Original Article

Prediction of Stature Based on Anthropometric Measurements of Hand Dimensions among Adult Bangladeshi Males and Females

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Abstract

Background: *Stature is one of the parameters widely used in forensic investigation. Hand anthropometry provides great contribution in personal identification of an individual with the increasing frequency of mass disaster & identify the individual by analyzing the disintegrated human body parts* by *any forensic investigator. This study was done to measure the stature as well as hand length (HL) and hand span (HSp) to determine the correlation between the stature (S) and hand dimensions.* ***Methods:*** *A cross sectional, observational analytical study was conducted on 200 participants where 100 were adult males and 100 were females. Age between 25 to 45 years were selected by convenience sampling technique for the study in the Department of Anatomy of Chittagong Medical College (CMC), Chattogram. Sex differences were tested by using unpaired student's t-test. Correlation between stature and hand length and hand span were assessed. Multiplication factor (MF) was calculated for estimating the stature.* ***Results:*** *The present study showed significant ($p<0.001$) positive correlation between the stature and hand span in both genders. In hand length we found significant positive correlation only in females but in case of males it was not reached up to significant correlation with the stature. We calculated multiplication factor which was helpful for estimation of stature from respective measurements.* ***Conclusion:*** *According to result this study has implication in mass disaster or in criminal cases for nearly accurate estimation of the stature of an unknown individual.*

Key words: Stature, Anthropometry, Hand length, Hand span, Forensic Science

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Introduction

Now a days in any medico legal investigation, identification of a person or dead body is important as it helps in connecting the criminal to the crime[1]. The stature prediction occupies relatively a central position in the anthropometric research[2]. Though all the human beings occupying this globe belong to the same species, exhibiting consistent proportion in their body, but there are no two individuals, who are exactly alike in all their measurable traits[3]. Even genetically identical twins are differed in some respects[3].

One of the important body dimensions is morphology of limb bone[4]. Limb bone morphology is significantly related with climatic, nutritional and some environmental factors[4]. Peoples who live in cold climates tend to have low tibiofemoral index values, while the opposite is true for those in warm climates[4]. Identification of dismembered or decomposed human body parts from natural disasters is an important aspect of study for anthropologists and forensic experts[5]. To identify an individual, a forensic examiner has continuously used anthropometry to determine the biological profile by estimating of race, sex and stature[6]. This process can narrow down the pool of victims to match but more definite markers will be needed such as DNA, that we can reach up to final identification[7].

Despite the significance and potential utility, little information is known concerning relationship between hand dimensions and stature among the population of the South Asian country. So, region-wise and population specific study seems to be necessary[8]. That's why the dimensional relationship between body segments and assessment of stature has been the main focus or interest of scientist, anatomist and anthropologist for many years[9].

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Stature provides an insight in to various factors of a population including, nutrition, geographical areas, environment and climates[10]. That's why stature is considered as one of the most important parameters along with other parameters like age, sex and race for personal identification which is necessary in forensic science. The stature can be estimated from fragmented body remains measuring different hand dimensions to determine biological profile of an individual also[11].

Hand dimension provides great contribution for stature estimation from the body remains. It also contributes for ergonomic designing like cloths, hand gloves and biomedical prosthesis[12]. So, any study on limb morphology can provide the understanding of human variation which is necessary for clinical practice[13]. There have been many studies where the importance of measuring hand dimensions to determine the important parameters of identification i.e., stature is emphasized[13]. Many previous studies have shown the correlation of stature with different body parts such as lower limb, arm span, upper limb[12,14,15].

No single anthropometric formula is suitable to draw complete anthropometric picture in Bangladesh[16]. For this reason, different formulae are required for calculating stature and different bones or body parts for identification of different populations.

Materials and Methods

Study design: The study was a cross sectional observational analytical study. ***Study sample:*** It was conducted on 200 adult healthy Bangladeshi population comprising of 100 males and 100 females. Ten percent of extra (total 110+110=220) male and female were taken to mitigate the dropping out of the subjects. Participants were selected from Chittagong Medical College and Hospital (CMCH) Chattogram. All the measurements were taken during a particular time of the day (from 9AM to 4PM) to avoid diurnal variations[17]. ***Study period:*** From January 2018 to January 2019. ***Study place:*** Data analyses were carried out in the department of Anatomy, CMC, Chattogram, Bangladesh.

