Soc. Bull.*, 20: 1-2.
- Dean, R.S., 2006. Sexual dimorphism in upper Palaeolithic hand stencils. *Antiquity*, 80: 390-404.
- Ethel, J.A., 1995. The anthropology and social significance of the human hand. *Virtual Library Project*, 2(2): 4-21.
- Fraser, T.M., 1980. *Ergonomic Principles in the Design of Hand Tools*. Occup Safety and Health Series No. 44. Geneva: International Labour Office, pp: 93.
- Freivalds, A., 1987. The ergonomics of tools. *Int. Rev. Ergonom.*, 1: 43-75.
- Imrhan, S.N., M.D. Sarder and N. Mandahawi, 2008. Hand anthropometry in survey of Jordanian. *Int. J. Indus. Ergonom.*, 38(11-12): 966-976.
- Imrhan, S.N., M. Nguyen and N. Nguyen, 1993. Hand anthropometry of americans of vietnamese origin. *Int. J. Indus. Ergonom.*, 12: 281-287.

- Imrhan, S.N., M.D. Sarder and N. Mandahawi, 2005. Hand anthropometry in a sample of Bangladesh females. Proceedings of the 10th Annual International Conference on Industrial Engineering-Theory, Applications and Practice, Clearwater, FL, pp: 566-569.
- Imrhan, S.N., M.D. Sarder and N. Mandahawi, 2006. Hand anthropometry in a sample of Bangladesh males. Proceedings of the Eighth Annual Industrial Engineering Research Conference, Clearwater, FL, pp: 15-18.
- surani, I., N. Ganananda and P. Nadeeka, 2009. Prediction of personal stature based on the hand length. Galle Med. J., 14: 1.
- Kanchan, T. and P. Rastogi, 2009. Sex determination from hand dimensions of North and South Indians. J. Forensic Sci., 54(3): 546-550.
- Krogman, W.M. and M.Y. Iscan, 1986. Determination of Sex and Parturition. The Human Skeleton in Forensic Medicine. Charles C Thomas Publishers, Springfield, pp: 208-259.
- Nabeel, M., S.I. Salman and B.S. Al-Shobaki, 2008. Hand anthropometry survey for the Jordanian population. Int. J. Indus. Ergonom., 38: 966-976.
- Malina, R.M., 1994. Physical activity and training: Effects on stature and adolescent growth spurt. Med. Sci. Sport. Exer, 26(6): 759-766.
- McFadden, D. and E. Shubel, 2002. Relative lengths of fingers and toes in human males and females. Horm. Behav., 42: 492-500.
- Vandana, M.R., S. Sushmita and B. Puja, 2008. Mandibular canine index as a sex determinant: A study on the population of western Uttar Pradesh. J. Oral Maxillofac Pathol., 12: 56-59.
- Wilder, H.H., 1920. A laboratory manual of anthropometry, Blakiston, Philadelphia, pp: 84-109.