

## Anthropometric Study of Correlation between the Stature and Selected Upper Limb Dimensions in Adult Bangladeshi Manipuri Females

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### ABSTRACT

**Introduction:** Limb anthropometry provides great contribution in personal identification of any individual by determining the morphological variation of different population which is done by anthropologists and forensic scientists as well as anatomists. Stature is considered as one of the important parameters along with other parameters like age, sex and race for personal identification which helps in forensic investigation. The Manipuri community is one of the oldest ethnic communities in Bangladesh.

**Objective:** In this study our main goal is to find out the correlation between the stature and four selected linear upper limb dimensions of left side; length of the arm, forearm, ulna and hand.

**Materials and Methods:** This anthropometric study was carried out in 100 adult Bangladeshi Manipuri female population aged between 25 to 45 years. Direct measurements of stature and four selected linear upper limb dimensions were taken and statistical analysis was performed using SPSS software (version 22.0).

**Results:** The four selected upper limb dimensions showed significant positive correlations ( $p \leq 0.05$ ) with the stature. Highest correlation of the stature with the dimensions studied, was found in the length of forearm ( $r=0.511$ ).

**Conclusion:** The findings of the present study show that there was significant positive correlation between the stature and the selected four upper limb dimensions and thereby indicating that stature could be predicted successfully using length of the arm, forearm, ulna and hand among Bangladeshi Manipuri female population.

**Keywords:** Linear, Upper limb dimensions, Anthropometry, Morphological variation, Stature.

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### INTRODUCTION

Anthropometry deals with the measurement of size, weight, stature and proportion of the body parts of human. The normative upper limb dimensions, accessed by limb anthropometry are required to treat or reconstruct any congenital and post-traumatic disfigurements. It also contributes to an individual's identification process from dismembered or amputated limb of different population. Nature has always been admired for its patterns and symmetry, and the human body is an example of nature's proportion. Though all the human beings occupying this globe belong to the same species, Homo sapiens, exhibiting consistent proportion in their body, but there are no two individuals, who are

exactly alike in all their measurable traits, even genetically identical twins differ in some respects.<sup>1</sup> It is important to remember that body dimensions vary from population to population and ethnic community to ethnic community. One of the important body dimensions is morphology of limb bone. Limb bone morphology is significantly related with climatic, nutritional and some environmental factors. For example, peoples who live in cold climates tend to have low tibiofemoral index values, while the opposite is true for those in warm climates.<sup>2</sup> That is why variations and changes in the forms of the human body are obvious, existing in the earth which is an ancient concern to the anthropologist.

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.<sup>3</sup> The anthropometric characteristics are directly related with age, sex, shape and form of an individual, and these factors are very much linked with each other.

Personal Identification of an individual is an essential issue especially when unknown, highly decomposed, fragmentary, amputated and mutilated human body remains were found as a result of mass disasters and natural events. Then stature can be assumed for identification from that body remains. 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. Gupta et al. suggested that the stature can be estimated from fragmented body remains measuring different upper limb dimensions to determine biological profile of an individual.<sup>4</sup>

Limb anthropometry provides great contribution to stature estimation from the body remains. It also contributes for ergonomic designing like cloths, hand gloves and biomedical prosthesis. Besides this, Jaswant and Nitish stated that Age, sex and population specific upper arm anthropometry is assumed to be an important technique to determine the body-composition and nutritional status especially in epidemiological and clinical diagnosis.<sup>5</sup> It was suggested that, no single anthropometric formula is suitable to draw complete anthropometric picture in Bangladesh. For this reason, different formulae are required for calculating stature and different bones or body parts identification of different populations.<sup>6</sup>

The Manipuri are one of the oldest ethnic communities in Bangladesh and ethnically Manipuri belongs to Mongoloid ethnics. They belong to Kuki-Chin group of the Tibeto-Burman family of Mongolian ethnics who speak in meithei language. In Bangladesh, the Manipuri peoples are mostly inhabited in Kamalganj upazila of Moulvibazar district of Sylhet division. It is well known that morphological variation is one of the most important phenomena

occurring in human. In Bangladesh, there are many people died because of natural disasters like cyclones, tornado, landslides, heavy rainfall etc. and man-made disaster like plane crash, bus or train accident, terrorist attack and building collapse. Among those situations, limb anthropometry can play a significant role in personal identification of any individual. It also helps to determine morphological variations and characteristics of different ethnic communities.