Inclusion criteria: Adult Bangladeshi population both males and females between 25 to 45 years were selected as research participants.

Exclusion criteria: Participants who were of mixed in origin, any history of marriage with any other tribe and left-handed persons, were excluded from the study. Participants having any diseases or deformity of the hand, finger and spine were not included in this study. Any genetic disorder, endocrine disorder, trauma, surgery or pathological condition that can affect the features of the hand were also excluded.

Measurement Procedure: A participant's selection check list was organized to check the inclusion and exclusion criteria and take physical measurements in data collection sheet after taking their informed approval. Measurements were taken as follows:

Stature: Stature was measured as a vertical distance from vertex to the floor after the individual were instructed to stand erect and barefooted in anatomical position with the head in Frankfort horizontal plane[18]. Arms were hung freely by the sides with the palm facing towards the thighs and heels together so that, his or her heels, buttocks, shoulders and the head touched the wall to measure the stature (Figure-1)[18].

A B

Figure-1: Measurement of stature: A. Placing the steel plate against the head & wall and marking the maximum stature on the wall. B. Measuring the stature from the marked point on the wall to the floor by using steel tape.

Figure-2: Procedure of measuring the length of the hand

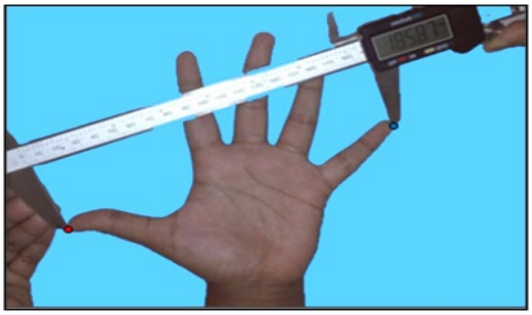

Figure-3: Procedure of measuring the hand span

Hand length: The length of the hand was measured as the linear projected distance from the mid-point of the distal wrist crease to the most anterior projecting point on the middle finger[18]. A digital sliding caliper was used to measure the hand length (Figure-2).

Hand span: The hand span was measured in centimeters by using digital sliding caliper. It was measured as linear distance from the tip of the thumb to the tip of the little finger, when the hand was placed on a flat surface and fingers were abducted and extended as far as possible (Figure-3)[19].

Calculation of multiplication factor: Each 'multiplication factor' is the ratio of the stature to the respective physical measurements. A mean multiplication factor (MMF) was then calculated for each measurement. These mean multiplication factors were used for estimating the stature from the selected hand dimensions.

So, multiplication factor (MF) for estimating the stature from each of the selected hand dimensions was calculated by using the following formulae[6]:
MF= Stature/ Respective hand dimension

Statistical Analysis: Results were prepared on the basis of collected data. Data was expressed as mean±SD (Standard deviation). Unpaired t-test was done to analyze the difference between males and females for all variables. Pearson's correlation co-efficient were calculated to measure the strength of correlation between stature and hand dimensions. P-value less than 0.05 (P<0.05) was considered as significant. All statistical analyses were performed by using SPSS-22 and MS Excel.

Ethical Consideration: The protocol of this study was approved by the members of the Ethical Review Board (ERB) of Chittagong medical College, Chattogram and received a certificate of ethical clearance of ERB [Reference No.: CMC/PG/2018/408; dated 19/06/2018]

Results

Table-I showed the descriptive statistics of left-hand dimensions along with stature of adult males and females. It was observed that mean stature of adult Bangladeshi males and females were 165.78±7.14 cm & 155.47± 4.98 cm respectively. It was also evident that hand length (HL) in case of males 18.26± 0.97 cm and hand span (Hsp) 18.72±1.22 cm where in females HL 16.98±1.00 and Hsp 17.22±1.27 cm. The mean value of stature, hand length and hand span were significantly high among Bangladeshi males compared to females.

