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Estimation of Stature from Index Finger and Ring Finger Length of Male Adults of Central Punjab

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ABSTRACT

Forensic anthropology often relies on skeletal measurements for identifying unknown deceased individuals, with stature estimation being pivotal in cases involving dismembered remains. **Objectives:** To examine the correlation between stature and the lengths of the index and ring fingers in Central Punjabi adult male and to develop population-specific regression equations for height estimation. **Methods:** A descriptive cross-sectional study was conducted on 246 male adults aged 21-40 from Central Punjab at PGMI/Ameer-ud-Din Medical College Lahore. Height and finger lengths were measured using standardized methods, with a Vernier caliper for finger lengths. Data were analyzed using SPSS version 25.0. Pearson's correlation and regression analyses determined relationships and predictive models. **Results:** Statistically significant moderate positive correlations were observed between stature and both index and ring finger lengths. The right index finger length showed the highest correlation ($r=0.512$, $p<0.001$). Regression equations were derived, with Right Index Finger Length providing the best height prediction ($R^2 = 0.259$). **Conclusions:** Index and ring finger lengths can reliably estimate stature in Central Punjabi male, with right-hand measurements proving more predictive. Population-specific regression models enhance accuracy and provide important forensic tools for victim identification from mutilated remains. These findings bolster forensic research by enabling better biological profiling in this demographic.

INTRODUCTION

Anthropometry is the measuring of people. Measurements of persons, both alive and deceased, can be studied using anthropometric methods and equipment. In terms of anthropometric measurements, humans differ greatly from one another. The oldest instance of anthropometrics is seen in the Stone Age. The Warring States period of ancient China (770–221 B.C.) is when physiological anatomy, a forerunner of anthropometry, first emerged [1]. Alphonse Bertillon, who was unsatisfied with the existing methods of identification in the nineteenth century, developed a scientific system of detection for the French police that utilized anthropometry in order to identify suspects with greater accuracy. He also developed a method to effectively store and retrieve such data. Identifying the individual is one of the primary goals of a medico-legal examination. This identification is established on the "big four" anthropological characteristics of age, sex, stature, and race [2]. The height of a person rises during adolescence but falls with old age. A human being's entire height is directly correlated with the dimension of a specific bone [3]. When the entire body has been discovered at the crime scene, it is very simple to identify

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the person by their stature [4]. However, in certain circumstances, such as killing, mass disasters, aeroplane crashes, terrorist assaults, unresolved natural deaths, conflict, corruption, and numerous others, when chopped-up figure portions or removed limbs of the figure are present at these kinds of events, it is very challenging to identify the person. The index and ring fingers are very important for determining stature due to their size. There is a considerable chance of finding little bones under the circumstances previously mentioned, which could be helpful to forensic experts as they carry out the investigation [5]. Numerous elements, including racial, ethnic, and dietary aspects, are crucial to the development and growth of humans; hence, distinct nomenclatures are required for various populations [6]. Stature (or bodily height) is typically calculated in forensic investigations utilizing 'anatomical' and mathematical methods. Researchers have discovered a connection between stature and other body component evaluations, which is frequently expressed by a linear regression equation generated from them [7, 8]. There are two ways to gauge someone's stature: a mathematical method and an anatomical method. Stature assessment using independent variables is a mathematical technique that can be applied to a given group or community, as opposed to anatomical methods that measure lower leg length, vertebral column length, and skull height. Numerous Long bones, comprising their component elements, the hip bone, scapula, skull, and small hand and foot bones, were used in studies to estimate stature [9, 10]. A forensic specialist's crucial job is to confirm identification. Only a very small amount of Pakistani DNA data is collected due to the country's poor economic conditions. Because of this, forensic experts rely on a person's biological description, which aids in determining their identity. One of the most crucial biological characteristics used to establish identity is stature [11]. Using the index and little fingers is one statistically significant way to estimate height. The length of a person's fingers is a reliable indicator of their stature. The average person may be reliably and accurately estimated using hand observations. The most accurate parameter to determine stature from basic linear regression models in both sexes is right-hand length [12]. In the right hand, the index finger is substantially more positively correlated with height than the other fingers [13]. There is a statistically significant association between the index finger and height, according to a study conducted in Pakistan [14, 15].