The present study is designed to provide a baseline quantitative data on stature and some selected upper limb dimensions determining the characteristics of the Manipuri ethnic community by studying on adult Bangladeshi Manipuri females. This study will also contribute to make a basis for comparison the Manipuri features with other ethnic communities.

### AIMS AND OBJECTIVES

- To study any correlations of the stature with the length of the arm, forearm, ulna and hand.
- To find out which dimension is best to estimate the stature of an individual.

### METHODS AND MATERIALS

#### Study Design and Participants

This study was a cross-sectional study with some analytical components. The study was carried out on a hundred adult Bangladeshi Manipuri females residing at Madhavpur village of Kamalganj upazila of Moulvibazar district of Sylhet division. All measurements were taken during a particular time of the day (from 9 AM to 4 PM) to avoid diurnal variations.

#### Place and Period of the Study

The study was carried out on the adult Bangladeshi Manipuri females of Madhavpur village at Kamalganj upazila of Moulvibazar district of Sylhet, Bangladesh (Figure 1A and 1B). The period of the study was March 2017 to February 2018. Data analysis was carried out in the Department of Anatomy, Bangabandhu Sheikh Mujib Medical University (BSMMU), Dhaka, Bangladesh.

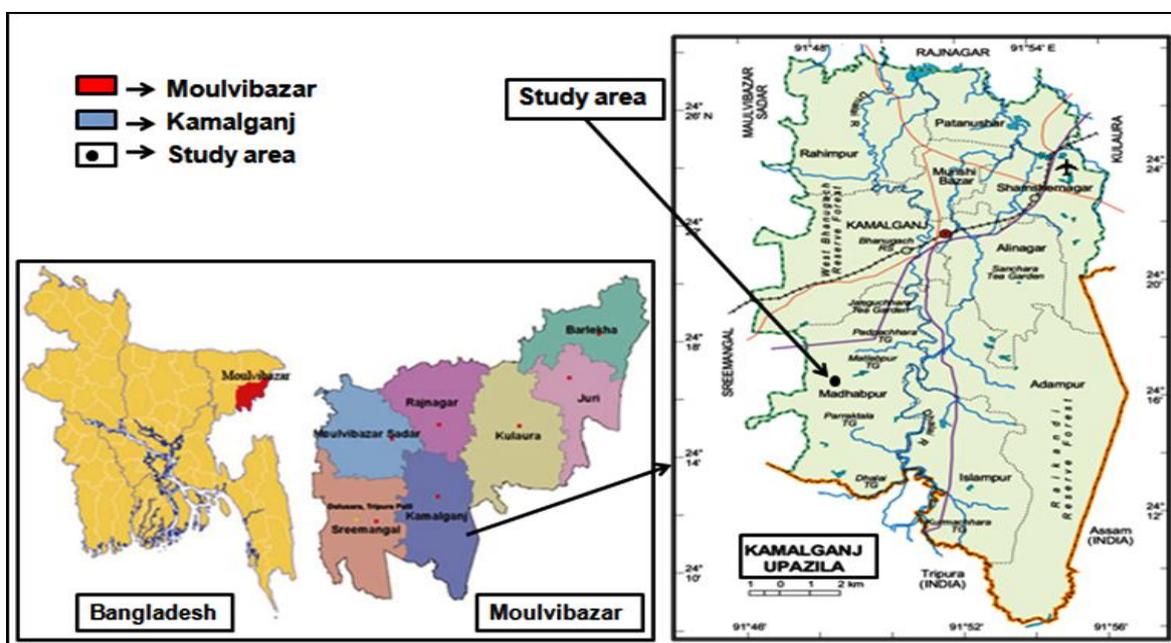


Figure 1: Geographical location of the study area A) Map of Bangladesh with Moulvibazar district highlighted in red and Moulvibazar district with different upazila B) Madhavpur Manipuri area in the map of Kamalganj upazila where study area pointed with a black dot.<sup>7,8</sup>

