

Sex Determination from Hand Dimensions in Nepalese Medical Students:

A Cross-Sectional Study

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ABSTRACT

Introduction: Sex determination is one of the important parts of forensic investigation other than race, age and stature especially when mutilated, decomposed and skeletonized human remains are encountered. Studies in various populations have shown hand dimensions to be useful in sex differentiation. Present study aims at determining sex from hand dimensions in Nepalese medical students.

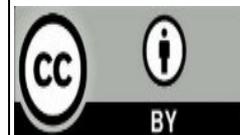
Methods: This was cross sectional study was conducted from February 2024 to August 2025 in Nobel Medical College Teaching Hospital, Nepal, including 412 Nepalese medical students (182 males and 230 females). Hand length and hand breadth were measured and hand index calculated. Data was analyzed using SPSS (Ver.20) software. Male and female parameters were compared using independent sample t-test. P value < 0.05 was considered significant. The average value of male and female was set as sectioning point for each parameter to calculate the diagnostic accuracy of sex determination.

Results: Males had significantly greater hand length, hand breadth and hand index (P < 0.001) with sectioning points calculated as 17.84cm, 7.96cm and 44.59 respectively for sex differentiation. Discriminant analysis showed diagnostic accuracy of hand breadth, hand index and hand length to be 89.6%, 81.3% and 79.1% for females and 78%, 74.7% and 72% for males respectively in determining sex.

Conclusions: Sex differentiation by sectioning point analysis of hand dimensions is reasonably accurate in Nepalese medical students. Hand breadth is the most accurate followed by hand index and hand length. Diagnostic accuracy is greater in females than males.

Key Words: *Anthropometry, Dimensions, Hand, Identification, Sex determination*

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INTRODUCTION

Identification of human remains is one of the important tasks falling under the domain of forensic medicine experts. Examination becomes even more difficult when mutilated, decomposed and skeletonized human remains are encountered which are often results of criminal activities, mass disasters, aviation and road accidents. Out of big four parameters sorted out initially to narrow down identification, sex determination remains one of the important components in addition to race, age and stature. Anthropometric measurements and calculations of various parts of the body are often used to differentiate sex. [1, 2]

Multiple studies have been carried out in the past, regarding sexual differentiation from isolated body parts and complete or partially skeletonized human remains, with various accuracies. Though pelvis and skull are still considered the best bones exhibiting sexual dimorphism, various studies aimed at differentiating sex from hand and foot dimensions have also been carried out in recent past in various populations, revealing promising conclusions. They have shown hand dimensions to be reliable in differentiating sex. [3-7]

Present study aims at finding out the sexual dimorphism in hand length, hand breadth and hand index for Nepalese medical students, to obtain the sectioning points for each parameter and determine the accuracy of sex determination from each. The result of this study is expected to prove beneficial in relevant forensic practical scenarios for Nepalese population, where only minimal studies have been done previously in similar context [8].

METHODS

This was a prospective cross-sectional study done in Forensic Medicine Department of Nobel Medical College Teaching Hospital, Biratnagar, Nepal; from February 2024 to August 2025. Ethical approval for the study was obtained from Institutional Review Committee of the same institution (IRC-NMCTH 08/2024). The sample size was calculated using, $n = z^2 p (1-p) / e^2$. Where, $z=1.96$ (95% confidence limit), $p=0.5$ (50% population proportion) and $e=0.05$ (5% allowable margin of error). The estimated minimum sample size was 385 however 412 Nepalese medical students over 20 years of age were included in the study, as all the epiphyseal

centers fuse by 20 years providing static hand dimensions.

Informed expressed consent was taken from the participants for their enrollment in the study. Standard sliding caliper was used for taking measurements by the same person. Measurements were taken from both hands and average value was taken as final single measurement. Hands with injuries, deformities, and previous history of fracture of hand bones were excluded.

The hand was placed supine on the table with long axis of the hand kept in line with the long axis of forearm. *Hand length* was taken as straight distance, between the distal most part of middle finger and distal crease of wrist. *Hand breadth* was taken as straight distance between lateral most point over head of 2nd metacarpal and medial most point over head of 5th metacarpal. *Hand index* (HI) was calculated as: (Hand breadth / Hand length) x 100. [9]

The data was recorded in standard proforma and entered in Statistical Package for Social Sciences (SPSS) Ver. 20 for statistical analysis. Independent samples t-test was used to compare the significance

of difference in sex among various parameters. P value < 0.05 was considered significant. *Sectioning point* (SP) for sex discrimination was derived as an average of mean values of hand length, hand breadth and hand index between males and females. The accuracy of respective sectioning points was tested for sex differentiation. [10]

RESULTS

Out of 412 participants enrolled for the study 182 (44.17%) were males and 230 (55.83%) were females. All the participants were between 20 to 26 years of age. The mean hand length, mean hand breadth and mean hand index, all were greater in males than in females. Various descriptive statistics regarding hand dimensions are presented in Table 1

Table 1: Descriptive statistics for hand dimensions (cm). (n =412)

Variables		Hand Length	Hand Breadth	Hand Index
Male (n=182)	Mean	18.54	8.62	46.57
	Std. Error	0.09	0.05	0.24
	Std. Deviation	1.25	0.77	3.36
	Minimum	15.90	7.30	38.09
	Maximum	21.50	11.00	56.12

	Range	5.60	3.70	18.03
Female (n=230)	Mean	17.12	7.29	42.60
	Std. Error	0.05925	0.03	0.15
	Std. Deviation	0.89	0.49	2.33
	Minimum	14.80	5.90	35.79
	Maximum	20.00	8.50	47.76
	Range	5.20	2.60	11.97

Independent sample t-test was performed to compare the hand length, hand breadth and hand index between sexes. Results revealed significant differences among hand length, hand breadth and hand index between males and females ($p < 0.001$ for each parameter). The sectioning points [(Mean male value+ Mean female value)/2] were derived for hand length, hand breadth and hand index, from the mean values of respective parameters, to differentiate sex. The values below and above the sectioning points were considered as female and male respectively. The relevant statistical parameters are presented in Table 2.

