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Study of Correlation of Hand Parameters with Stature in Humans

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Abstract

Aims: The aim of the present study is to study the correlation of hand parameters with stature. *Materials and Methods:* Sample size of the present study consisted of 200 students (Males = 84 and Females = 116) between 17 and 24 years of age from Government Medical College. Their stature and hand parameters were recorded. *Results:* It was observed that males had higher mean, standard deviation and range for each of the parameter considered than those of females. Significant correlation was observed between height and the hand parameters. From the regression equations derived, one can calculate height from any known parameter and *vice versa*. *Conclusion:* Hand length and hand breadth showed statistically significant correlation with height in total cases and also when male and female cases were evaluated separately. Hand length and hand breadth also show significant positive correlation with each other. When one has to calculate height using one parameter, we recommend the use of hand length for the same as it showed highest correlation with height. This study will be useful for stature estimation from available skeleton material or parts of the deceased body that are available.

Keywords: Correlation; Hand; Parameters; Stature.

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Introduction

Growth which is the vital process is measured by measuring the height of a person.[1] Stature estimation is an important factor in identification of commingled remains in forensic examinations.[2.] It has been proved that stature can be estimated from imprints of hand, foot or from a shoe left at the scene of a crime. Hand length has also been studied by various researchers to predict stature.[3] It has been proved that hand length can predict body weight and body surface area independently of the gender of the subject[4] This study is done to estimate height of an individual from measurement of hand length, hand breadth and also to study the correlation among these parameters themselves.

Aim

To study the correlation of foot parameters with stature.

Materials and Methods

Sample size of the present study consisted of 200 students (Males = 84 and Females = 116) from Government Medical College. Subjects known to have any significant disease, orthopaedic deformity, metabolic or developmental disorders which could have affected the general or bony

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growth were not included in this study. The age of the sample group ranged between 17 and 24 years. The parameters studied were stature *i.e.,* height, hand length and hand breadth. The material used for the present study was standiometer (height measuring instrument), measuring scale, paper, pencil.

The measurements were taken on both sides in each subject by using standard anthropometric instruments in centimeter in the following manner:

Height of the individual was measured as vertical distance from the vertex to the floor. Measurement was taken by making the subject stand erect on a horizontal resisting plane bare footed. No pressure was exerted since this is a contact measurement.[5]

Hand measurements

Before taking measurements, it was checked that nails were trimmed. Each subject was asked to place his/her hand on a white paper with palm facing upwards keeping the fingers close together with thumb lying comfortably but not tightly against the radial aspect of the hand and index finger. A tracing of the hand was made with a lead pencil. The tracing proceeded from the radial styloid process to the ulnar styloid process.[6] Care was taken to see that there was no abduction or adduction at wrist joint, *i.e.,* forearm was directly in line with the middle finger[7] (**Fig. 1**).

Fig. 1: Showing hand tracing done.

1. *Hand Length*: A line was drawn joining the two styloid tips. This line is designated as the interstyloid line (**Fig. 2**). Distance between the midpoint of the interstyloid line and the tip of the middle finger in extension was measured as length of the hand.[6,8,9]
2. *Hand breadth*: Hand breadth was measured as the distance between the lateral aspect of index finger from where the thumb diverges and the natural concavity near the palmer digital creases on the medial aspect of little finger[6] (**Fig. 2**).

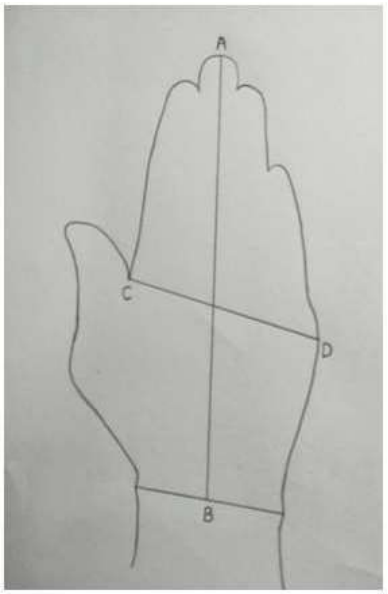

Fig. 2: Landmarks for hand measurements[6]:

Distance between A and B = Hand length;

Distance between C and D = Hand Breadth.