### Inclusion Criteria

Each participant was selected who fulfil the following criteria:

- a) Aged between 25 and 45 years
- b) Bangladeshi by nationality
- c) Manipuri by ethnicity
- d) Female by sex

### Exclusion Criteria

- a) Mixed in origin: If there was any history of marriage with Bengali people or with any other tribe within three generations
- b) The subjects with the history of
  - i) Genetic disorder
  - ii) Endocrine disorder
  - iii) Trauma
  - iv) Surgery
  - v) Congenital anomalies that can affect the stature or other dimensions

- c) Pathological conditions that can affect the features of the extremities of an individual
- d) Pregnancy

A participant's selection check list was designed to check the inclusion and exclusion criteria in selecting participants to take physical measurements in data collection sheet after taking informed consent.

**Stature:** Stature is measured as the vertical distance from the top of the head (the vertex) to the floor. The participant's head positioned in the Frankfurt horizontal plane asking to stand with her heel together, toes apart and her back as straight as possible. So that, her heels, buttocks, shoulders and the head touched the wall to measure the stature. A steel plate was placed against the head and wall to determine maximum stature on the wall, and this was marked by black eye pencil. The participant was then told to step away from the wall and then measured from the floor to the marked point on the wall with a measuring steel tape (Figure 2).



Figure 2: Procedure of measuring stature

- A) Placing the steel plate against the head and wall
- B) Marking the maximum stature on the wall
- C) Measuring the stature from the marked point on the wall to the floor by using steel tape.

Four selected linear upper limb dimensions of the left side were measured by direct physical procedure using digital sliding caliper and spreading caliper as applicable (Figure 3).

**The Length of the Arm:** The length of the arm is measured as the distance from the most lateral point on the end of the acromial process of the shoulder blade to the most distal point on the Capitulum of humerus (Figure 3A).

**The Length of the Forearm:** The length of the forearm is measured as the distance from the head of the radius to the most distal point on the styloid process of the radius in the extended elbow. Here this length of the radius is considered as the length of the forearm (Figure 3B).

**The Length of the Ulna:** The length of the ulna is the distance from the tip of the olecranon process to the most distal point on

the styloid process of the ulna in the flexed elbow (Figure 3C).

**The Length of the Hand:** The length of the hand is the linear distance between the mid-point of the distal wrist crease and the tip of the most anterior projecting point that is tip of the middle finger (Figure 3D).

### Data Analysis

During the study all the data were checked and the data were entered into computer and statistical analyses of the results were obtained by using window-based computer software devised with Statistical Packages for Social Sciences (SPSS version 22.0) and Microsoft Excel. The Shapiro-Wilk test which is a normality test was done for determining the pattern of the distribution of data and then correlations of the stature with each of the selected four upper limb dimensions were tested by Pearson's correlation test.

