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The stature estimation from students' forearm and hand length in Iran

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Abstract
Objectives: The purpose of this study was to determine the stature from student's forearm and hand length in Hamadan University of Medical Sciences.
Methods: For measurements, the forearm and hand length of 160 students were measured. The range of the sample ages were between 18 and 22 years, selected randomly. In this descriptive and analytical study, the cluster sampling method was used to select the subjects. For anthropometric measurements, we used metal and plastic tape, goniometer, caliper, and scale. The height and length of the forearm and hand were measured separately.
Results: The mean ± SD of the stature were 164.435±5.072 cm and 180.446±5.569 cm, in females and males, respectively. The mean ± SD of the forearm length were 24.906±1.347 cm and 27.751±1.294 cm, in females and males, respectively. The mean ± SD of hand length were 17.356±2.223 cm and 19.418±0.888 cm, in females and males respectively. Besides, there was a correlation between height and forearm length of all cases. Also, this correlation was seen for the stature and hand length.
Conclusion: According to our study, forearm and hand length have correlation with the stature, so they can be used as factors for stature estimation.
Keywords: Anthropology, Stature, Forearm length, Hand length, Hamadan

Introduction

Anthropology is a science study about characteristics of the human body skeleton.[1] The central axis of anthropology is estimating race, gender, and the other human features from the body skeleton.[2] Anthropometric data are collected from the dead or alive samples.[3] Physical characteristics of the human skeleton depend on the race, age, sex, and lifestyle.[4] The forearm is one of the important parts in the upper extremity and the hand portion is the most mobile part, and plays an important role in the movement of the upper limb.[5] Through measuring the length of some parts, like forearm and hand, estimating the body size and height can be occurred.[6] We can use these indicators to determine gender, sex, and environmental conditions.[7] Moreover, for designing pre-fabricated upper limb prosthesis or designing the ergonomic instrument in different nations, having information about the length of the different parts of the body such as upper limb, can be useful.[2]Therefore, this study was carried out for measurement of forearm and hand length in the students of Hamadan University of Medical Sciences.

Materials and Methods

In this analytical–descriptive study, 160 students (age range: 18–22) were included and the samples were randomly selected. Exclusion criteria were subjects who had a fracture in the forearm and hand bones. A measurement protocol to guide the project team colleagues were used.[2] Anatomical position and body landmarks recognition were taught to all members in the measurement team as a training program. Through the indirect measurement methods, superficial forearm and hand size of 160 samples were evaluated. Measured parameters included: stature, weight, forearm, and hand length (the apparent size of the forearm was measured from the tip of the olecranon to the point between the radius and ulnar styloid). The hand length measurement was done from the midpoint between the radius and ulnar styloid to the tip of the middle finger. Plastic meters and scales were used for measurements.

Statistical Analysis

SPSS 22.0 software was used for statistical analysis. The association of parameters was assessed by Pearson's correlation coefficient r. Regression equations were computed to examine the relationship between the stature and hand length, in addition to the stature and forearm length. The P values less than 0.05 were considered statistically significant.

Results

In this study, 160 samples were examined. The mean of stature, weight, forearm, and hand length for all samples are mentioned in Table 1. Table 2 shows the comparison between males and females stature in addition to the other parameters. Moreover, it demonstrates the significant differences between two genders in all parameters (P=0.000). Statistically, significant correlation was observed among stature and other parameters in all cases (P=0.000) (Table 3). Our study demonstrated an obvious correlation and significant differences among the stature

Table 1. **Comparison of mean of stature and other parameters for total subjects (N=160).**

Parameters	N	Mean ± SD
Stature	160	172.440±9.627
Weight	160	68.776±11.974
Hand Length	160	18.387±1.979
Forearm Length	160	26.328±1.941
Foot Length	160	25.170±1.864

Table 2. **Comparison of mean of stature and other parameters between males and females (N=80).**

Parameters	N		Mean ± SD		P-value	Significance
	Male	Female	Male	Female		
Stature	80	80	180.446±5.569	164.435±5.072	0.000	Sig.
Weight	80	80	75.413±11.098	62.138±8.729	0.000	Sig.
Hand Length	80	80	19.418±0.888	17.356±2.223	0.000	Sig.
Forearm Length	80	80	27.751±1.294	24.906±1.347	0.000	Sig.
Foot Length	80	80	26.566±1.337	23.775±1.123	0.000	Sig.

