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Determination of stature from hand dimensions

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Abstract

Background: Due to increase events of mass disaster and brutal murders, dismembered body parts are sent to post-mortem examination every now and then. Determination of stature from dismembered body parts can play vital role for identification of person. This study can be helpful there to determine stature from Hand length and Hand breadth. **Aims and Objectives:** To derive Regression formula and multiplication factor to determine stature from Hand length and Hand breadth for population in and around Rajkot region of Gujarat. **Study Design:** Cross Sectional Study. **Materials and Methods:** This study was carried out on 100 male cases and 100 female cases randomly selected from cadavers brought for post-mortem examination at mortuary of P. D. U. Govt. Medical College and Hospital, Rajkot. Stature was measured with measuring tape and Hand dimensions were measured by Sliding caliper after breaking Rigor mortis, if developed. **Statistics:** Collected data were statistically analysed using software like Epi info 7 and Microsoft excel. **Results:** Hand length and Hand breadth of right as well as left sides were positively and significantly correlated to stature (r ranging from 0.423 to 0.639, $p<0.001$). No significant difference was observed in Hand length of both sides ($p>0.05$), however Hand breadth of right side wassignificantly higher than left side ($p<0.05$). Stature, Hand length and Hand breadth of male were significantly greater than of female ($p<0.05$). Regression formula were showing standard error of estimate (SEE) ranging from ±4.70 to ±5.99. Hand length was showing less SEE than Hand breadth, making it more useful for determination of stature. **Conclusion:** Hand length and Hand breadth are showing good correlation with stature. It was found from the study that regression formula can measure stature more precisely than multiplication factor, moreover regression formula derived from Hand length predicts stature more accurately than from Hand breadth. Regression formula and multiplication factor derived by present study for population in and around Rajkot region can be used for identification purpose in medico-legal cases.

Keywords: Forensic anthropometry, Stature, Hand length, Hand breadth.

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INTRODUCTION

Forensic anthropometry is a scientific specialization emerged from the discipline of forensic anthropology dealing with identification of human remains with the help of metric techniques [1]. Dismembered body parts are frequently found in modern era, due to increased events of natural disasters like earthquake, landslide etc. and man-made disasters like stampedes, building collapse, road traffic, air traffic and railway accidents, mining accidents, fire, explosions etc. Dismembered body parts are frequently found also due to increased events of the murders where the mutilation of dead body is done by a murderer to destroy all traces of identity as well as to facilitate the disposal of the dead. Forensic anthropometrist plays major role there as they provide a tentative identification of unknown remains by formulating a 'biological profile', which involves the determination of stature, sex, age and ethnicity [2]. Among this 'big fours' of the biological profile, determination of stature is considered as one of the main parameter of personal identification in forensic examinations. It can be measured by anatomical or Fully method and mathematical method. Anatomical or Fully method reconstructs stature by summing the measurements of the skeletal elements that contribute to stature and adding a correction factor for the soft tissues. Mathematical method derive regression formula and multiplication factor to determine stature from bone or body part. Mathematical method is more useful in medico-legal cases asit can be applied even when only part of body is available. However, due to difference in body proportions between populations such as the relative lengths of the limbs and trunk, population-specific regression formula and multiplication factor should be used for this purpose [3]. Keeping this in view, present study was carried out to derive regression formula and multiplication factor to determine stature from Hand dimensions for population in and around Rajkot region.

MATERIAL AND METHOD

This study was carried out on 100 male cases and 100 female cases ageing more than 20 years randomly

selected from cadavers brought for post-mortem examination at mortuary of P. D. U. Govt. Medical College and Hospital, Rajkot during the period of December, 2012 to July, 2014. The cadavers with any injury, disease or anomaly that affects Hand dimensions or stature were excluded from the study. Decomposed, charred or mutilated dead bodies were also excluded from the study. Measurements were taken up to nearest 0.1 cm as below after breaking rigor mortis, if developed.

Stature: The body was placed in supine position on a flat, hard surfaced autopsy table. Head was fixed in such way that Frankfort plane remains at right angle to autopsy table. Frankfort plane is defined as plane adjoining the upper margin of the ear openings and lower margin of the orbit of the eyes [4]. Knee and hip joints were kept extended, and the neck and feet were kept in neutral position. Stature (Total Body Length) was measured between the vertex of the head and the heel using a measuring tape.

