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Correlation of Human Height with Hand Dimensions: A Study in Young Population of Central India

Charmode SH[1], Kadlimatti HS[2,*], Pujari D[3]

[1]Assistant Professor of Anatomy, Department of Anatomy, ESIC Medical College Gulbarga, Karnataka, India

[2]Professor of Anatomy, Department of Anatomy, ESIC Medical College Gulbarga, Karnataka, India

[3]Associate Professor of Anatomy, Department of Anatomy, ESIC Medical College Gulbarga, Karnataka, India

Abstract

Background and Objective

Identification of sex, age, race and stature is the most important aspect of any forensic investigation. There is a strong correlation of stature with hand dimensions and if either of the measurements is known, the other can be calculated. With this objective, the present study was designed to correlate the hand dimensions with stature of an individual and to record the standard deviation in the estimation of stature.

Methodology

This cross-sectional study was conducted amongst 1000 participants (500 male and 500 female) of ESIC Institute Gulbarga over a period of 14 months. Hand dimensions along with stature and weight were measured. Linear regression coefficient was calculated.

Results

Mean stature was 161.88 cm. Mean hand length was 18.11 cm on right side and 18.10 cm on left side. Mean hand breadth was 9.91 cm on right side and 9.83 cm on left side.

Conclusion

Highly significant difference in right and left side mean hand length and breadth measurements was observed. Also observed was a strong positive statistically significant correlation between height and hand dimensions. This data might be useful for forensic, epidemiological and anthropometric studies where stature determination is of utmost importance.

Corresponding author: Kadlimatti H.S, Professor And Head, Department of Anatomy, ESIC Medical College Gulbarga, Phone: 6360106446, Email: sundip.charmode@yahoo.com

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Introduction

There are many studies undertaken to emphasize the importance of measuring the hand dimensions to estimate stature. The hand dimensions, being genetically derived varies in different races and ethnic groups and is used to determine sex, age, stature and nutritional status of an individual. Identification of sex, age, race and stature is the most important aspect of investigations in cases of mass disasters like Bomb explosions, public vehicle (plane, railway, bus, truck, car) accidents, cross border terrorist attacks, natural calamities, murders where bodies or isolated extremities are found in disintegrated, mutilated and skeletonized state[1,2].

Hand dimensions have been found to have a correlation with the stature of an individual. In Central India, a few studies have been conducted in past on the same subject but achieved insignificant findings due to various factors. Over all crime and accidents have grown in this region in last couple of decades. The present study was thus proposed to study hand dimensions in relation to stature and weight of an individual over a large sample size with the objective to provide statistically significant data for forensic department in this region for accurate estimation of stature from hand dimensions.

Methodology

Study Design

Descriptive cross-sectional study

Setting

Anthropometric section of Department of Anatomy, ESIC Medical College and Hospital Gulbarga, Karnataka.

Duration of Study

14 months; from 31st October 2017 to 31th December 2018.

Sample Size

1000 participants, (500 – male , 500 –female) which includes Medical, Dental and Nursing students aged between 17 and 20 years of age in ESIC Medical College Gulbarga.

Sampling Technique

Inclusion Criteria

Medical, Dental and Nursing students aged between 17 and 20 years in ESIC Medical College Gulbarga.

Exclusion Criteria

Students of NRI quota, students those with poorly defined wrist creases, deformities of vertebral column & limbs, contractures, missing limbs, history of trauma to hand and foot, with features suggestive of dysmorphic syndromes, chronic illness, hormonal therapy were excluded from the study[3,4].

Sample Selection

Simple random sampling method[5] was used to select 1000 participants (500 – male, 500 –female) from our Medical, Dental and Nursing students (total -3000) after satisfying the inclusion criteria. Students were easily accessible and also represented the young adult age group.

Data Collection Procedure

After receiving the Ethical Committee approval of Institutional Ethical Committee, the data collection procedure was started after taking informed consent. Tutors and junior residents took the measurements after training. Measurements were taken thrice and average was taken. Diurnal variation was avoided by taking the measurements between 1-2 pm only daily. Hand dimensions have been measured in different way in different studies but we followed the method adopted by study of Mohite et al [6] in Central Indian population. The measurements were taken as follows:

Hand Length

Each subject was made to place his / her hand on a white paper with the palm facing upwards keeping the fingers close together with the thumb lying comfortably but not tightly against the radial aspect of the hand and index finger (Figs. 1,2). A tracing of the hand was made with a lead pencil. The tracing proceeded from the radial styloid process to the ulnar styloid process. A line designated as the inter-styloid line was drawn joining the two styloid tips. Hand length (L) was measured using a Vernier Slide Calipers as the distance between the distal crease of wrist to tip of middle finger [6].

