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Original Article

Reconstruction of Stature by Percutaneous Measurement of Hand: An Anthropometric Study

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ABSTRACT

Stature is one of the important criteria for establishing identification of unknown person/dead body. Reconstruction of stature is a tedious job when dead bodies are mutilated, burnt or skeletonised. In this study, attempt is made to reconstruct stature by percutaneous measurement of hand as in cases of dismembered remains where most of other body parts are damaged. Stature is calculated from the length of hand which is the distance from the mid-point of styloid process of radius and ulna on the back of wrist to tip of middle finger. Standing height and length of hand are measured in 100 adult male and female students of 19–25 years of age and regression equation is derived by using formula. $y = \pi \frac{\delta y}{\delta x}(x - \bar{x}) - \bar{y}$. Here x stands for length of hand and y the standing height. Regression equations are derived separately for both the sexes which is $5.1x + 67.9$ for male and $4.8x + 70.2$ for female. The multiplication factor for hand is 8.5 & 8.7 for male and female, respectively. Stature calculated by regression equations is found close to the actual height (±3 cm) and by multiplication factors, it is more than ±5 cm in large number of the cases. This indicates regression equations are superior and more reliable than multiplication factors.

Keywords: Dismembered remains, Hand, Multiplication factor, Regression equation, Stature, Tip of middle finger, Wrist

INTRODUCTION

The study 'Reconstruction of stature by percutaneous measurement of hand' is a part of our research project 'Reconstruction of stature from the parts of upper and lower extremities' and regression equation and Multiplication factor are derived for distal part of upper extremity (combined length of forearm and hand), leg and foot[1–3] separately in males and females. A direct correlation is also observed between standing height and length of hand (the distance from the mid-point of styloid process of radius and ulna on the back of wrist to tip of middle finger).

In this paper, multiplication factors and regression equations for stature are derived from the length of hand separately in male and female. This will help forensic pathologists in establishing stature from mutilated remains when most of the body parts are damaged but hand is intact.

MATERIALS AND METHODS

A total of 200 healthy students (100 males and 100 females) of Subharti Medical College Meerut between 19 and 25 years of age were selected for this study irrespective of their caste, religion, dietary habits & socio-

economic status. Students having significant growth disorders, deformities, bony anomalies, fracture/ amputation of hand are excluded to rule out any abnormal result in reconstruction of stature.

After taking consent, the standing heights of all the selected students are measured on stadiometer without shoes as distance between standing surface to the highest point on the head in mid-sagital plane. For the length of hand, subject is requested to put his/her hand on plane white paper on which tip of styloid process of radius and ulna and tip of middle finger are marked with pencil. A line is drawn between the tips of two styloid processes and mid-point is marked. The distance between the mid-point and tip of middle finger is measured as length of hand.

These measurements are compiled on master chart and also on excel format in computer. Regression equation is derived by using the formula:

$$y - \bar{y} = byx(x - \bar{x}) = \pi \frac{\delta y}{\delta x}(x - \bar{x})$$

$$y = \pi \frac{\delta y}{\delta x}(x - \bar{x}) - \bar{y}$$

where

y = standing height (stature)

$\bar{y}$ = average (mean) of standing heights

x = length of hand

$\bar{x}$ = Average (mean) of length of hands

δy = Standard deviation of standing height

δx = Standard deviation of length of hand

π = co-relation coefficient between standing height and length of hand

The mean and standard deviation (SD) of standing height and mean and SD of length of right and left hand and average of both hands are calculated, from which their correlation coefficient with standing height are derived. There regression equations for reconstruction of stature are derived separately in male and female. Multiplication factors are also derived in both the sexes as an average of ratio of stature and length of hand.

OBSERVATION AND RESULTS

Stature: The standing height of males varied from 158.5 cm to 184 cm with mean value of 170.9 cm and SD 6.00673. The stature of females varied from 147.5 cm to 167.5 cm with mean value of 156.6 cm and SD 4.73963 (Table 1).