Hand length and Hand breadth: Hand of the subject was kept straight and flat on autopsy table. All fingers were kept extended and adducted. Thumb was kept extended and abducted. Hand length was measured from a palmer aspect of hand as a straight distance between the midpoint of distal transverse crease of wrist joint and the tip of the middle finger and Hand Breadth was measured from a palmer aspect of hand as a straight distance between most laterally placed point on the head of the 2nd metacarpal to the most medially placed point on head of the 5th metacarpal. Hand length and Hand breadth were measured with manual sliding caliper.

STATISTICAL ANALYSIS

All the measurements were statistically analysed using software like Epi info 7 and Microsoft Office Excel 2007. Pearson correlation coefficient (r) was calculated to assess the correlation of stature with Hand length and Hand breadth. Independent samples T-test was applied to determine statistical significance of bilateral differences of Hand length and Hand breadth as well as to determine statistical significance of gender differences in stature, Hand length and Hand breadth. P-value of less than 0.05 was considered significant. Regression formula and multiplication factors were derived to determinestature from Hand length and Hand breadth. To assess accuracy of prediction of stature by regression formula, standard error of estimate (SEE) and Coefficient of determination (R^2) were used.With the increase in value of SEE,accuracy of prediction of stature by regression formula decreases, while with the increase in value of R^2, accuracy of prediction of stature by regression formula increases.

RESULTS

Table-1 is showing descriptive statistics of 100 male and 100 female cases. It is evident from the table that mean stature, Hand length as well as Hand breadth are higher for male than for female. Mean of right sided Hand length and breadth are more than mean of left side.

Table 1: Descriptive statistics of male and female cases (Mean ± SD)

Parameter	Male	Female
Stature	165.57 ± 6.59	151.02 ± 5.69
Right hand length	17.98 ± 0.95	16.65 ± 0.84
Left hand length	17.80 ± 0.98	16.57 ± 0.87
Right hand breadth	8.26 ± 0.53	7.27 ± 0.33
Left hand breadth	8.09 ± 0.60	7.15 ± 0.43

Table 2: comparison for bilateral difference in hand length and hand breadth

Cases	Parameters	Mean		T value	P value*
		Right	Left		
Male	Hand length	17.98	17.80	1.347	0.180 (ns)
	Hand breadth	8.26	8.09	2.162	0.032(s)
Female	Hand length	16.65	16.57	0.614	0.540 (ns)
	Hand breadth	7.27	7.15	2.336	0.020(s)

S=Significant, NS=Not Significant; *p Value<0.05 is significant.

It is evident from above table that there is no significant difference between right and left Hand length in all cases but right Hand breadth is significantly higher than left Hand breadth in all cases.

Table 3: Comparison for gender difference in stature, hand length and hand breadth

Parameter	Mean		T value	P value*
	Male	Female		
Stature	165.57	151.02	16.712	0.000 (s)
Right hand length	17.98	16.65	10.566	0.000 (s)
Left hand length	17.80	16.57	9.403	0.000 (s)
Right hand breadth	8.26	7.27	15.991	0.000 (s)
Left hand breadth	8.09	7.15	12.909	0.000 (s)

S=Significant; *p Value<0.05 is significant and p Value<0.001 is highly significant.

It is evident from the table that there is highly significant gender difference for stature, both Hand length and both Hand breadth. T value shows difference between means of two parameters. Here, highest T value is found for stature, followed by both Hand breadth, from which it can be interpreted that among all the parameters, highest gender difference is seen in Stature followed by both Hand breadth. Both Hand length are showing least gender differences among these parameters.

Table 4: Correlation of hand length and hand breadth with stature

Parameter	Pearson correlation coefficient (r)*	
	Male	Female
Right hand length	0.639	0.571
Left hand length	0.604	0.556
Right hand breadth	0.535	0.472
Left hand breadth	0.427	0.423

*p Value is less than 0.05 for all.

It is evident from above table that both Hand length as well as both Hand breadth are showing positive and significant correlation with stature but both Hand length are showing stronger correlation with stature than both Hand breadth in all cases.