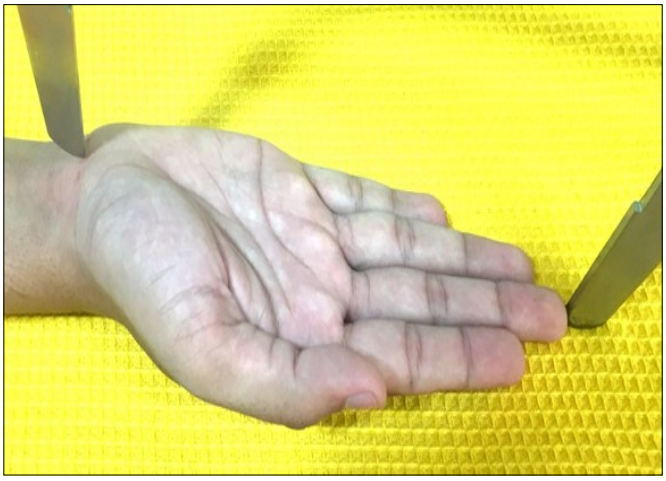


Figure 1. Hand Breadth: Measured from 1st metacarpo-phalangeal joint to base of 5thmetacarpal in cm using Vernier Caliper [6].

Figure 2. Hand Breadth: Measured from 1st metacarpo-phalangeal joint to base of 5thmetacarpal in cm using Vernier Caliper [6].

Figure 3. Measurement of Height (cm) from the sole of the feet to the vertex of the head using Stadiometer.

Height

Measured to the nearest centimeters (cm) using a Stadiometer with subject standing erect on a horizontal resting plane bare footed having the palms of the hands turned inward and the finger pointing downwards (Fig. 3). The height was measured from the sole of the feet to the vertex of the head as recommended by International Biological Program 7.

Data Collection Tools

Vernier slide calipers, Calibrated foot board, Stadiometer, Regular weight machine, Questionnaire for collection of personal details, academic scores, Lead pencils, stationary etc.

Data collected were tabulated, graphically represented and statistically analyzed.

Results

Table 1 shows statistically highly significant positive correlation between Height and Hand length of right and left (P<0.01). Study reveals that hand length of both sides was also significantly more in those having more stature. Through the linear regression equation Height = 75.31 + 4.782 * Hand length (right) and Height = 75.26 + 4.786 *Hand length (left) we are able to estimate height by the known value of hand length.

There was a highly statistically significant positive correlation between height and hand breadth of right and left (P<0.01). The study revealed that hand breadth of both sides was also significantly more in those having more stature. There was a linear regression equation Height = 63.186 + 4.782 * Hand breadth (right) and Height = 68.798 + 4.786 * Hand breadth (left) (Graphs 1,2).

There was statistically very highly significant difference in hand length (right and left), hand breadth (right and left), Height and weight between males and females (P<0.001) (Table 3). The hand length (right and left), hand breadth (right and left), height and weight were significantly more in males as compare females (Graph 3).

Discussion

In present study, human stature ranged from 135.2 cm to 195.2 cm. mean stature was 161.88 cm with SD of 13.45. These findings correspond closely with studies done on Indian population like that of Patel et al[2] and Mohite et al[6] and Chikhalkar et al[11].

Hand length on right side ranged from 13.9 cm to 23.8 cm with mean of 18.11 cm and SD of 1.38. Hand length on left side ranged from 13.9 cm to 24.6 cm with mean of 18.10 cm and SD of 1.47. These findings correspond closely with those of Oommen et al [8], Shankar et al[10], Chikhalkar et al[11]and Kavyashree et al[12], (Table 1).