Table 1: Stature of the study group

Stature	Total Males (100)	Total Females (100)
Minimum	158.5	147.5
Maximum	184	167.5
Mean	170.9	156.6
Standard deviation	6.00673	4.73963

Length of Hand

(a) Males: The length of right hand varied from 18.1 cm to 22.5 cm in males with mean value of 20.2 cm, SD 0.897676 and co-relation coefficient with standing height 0.784706. The length of left hand varied from 18 cm to 22.3 cm with mean value of 20.2 cm, SD 0.948409 and co-relation coefficient with standing height 0.751011. The average of lengths of right and left hands varied from 18.05 cm to 22.4 cm with mean value of 20.2 cm, SD 0.912594 and co-relation coefficient with stature 0.776181 (Table 2).

Table 2: Length of hand in males

Measurement	Length of hand (cm)		
	Right side	Left side	Average
Minimum	18.1	18.0	18.05
Maximum	22.5	22.3	22.4
Mean	20.2	20.2	20.2
Standard deviation	0.897676	0.948409	0.912594
Co-relation coefficient with stature	0.784706	0.751011	0.776181

(b) Females: The length of right hand varied from 16.2 cm to 20.2 cm in females with mean value of 18 cm, SD 0.78 and co-relation coefficient with standing height 0.804297. The length of left hand varied from 16 cm to 20.4 cm with mean value of 18 cm, SD 0.82 and co-relation coefficient with standing height 0.771873. The average of length of hands of both the sides varied from

16.1 cm to 20.3 cm with mean value of 18 cm, SD 0.79 and co-relation coefficient with stature 0.79966 (Table 3).

Table 3: Length of hand in females

Measurement	Length of hand (cm)		
	Right side	Left side	Average
Minimum	16.2	16	16.1
Maximum	20.2	20.4	20.3
Mean	18	18	18
Standard deviation	0.78	0.82	0.79
Co-relation coefficient with stature	0.804297	0.771873	0.79966

Regression Equations: Practically, there is no significant difference in the length of right and left side hand; regression equation for estimation of stature were derived from the average length of both side hands separately in male and female with the formula $y = \pi\frac{\delta y}{\delta x}(x - \bar{x}) - \bar{y}$ as discussed above. The regression equations are calculated as follows:

For male: 0.776181 × 6.600673/0.912594 (***x*** – 20.2) + 170.9 = **5.1*x* + 67.9**

For female: 0.79966 × 4.74/0.79 (***x*** – 18) + 156.6 = **4.8 *x* + 70.2**

By putting the value of *x* in different situation, statures are calculated and compared with the corresponding real standing heights, the error in reconstruction of stature varied from −7.3 to +7.8 cm in males and −5.5 to +6.5 cm in females but less than ±3 in majority of the cases (Table 4 and Figures 1 and 2).

Multiplication Factor: To establish multiplication factor, ratio of standing height and average of combined length of right and left hand are calculated separately in males

