ORIGINAL ARTICLE

Correlation of Human Height with Hand Dimensions: A Study among Medical students

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Citation

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Abstract

Background: Anthropometry is widely used for Identification of an individual. Height is one of the most important parameters of anthropometry. It is strongly correlated with the individual's hand dimensions and if either of the measurements are known, the other can be calculated. **Aim and Objective:** To know correlation between the hand dimensions and Height of an individual and to apply the regression line of height on hand dimension of the person. **Methods and Material:** A cross-sectional study was conducted among the medical students. Anthropometric indices were recorded after obtaining written consent and institutional approval using standard equipments. Linear regression and Pearson coefficient were calculated to study the correlation and arrive at the equation to calculate Height from Hand length. **Results:** Age of the study participants who consented for study (150) ranged between 18-24 years. Mean height was 165.91 cm. Mean right hand length was 17.71 cm and 17.69 cm on left hand. Mean hand width was 7.79 cm on right side and 7.56 cm on left side. A statistically significant positive correlation was observed between height and the hand dimensions. **Conclusions:** There was a statistically significant positive correlation between hand dimensions and height. Forensic investigation, body identification and triage can be facilitated through calculating Height from hand dimensions when only mutilated body remains are received during disasters.

Keywords

Introduction

Disasters like Bomb explosion, vehicle accidents, terrorist attacks, natural calamities and homicides are very common these days, where bodies or isolated extremities are found in disintegrated, mutilated and in skeletonized state. (1) In such circumstances, identifying the body (parts) and handing over to the relatives becomes challenging. Predicting the height by measuring various body segments will facilitate the process of Victim identification.(2) The differences between various ethnicities based on height measurement led to diverse locomotive patterns and body mass index have been studied and quantified world-wide.(3) Various factors like environment, puberty onset, genetics, physical activity and nutrition affects the Height of an individual.(4) Hand dimension varies in different ethnic groups and may be useful to determine gender, age, nutritional status and stature of an individual.(5) Studies have shown that height of an individual was related with the hand segment measurements in the past.(4,5)

Aims and Objectives

1. To correlate the hand dimensions with height of an individual
2. To derive an equation for calculating the height from hand length.

Material and Methods

This study was conducted in the Departments of Community Medicine and Anatomy, in a private medical college, Gautam Buddh Nagar, among the Medical Students, from July 2021 to December 2021.

After obtaining approval from the Institutional Ethical Committee, anthropometric indices of all the students who consented to participate were recorded. Those students with deformities of vertebral column and/or limbs, contractures, missing limbs and any history of trauma to hand, were excluded from the study, similar criteria were followed for inclusion/exclusion.(6,7)

Measurements were taken thrice and average was taken in order to avoid any bias. Hand dimensions were measured following the method adopted by previous study among the Central Indian population. To measure hand dimensions, 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. A line designated as the inter-styloid line joining the two styloid tips (Radial and Ulnar).(8)

Hand dimensions were measured using digital vernier calipers. Hand length (L) was as measured as the distance between the distal creases (inter-styloid line) of wrist to tip of middle finger. Hand width was measured as the distance between the most laterally placed point on the head of 2nd metacarpal bone to the most medially placed point located on the head of 5th metacarpal bone. Height was measured to the nearest centimeter (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. The height was measured from the sole of the feet to the vertex of the head.(9) Weight was measured to the nearest kilograms using a calibrated bathroom weighing scale with subject standing erect on the weighing machine with minimal clothing, bare footed, looking straight, having the palms of the hands turned inward and the finger pointing downwards.

The collected data was statistically analysed using SPSS Vr.16 (Trial) software and represented in tabulation and graphs. Linear regression and Pearson's correlation coefficient were applied to study the correlation and to derive regression equation. The correlations were considered to be statistically significant with p-values < 0.05 and 0.01.

Regression equation for the Height of the study participants was derived using the formula "Y = a+bx". Where Y is dependent variable (Height) and x is independent variable (Hand dimension).(10)

Results

In the current study, a total of 150 subjects participated among whom 52% were male and 48% females. Based on age, it was observed that majority of the students (37.3 %) belonged to the 20 years of age followed by 19 years (27.3%), 21 Years (17.3%) and 18 years (10.7%). However, 7.4% of participants aged between 22-24 Years (Figure 1). (Table 1 shows the descriptive statistics of selected variables of the students and Table 2 shows the correlation between student's height with the hand length and width (both hands). It was found that the relationship between height and the hand dimensions showed strong correlation with coefficients values of 0.672 (left hand length) 0.675 (right hand length), 0.534 (left hand width) and 0.527 (right hand width) and all were significant at 1% level of significance.