Accurate stature estimation is a fundamental component of forensic identification, particularly in cases involving fragmented or mutilated remains. Although various studies have explored the relationship between long bones and stature, limited research has focused on smaller skeletal elements such as finger lengths within specific Pakistani populations. Furthermore, anthropometric relationships vary across ethnic and regional groups, making the use of non-local regression models potentially inaccurate. There is a lack of population-specific data for Central Punjabi adult males, highlighting the need to develop localized regression equations for reliable stature estimation. This study aimed to examine the correlation between stature and the lengths of the index and ring fingers in Central Punjabi adult males and to develop population-specific regression equations for height estimation.

METHODS

A descriptive cross-sectional study was conducted in the Department of Forensic Medicine and Toxicology in PGMI/Ameer-ud-Din Medical College, Lahore. The study population was Male adults of Central Punjab. The sample size was 246 individuals. The sample size was calculated by the following formula, keeping the confidence level equal to 95% and the margin of error equal to 5%. $n = (Z\sigma^2 p(1-p))/ W^2$. $Z\sigma^2 = 1.960$ Standard Normal Deviate for α, $\alpha = 0.025(1-CL)/2)$ [16], P=0.5 (Expected Proportion), W = 0.1 (Total width of confidence interval) and CL = 95% (Confidence Level). Purposive sampling, one of the non-probability samplings, was the method used for sampling. Written informed consent was taken. Study variables were Stature (Dependent), Index Finger length (Independent), and Ring Finger Length (Independent). The study lasted for three month from April, 2025 to June, 2025. IRB was issued through letter no 2245. Inclusion criteria included apparently Normal Healthy Hands and asymptomatic male adults, between the ages of 18-40 years, residents of Central Punjab. Exclusion criteria were skeletal, spinal, and long bone abnormalities (acquired or congenital), dwarfism, gigantism, people who had a noticeable hand deformity or who had had surgery to repair damage to their index and ring fingers. Purposive sampling was selected over random sampling to ensure that the study targeted a specific population subgroup, male adults residing in Central Punjab, with relevant characteristics such as age (18-40 years) and ethnicity. This approach allowed for focusing on participants most likely to provide useful data pertinent to the study objectives. Purposive sampling was chosen because: Specific characteristics were needed (e.g., age group, ethnicity and region). The goal of the study was a particular subgroup relevant to the research. Resources or access were limited, and the study had to focus on participants who were most likely to provide useful data. In the context of stature estimation, the sample may have been limited to individuals of a particular population or ethnicity to develop population-specific

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regression models. Random sampling might have included too much variability, making it harder to build accurate models for that specific group. This study consists of 246 male Punjabi adults from Central Punjab. A thorough explanation of the study's objective was to include the subjects before obtaining their written permission. Only male adults travelling to Lahore General Hospital in Lahore were chosen for sampling using a non-probability purposive manner. The computerized national identity card issued by NADRA was used to verify the age. A single individual gathered the data to prevent measurement errors. The measurements were taken according to the following standards: The straight distance between the ring finger's tip and the border crease with the palm was measured. A Vernier caliper was used to measure it. Index Finger Length. It was measured as the straight distance from the tip of the index finger to the border crease with the palm. A Vernier caliper was used to measure it. In order to eliminate errors that could arise from individual variances, all measurements were taken by the same person. Standing straight-backed on the Frankfurt Plain was used to gauge an individual's height. The vertical distance between the vertex and the floor was employed for measuring it. Finger lengths were measured from the same anatomical landmarks on both hands, specifically from the tip of the finger to the border crease where the finger meets the palm. A Vernier caliper was used for measurement to ensure accuracy and consistency across all subjects. Analysis based on statistics. All statistical data were analyzed using version 25.0 of the Statistical Package of Social Sciences (SPSS). For height, index finger length, and ring finger length, we calculated descriptive statistics. The measurements listed above were totaled and statistically examined. The data's mean, standard deviation (SD), minimum, and maximum were shown. Pearson's correlation coefficient (r) was used to analyze the association between stature and both the length of the index finger and the ring finger. At p=0.050, the significance threshold was determined.