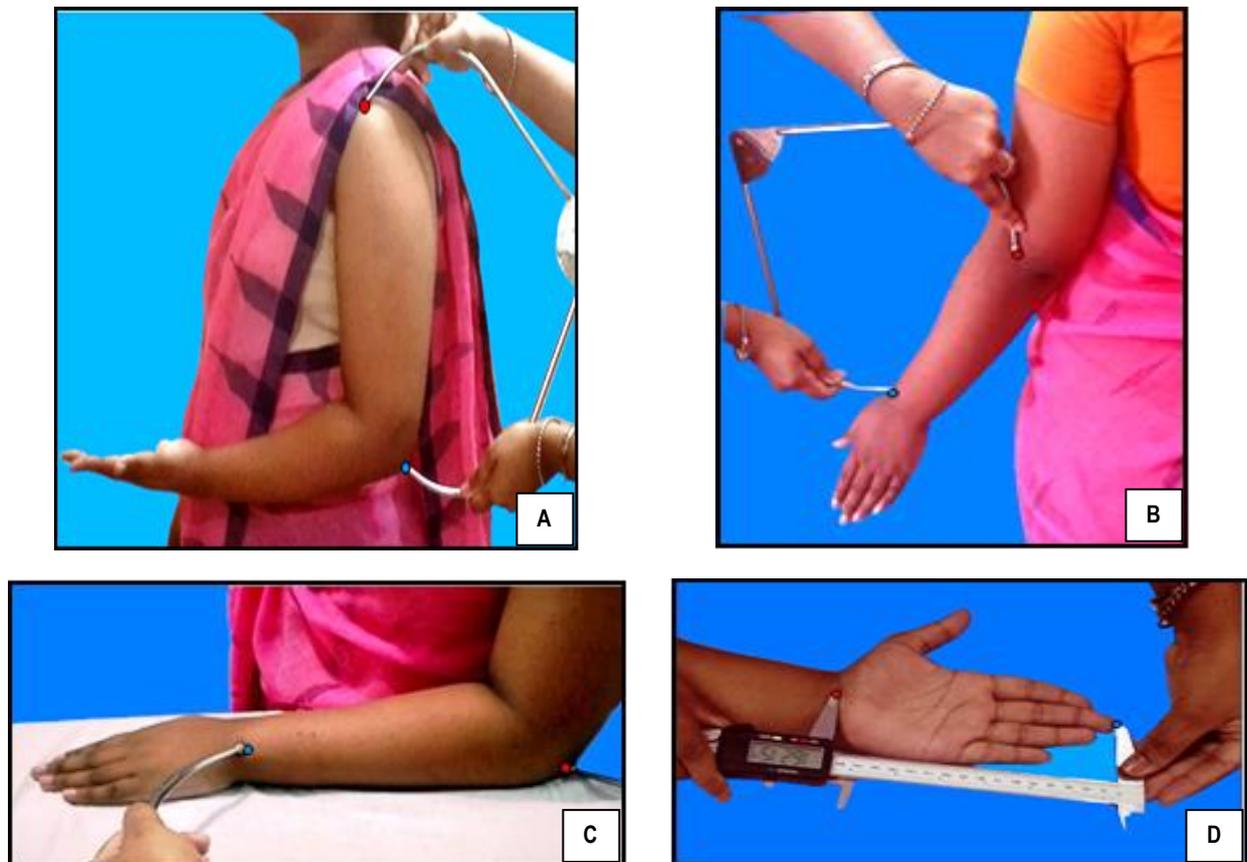


Figure 3: Procedure of measuring the length of the arm, forearm, ulna extending from red dot to blue dot using the spreading caliper A) Length of the arm, B) Length of the forearm, C) Length of the ulna and D) Length of the hand using digital sliding caliper.

Table 1: Values of the stature and selected linear upper limb dimension in adult Bangladeshi Manipuri females (n= 100)

Dimension (cm)	Value (cm)	
	Range (Min–Max)	Mean ( $\pm$ SD)*
Stature	142.20–165.40	152.19 ( $\pm$ 5.08)
Length of the arm	20.50–34.70	28.24 ( $\pm$ 2.64)
Length of the forearm	20.50–25.70	22.72 ( $\pm$ 1.22)
Length of the ulna	20.50–26.70	23.37 ( $\pm$ 1.23)
Length of the hand	14.03–18.85	17.00 ( $\pm$ 0.84)

SD\*: Standard deviation

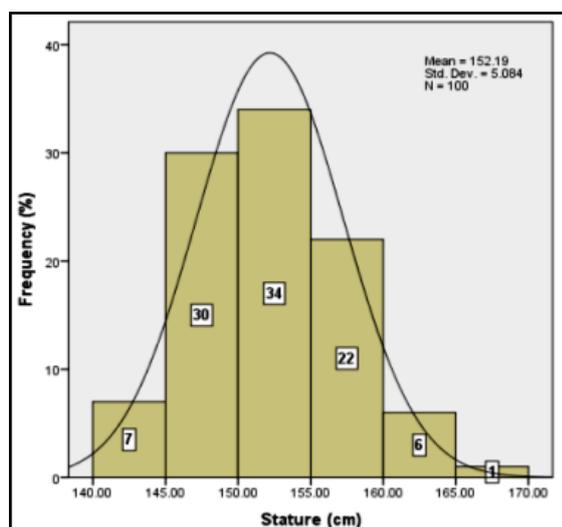


Figure 4: Frequency distribution of the stature of adult Bangladeshi Manipuri females (n= 100).