Table 3 shows Linear regression analysis where height was considered to be the dependent variable and left-hand length, right hand length, left hand width and right-hand width were taken as independent variables in regression models 1, 2, 3 and 4 respectively.

These regression models (Table 3) showed R-square values of 0.451 (height and left hand length), 0.455 (height and right hand length), 0.285 (height and left hand width) and 0.279 (height and right hand width). This inferred that, about 45% variation of the dependent variable (height) can be explained by the independent variable – lengths of both the hands (average model). Similarly, variation of height can be explained by 28.5% with left hand width and 27.9% by right hand width.

From each of these regression models Coefficient constants (a) and predictor constants (b) were derived as shown in respective regression each model, which were statistically significant at 5% and 1% level of significance.

All the models were well described and validated as represented by respective normal residual P-P plots (Figure. 2).

Discussion

Findings of the current study were compared with similar studies conducted by various researchers in different parts of the world and India, which has been presented in Table 4.

In current study, height of the study participants ranged from 143.5 to 187.0 cm and mean height was 165.91 cm with SD of 9.48 which closely corresponds with studies done on Indian populations.

Left hand length range was 15 to 21 cm with mean of 17.69 cm and SD of 1.30 and Right-hand length measured from 15 to 21.9 cm with mean of 17.71 cm and SD of 1.30 and. Almost similar findings were found by Shankar et al(7), Chikhalkar et al(12) and Kavyashree et al(13).

Width of left hand ranged from 4.96 to 14.80 cm with mean 7.56 cm ± 1.18 and Right-hand width range was 4.89 to 14.80 with mean 7.79 ± 1.18. These findings were higher than those observed in almost all the previous studies done by Chikhalkar et al(12) and Kavyashree et al(13). This may be because in the present study, selected

sample was from adult (17 to 24 years) of old, whereas in previous studies it was considered overall age's group.

A statistically significant positive correlation was observed between Height and hand dimensions (length and width) and height was found to be 8.9-9.5 times that of hand length. Nanayakkara et al(14) in their study who concluded that hand length was a precise tool to estimate stature of an un-known person similar to our study where Height can be estimated up to 45% with Hand length and up to 28% variation with Hand width; this variation is because height also varies with age (below18 years) and gender which is statistically significant. It has been observed (table4) similar results were reported by Patel et al(3)(2012) and Tandon et al(6) (2016) for hand length.

In present study, a very good positive and significant correlation was observed between human height and hand length similar to findings of Rastogi et al(4).

Conclusion

In this study, correlation as well as regression line were applied between height and hand length and width of person. It was found that there was good positive relation between the variables. Height of a person can be calculated when Hand length or width were made available with simple linear regression formula "Y = a+bx". At the same time other factors like age and gender also needs to be taken into consideration.

Recommendation

Height calculation is essential for identification of an individual and when it is not recordable, measurement of hand dimensions is recommended. Age and other factors like foot dimensions of persons can also be considered for estimation of height.

Limitation of the study

1. In the present study, participants of 17 to 24 years age group only were considered so generalization to whole population is not possible.
2. Applicability of anthropometric measurements in living and deceased individuals may practically differ.
3. Gender wise variations were not considered in the current study.

Relevance of the study

This study is relevant in anthropometric assessment and for forensic investigations to identify the body parts and to estimate the height using hand dimensions. Anthropometry plays a major role in detecting diverse ethnicity, locomotive functions and gender identification. The stature varies in different race and ethnicity and also with gender, thus current endeavor was made to assess possibility of applying leaner regression model in north Indian population.

