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Original Research Article

# A STUDY ON THE UTILITY OF FINGER LENGTHS ON ESTIMATION OF STATURE IN EASTERN UTTAR PRADESH POPULATION

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## Abstract

**Background:** Identity of person can be established by stature estimation which has a significant role in forensic investigation when entire body is not available for analysis. Hence in the present study main aim was to generate a regression equation using finger length and estimate stature with the help of that equation. Another aim of this study was to evaluate correlation of finger length with the estimated stature. This study was commenced with 100 male and 100 female participants among whom the lengths of index finger, middle finger and ring finger were measured using Vernier caliper. The study was undertaken in the department of Anatomy, Heritage Institute of Medical Sciences, Varanasi, UP. The height of participants was measured using stadiometers. The data was analyzed using student's t-test and Pearson's correlation coefficient. In this study, mean values of stature and finger lengths were larger in males. Linear and strong correlation was found between stature all the finger length in both male and female participants. The stature was calculated using the regression equation generated from finger lengths and compared with the actual stature in both the participants. Statistically significant difference was not observed between actual and calculated stature. The result of this study shows that finger lengths especially index finger, middle finger and ring finger can be used to estimate stature of an individual accurately. This study might be useful to medicolegal experts for determining personal identity of an individual when intact finger available for stature estimation. **Materials and Methods:** . This study was commenced with 100 male and 100 female participants among whom the lengths of index finger, middle finger and ring finger were measured using Vernier caliper. The study was undertaken in the department of Anatomy, Heritage Institute of Medical Sciences, Varanasi, UP. The height of participants was measured using stadiometers. The data was analyzed using student's t-test and Pearson's correlation coefficient. **Result:** In this study, mean values of stature and finger lengths were larger in males. Linear and strong correlation was found between stature and all the finger lengths in both male and female participants. The stature was calculated using the regression equation generated from finger lengths and compared with the actual stature in both the participants. Statistically significant difference was not observed between actual and calculated stature. ***Conclusion:*** The result of this study shows that finger lengths especially index finger, middle finger and ring finger can be used to estimate stature of an individual accurately. This study might be useful to medicolegal experts for determining personal identity of an individual when intact finger is available for stature estimation.

## INTRODUCTION

Anthropometry refers to the estimation of stature of an individual from measurement of different body parts such as bones. It is useful in forensic investigation in which human body remains used for identification in medicolegal aspects.[1] Since past several years forensic experts and medicolegal experts have been using stature as a key parameter of personal identification and one of the big fours (viz: age, race, gender and stature) of forensic anthropology. Estimation of the stature is based on the fact that every part of the body has constant association with height of an individual.[2]

Stature may be defined as a distance from feet to the vertex when a person stands erect. The stature increases continuously during childhood and declines in old age.[3] It becomes easy to identify individuals from stature when entire body is available at crime scene. However, in certain cases like mass disaster, genocide, war, accidents and many other cases where dismembered or amputed by body parts are available, it becomes difficult to the forensic expert in personal identification. In such cases, use of such body parts can be made to generate a formula which can accurately estimate the stature of an individual.[4,5]

Stature of an individual can be determined by two methods viz. anatomical method and mathematical method.[6] In anatomical method, measurement of length of lower limb, length of vertebral column and height of skull is taken in mathematical method, mathematical formula is generated through independent variables which can be used for stature estimation in specific population or community.[7] Previous studies have shown that regression equations can provide better estimate of stature. However, it should be noted that the population of world is highly variable, hence, the regression equation generated for one group of population may not give accurate result when applied for the other group of population.[1,8]

Number of studies have been done to estimate stature from long bones of upper and lower limbs while very few studies are available on the phalanges and finger length. The importance of using finger length to estimate stature is attributed to its size since in disasters and accidents there is maximum probability of attaining these small bones at crime scenes, which could be beneficial for forensic experts to carry on investigation with the case. Therefore, the aim of the present study was to determine stature from the length of index finger, middle finger and ring finger by generating separate regression equation in Easter UP. The result of this study may be useful in the cases where only hand or its parts are available for personal identification.

## MATERIALS AND METHODS

This study was conducted in the department of Anatomy, Heritage Institute of Medical Sciences, Varanasi, UP. About 200 participants including 100 males and 100 females of age 16-25 years were included. The study was initiated after obtaining institutional ethical clearance and written consent from the participants.