## RESULTS

The Shapiro-Wilk test which is a normality test was done for determining the pattern of the distribution of data, which was normal in the present study (Figure 4 and Figure 5). Table 1 presents the mean values as well as the ranges of the dimensions of adult Bangladeshi Manipuri females. The mean length of the arm, forearm, ulna and hand of the left side were 28.24 ( $\pm$ 2.64), 22.72 ( $\pm$ 1.22), 23.37 ( $\pm$ 1.23), 17.00 ( $\pm$ 0.84) centimetres respectively while the mean stature was 152.19 ( $\pm$ 5.08) centimetre. Correlation coefficient (r), coefficient of determination ( $r^2$ ) and p- value of the four selected linear upper limb dimensions is shown in Table 2. Correlations of the stature with each of the selected linear upper limb dimensions were assessed and displayed using scatter diagrams in Figure 6 to Figure 9. The four upper limb dimensions were found to have significant correlation with the stature. Best correlation coefficient of the dimensions the stature studied, was found in the length of forearm ( $r = 0.511$ ) followed by length of ulna ( $r = 0.414$ ).

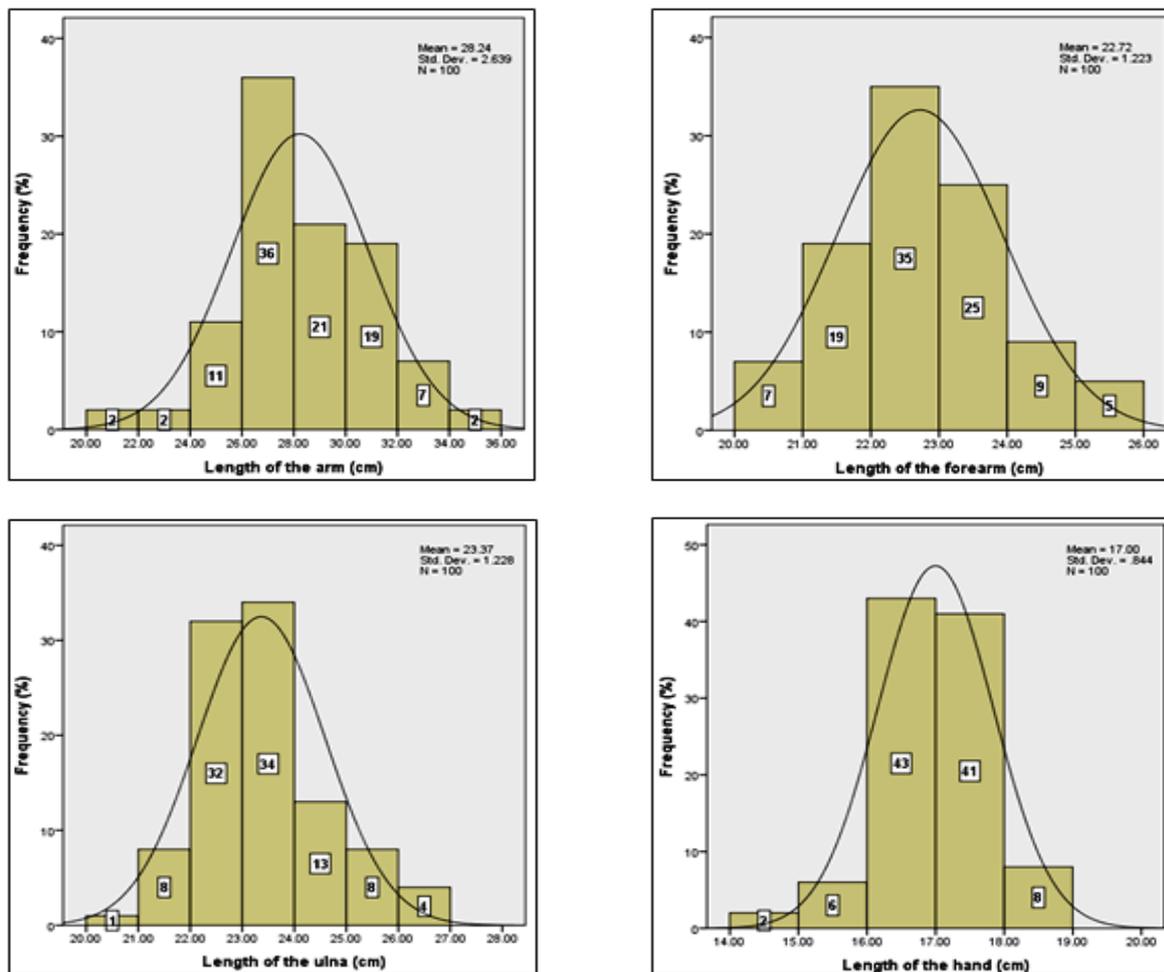


