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Interphalangeal Crease Distance as a Predictor of Stature

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Abstract

Background: Identifying people from fragmentary human remains is frequently required in forensic anthropometry, particularly in circumstances of mass disasters, accidents, or criminal cases where intact bodies are not usually retrieved. Hands are among the body parts most frequently preserved and recovered in such situations. The purpose of this study is to determine whether the right middle finger's interphalangeal crease (IPC) distance can accurately predict a person's height. When conventional full-body measurements are impractical, this non-invasive, reasonably priced technique might be especially helpful.

Materials and Method: The study included 100 healthy participants from APG Shimla University. Stature was measured with a measuring tape, and the IPC distance of the right middle finger was measured with a verrnier caliper. Each measurement was taken three times. The collected data was evaluated using Microsoft Excel. Using descriptive statistics, paired sample t-tests, and Spearman's rank correlation, the relationship between stature and IPC distance was assessed.

Results: According to descriptive statistics, men were slightly taller than women on average and had slightly longer (IPC) distances. Nevertheless, scatter plot studies with low R^2 values revealed a weak linear association between stature and IPC distance. Spearman's rank correlation indicated a strong positive monotonic relationship for both sexes. Furthermore t-tests confirmed statistically significant gender-based differences in stature; however, the IPC distances did not differ significantly between males and females.

Conclusion: According to the study's findings, IPC distance has a correlation with stature and can be a helpful in forensic investigations involving the use of just hand remains because of its affordability, ease of use, and durability, it is a useful supplement to forensic anthropometric methods. It is recommended that future research focus on larger and more diverse populations.

Keywords: Stature measurement, forensic anthropology, forensic identity, interphalangeal folds, finger crease distance, height prediction, and anthropometry.

Introduction

Forensic anthropometry is the scientific study of human body measurements, used widely in forensic investigations to identify individuals based on parameters such as height, weight, and body proportions. These measurements provide insight into an individual's health, nutrition, and physical characteristics. Standardized methods, as established by ISAK, WHO, and ISO, ensure accuracy and reliability in anthropometric assessments [1]. Forensic anthropology applies these measurements in legal contexts,

particularly when remains are decomposed or skeletal. It aids in constructing biological profiles that include age, sex, and stature [2].

Anthropometric methods are valuable in reducing identification time during forensic investigations. Modern forensic anthropology often works in collaboration with other disciplines to examine both skeletal and soft tissue remains. However, challenges persist, particularly regarding unclear professional roles and training standards in various countries [3]. Because it drastically reduces the number of possible identities in forensic situations, stature assessment is particularly. Traditionally, measurements of the hands and feet or long bones are used to assess height [4]. Yet, when these parts are unavailable, alternative metrics become essential.

Recent research has explored the use of hand features—like finger lengths, phalange dimensions, and wrist circumference—for stature estimation. These studies suggest that such parameters can yield reliable predictive equations [5]. However, regression models are often population-specific and may not apply universally [6]. Interphalangeal creases, which form at the joints of the fingers and persist throughout life, have recently gained attention as potential forensic markers [7]. These creases vary in position and distance between individuals and may correlate with physical attributes such as height, age, and sex.The hand, comprising 27 bones and multiple joints, offers a durable structure for postmortem examination. Interphalangeal creases, being skin folds over the joints, provide measurable landmarks that remain intact even after tissue degradation. Despite their forensic potential, limited literature is available on the use of interphalangeal crease distance for stature estimation, particularly in young adult Indian populations [8].

Aim of the work

This study aims to determine the correlation between interphalangeal crease distance of the right middle finger and stature among young adults aged 18–25 years at APG Shimla University.