Table 3. **Correlation between stature and other parameters in total sample (N=160).**

Variables	Pearson correlation (r)	P-value	Significance
Stature	1	-	-
Weight	0.593	0.000	Sig.
Hand Length	0.560	0.000	Sig.
Forearm Length	0.813	0.000	Sig.
Foot Length	0.849	0.000	Sig.

and all parameters in males and females (P=0.000), except the comparison between the stature and hand length in females, which was not meaningful (P=0.102) (Table 4). The analysis of the linear regression with the stature as the dependent variable and weight as independent variable showed for all samples. Also, the regression model is meaningful in both males and females (P=0.000, P=0.016, P=0.007, respectively) (Table 5). The analysis of the linear regression for study population with stature as the dependent variable and hand length as independent variable demonstrated that the regression model is meaningful in total samples and males (P=0.000) but it is not meaningful in females (P=0.102) (Table 6). The analysis of the linear regression for study population with stature as the dependent variable and forearm length as independent variables exhibited that the regression model is meaningful in total samples, separately (P=0.000) (Tables 7, 8). Correlation between stature (cm) with weight (kg), hand length (cm) and forearm length (cm), in total samples, both in males and females are shown in Figs 1, 2, and 3.

Discussion

For the forensic experts, identification of the corpse is an important challenge, and estimation of the stature can be useful for this subject.[8] In this study, we examined 160 healthy male and female participants. Our findings indicated a higher height for males as compared with females which is in the line with Ilayperuma et al. results.[9] Linear regression is considered as a suitable method for estimating the relationship between stature and body fragments.[10] In our study, it was shown that there was a strong positive correlation between forearm length and stature, and a moderate positive correlation between the stature and hand length. (Stature=66.268+4.033×forearm length, SEE= 0.230 and R2= 0.661) and hand length (Stature= 122.327+2.725×hand length, SEE= 320 and R2= 0.314) was found for all cases based on linear regression equation.

An anthropological study on the sample of a Turkish adult population reported that the correlations between stature and hand length for both genders are statistically significant which is in the same line with our results.[11] Our statistical analysis showed a significant correlation among the forearm, hand length, and the examinee's stature. The mean stature were 180.446±5.569 and 164.435±5.072 for males and females, respectively. The stature factor between the two sexes was statistically significant (P=0.000). We observed remarkable differences in forearm and hand length between male and female groups. Akhlaghi et al. (2012) in their study reported the correlation between forearm length and stature (r=0.580).[12] However, in their study, the correlation coefficient value was lower than our results which can be considered as the differences between distinct Iranian ethnic groups.[12] Gender and stature determination are among the most important issues in the context of forensic science.[13] In the case of human remains or incomplete skeleton, parts of the body such as forearm or hand bones can be helpful to find more evidence.[14] According to the findings of the present study, it is concluded that forearm and hand length are longer in males compared with females in the Iranian population. However, the effective role of nutrition and genetic factors should be considered.[14] Another study determined, the relationship between stature and long bones through the radiographic images of individuals, whose results are in accordance with our findings.[15] Mccluskey et al. showed that athletes with longer limb had high speed and in this study, all examined parameters showed a significant difference between the sexes.[15] Accordingly, an appropriate strategy seems to be necessary for product designing based on natural differences among body dimensions in males and females.[15] Consequently, anthropometric indexes can provide supportive information for designing of equipment.[16]In conclusion, our results showed that there is a statistically significant correlation among stature, forearm, and hand length for students of Hamadan University of Medical Sciences. Furthermore, the forearm length is a more predictive factor than hand length in stature estimation.

Table 4. **Correlation between stature and other parameters in between males and females (N=80).**

	Male			Female		
Variables	Pearson correlation (r)	P-value	Significance	Pearson correlation (r)	P-value	Significance
Stature	1	-	-	1	-	-
Weight	0.269	0.016	Sig.	0.301	0.007	Sig.
Hand Length	0.546	0.000	Sig.	0.184	0.102	NS
Forearm Length	0.619	0.000	Sig.	0.449	0.000	Sig.
Foot Length	0.576	0.000	Sig.	0.657	0.000	Sig.