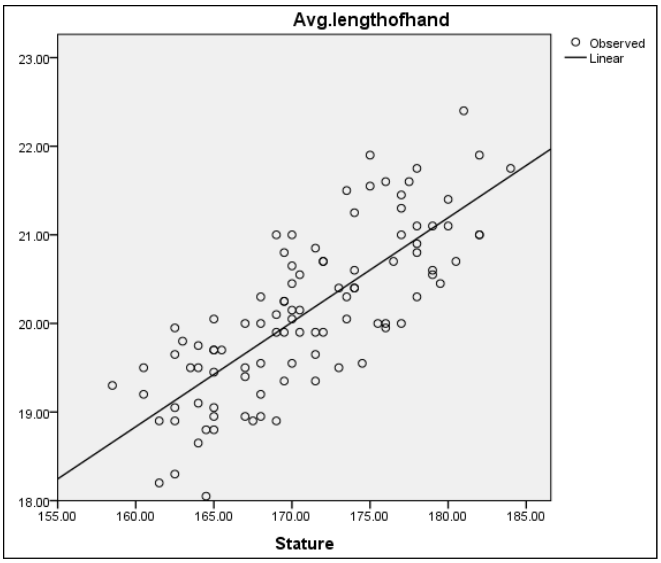

Figure 1: Graph showing relation of hand length with stature in male

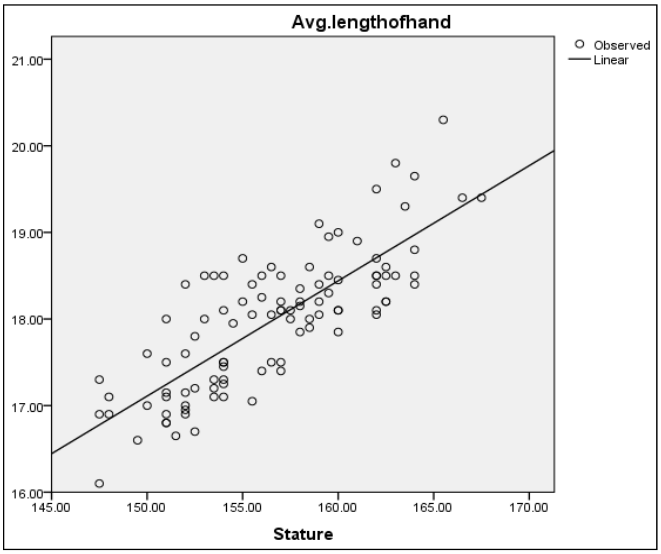

Figure 2: Graph showing relation of hand length with stature in female

Table 4: Variations in calculated stature by regression equations

Subject	Regression Equation	Standing height (cm)	Length of hand (cm)	Calculated stature (cm)	Variation (cm)
Male	5.1*x* + 67.9	Min. 158.5	18.05	160.0	+1.5
		Max. 184	22.4	182.7	–1.3
Female	4.8*x* + 70.2	Min. 147.5	16.1	147.5	0.0
		Max. 167.5	20.3	167.6	+0.1

Table 5: Variations in calculated stature by multiplication factor

Subject	Multiplication Factor	Standing height (cm)	Length of hand (cm)	Calculated Stature (cm)	Variation (cm)
Male	8.5	Min. 158.5	18.05	157.2	–1.3
		Max. 184	22.4	190.4	+6.4
Female	8.7	Min. 147.5	16.1	140.1	–7.4
		Max.167.5	20.3	176.6	+9.1

and females which ranged from 7.99 to 9.11 with average 8.5 in males and 6.15 to 9.16 with average 8.7 in females (Table 5). By using these multiplication factors, the error in reconstruction of stature ranges from −10.5 to + 11.8 cm in males and −11.1 to + 7.4 cm in females with variation of more than ± 5 cm in 35% of males and 22% of females.

DISCUSSION

Estimation of stature is a crucial requirement in postmortem examination of dead bodies especially when they are unidentified and badly decomposed, mutilated or skeletonised. A direct relationship was observed between length of hand and standing height by a number of forensic pathologists in different parts of country and regression equations and multiplication factors were derived[4–9].

In this study, regression equation and multiplication factor are derived from the length of hand to reconstruct stature both in male and female. The regression equation is $5.1x + 67.9$ for male and $4.8x + 70.2$ for female and when we calculate statures by these formulae, the results are very close to actual height, less than ±3 cm in majority of the cases. A variation of more than ±5 cm was observed only in 11% of males and 6% of females.

The multiplication factor is 8.5 for male and 8.7 for female. By using these factors, the errors in reconstruction of stature are more, greater than ±5 cm in 35% of males and 22% of females. So multiplication factors are statistically inferior and less reliable than the regression equations.

CONCLUSION

- The direct relationship is observed between length of hand and stature in both the sexes.
- Regression equations and multiplication factors are derived separately in male and female for reconstruction of stature from the length of hand.
- The regression equation is $5.1x + 67.9$ for male and $4.8x + 70.2$ for female, where x is the length of hand.
- Calculated statures from these equations are close to the actual height, only ± 3 cm in most of the cases.
- The multiplication factors between stature and hand are 8.5 for male and 8.7 for female. Stature calculated with multiplication factors is less compatible with actual height.
- Regression equations are statistically superior and more reliable than multiplication factors.

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