Figure 5: Frequency distribution of A) The length of the arm, B) The length of forearm, C) The length of ulna and D) The length of hand of adult Bangladeshi Manipuri females (n= 100).

Table 2: Correlation coefficient of the stature with the selected linear upper limb dimension in adult Bangladeshi Manipur females (n= 100)

Selected linear upper limb dimension (cm)	Correlation coefficient (r)	Coefficient of determination (r <sup>2</sup> )	P-value of correlation with the stature
Length of the arm	+0.224	0.050	0.025
Length of the forearm	+0.511	0.261	<0.001
Length of the ulna	+0.414	0.172	<0.001
Length of the hand	+0.220	0.048	0.028

\*p= Probability; If p ≤ 0.05, it is considered as significant.

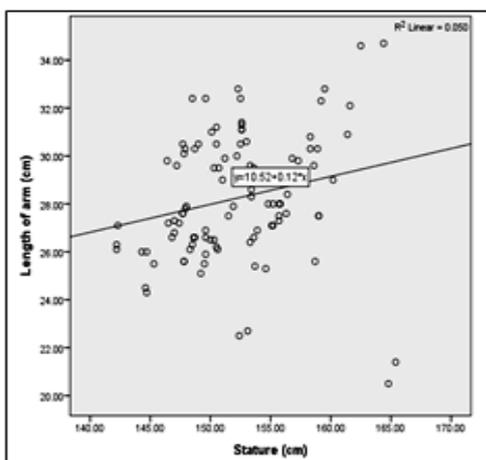


Figure 6: Scatter plot with regression line showing significant positive correlation (r = +0.224, r<sup>2</sup>= 0.050, p = 0.025) of the stature with the length of the arm.

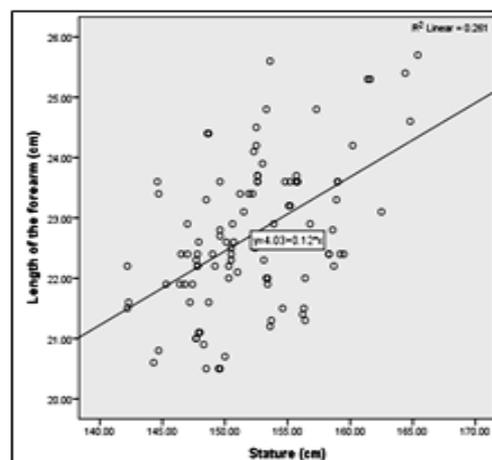


Figure 7: Scatter plot with regression line showing significant positive correlation (r = +0.511, r<sup>2</sup>= 0.261, p = <0.001) of the stature with the length of the forearm.