Authors Contribution

Acknowledgement

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Tables

TABLE 1 DESCRIPTIVE STATISTICS OF THE SELECTED VARIABLES

Variables (n=150)	Range	Mean	SD
Age	18 - 24	19.89	1.22
Height of Students	143.5 - 187	165.91	9.48
Length of left Hand	15 – 21.0	17.69	1.3
Length of Right Hand	15 - 21.9	17.71	1.3
Width of Left hand	4.96 - 14.8	7.56	1.18
Width of Right Hand	4.89 - 14.8	7.79	1.18

TABLE 2 PEARSON'S CORRELATION BETWEEN SELECTED VARIABLES

Correlation of height with (n=150)	Pearson Coefficient	Pvalue
Age	0.540**	0.000
Left Hand Length	0.672**	0.000
Right Hand Length	0.675**	0.000
Left Hand Width	0.534**	0.000
Right Hand Width	0.527**	0.000
*** Correlation is significant at the 0.01 level (2-tailed).*		

TABLE 3 REGRESSION MODELS OF HEIGHT ON HAND DIMENSIONS

Model	Model Summary[(y)]				Coefficients		
	R	R^2	Adj. R^2	SE	Coeff. (SE)	t-test (p-value)	Range (95% CI)
Model 1	0.672	0.451	0.447	7.076	79.4[a] (7.89)	10.06 (0.000)	63.8 - 94.99
					4.9[b] (0.44)	11.03 (0.015)	4.014 – 5.77
Model 2	0.675	0.455	0.451	7.05	78.77[a] (7.9)	9.99 (0.000)	63.19 – 94.34
					4.92[b] (0.44)	11.08 (0.000)	4.04 – 5.8
Model 3	0.534	0.285	0.28	8.07	133.4[a] (4.3)	31.00 (0.000)	124.9 - 141.88
					4.3[b] (0.56)	7.65 (0.000)	3.2 - 5.42
Model 4	0.529	0.279	0.275	8.1	132.5[a] (4.47)	29.65 (0.000)	123.7 - 141.36
					4.29[b] (0.568)	7.55 (0.000)	3.16 - 5.41

a – Coeff. constant of the model; b – Coeff. constant of independent variable (hand dimension) applied in the Model; y – dependent variant (Height); Model 1and3 – Left hand (length and width respectively); Model 2and4 – Right hand (length and width respectively)

TABLE 4 COMPARISON OF FINDINGS FROM SIMILAR PREVIOUS STUDIES.

S. No	Studies (Year)	n	Parameters studied	Mean height (cm) M/F	Mean Hand length in cm		Mean Hand width in cm	
					Right M/F	Left M/F	Right M/F	Left M/F
1	Danborno and Elukpo[2] (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
2	Patel et al[3] (2012)	273	H, FL, FB, HL, HB, AS	164.59	17.75	NM	7.91	NM
3	Tandon et al6 (2016)	497	H, HL, HB, FL, FB, DL	172.7 / 157.1	19.3 / 17.3	NM	8.3/7.2	NM
4	Shankar et al[7] (2017)	220	H, HL	NA	18.2 / 18.8	18.3/18.8	NM	NM
5	Mohite et al[8] (2015)	230	H, HL, HB, FL	165.02	171.13* (mm)	NM	68.04	NM
6	Chikhalkar et al[12] (2009)	300	H, W, HL, HB, FL, FB	167.26	18.93	18.93	7.53	7.53
7	Kavyashree et al[13] (2015)	66 (North Indian)	H, HL, HB	169.04 / 158.42	18.95 / 17.30	18.70/17.31	8.24/7.26	8.10/7.22
8	Ibrahim et al[15] (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
9	Charmonde SH[16] (2019)	1000	H, HL, HB	161.8	18.90 / 17.18	18.96/17.11	10.36/9.39	10.29/9.31
0	Present study (2021)	150	H, HL, HB	165.91	17.71	17.69	7.79	7.56

S/H – Stature/Height; HL – Hand length; HB – Hand width (width); FL – Foot length; FB – Foot width (width); NM – Not mentioned

Figures

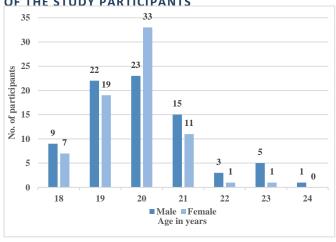### FIGURE 1 AGE AND GENDER WISE DISTRIBUTION OF THE STUDY PARTICIPANTS

FIGURE 2 NORMAL P-P PLOT OF REGRESSION STANDARDIZED RESIDUALS OF MODELS 1-4