Results

The data was analysed using SPSS software version 20.

As there was no significant difference between the measurements of right and left sides, we have taken the average of the right and left sides of each parameter into consideration for the study.

From **Table 1**, one can note that males had higher mean, standard deviation and range for each of the parameter considered than those of total cases which are higher than those of females. $p < 0.01$ indicates that the probability of difference being due to chance is less than 1%.[10] This proved that the difference between the values of Males and Females is highly significant.

The extent or degree of relationship is measured by correlation co-efficient which is denoted by '*r*'. '*r*' ranges between -1 and +1. If $r = 1$, it indicates perfect positive correlation with two variables directly proportional to each other; $r = -1$ indicate perfect negative correlation with two parameters inversely proportional to each other; *r* between 0 and 1 indicate two variables are directly proportional to each other and have a moderate positive correlation, *r* between 0 and -1 indicate two variables are inversely proportional to each

Table 1: Distribution of various parameters in study population with '*t*' values indicating the difference in Male and Female parameters.

Sl. no.	Parameter		Total Cases	Males	Females	t	*p* Value
1	Height	Mean ± SD	163.08 ± 8.36	169.76 ± 6.42	158.23 ± 5.90	13.149**	0.001
		Range	142–185	155–185	142–171		
2	Average Hand Length	Mean ± SD	17.72 ± 1.14	18.58 ± 0.97	17.09 ± 0.80	12.002**	0.001
		Range	14.95–21.25	16.6–21.25	14.95–18.65		
3	Average Hand Breadth	Mean ± SD	7.52 ± 0.57	8.02 ± 0.46	7.17 ± 0.36	14.582**	0.001
		Range	6.05–9.1	7–9.1	6.05–7.95		

If $p \leq 0.01$ or 0.001 Highly Significant ** Highly Significant

other and have a moderate negative correlation.[10]

Pearson's correlation co-efficient (*r*) for height and hand length is 0.717, 0.510 and 0.479 for total cases, males and females respectively. Pearson's correlation co-efficient (*r*) for height and hand breadth is 0.619, 0.224 and 0.282 for total cases, males and females respectively. Pearson's correlation co-efficient (*r*) for hand length and hand breadth is 0.733, 0.499 and 0.510 for total cases, males and females respectively. All values are significant at 0.01 level ($p = 0.001$). Correlation of height with hand length and hand breadth is highly significant; hand length showing stronger correlation than hand breadth. Also hand length and hand breadth show highly significant correlation among them.

Linear regression model[10] is given by:

$$y = a + bx$$

where y = dependent variable (which is height in our case)

x = independent variable (Hand Length/ Hand Breadth)

b = regression co-efficient

a = intercept (a constant)

The linear equations derived for calculating height from hand length are:

For total cases: Height = 70.128 + 5.246 HL

$R^2 = 0.515$ and f value = 209.94, $p = 0.001$

For males: Height = 106.76 + 3.389 HL

$R^2 = 0.261$ and f value = 28.89, $p = 0.001$

For females: Height = 97.64 + 3.546 HL

$R^2 = 0.229$ and f value = 33.89, $p = 0.001$

The linear equations derived for calculating height from hand breadth are:

For total cases: Height = 96.506 + 8.848 HB

$R^2 = 0.383$ and f value = 123.05, $p = 0.001$

For males: Height = 144.93 + 3.098 HB

$R^2 = 0.05$ and f value = 4.34, $p = 0.040$

For females: Height = 125.15 + 4.616 HB

$R^2 = 0.079$ and f value = 9.83, $p = 0.002$

If $p \leq 0.01$ or 0.001 Highly Significant

$p \leq 0.05$ Significant

The high '*f*' value with low '*p*' value indicates significant functional relationship between dependent variable and independent variable. *R* square is the square of the correlation co-efficient.[10] It determines the strength of association among the parameters considered. In equation of deriving height from hand length in total cases, it is 0.515 which indicates that 51.5% of variation in height is due to variation in hand length. From the linear equation model, it is clear that height can be better predicted from hand length than hand breadth.