Hand Breadth on Right side ranged from 7.6 cm

Table 1. Correlation of hand length and stature

Variables	Minimum	Maximum	Range	Mean	SD	N	Correlation r	P value
Height (cm)	135.2	195.2	60.0	161.88	13.45	1000	--	--
Hand length right (cm)	13.9	23.8	9.9	18.11	1.38	1000	r = 0.493	P<0.01 HS
Hand length left (cm)	13.9	24.6	10.7	18.10	1.47	1000	r =0.524	P<0.01 HS
Linear Regression Equation	Height = 75.31 + (4.782 * Hand length (right))							
Linear Regression Equation	Height = 75.26 + (4.786 *Hand length (left))							

NS= not significant, S=significant, HS=highly significant, VHS=very highly significant

to 19.0 cm with mean of 9.91 cm and SD of 0.76. Hand Breadth on left side ranged from 7.6 cm to 19.0 cm with mean of 9.83 cm and SD of 0.77, (Table 2). These findings were higher than those observed in almost all the previous studies (Table 4). This is might because in present study, hand breadth was measured from 1st metacarpo-phalangeal joint to base of 5thmetacarpal; whereas in previous studies it was measured from 2nd metacarpo-phalangeal joint to base of 5thmetacarpal. Hand breadth observations matched with Mohite et al[6].

Gender related comparison of hand dimensions was done and found them to be significantly more in males as compared to females. These findings matched findings from almost all previous studies as mentioned in Table 4.

Correlation coefficient 'r' calculated for hand length (right : r = 0.493, left : r =0.524) and hand breadth (right : r = 0.569, left : r = 0.547) corresponds with that calculated in studies of Chikhalkar et al[11] (hand length r = 0.5902, hand breadth r = 0.6004); Patel et al[2] (hand length r = 0.806 , hand breadth r = 0.467); Pal et al[17] (HL r = 0.683, HB r = 0.53), Tandon et al[9] (male , HL r = 0.224, HB r =0.154 ; female, HL r = 0.313, HB r = 0.272), Patel et al[2] (hand length r = 0.806, hand breadth r = 0.467). A strong correlation was observed in present study between human height and hand length and breadth similar to findings of Rastogi et al[3].

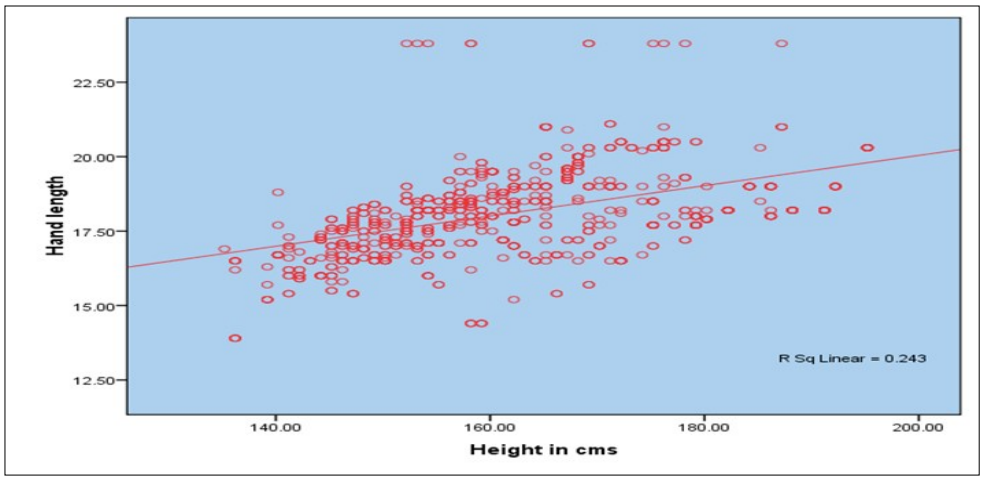
Linear Regression Equation calculated in the present study corresponds with that calculated in previous studies like Tandon et al[9] (regression formulae for male, female and complete samples were: y = 5.79x + 124.54; y = 7.125x + 105.5 and, y = 11.36x + 76.49 respectively); Shankar et al[10] (male : y = 7.96 + (0.061 *right hand length), female : y = 10.49 + (0.04 * left hand length); Mohite et al[6] (2015) (h = 65.60+ (0.54*head length), h = 104.03+(0.76*head breadth) ; Patel et al[2] (y=59.52+5.9163* HL,