RESULTS

246 male Punjabi adults from central Punjab participated in this study. Participants in the study ranged in age from 21 to 40 years old, with a mean age of 26.3 ± 4.97. People in the study had their height, index, and ring finger lengths measured. With a range of 162.5 to 189.3, the average body height length was 172.9 ± 5.64 cm. The right index finger's length ranged from 6.4 to 8.4 cm, with an average of 7.42 ± 0.41 cm. The left index finger's length ranged from 6.6 to 8.6 cm, with an average of 7.45 ± 0.39 cm. The right ring finger's length ranged from 6.4 to 8.5 cm, with an average of 7.48 ± 0.41 cm. The left ring finger's length ranged from 6.4 to 8.4 cm, with an average of 7.44 ± 0.41 cm (Table 1).

Table 1: Descriptive Statistics of Study Participants

Variables	Minimum	Maximum	Mean ± SD
Age (years)	21	40	26.3 ± 4.97
Stature (cm)	162.5	189.3	172.9 ± 5.64
Right Index Finger (cm)	6.4	8.4	7.42 ± 0.41
Left Index Finger (cm)	6.6	8.6	7.45 ± 0.39
Right Ring Finger (cm)	6.4	8.5	7.48 ± 0.41
Left Ring Finger (cm)	6.4	8.4	7.44 ± 0.41

The dependent variable (stature) and the independent variables (index and ring finger length) are correlated in the table below. Right index finger length (r=0.512) and left index finger length (r=0.491) show a moderately positive connection with stature. These correlations were statistically significant, as indicated by the p-value. In a similar vein, stature and the length of the right and left ring fingers showed a moderately positive link (r=0.467 and 0.444, respectively). Additionally, these associations were statistically significant (Table 2).

Table 2: Index and Ring Finger Length Pearson Correlation Coefficient (r) with Stature

Variables (cm)	Stature	
	Correlation Coefficient (r)	p-value
Right Index Finger	0.512	<0.001*
Left Index Finger	0.491	<0.001*
Right Ring Finger	0.467	<0.001*
Left Ring Finger	0.444	<0.001*

The right index finger length is more correlated with body height than all other finger lengths under study.

Using a regression equation, stature is estimated from the length of the index and ring fingers. The regression equation for determining stature from index and ring finger length separately was obtained using a straightforward regression analysis (Table 3).

Table 3: Univariate Regression Equation for Estimation of Stature from Index Finger and Ring Finger Length (n=246)

Variables	Constant	β	SE	p-value	95% CI		Mean ± SD
					Lower	Upper	
Right Index Finger (RIF)	120.23	7.097	0.762	<0.001*	5.596	8.597	120.23 + 7.097
Left Index Finger (LIF)	120.31	7.056	0.801	<0.001*	5.478	8.635	120.31 + 7.056
Right Ring Finger (RRF)	124.59	6.459	0.783	<0.001*	4.916	8.001	124.59 + 6.459
Left Ring Finge (LRF)	127.38	6.122	0.791	<0.001*	4.565	7.679	127.38 + 6.122

The regression formula for body height determination from the Right Index Finger (RIF) was analyzed, and Stature = 120.23 + 7.097(RIF) (Figure 1).

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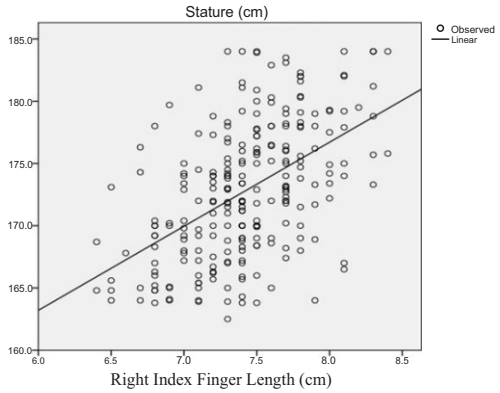

Figure 1: Regression Formula for Body Height Determination from Right Index Finger(RIF)

The regression formula for body height determination from the Light Index Finger (LIF) was analyzed, and Stature = 120.31 ± 7.056(LIF)(Figure 2).