Multiple regression model is given by: $y = \beta_0 + \beta_1$ (HL) + β_2 (HB)

where y = dependant variable (height in our case)

β_0 = regression co-efficient

β_1 = regression co-efficient for HL

β_2 = regression co-efficient for HB

For total cases: Height = 67.60 + 4.17HL + 2.88HB

$R = 0.73$, $R^2 = 0.53$ and f value = 112.60, $p = 0.000$

For males: Height = 108.76 + 3.52HL – 0.56HB

$R = 0.51$, $R^2 = 0.26$ and f value = 14.36, $p = 0.000$

For females: Height = 94.95 + 3.35HL + 0.83HB

$R = 0.48$ $R^2 = 0.23$ and f value = 16.98, $p = 0.000$

The multiple correlation co-efficient (*R*) was highly significant at $p = 0.001$.

Thus, height can be calculated from all the parameters with good accuracy by using multiple regression equation.

Multiple regression model fitted well to the observed data than the linear regression model as the values of multiple correlation co-efficients

are a bit higher than the Pearson's correlation co-efficients.The results of the present study show that there was strong positive and significant correlation of height with hand length and hand breadth respectively. There also existed a strong positive significant correlation among these parameters themselves.

It must be noted that these equations are applicable to the population from which data has been collected because genetic, racial and environmental factors (climate, nutrition etc.) may influence the parameters under consideration.

Discussion

Anthropometric characteristics have direct relationship with sex, shape and form of an individual and these factors are intimately linked with each other[1]. Establishing the identity of an individual from mutilated, decomposed, and amputated body fragments has become an important necessity in recent times due to natural disasters like earthquakes, tsunamis, cyclones, floods and man-made disasters like terror attacks, bomb blasts, mass accidents, wars, plane crashes etc. It is important both for legal and humanitarian reasons.[12] But there are inter-racial and inter-geographical differences in measurements and their correlation with stature. What may be true for one race or one region may not be true for the other.[13]

The difference between male and female measurements was statistically significant. These differences in stature and foot measurements between males and females can be attributed to the fact that fusion of epiphyses of bones occurs earlier in girls in comparison to boys. Boys have about two more years of bony growth than girls.[14]

We observed that mean value of height in our study matches with the findings of Khanapurkar[15] (2012) and Patel[16] (2012) but is lower than the findings of Bhatnagar[17] (1984), Sanli[18] (2005), Chikhalkar[13] (2009) and Jakhar[19] (2010). Bhatnagar[17] (1984) has done their study in Punjabi population, Jakhar[19] (2010) studied the Haryanvi population whereas Sanli[18] (2005). Punjabi and Haryanvi are known to have larger stature than the Western Indian population. Our study supports the same finding.

Mean hand length of our study is lower than the findings of Bhatnagar[17] (1984), Sanli[18] (2005); whereas it is comparable with the rest of the studies done.

Mean hand breadth of our study is comparable with the findings of the other studies done by the various authors mentioned above.

The difference in the findings of present study from those of the other studies may be attributed to the geographical as well as racial factors that may influence growth and stature of an individual.In the present study, we observed highly significant differences in all dimensions of males and females. Jakhar[19] (2010) reported similar significant differences in males and females.

Comparison of Correlation Co-efficients

Correlation co-efficient between two parameters gives us an idea whether these parameters are related to each other or not; if yes then to what extent.

Chikhalkar[13] (2009) observed that correlation co-efficients (*r*) of hand length and breadth with height to be 0.5902 and 0.6004 respectively. Patel[16] (2012) observed '*r*' values for hand length and breadth to be 0.806 and 0.467 respectively. The findings of our study are comparable with those of the above studies.

Jasuja and Singh[20] (2004) measured stature and phalanges length of all fingers of both the hands in 60 sixty adult male and female Jat Sikhs. No bilateral difference in the hand length or any statistically significant difference was observed in print length from the actual hand length.

Height can be calculated from hand length and hand breadth separately using linear regression equations derived from the present study. Similar equations are derived by various authors like Bhatnagar[17] (1984), Chikhalkar[13] (2009), Patel[16] (2012).

In multiple regression equations, various parameters are used to calculate the dependant variable which was height in present case. These equations predict height better than the linear equations which takeonly one parameter into consideration.

Khanapurkar and Radke[15] (2012) studied estimation of stature from the measurement of foot length, hand length and head length. They found that contribution of head length in estimating height was not significant when it was considered with hand length and foot length. So they derived the equation taking hand length and foot length into consideration. The equation derived by them was Height = 59.451 + 2.552 FL + 2.295 HL.