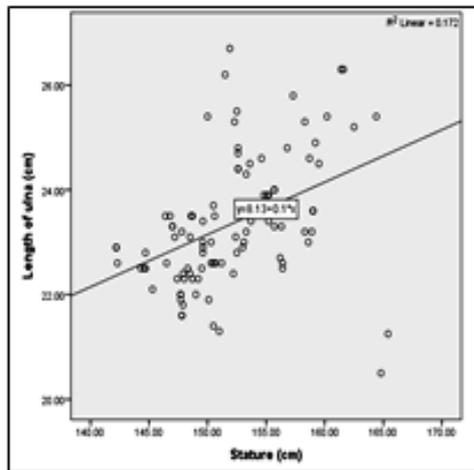


Figure 8: Scatter plot with regression line showing significant positive correlation ( $r = +0.414$ ,  $r^2 = 0.172$ ,  $p < 0.001$ ) of the stature with the length of the ulna.

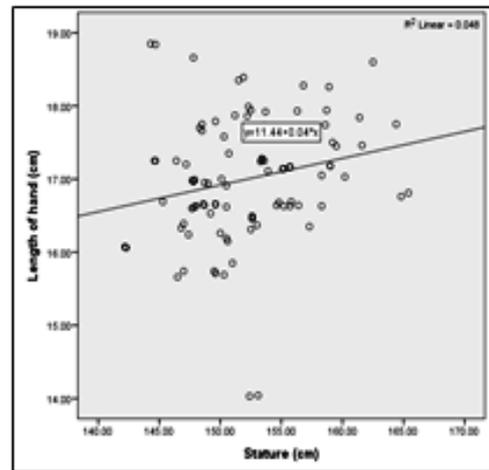


Figure 9: Scatter plot with regression line showing significant positive correlation ( $r = +0.220$ ,  $r^2 = 0.048$ ,  $p = 0.028$ ) of the stature with the length of the hand.

## DISCUSSION

Body segments show consistent ratios among themselves and relative to the stature. These ratios between body segments are dependent on age, sex, race and physical activity. There are differences in anthropometric measurements of different population in different geographical areas. So, region-wise and population specific study seems to be necessary.<sup>9</sup> For this reason, bodily measurements are the mainstay of anthropological research. The relationships between the stature and different upper limb dimensions are likely to differ according to age, sex and ethnic background. Therefore, anthropometric techniques that are commonly used to estimate stature and bone length from the skeletal remains and unknown body parts are of utmost interest to anthropologists, medical scientists and anatomists for over a hundred years. Anthropometric studies on upper limb have been carried out in different studies on different population of Negroid, Caucasoid and Australoid as well as on Mongoloid ethnics residing in different geographical regions of the world. In addition, it is also noted that every race of particular age group and sex should have its own equations for estimation of stature using various parameters. As the Manipuri ethnics belong to the Mongoloid, some similarities are expected to exist with other ethnic communities of Mongoloid and some dissimilarities may be expected with other ethnics.

In this study, the age of the participants was ranged between 25 and 45 years in the present study. Different researcher also chose the age limit in their studies. The age limit for the participants of the present study was based on the concept that the anthropometric measurements in adults should be standardized normative values at such an age when the development of the respective body part is complete. Hence the age related changes in the upper limb dimensions could be kept to the minimum.<sup>10-12</sup>

In the present study, the mean stature of the Bangladeshi Manipuri females was found as 152.19 centimeters. There was similar mean stature with the 'Garo' females in Bangladesh.<sup>11</sup> The Manipuri females of the present study were found to have smaller mean stature than Chinese,<sup>13</sup> Japanese<sup>14</sup> females. However, the adult Manipuri female of the present study had a greater mean than the rural Bengali<sup>15</sup> females of Bangladesh and Indian like Santhals of west Bengal<sup>16</sup>. Higher mean stature was found in the

Caucasian females of Turk<sup>17</sup> and Negroids like Efiks of Nigeria<sup>18</sup> in comparison to adult Manipuri females of Bangladesh. It should be noted that showed the greatest mean stature, was found in Negroid adult females like 'Efiks' of Nigeria while the 'Rural Bengali' females had the smallest one.

The mean length of the arm of adult Manipuri females was 28.24 centimeters. Interestingly, the Manipuri revealed greater mean length of the arm than Indian like Santhal of West Bengal<sup>16</sup> and Urban Bengali Bangladeshi<sup>10</sup> females. However, they showed similar mean to those of the Caucasoid like 'Turk<sup>17</sup>, Turkey. The adult Manipuri females found to have smaller mean length of the arm than Mongoloid 'Garo' females<sup>11</sup> of Bangladesh.