Table 5. **Linear regression analysis for study population with stature as dependent variable and weight as independent variable.**

Population	R	R^2	Adjusted R^2	SE	B	P-value
Total (160)	0.593	0.351	0.347	3.596	139.657 0.477	0.000
Male (80)	0.269	0.072	0.060	4.172	170.273 0.135	0.016
Female (80)	0.301	0.091	0.079	3.937	153.566 0.175	0.007

Table 6. **Linear regression analysis for study population with stature as dependent variable and hand length as independent variable.**

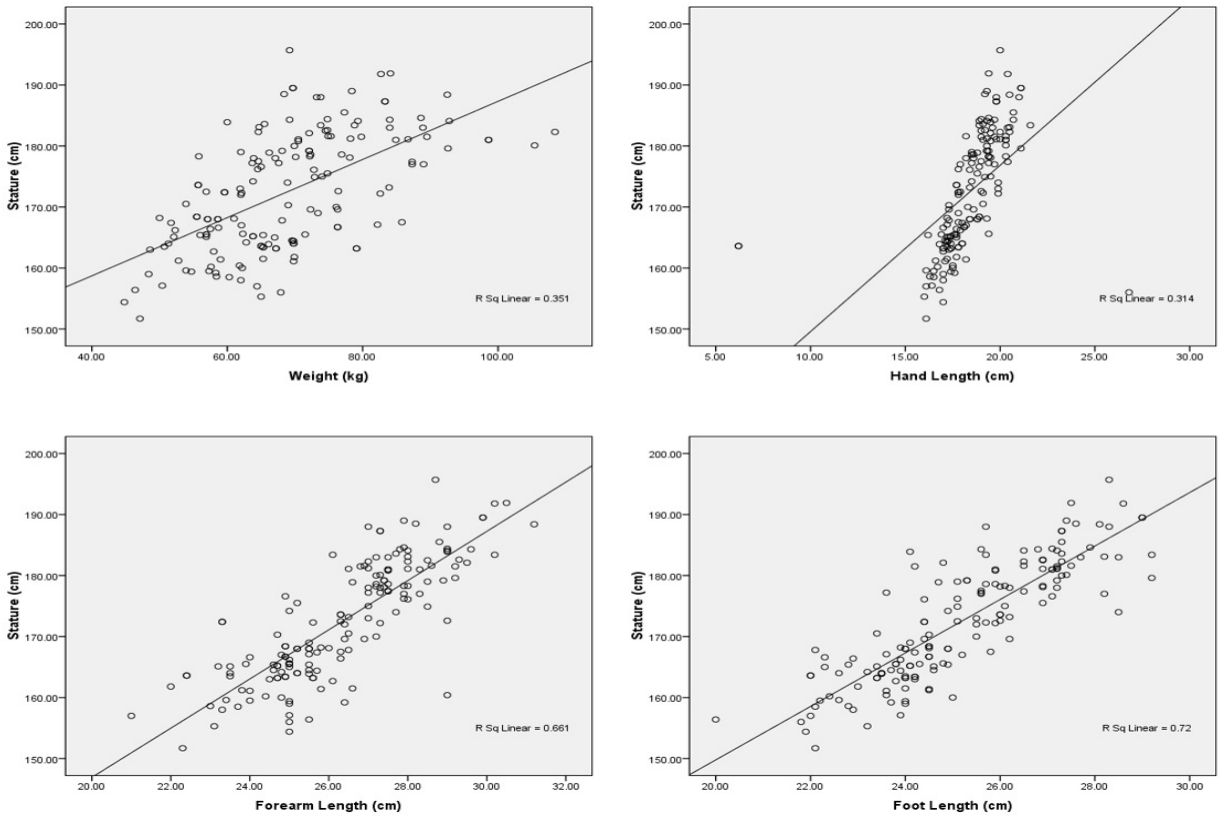
Population	R	R^2	Adjusted R^2	SE	B	P-value
Total (160)	0.560	0.314	0.310	5.926	122.327 2.725	0.000
Male (80)	0.546	0.298	0.289	11.563	113.975 3.423	0.000
Female (80)	0.184	0.034	0.021	4.442	157.147 0.420	0.102 NS