Table 2. Correlation of Hand Breadth and stature

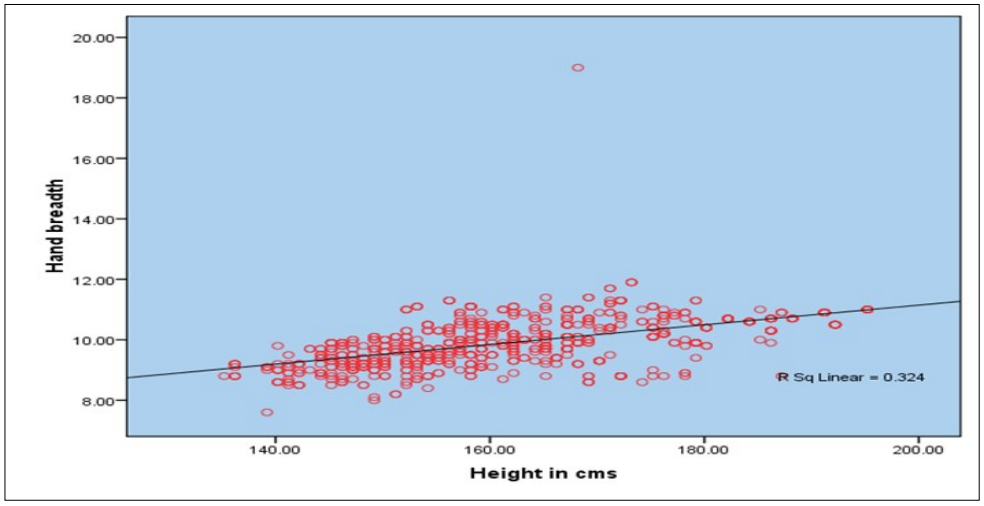
Variables	Minimum	Maximum	Range	Mean	SD	N	Correlation r	P value
Height (cm)	135.2	195.2	60.0	161.88	13.45	1000	--	--
Hand breadth right (cm)	7.6	19.0	11.4	9.91	0.76	1000	r = 0.569	P<0.01 HS
Hand breadth left (cm)	7.6	19.0	11.4	9.83	0.77	1000	r = 0.547	P<0.01 HS
Linear Regression Equation	Height = 63.186 + 4.782 * Hand breadth (right)							
Linear Regression Equation	Height = 68.798 + 4.786 * Hand breadth (left)							

Table 3. Gender wise comparison of parameters

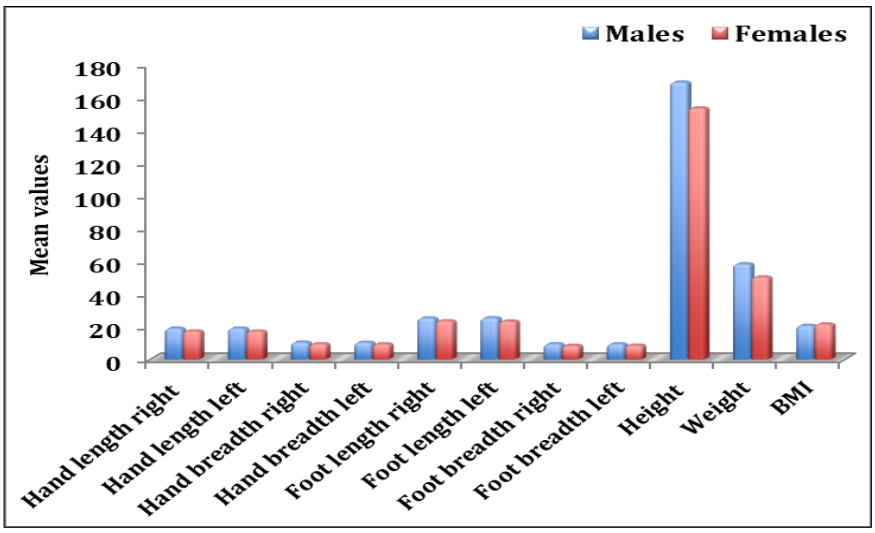
Variables	Male (N=500) Mean ± SD	Female (N=500) Mean ± SD	Z test value	P value and significance
Hand length right	18.90 ± 1.16	17.18 ± 0.99	Z = 24.48	P<0.001, VHS
Hand length left	18.96 ± 1.27	17.11 ± 0.99	Z = 24.79	P<0.001, VHS
Hand breadth right	10.36 ± 0.68	9.39 ± 0.47	Z = 25.02	P<0.001, VHS
Hand breadth left	10.29 ± 0.69	9.31 ± 0.47	Z = 21.56	P<0.001, VHS
Height	169.28 ± 11.75	153.42 ± 9.75	Z = 22.26	P<0.001, VHS