**Inclusion Criteria**

- Healthy participants of age between 16-25 years
- Students willing to participate
- Indian students residing in Eastern UP

**Exclusion Criteria**

- Participants with skeletal abnormalities or deformities and endocrinal disorders such as dwarfism, acromegaly and gigantism.
- Persons with amputed fingers or absence of fingers
- Persons with disease or deformity of bones of spine and fingers
- Participants not willing to participate

Measurement of stature and finger length of index finger, middle finger and ring finger were taken as follows:

**Stature**

Stature was measured using anthropometer. The participants were requested to stand erect barefooted in anatomical plane with shoulder blades and buttocks touching the wall. Anthropometer is placed vertically in front of the participants with head orientation in Frankfurt plane (eye-ear-eye plane) and the measurement was taken from foot vertex in mid sagittal plane.

**Finger Length**

Finger lengths were measured using Vernier caliper. The participants were requested to remove any jewelries that would interfere measurement of finger length and then asked to put hand on a flat table. The finger length was taken as a distance between proximal phalangeal ridge to the tip of the finger. Two readings for each index finger, middle finger and ring fingers were taken. For this, the Vernier caliper was placed horizontally on ventral surface of hand. The fixed jaw of caliper was placed on proximal phalangeal ridge and movable part was fixed at the tip of finger. Measurement of finger in both right and left hands were taken and recorded.

**Statistical Analysis**

The data was analyzed using SPSS version 25. Comparative analysis was done using students t-test while correlation was determined by Pearson's correlation coefficient. A p value less than 0.05 represented statistical significance. The regression equation for stature estimation is $y = ax + c$ where,

y = dependent variable (stature)
c = constant
a = independent variable coefficient
x = independent variable (finger length)

## RESULTS

Demographic variables such as age, height and weight were compared between male and female participants. There parameters were high in case of


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males and statistically significant difference was observed in cases of height and weight [Table 1].

The finger lengths (thumb, index finger, middle finger, ring finger and little finger) of right hand were compared between males and females. Males were found to have significantly long right index finger, right middle finger and right ring finger compared to females [Table 2].

The finger lengths (thumb, index finger, middle finger, ring finger and little finger) of left hand were compared between males and females. Males were found to have significantly long left index finger, left middle finger and left ring finger compared to females [Table 3].

In [Table 4 and 5], the finger lengths of right and left hands were compared in males and females. Statistically significant difference was not obtained.

In table 6, the regression equations were developed using each finger lengths of both the hands in males. This equation was used to calculate stature. The stature calculated was then compared with the actual stature of male participants. There was no significant difference in actual and calculated stature.

Similarly, in [Table 7], the regression equations were generated using each finger lengths of both the hands in females. From this equation stature was calculated. The stature calculated was then compared with the actual stature of female participants. There was no significant difference in actual and calculated stature.

In [Table 8], the stature was correlated with finger lengths (thumb, index finger, middle finger, ring finger and little finger) of both right and left hands in males and females. Significantly positive correlations were obtained in all the cases in both males and females.

**Table 1: Mean age, height and weight of participants.**

| Parameter | Male | Female | p |
|---|---|---|---|
| Age (years) | 20.81 ± 1.31 | 19.87 ± 1.46 | 0.305 |
| Height (cm) | 170.32 ± 6.11 | 158.6 ± 7.1 | 0.031* |
| Weight (Kg) | 61.05 ± 8.05 | 52.41 ± 6.18 | 0.042* |

NS: Non-significant (p>0.05), *: Statistically significant (p<0.05)

**Table 2: Comparison of length of finger of right hand in males and females**

| Finger length | Male | Female | p |
|---|---|---|---|
| Right Thumb Length (cm) | 5.31 ± 0.4 | 5.38 ± 0.29 | $0.612^{NS}$ |
| Right Index finger Length (cm) | 7.4 ± 0.41 | 6.73 ± 0.26 * | 0.021* |
| Right Middle finger Length (cm) | 8.24 ± 0.36 | 7.41 ± 0.72 * | 0.038* |
| Right Ring finger Length (cm) | 7.62 ± 0.52 | 6.87 ± 0.52 * | 0.014* |
| Right Little finger Length (cm) | 5.73 ± 0.31 | 5.54 ± 0.4 | $0.427^{NS}$ |

NS: Non-significant (p>0.05), *: Statistically significant (p<0.05)

**Table 3: Comparison of finger lengths of left hand in male and female**

| Finger length | Male | Female | p |
|---|---|---|---|
| Left Thumb Length (cm) | 5.31 ± 0.5 | 5.35 ± 0.17 | $0.433^{NS}$ |
| Left Index finger Length (cm) | 7.35 ± 0.48 | 6.77 ± 0.51 * | 0.026* |
| Left Middle finger Length (cm) | 8.36 ± 0.31 | 7.35 ± 0.54 * | 0.017* |
| Left Ring finger Length (cm) | 7.63 ± 0.29 | 6.79 ± 0.38 * | 0.044* |
| Left Little finger Length (cm) | 5.81 ± 0.39 | 5.51 ± 0.26 | 0.218NS |