Table 7. **Linear regression analysis for study population with stature as dependent variable and forearm length as independent variable.**

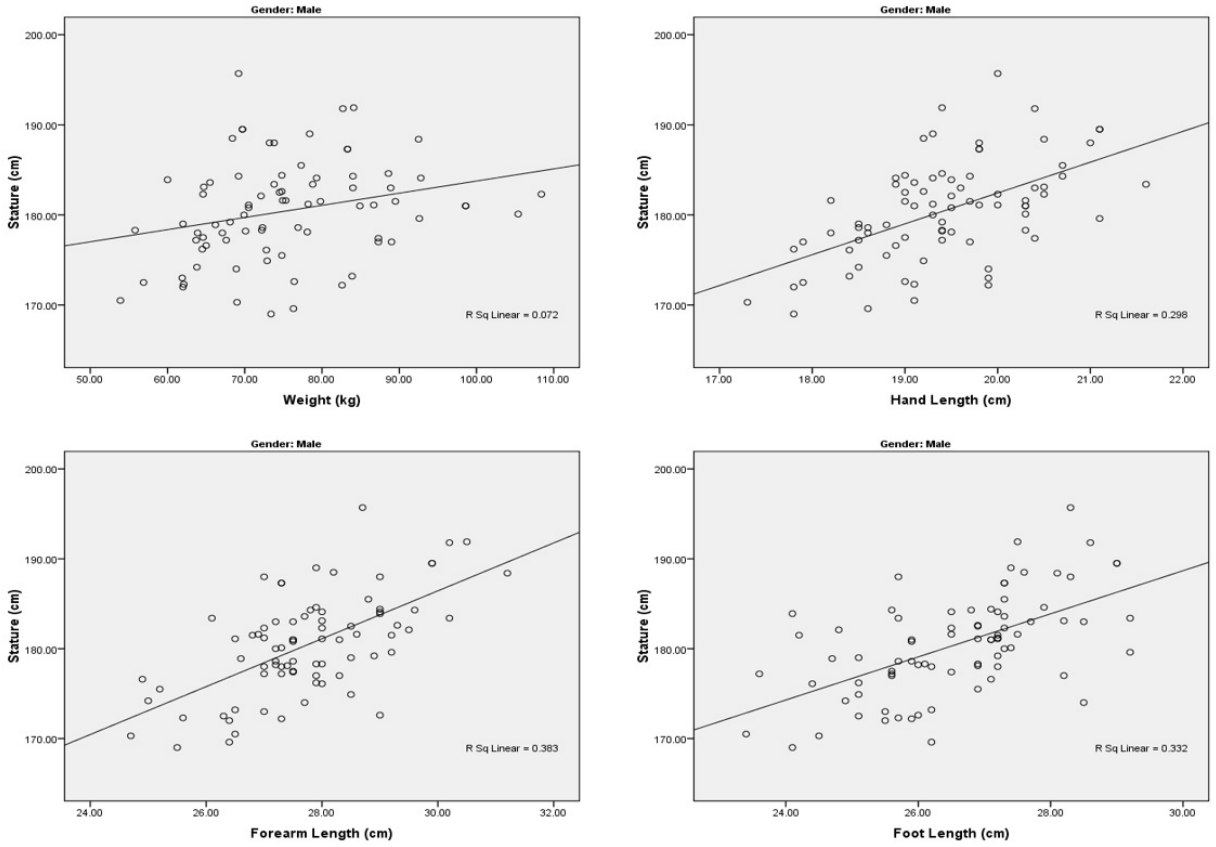
Population	R	R^2	Adjusted R^2	SE	B	P-value
Total (160)	0.813	0.661	0.659	6.060	66.268 4.033	0.000
Male (80)	0.619	0.383	0.375	10.632	106.489 2.665	0.000
Female (80)	0.449	0.202	0.192	9.501	122.302 1.692	0.000