Graph 1. Correlation between Hand length and Stature



Graph 2. Correlation between Hand Breadth and Stature



Graph 3. Multiple bar diagram represents gender wise comparison of variables

Table 4. Comparison of present study with previous studies

No	Study /Author	Year	Sample size (n)	Parameters studied	Observations				
					Mean height (cm)	Mean hand length (cm)		Mean hand breadth (cm)	
						Right M/F	Left M/F	Right M/F	Left M/F
1	Oommen et al [8]	2005	100	HL, FL	NA	19.06 / 17.32	19.06 / 17.24	NM	NM
2	Danborno and Elukpo [1]	2007	400	H, HL, HB, FL, FB	173.7 / 160.0	19.8 / 18.5	19.9 / 18.5	8.9 / 7.8	8.6 / 7.7
3	Patel et al[13]	2007	502	H, FL	170.9 / 156.14	NM	NM	NM	NM
4	Rastogi et al [3]	2008	500	HL, HB, H	NA	NA	NA	NA	NA
5	Chikhalkar et al[11]	2009	300	H, W, FAL, HL, HB, FL, FB	167.26	18.93	18.93	7.53	7.53
6	Krishan, et al[14]	2011	246	HL, HB, FL,FB	NA	NA	NA	NA	NA
7	Patel, et al[2]	2012	273	H, FL, FB, HL, HB, AS	164.59	17.75	NM	7.91	NM
8	Ibegbu, et al[7]	2013	600 children	H, HL	NC	NC	NC	NC	NC
9	Mohite, et al[6]	2015	230	H, HL, HB, FL	165.02	171.13*	NM	68.04	NM
10	Bodorikova and Nescakova[15]	2015	250	H, HL, HB, FL, FB	NA	NA	NA	NA	NA
11	Kavyashree et al[12]	2015	294	H, HL, HB	NM	18.81	18.74	8.24	8.00
12	Dey and Kapoor [16]	2015	147	HL, HB	NM	19.2 / 17.3	19.0 / 16.5	8.3 / 7.57	8.18/7.45
13	Pal, et al[17]	2016	1662 women	HL, HB, W, H, DL	NM	16.3	16.31	7.05	7.03
14	Tandon et al[9]	2016	497	H, HL, HB, FL, FB, DL	172.7 / 157.1	19.3 / 17.3	NM	8.3 / 7.2	NM
15	Shankar et al[10]	2017	220	H, HL	NM	18.21 / 18.81	18.35 / 18.82	NM	NM
16	Kim, et al[18]	2018	5195	H, HL, HB, FL, FB	NM	NM	NM	NM	NM
17	Samoon et al.[19]	2018	158	HL, H	NM	NM	NM	NM	NM
18	Ibrahim et al.[20]	2018	350	S, HL, PL, HB, FL	175.44 /158.96	20.11/18.65	20.75/18.6	8.76/7.66	8.7/7.62
19	Present study	2019	1000	H, HL, HB	161.88	18.90 / 17.18	18.96 / 17.11	10.36/9.39	10.29 / 9.31

H- Height, HL – Hand length, HB – Hand breadth, FL – Foot length, FB – Foot breadth, PL – Palm length, DL – Digit / finger length, AS-Arm span, FAL – Forearm length, NM – Not measured NC - Not comparable, NA – Data not available.

y=121.69+5.4188*HB).

Conclusions

1. Highly significant difference was observed in mean hand length and breadth on both sides.
2. Positive statistically significant correlation was observed between height and hand dimensions.
3. The linear regression formula derived can be used for adult between 17-20 years but it might be of limited use for children and older people for measuring the stature and shoe design.
4. The stature of an individual can be calculated from either of the dimension of hand, i.e. length or breadth and vice versa.
5. This data might be useful for forensic, epidemiological and anthropometric studies.

Limitations

1. In the present study, age range of only 17 to 20 years was considered.
2. Only healthy individuals were included in the study. Hence the data may not be applicable students those with poorly defined wrist creases, deformities of vertebral column & limbs, contractures, those with h/o of trauma to hand and foot, those with features suggestive of dysmorphic disorder.
3. Applicability of anthropometric measurements in living & deceased individuals may practically differ.
4. The present study is a preliminary one & would be followed up by other studies to address the above limitations.

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