Simple regression formula to determine stature:

- **For Male**

1. From Right Hand Length (RHL)

Stature= 85.517 + 4.452 X RHL
SEE= 5.09, R^2= 0.408

2. From Left Hand Length (LHL)

Stature= 92.972 + 4.079 X LHL
SEE= 5.28, R^2= 0.365

3. From Right Hand Breadth (RHB)

Stature= 110.301 + 6.688 X RHB
SEE= 5.60, R^2= 0.286

4. From Left Hand Breadth (LHB)

Stature= 127.334 + 4.725 X LHB
SEE= 5.99, R^2= 0.183

- **For Female**

1. From Right Hand Length (RHL)

Stature= 86.430 + 3.880 X RHL
SEE= 4.70, R^2= 0.326

2. From Left Hand Length (LHL)

Stature= 90.432 + 3.656 X LHL
SEE= 4.76, R^2= 0.309

3. From Right Hand Breadth (RHB)

Stature= 91.585 + 8.174 X RHB
SEE= 5.04, R^2= 0.223

4. From Left Hand Breadth (LHB)

Stature= 110.798 + 5.629 X LHB
SEE= 5.18, R^2= 0.179

Here, standard error of estimate (SEE) is less for both Hand length compared to SEE of both Hand breadth. For Coefficient of determination (R^2), it is reverse. Thus, regression formula predicts stature more accurately from Hand length than from Hand breadth.

Table 5: Mean multiplication factor to estimate stature

Parameter*	Male	Female
Right hand length	9.22	9.08
Left hand length	9.32	9.13
Right hand breadth	20.09	20.80
Left hand breadth	20.54	21.19

*Stature= Parameter X Mean multiplication factor

Table 6: Comparison of stature estimated by regression formula and by mean multiplication factor (Mean ± SD)

Parameter	Male	Female
Measured stature	165.57 ± 6.59	151.02 ± 5.69
Stature estimated by regression formula		
Right hand length	165.58 ± 4.21	151.02 ± 3.25
Left hand length	165.58 ± 3.98	151.03 ± 3.16
Right hand breadth	165.57 ± 3.52	151.02 ± 2.69
Left hand breadth	165.57 ± 2.82	151.02 ± 2.41
Stature estimated by mean multiplication factor		
Right hand length	165.80 ± 8.72	151.16 ± 7.61
Left hand length	165.90 ± 9.09	151.32 ± 7.90
Right hand breadth	166.02 ± 10.59	151.24 ± 6.83
Left hand breadth	165.21 ± 12.24	151.40 ± 9.06

SD=Standard Deviation

Standard deviation (SD) measures amount of dispersion from mean value. From above table, it is evident that mean stature estimated by regression formula as well as multiplication factor are very nearer to mean measured stature, which means that regression formula and multiplication factor, both are useful for determination of stature from Hand dimensions. However, SD of stature estimated by mean multiplication factor are higher than SD of stature estimated by regression formula, which means stature estimated by mean multiplication factor is showing moredispersion from its mean value. So, regression formula measures stature more precisely than mean multiplication factor.

DISCUSSION

The main objective of this study is to analyserelation of Hand dimensions with stature and use result of this analysis as a basis for developing stature estimation standards for population in and around Rajkot region of Gujarat.

Table-7 is showing comparison between similar studies done by other authors. It is evident from the table that all studies have been carried out on different population of same age group. Mean of stature, Hand length and Hand breadth of all studies are different from each other, which substantiate well known fact that different population shows difference in stature as well as in body proportions.

Present study has found bilateral asymmetry in Hand breadth but Hand length were bilaterally symmetrical. Such finding were also observed in Australian and male Thaipopulation in the study done byIshak NI *et al* [5] and Laulathapho P *et al* [8] respectively.

Present study has found that mean of stature, Hand length and Hand breadth are significantly higher in males than females. Such finding were also observed in Australian, Thai, Kayastha (India)and Rajput (India) populationin the study done byIshak NI *et al*. [5], Laulathapho P *et al* [8], Srivastava A *et al* [9] and Krishan K *et al* [10] respectively. Similarly,Numan AI *et al* [6] also found significant gender difference in stature for Hausa, Igbo as well as for Yoruba population of Nigeria, however, no such gender difference were found in Hand breadth of Hausa, Igbo and Yoruba population and no such gender difference was found in Hand length of Yoruba population.

Present study has found that though regression formula and multiplication factor, both are useful to determine stature from Hand dimensions, regression formula measures stature more precisely than multiplication factor. Such finding was also observed by Krishan K *et al* [10] for Rajput (India) population.

Table-8 is showing comparison of Pearson correlation coefficient (r) with other studies. Present study has found that both Hand length as well as Hand breadth are showing positive and statistically significantcorrelation with stature, but Hand length is showing more correlation with stature as compared to Hand breadth. Such finding were also observed in Australian and Thai population in the study done by Ishak NI *et al* [5] and Laulathapho P *et al* [8] respectively. However, Hossain S *et al* [7] found that correlation between Hand length and stature is statistically significant but correlation between Hand breadth and stature is not significant.