In the present study, the mean length of the forearm of the adult Bangladeshi Manipuri females was 22.72 centimeter. The Adult Manipuri females showed similar mean to those of Mongoloid female like 'Garo'<sup>11</sup> of Bangladesh, Japanese<sup>14</sup> and Caucasoid females of 'Turk'<sup>17</sup> while have greater mean than 'Urban Bengali' females<sup>10</sup> of Bangladesh.

The mean length of the ulna of the adult Bangladeshi Manipuri females of the present study was 23.37 centimeter which was similar to that of Mongoloid like Garo<sup>11</sup> females of Bangladesh while it was smaller than 'Urban Bengali'<sup>10</sup> females of Bangladesh. However, the Manipuri showed a smaller mean than Negroid females like 'Uromi'<sup>19</sup> of Nigeria and Caucasoid females like Sudanese<sup>20</sup>.

The mean length of the left hand of the adult Manipuri females was 17.00 centimeter. Similar finding was revealed in that of North Indian<sup>21</sup> female. However, it was smaller than that of the Negroid like 'Efiks' of Nigeria<sup>19</sup>. They have greater mean length of the hand than Mongoloid 'Garo'<sup>11</sup> females of Bangladesh. From the above view, it may be suggested that variation is not only present in between different races or ethnic groups but also present in individual communities of same ethnic group or races.

Regarding the correlation between the stature and the different lengths of upper limb studied in this study, it is evident that the measured linear upper limb dimensions of the left side investigated in the present study were found to have significant positive correlation with the stature in adult Bangladeshi Manipuri females.

El-Din, Elkholy and Yousef<sup>12</sup> have conducted a study on 500 adult Arab Egyptian, comprising 250 males and 250 females. It was done for assessing the relationship between stature and upper limb dimensions. Upper arm length was found more predictive than other upper limb dimensions for stature in both sexes for Egyptian. But in this study, the length of the forearm was found to have highest correlation with the stature ( $r = 0.511$ ) followed by length of the ulna ( $r = +0.414$ ). So the length of the forearm was found to be more predictive for stature estimation than other upper limb dimensions studied in the present study. On the other hand, correlation between stature and length of the arm, hand in adult Bangladeshi Manipuri female was a poor predictor for stature estimation, though it was positively correlated. The correlation co-efficient indicates that there is a strong relationship between the parameters. So, the positive correlation suggests that if the length of forearm increases or decreases, the stature of an individual also increases or decreases and vice versa. The findings of the present study were consistent to the result of Laila<sup>10</sup> and Hossain.<sup>11</sup>

Prediction of the dimensions of body segments is useful in many areas of modern science. For example, in growth and development the use is made of the relationships between body segments in the assessment of normal growth as well as in specific syndromes. Body proportions and the dimensions of various body segments, including the long bones of the limbs and the bones of the hand and foot have been used to estimate stature. The long bones of the limbs, however, have been the most widely studied.<sup>22-25</sup>

## CONCLUSION

In the present study an attempt was made to document the relationship between the stature and the selected upper limb dimensions of adult Bangladeshi Manipuri females. Correlation of the stature with each of the selected linear upper limb dimensions of the left side were assessed which were positively correlated. There is a strong relationship between the stature and selected upper limb dimensions. So, significant positive correlations between most of the dimensions can be utilized in the determination of one dimension from another. These data can be utilized in personal identification for medico legal purpose. The results of this anthropometric study on the adult Bangladeshi Manipuri population provide the baseline information, regarding some selected dimensions of a particular population (defined for the present study as Bangladeshi Manipuri female population aged 25 to 45 years). This helps to develop a standard for such data on various sub population and the population as a whole. Some amount of comparisons made with other populations contributes to the understanding of the relative status of adult Bangladeshi Manipuri female population in the context of the anthropometric variations around the world, especially among the Mongoloid population. This should encourage others in taking up further research in this field.

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