Table 2: Comparison of hand dimensions between male and female (n =412)

Diagnostic accuracy	Male	Female
Hand Length	72 %	79.1 %
Hand Breadth	78 %	89.6 %
Hand Index	74.7 %	81.3 %

The sectioning points were used to determine the diagnostic accuracy of hand length, hand breadth and hand index in discriminating sex. Hand length determined sex accurately in 72% males and 79.1% females. Hand breadth determined sex accurately in 78% males and 89.6% females. Similarly, hand index determined sex accurately in 74.5% males and 81.3% females. All the parameters revealed higher diagnostic accuracy in determining females compared to males. Hand breadth was most accurate in determining sex followed by hand index and hand length for both the sexes. (Table 3)

Table 3: Diagnostic accuracy of hand dimensions in determining sex. (n =412)

Statistical parameters	Hand Length	Hand Breadth	Hand Index
Sectioning points	17.83	7.96	44.58
t-value	12.81	20.10	13.52
Degree of freedom (df)	315.83	289.56	309.37
p-value	< 0.001	< 0.001	< 0.001
Mean difference	1.41	1.33	3.96
95 % Confidence Interval	1.19 – 1.63	1.20 – 1.46	3.38 – 4.54

DISCUSSION

Sex determination as a part of forensic identification process is relatively easier when

intact human body is encountered. But the usual cases brought by the police for medico-legal examination comprises of mutilated, fragmented and charred human remains. In all these incidents hands are one of the common structures preserved which can prove invaluable in determining sex and this has been demonstrated by various studies in the past. Hand dimensions have been shown accurate to various degrees in determining sex. [11, 12]

In present study hand length, hand breadth and hand index were found to be significantly larger in males ($p < 0.001$) compared to female Nepalese students. The mean hand length and breadth were 18.54 cm and 8.63 cm for males respectively whereas for females it was 17.13 cm and 7.29 cm respectively. This finding was similar to observations made by Krishnan K et al. in North Indian population [13], Agnihotri AK et al. in Mauritian population [14], Aboul-Hagag KE et al. in upper Egyptian population [15], Ibrahim MA et al. in North Saudi population [11] and Zahor S et al. in adult Tanzanian population [9]. All of these studies showed male hand dimensions to be greater than that of female.

In present study mean hand indices for male and female were 46.57 and 42.61 respectively. Various studies done in different Indian populations showed lower mean hand indices; ranging from 40 to 40.7 in males and 39.5 to 40.5 in females, compared to present study. [16] Similar were the findings in North Saudi, Mauritian and Egyptian population where mean hand indices were lower [11, 14, 15]. But study done in Tanzanian population showed higher values of mean hand indices (> 48 for both males and females) compared to present study and many other studies [9].

In present study average of left and right hand's measurement was considered as final measurement for hand dimension. Other studies considered right and left hand separately where most of them found right hand dimensions to be greater for both sexes. While some studies found left hand dimensions greater usually in females. In few other studies both sides had almost equal hand dimensions for each sex. However, no common pattern was identified through any of the studies. [8-17]

The cut off values in present study for hand length, hand breadth and hand index for sex differentiation were 17.84 cm, 7.96 cm and 44.59 respectively.

These sectioning points were almost similar to the sectioning points derived by Krishnan K et al. in North Indian population [13] but slightly higher than that derived by Shah SK et al. for Nepalese population [8] and Asha KR in Indian population [18]. On the other hand, the sectioning points derived by Zahor S on Tanzanian population were much higher than that derived in the present study [9].

The hand breadth was found diagnostically more accurate (Female 89.6% and Male 78%) followed by hand index (Female 81.3% and Male 74.7%) and hand length (Female 79.1% and Male 72%) in sex determination in present study for both the sexes. The accuracies were even more for females than males. Similar observations were made by other Indian studies where hand breadth had highest diagnostic accuracy. But in their study hand length was found more accurate than hand index. Similarly, hand length and breadth were found to be more accurate in females opposed to males while hand index was found more accurate in males compared to female in determining sex. [13, 16, 17] While other study done in West India by Gupta R et al. showed hand length to be more accurate than

hand breadth. Also, more accuracy was found in determination of male than female through hand dimensions [19].

CONCLUSIONS

Hand dimensions are found to be reasonably accurate in sex determination. Hand breadth is the most accurate parameter followed by hand index and hand length in determining sex by sectioning point analysis in Nepalese medical students. Diagnostic accuracy in females is greater than that of males. Results of this study can be useful for forensic investigative works in Nepalese context and similar future studies in Nepalese population.

CONFLICT OF INTEREST

None

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None

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