CONCLUSION

Present study has found positive and statistically significant correlation of Hand length and Hand breadth with stature for population in and around Rajkot region of Gujarat. So, regression formula and multiplication factor derived by present study can be used for this population. However, regression formula can measure stature more precisely than multiplication factor. Moreover, it is found that regression formula derived from Hand length predicts stature more accurately than from Hand breadth.

As different population shows difference in stature as well as in body proportions, Regression formula and multiplication factor derived by present study cannot be applied in other population. So, similar study should be conducted for other population to derive population specific formula and multiplication factor.

Conflicts of interest

Authors have declared that no competing interests exist for the present study.

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Table 7: Comparison of mean of stature, hand length and hand breadth with other studies

Author	Study Population	Age Range (Years)	Sex	Stature (Mean ± SD)	Hand Length (Mean ± SD)		Hand Breadth (Mean ± SD)	
					Right	Left	Right	Left
IshakNI *et al* [5]	Western Australia	18-68	M	178.50 ± 7.05	19.54 ± 0.93	19.56 ± 0.92	9.10 ± 0.48	9.04 ± 0.49
			F	163.67 ± 7.14	17.59 ± 0.82	17.60 ± 0.82	7.93 ± 0.45	7.84 ± 0.45
Numan AI *et al* [6]	Hausa (Nigerian)	18-35	M	174.79 ± 0.86*	20.62 ± 0.13*	-	9.73 ± 0.01*	-
			F	167.03 ± 1.04*	19.85 ± 0.18*	-	9.00 ± 0.07*	-
	Igbo (Nigerian)	18-35	M	171.58 ± 1.23*	20.22 ± 0.15*	-	9.57 ± 0.06*	-
			F	169.40 ± 0.73*	19.97 ± 0.10*	-	9.22 ± 0.07*	-
	Yoruba (Nigerian)	18-35	M	170.53 ± 1.00*	19.55 ± 0.08*	-	9.57 ± 0.04*	-
			F	164.05 ± 0.80*	19.27 ± 0.13*	-	9.38 ± 0.07*	-
Hossain S *et al* [7]	Bangladeshi	25-45	F	152.79 ± 5.62	16.39 ± 0.72	16.33 ± 0.67	7.22 ± 0.38	7.18 ± 0.37
Laulathapho *P et al* [8]	Thai	18-26	M	171.58 ± 4.41	18.18 ± 0.87	18.13 ± 0.80	8.17 ± 0.45	7.98 ± 0.48
			F	159.63 ± 5.28	16.68 ± 0.86	16.60 ± 0.92	7.13 ± 0.46	6.99 ± 0.46
Srivastava A *et al* [9]	Kayastha Community-Bundelkhand(India)	20-40	M	170.90 ±0.71*	-	18.40 ± 0.08*	-	8.18 ± 0.04*
			F	156.21 ± 0.49*	-	16.74 ± 0.11*	-	7.26±0.10*
Krishan K *et al* [10]	Rajput (Himachal Pradesh- India)	17-20	M	168.20 ± 6.50	-	18.20 ± 0.90	-	8.10 ± 0.40
			F	155.7 ± 5.20	-	16.80 ± 0.80	-	7.30 ± 0.40
Present Study	Rajkot region of Gujarat	>20	M	165.57 ± 6.59	17.98 ± 0.95	17.80 ± 0.98	8.26 ± 0.53	8.09 ± 0.60
			F	151.02 ± 5.69	16.65 ± 0.84	16.57 ± 0.87	7.27 ± 0.33	7.15 ± 0.43

*Showing Mean ± Standard Error of Mean instead of Mean ± SD; M=Male, F=Female

Table 8: Comparison ofpearson correlation coefficient with other studies

Authors	Sex	Pearson Correlation Coefficient (r)			
		Hand Length		Hand Breadth	
		RT	LT	RT	LT
Ishak NI et al.[5]	Male	0.74*		0.52*	
	Female	0.70*		0.47*	
Hossain S et al.[7]	Female	0.51	0.49	0.17	0.19
Laulathapho P et al.[8]	Male	0.674	0.667	0.349	0.439
	Female	0.736	0.716	0.412	0.404
Srivastava A et al.[9]	Male	-	0.61	-	0.34
	Female	-	0.30	-	0.31
Present Study	Male	0.639	0.604	0.535	0.427
	Female	0.571	0.556	0.472	0.423

RT=Right, LT=Left; *showing value for combined left and right hand measurements.

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