NS: Non-significant (p>0.05), *: Statistically significant (p<0.05)

**Table 4: Comparison of right and left hand finger lengths in male**

| Finger length | Right (cm) | Left (cm) | p |
|---|---|---|---|
| Thumb | 5.31 ± 0.4 | 5.31 ± 0.5 | $>0.05^{NS}$ |
| Index finger | 7.4 ± 0.41 | 7.35 ± 0.48 | $>0.05^{NS}$ |
| Middle finger | 8.24 ± 0.36 | 8.36 ± 0.31 | $>0.05^{NS}$ |
| Ring finger | 7.62 ± 0.52 | 7.63 ± 0.29 | $>0.05^{NS}$ |
| Little finger | 5.73 ± 0.31 | 5.81 ± 0.39 | $>0.05^{NS}$ |

NS: Non-significant (p>0.05)

**Table 5: Comparison of right and left hand finger length in females**

| Finger length | Right (cm) | Left (cm) | p |
|---|---|---|---|
| Thumb | 5.38 ± 0.29 | 5.35 ± 0.17 | $>0.05^{NS}$ |
| Index finger | 6.73 ± 0.26 | 6.77 ± 0.51 | $>0.05^{NS}$ |
| Middle finger | 7.41 ± 0.72 | 7.35 ± 0.54 | $>0.05^{NS}$ |
| Ring finger | 6.87 ± 0.52 | 6.79 ± 0.38 | $>0.05^{NS}$ |
| Little finger | 5.54 ± 0.4 | 5.51 ± 0.26 | $>0.05^{NS}$ |

NS: Non-significant (p>0.05)

**Table 6: Comparison of stature and estimated stature in males**

| Finger length | Mean (X) | Regression equation (Y=c +aX) | Actual stature | Estimated stature (cm) | p |
|---|---|---|---|---|---|
| Right Thumb Length | 5.31 | 155.46 ± 2.29 X | 170.32 cm | 167.61 | $>0.05^{NS}$ |


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| | | | | | |
|---|---|---|---|---|---|
| Right Index finger Length | 7.4 | 133.49 ± 4.94X | | 170.05 | >0.05$^{NS}$ |
| Right Middle finger Length | 8.24 | 123.85 ± 5.62X | | 170.16 | >0.05$^{NS}$ |
| Right Ring finger Length | 7.62 | 127.74 ± 5.81X | | 172.01 | >0.05$^{NS}$ |
| Right Little finger Length | 5.73 | 148.23 ± 3.16X | | 166.34 | >0.05$^{NS}$ |
| Left Thumb Length | 5.31 | 154.84 ± 2.42X | | 167.69 | >0.05$^{NS}$ |
| Left Index finger Length | 7.35 | 112.26 ± 8.11X | | 171.86 | >0.05$^{NS}$ |
| Left Middle finger Length | 8.36 | 119.9 ± 6X | | 170.06 | >0.05$^{NS}$ |
| Left Ring finger Length | 7.63 | 139.9 ± 4.16X | | 171.64 | >0.05$^{NS}$ |
| Left Little finger Length | 5.81 | 150.78 ± 2.49X | | 165.24 | >0.05$^{NS}$ |

NS: Non-significant (p>0.05)

**Table 7: Comparison of actual stature and estimated stature in females**

| Finger length | Mean (X) | Regression equation (Y=c +aX) | Actual stature | Estimated stature (cm) | p |
|---|---|---|---|---|---|
| Right Thumb Length | 5.38 | 131.31 ± 4.54X | 158.6 cm | 155.73 | >0.05$^{NS}$ |
| Right Index finger Length | 6.73 | 112.27 ± 7.12X | | 160.18 | >0.05$^{NS}$ |
| Right Middle finger Length | 7.41 | 109.34 ± 6.61X | | 158.32 | >0.05$^{NS}$ |
| Right Ring finger Length | 6.87 | 99.96 ± 8.42X | | 157.8 | >0.05$^{NS}$ |
| Right Little finger Length | 5.54 | 122.23 ± 5.91X | | 154.97 | >0.05$^{NS}$ |
| Left Thumb Length | 5.35 | 139.7 ± 3.17X | | 156.65 | >0.05$^{NS}$ |
| Left Index finger Length | 6.77 | 114.91 ± 6.59X | | 158.52 | >0.05$^{NS}$ |
| Left Middle finger Length | 7.35 | 124.35 ± 4.59X | | 158.08 | >0.05$^{NS}$ |
| Left Ring finger Length | 6.79 | 116.85 ± 6.28X | | 159.49 | >0.05$^{NS}$ |
| Left Little finger Length | 5.51 | 132.17 ± 4.38X | | 156.3 | >0.05$^{NS}$ |