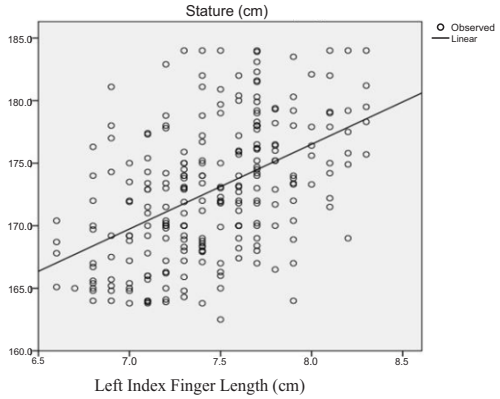

Figure 2: Regression Formula for Body Height Determination from Left Index Finger(LIF)

According to the Regression Formula, Stature = 124.59 + 6.459 for Right Ring Finger(RRF)(Figure 3).

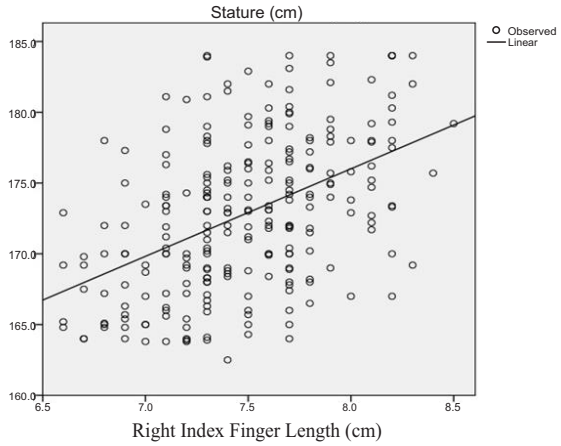

Figure 3: Regression Formula for Body Height Determination from Right Ring Finger(RRF)

According to the Regression Formula, Stature = 127.38 + 6.122 for Left Ring Finger(LRF)(Figure 4).

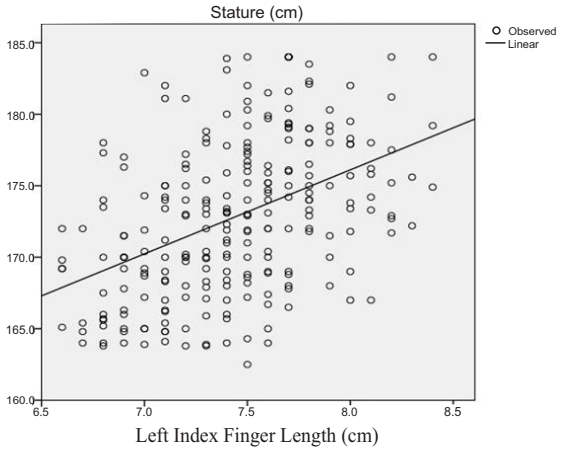

Figure 4: Regression Formula for Body Height Determination from Left Ring Finger(RRF)

Normality tests of data of stature, index and ring fingers length were analyzed(Table 4).

Table 4: Tests of Normality

Variables	Kolmogorov-Smirnova			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
Stature (cm)	0.068	246	0.200	0.975	246	0.129
Right Index Finger Length (cm)	0.078	246	0.104	0.988	246	0.098
Left Index Finger Length (cm)	0.079	246	0.074	0.983	246	0.059
Right Ring Finger Length (cm)	0.083	246	0.200	0.985	246	0.111
Left Ring Finger Length (cm)	0.062	246	0.200	0.985	246	0.129

a. Lilliefors Significance Correction

Mean, median, mode, skewness and standard error of skewness of stature, index and ring fingers length were calculated(Table 5). The correlation analysis demonstrated that the right index finger length is the strongest predictor of stature (r=0.512), with all correlations being statistically significant (p<0.001). The right index finger length had a higher coefficient of determination (R^2 = 0.259) compared to the left index finger (R^2 = 0.239). Right-hand measurements showed slightly better predictive capacity than left-hand measurements, supporting the use of right-hand finger lengths in regression models. The regression models were validated within the study population through multiple statistical approaches, including Pearson's correlation to confirm the strength and significance of associations, univariate regression to develop predictive equations, calculation of R^2 values to assess model fit, and normality tests to verify the assumptions of regression analysis. These steps collectively ensured the predictive accuracy and reliability of the regression equations for estimating stature from finger lengths in the Central Punjabi male population. The values of R2 were as follows: Right Index Finger Length = 0.259, Left Index Finger Length = 0.239, Right Ring Finger Length = 0.216 and Left Ring

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Finger Length = 0.197. The right index finger length is more predictive of height than all other lengths calculated. Fingers of the right hand are more predictive of body height.