Table-II represented correlation coefficient values (r) of the stature with the selected hand dimensions which were shown by using scatter diagrams in Figure 4-7. Among the two hand dimensions, it was observed that, HSp significantly correlated with the stature in both sexes but in hand length it was significantly correlated only in females.

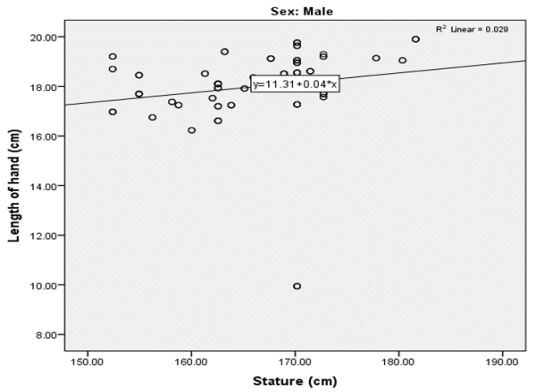

Figure-4: Scatter plot with regression line showing not significant positive correlation (r=+0.171, R2=0.029, p=0.089) of the stature with the length of the hand in males

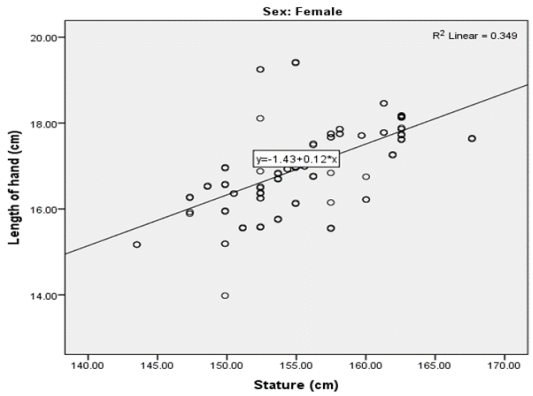

Figure-5: Scatter plot with regression line showing significant positive correlation (r=+0.591, R2=0.349, p<0.001) of the stature with the length of the hand in females

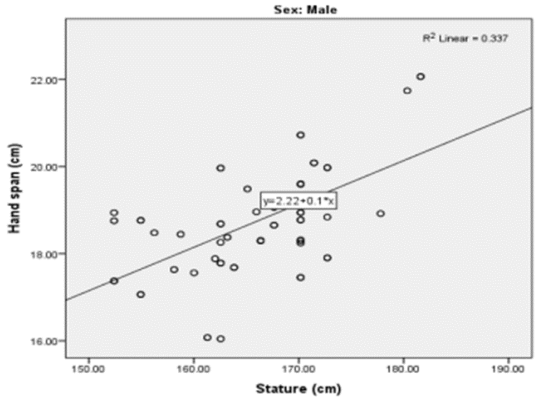

Figure-6: Scatter plot with regression line showing significant positive correlation (r=+0.581, R2=0.337, p<0.001) of the stature with the hand span in males

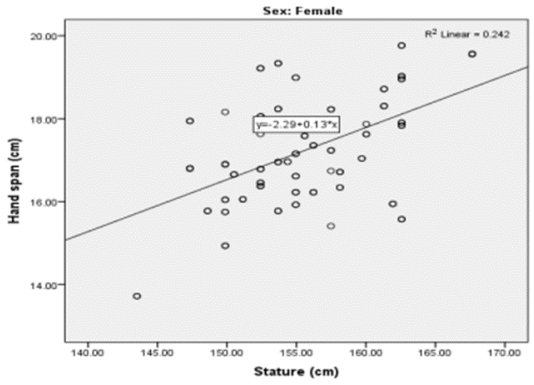

Figure-7: Scatter plot with regression line showing significant positive correlation (r=+0.492, R2=0.242, p<0.001) of the stature with the hand span in females

Multiplication factor was derived for estimation stature from hand length and hand span. If we multiply these measurements by respective multiplication factor, the approximate stature of an individual can be obtained.