Table 8. **Linear regression analysis for study population with stature as dependent variable and foot length as independent variable.**

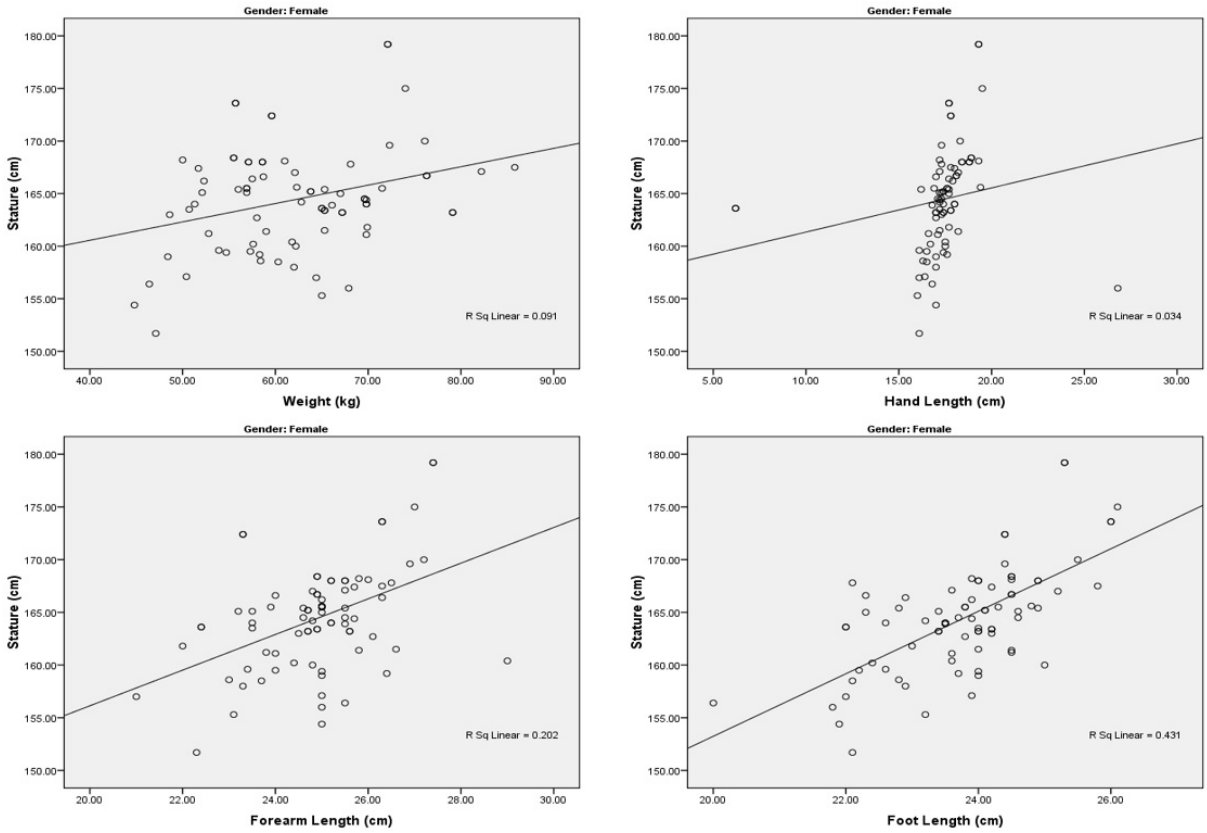
Population	R	R^2	Adjusted R^2	SE	B	P-value
Total (160)	0.849	0.720	0.719	5.483	62.137 4.382	0.000
Male (80)	0.576	0.332	0.323	10.250	116.735 2.398	0.000
Female (80)	0.657	0.431	0.424	9.172	93.946 9.965	0.000



Fie 1. **Correlation between stature (cm) with weight (kg), hand length (cm), forearm length (cm) and foot length (cm).**



Fie 2. **Correlation between stature (cm) with male weight (kg), hand length (cm), forearm length (cm) and foot length (cm).**



Fie 3. **Correlation between stature (cm) with female weight (kg), hand length (cm), forearm length (cm) and foot length (cm).**

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