Table 5: Statistics of All Variables

Statistics		Stature (cm)	Right Index Finger Length (cm)	Left Index Finger Length (cm)	Right Ring Finger Length (cm)	Left Ring Finger Length (cm)
N	Valid	246	246	246	246	246
	Missing	0	0	0	0	0
Mean		172.800	7.422	7.452	7.482	7.437
Median		172.900	7.400	7.400	7.500	7.450
Mode		170.0	7.4	7.7	7.3	7.5
Skewness		0.191	-0.022	0.058	0.049	0.074
Std. Error of Skewness		0.155	0.155	0.155	0.155	0.155

DISCUSSION

In the current study, stature in males aged 21 to 40 is determined by the link between stature and several other factors. Srinivasulu *et al.* investigated the relationship between a person's height and the length of their middle, ring, and index fingers in men [17]. An examination of the length of the index and ring fingers in the Kashmiri population revealed a higher association in boys than in girls, according to Gupta and Sehrawat [18]. Another study was conducted by Pournima *et al.* By measuring the length of ten fingers, they were able to estimate the stature of the intended population of South Indian students, and they concluded that there was a statistically significant association between the length of all fingers and height [19].The length of a man's ring and index fingers is positively and significantly correlated, and these findings are in line with those of earlier research [20]. Venkatesan *et al.* carried out a second investigation on both male and female. They discovered that whereas females' ring finger length had a higher Pearson correlation coefficient, men's left finger length had a higher value [21]. 200 students participated in a study conducted by Rai *et al.* According to the computed correlation coefficients, they discovered a moderately favourable relationship between stature and the length of the right and left index fingers. Based on the derived p-values, the statistical analysis showed that these relationships were considered statistically significant [22]. Similarly, a study conducted in Bihar found a very substantial positive association between stature and the length of the ring and index fingers [23]. In contrast, the study by Rhiu and Kim shows that the correlation between height and little finger length is +.485 for boys and +.293 for girls. Girls showed a low degree of connection, whereas boys showed a moderate amount [24]. Another study shows a correlation between finger lengths and height: + 0.58 to + 0.66 [25]. A study found a moderate correlation between stature and index finger length. The correlation between height and index finger length in men was 0.53 and 0.41, respectively [26].

This study has certain limitations, including the use of non-probability purposive sampling and recruitment from a single center, which may limit the generalizability of the findings to the broader population. The inclusion of only male participants restricts the applicability of the regression models to females. Additionally, environmental and nutritional factors influencing stature were not assessed. Future research should include larger, multicenter samples with both genders and diverse age groups to develop more comprehensive and widely applicable regression models for forensic use.

CONCLUSIONS

The current study suggests that male stature can be determined by measuring the lengths of the index and ring fingers. In identification situations, estimating stature is crucial, as are anthropological findings in situations where body parts have been dissected. Population-specific regression equations derived from hand measurements, particularly of the right index finger, provide a valuable forensic tool for stature estimation and victim identification in Central Punjab. The use of purposive sampling targeting specific demographic characteristics allowed for the generation of relevant models. Consistency in anatomical landmarks and careful measurement methods ensured the validity of the data collected. The robust statistical validation further confirms the utility of these regression models in forensic anthropometry.

Authors' Contribution

Conceptualization: KM
Methodology: MA
Formal analysis: AF
Writing and Drafting: GM, AK, AH
Review and Editing: GM, AK, AH, AF, KM, MA

All authors approved the final manuscript and take responsibility for the integrity of the work

Conflicts of Interest

All the authors declare no conflict of interest.

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