NS: Non-significant (p>0.05)

**Table 8: Correlation of stature with finger length in males and females**

| Finger length | Male | | Female | |
|---|---|---|---|---|
| | r | p | r | p |
| Right Thumb Length | 0.48 | < 0.001** | 0.37 | 0.002** |
| Right Index finger Length | 0.39 | 0.001** | 0.61 | < 0.001** |
| Right Middle finger Length | 0.57 | < 0.001** | 0.63 | < 0.001** |
| Right Ring finger Length | 0.42 | < 0.001** | 0.47 | < 0.001** |
| Right Little finger Length | 0.27 | 0.005** | 0.44 | < 0.001** |
| Left Thumb Length | 0.31 | 0.002** | 0.32 | 0.002** |
| Left Index finger Length | 0.55 | < 0.001** | 0.47 | < 0.001** |
| Left Middle finger Length | 0.46 | < 0.001** | 0.68 | < 0.001** |
| Left Ring finger Length | 0.65 | < 0.001** | 0.52 | < 0.001** |
| Left Little finger Length | 0.47 | < 0.001** | 0.57 | < 0.001** |

**: Statistically significant (p<0.01)

## DISCUSSION

It is not always possible to retain whole body of an individual after mass disaster, accidents or crimes. In such scenario, identity of individual remains questionable. Several studies conducted globally have shown good correlation of stature with length of long bones and few studies with finger length. In this study, the length of index finger, ring finger were taken as independent variable for development of regression equation and estimation of stature. The estimated stature using regression equation was compared with the actual stature. The values did not differ significantly which indicated that length of the fingers (thumb, index middle, ring and little) can be used to accurately determine the stature of an individual.

Tyagi AK et al reported significant association between stature and finger length. The authors recommend use of regression equation to estimate stature.[9] Study of Gupta K et al showed that reliability of right index finger is more in females while for males it is left middle finger for stature estimation.[10] Similar reports were given by Barade RV et al,[11] who reported more significance of right index finger in females while inconsistent finding was observed in case of males. In the study of Suseelammna D et al,[12] left thumb was found to be more reliable while in the study of Ahuja P et al,[13] more reliability of left index finger and left middle finger was suggested. Likewise, a study of Krishan K et al,[14] document larger significance of index finger length and ring finger length for stature estimation in males. Contrary to this study, study of Raju GM et al suggested ring finger length predicted stature better than index finger length.[1] A study of Rastogi P et al,[15] also reported higher significance in males in south Indian population.

The estimated stature was also correlated with finger lengths of right side and left side in both males and females. Significant positive correlations were obtained. Raju GM et al,[1] reported that index finger length and ring finger length is significantly and positively correlated with stature. Study of Verghese AJ et al,[16] documented significant correlated between stature and middle finger length of right and left hands in both males and females. The authors suggested use of generated regression equation for stature estimation in Karnakata. Further Suseelamma D et al,[12] derived significant correlation between


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little finger length of both hand and stature. As per Krishan K et al,[14] stature of adolescent population in North India correlated significantly with the length of index finger and ring finger while Rastogi P et al,[15] in their study conducted in Manipal explained the existence of significant correlation between stature and middle finger length.

In the study of Ansari QA, a statistically significant correlation was of height was found between right index finger and ring finger lengths. As per the author index finger comparatively is a better predictor of stature in both males and females.[17] Significant positive correlation of stature with middle finger length in both males and females was document in the study of Rastogi P et al,[15] while significant correlation of ring finger length of both hands with stature was documented in the study of Pramod Kumar GN et al.[18] Higher correlation was observed for males compared to females.

Shivakumar AH et al,[19] also suggested fairly significant correlation of middle finger length with stature in South Indian population which was similar to that of Verghese AJ et al.[16] Study of Gupta K et al showed strong correlation of height with middle finger length when the participants were taken as whole while on considering male and female participants separately, left middle finger length in males and right index finger length in females were found to be more reliable for stature estimation.[10] However, a study conducted in Nepalese medical students showed strong correlation between stature and right middle finger length in both males and females.[20] In contrast, Kaulapur V et al,[21] showed fair correlation between stature and length of left middle finger in both genders. The findings of the present study suggests that finger length especially index finger, middle finger and ring finger can be successfully used to predict stature of an individual medicolegally.

## CONCLUSION

The present study strongly supports the fact that stature can be accurately estimated using length of fingers especially index finger, middle finger and ring finger with the development of suitable regression equation which may slightly vary depending on the group of population studied. Estimation of stature using finger length is useful in forensic cases when dismembered or mutilated bodies are available for investigation.

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