Conclusion

Present study was designed to estimate height from hand length and hand breadth. Correlation among these parameters was also studied.

- The difference in the measurements of males and females was statistically highly significant for each parameter.
- Hand length and hand breadth showed statistically significant correlation with height in total cases and also when male and female cases were evaluated separately.
- Hand length showed better correlation with height in all cases ($r = 0.717$) as well as in males ($r = 0.510$) and females ($r = 0.479$) separately than by hand breadth.
- Hand length and hand breadth also shows significant positive correlation with each other ($r = 0.733, 0.499, 0.510$).
- Linear and multiple regression equations were formulated which will help to calculate height from single parameter and both parameters respectively.
- When one has to calculate height using one parameter, we recommend the use of hand length for the same as it showed highest correlation with height.
- This study will be useful for stature estimation from available skeleton material or parts of the deceased body that are available.

References

1. Patel SM, Shah GV, Patel SV. Estimation of height from measurements of foot length in Gujarat Region. J Anat Soc, India. 2007;56:25–7.
2. Lundy J. The mathematical versus anatomical methods of stature estimate from long bones Am J Forensic Med Pathol. 1985;6:73–5.
3. Saxena SK. A study of correlations and estimation of stature from hand length, hand breadth and sole length. Anthropology Anz. 1984;42:271–76.
4. Standring S. Gray's anatomy, 39th edition. Philadelphia: Elsevier Churchill Livingstone. 2005;889–924,1507–542.
5. Iscan MY, Quatrehomme G. Medico-legal anthropology in France. Forensic Sci Int. 1999;100:17–35.
6. Zverev YP. Relationship between arm span and stature in Malawian adults. Ann Hum Biol. 2003;30:739–43.
7. Lundy JK. Living stature from long limb bones in the South African Negro. S Afr J Sci. 1983;79:337–38.
8. Lundy JK. Revised equations for estimating living stature from the long bones of the South African Negro. S Afr J Sci. 1987;83:54–5.
9. Dayal MR, Steyn M, Kuykendall KL. Stature estimation from bones of South African whites. S Afr J Sci. 2008;104:124–28.
10. Mahajan BK. Methods in biostatistics for medical students and research workers, 7th edition. Jaypee Brothers Medical Publishers Ltd, New Delhi. 2010.
11. Krishan K. Anthropometry in forensic medicine and forensic science forensic anthropometry. Internet J Forensic Sci. 2007;2(1):1–17.
12. Ismaila SO. Anthropometric data of hand, foot ande of university students in Nigeria. Leonardo Journal of Sciences. 2009 Jul–Dec;15(8):15–20.
13. Chikhalkar BG, Mangaonkar AA, Nanandkar SD, *et al.* Estimation of stature from measurements of long bones, hand and foot dimensions. JIAFM. 2009;32:329–31.
14. El-Meligy MMS, Abdel-Hady RH, Abdel-Maaboud RM, *et al.* Estimation of human body built in Egyptians. Forensic Sci Int. 2006;159:27–31.
15. Khanapurkar S, Radke A. Estimation of stature from the measurement of foot length, hand length and head length in Maharashtra Region. Indian Journal of Basic and Applied Medical Research. 2012 March;1(2):77–85.
16. Patel PN, Tanna JA, Kalele SD. Correlation between hand length and various anthropometric parameters. International Journal of Medical Toxicology and Forensic Medicine. 2012;2(2):61–63.
17. Bhatnagar DP, Thapar SP, Batish MK. Identification of personal height from the somatometry of the hand in Punjabi Males. Forensic Sci Int. 1984;24:137–41.
18. Sanli SG, Kizilkanat ED, Boyan N, *et al.* Stature estimation based on hand length and foot length. Clin Anat. 2005;18(8):589–96.
19. Jakahar JK, Pal V, Paliwal PK. Estimation of height from measurements of foot length in Haryana Region. J Indian Acad Forensic Med. 2010;32(3):231–33.
20. Jasuja OP, Singh G. Estimation of stature from hand and phalange length. J Ind Acad Forensic Med. 2004;26(3):100–106.