Table-I: Comparison of different variable between males and females (n=200)

Variable (cm)	Male (n=100)	Female (n=100)	P value
S	165.78±7.14	155.47±4.98	<0.001**
HL	17.97±1.68	16.98±1.00	<0.001**
HSp	18.72±1.22	17.22±1.27	<0.001**

S: Stature, HL: Hand length, HSp: Hand span, **: Statistically significant test.

Table-II: Correlation coefficients of selected hand dimensions with stature among males and females (n=200)

Variable (cm)	r	P Value	MMF
Male (n=100)			
HL	+0.171	<0.089	9.34±1.44
HSp	+0.581	<0.001**	8.88±0.48
Female (n=100)			
HL	+0.591	<0.001**	9.18±0.43
HSp	+0.492	<0.001**	9.07±0.59

HL: Hand length, HSp: Hand span, r: Correlation coefficient, MMF: Mean multiplication factors. **: Statistically significant.

Discussion

Anthropometric measurements can help in the determination of primary indicators of stature. In the present study, males showed higher mean values in all the parameters than females and difference in these measurements were found to be statistically significant (p<0.001). Hence our findings revealed a clear pattern of sexual dimorphism with females, which were agreement with many other studies conducted on different populations of Sudan, Sri Lanka, Malaysia and Punjab[7,18,20,21].

These statistically significant differences might be due to the early pubertal growth spurt in girls that stops early and under the influence of estrogen, which causes early fusion of epiphysis[10]. In males, the growth spurt occurs comparatively later. They continue to grow for a longer period under the influence of testosterone[10].

The mean left hand length was 18.26 cm in males and 16.98 cm in females. Closer result had been obtained among populations of Turkey and Himachal Pradesh, Maharashtra & Gujrat of India[6,22-24] but our study revealed smaller values when compared with the study done among the populations of Egyptian, Iranian and Nigerian[25-27]. A study done among the population of Srilanka found mean left hand span smaller in males than females which was correspond to our study[19].

Various studies have indicated that hand length is the most applicable and valuable predictor of the stature[7,26]. In current study, the correlation coefficient between the stature and selected hand measurements were found positively correlated. In case of females, hand length was the highest correlate parameter with correlation coefficient value r=+0.591 in our study, which was in agreement with previous studies done among the population of North India, Gujrat, Punjab, Sri Lanka, and Iran[1,18,21,24,26]. But the findings of the present study were on the contrary to those found in population of South India, Egypt and West Australia[1,28,29]. According to a study this variability indicated that different intralimb parts did not have perfectly parallel variations in regard to stature, as they differed between the sexes and among members of the same population[7]. In other studies, the researchers also found a significant correlation between stature and hand length in both males and females[1,18,21,26-29]. But in males, hand length (r=+0.171) not reached up to the significant level in our study.

Hand span was also found to be predictive for the stature estimation. In the present study, the hand span showed a significant positive correlation with the stature in both sexes (Males r=+0.581 and Females r=+0.492) & highest correlation with the stature was found in males. A study done by Gunathilake KMTB on 340 participants of 18-74 years showed significant positive correlation between stature and hand span among both sexes which was similar to our study[19].

In our study, we have formulated both regression equation and multiplication factor for estimation of stature from hand dimensions and regression equation is the best method than multiplication factor. Such findings were observed in other studies[6,30].

Conclusion

This study provides anthropometric correlation of hand dimensions with stature of Bangladeshi adult population. The result of the present study revealed that there was a relationship between stature and the selected hand dimensions. Correlations of the stature with each of the selected hand dimensions of the left side were assessed and it was positively correlated. In addition to the medico-legal investigation it may be helpful for the clinician in plastic and reconstructive surgery, anatomist, archeologist and anthropologist.

Limitations of the study

In the present study several limitations could be identified. Time period was short & sample size was relatively small. So, the results obtained from this study might not fully represent the norm for the whole population and measurement had been taken manually in some cases which might have occur minor errors of measurement.

Recommendations

As the sample size was small, so further larger sample should be used for developing standard normative values. Similar studies should be conducted on other age groups to reveal the differences in stature and normative linear hand dimensions across the ages. In future studies extensive anthropometric methods such as laser scanning, infrared imaging etc. should be used for reliable findings of data.

Conflict of Interest

The authors declare to have no conflicts of interest.

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