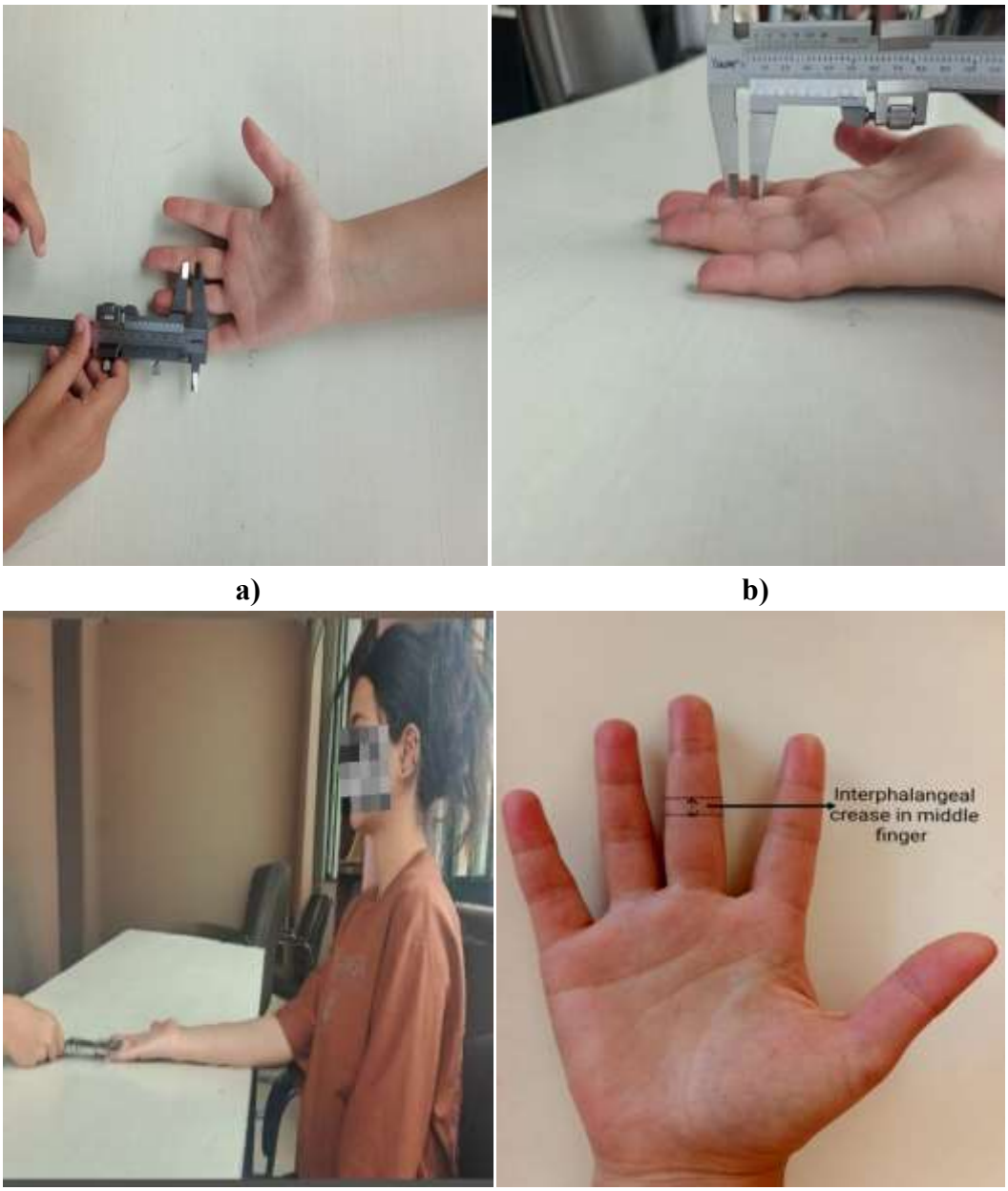
Materials and Methods

The study utilized a vernier caliper to measure the interphalangeal crease (IPC) distances, a measuring tape for recording stature, a pencil for marking reference points on the body, and Microsoft Excel for data entry, management, and statistical analysis. This was a cross-sectional anthropometric investigation carried out in April 2025 at Alakh Prakash Goyal Shimla University, Himachal Pradesh. The primary aim was to explore the correlation between the IPC distance of the right middle finger and an individual's stature.100 healthy volunteers, 50 men and 50 women between the ages of 18 and 25, were recruited. Individuals exhibiting hand deformities, previous hand injuries, or diagnosed growth abnormalities were excluded. Participants were recruited using a simple random sampling approach and gave verbal informed consent prior to participation.

Measurement of Interphalangeal Crease Distance: The IPC distance was defined as the straight-line measurement between the distal and proximal skin creases of the right middle finger. Participants were asked to rest their right hand in a supinated position on a flat surface. Measurements were taken using a vernier caliper with a precision of 0.01 mm. Three separate readings were recorded for each subject, and the average of these readings was used for analysis to enhance measurement accuracy as shown in **(Fig 1)**.

Measurement of Stature

In order to measure height, measuring tape was used the participants had to stand barefoot against a wall with their heads, shoulders, buttocks, and heels touching the vertical surface. A pencil was used to mark the topmost point on the wall, and a measuring tape was used to record the height. Three readings were obtained for each individual, and the mean value was calculated to ensure consistency as shown in **(Fig 2)**.



a) **b)**

c) **d)**

Fig 1-Measurement of IPC crease distance :a)Measurement of IPC crease distance (front view), b) Measurement of IPC crease distance (side view), c) Measurement of IPC crease distance of participant using vernier caliper d) Location of IPC in middle finger

Fig 2 - Measurement of stature using measuring tape

Data Analysis

The collected data were compiled in Microsoft Excel and subjected to statistical analysis to evaluate the relationship between interphalangeal crease (IPC) distance and stature. Descriptive statistics, including mean and standard deviation, were computed separately for male and female participants to summarize the central tendency and dispersion of the measurements. A scatter plot was generated to visually assess the pattern of association between IPC distance and stature. Because the data was non-parametric, Spearman's rank correlation coefficient (ρ) was computed to measure the direction and strength of this link. A separate analysis was performed for male and female groups to determine gender-specific correlation trends. To determine if the differences in IPC distances and stature between male and female individuals were statistically significant, an independent samples t-test was used. A p-value of less than 0.05 was considered statistically significant for each test.

Result

This study includes a balanced sample of 100 participants (50 males and 50 females) to explore the relationship between interphalangeal crease (IPC) distance and human stature. A statistically significant correlation is observed, indicating that IPC distance may be a helpful marker for estimating height, especially in forensic cases involving incomplete remains such as severed hands.

Descriptive Statistics of Stature and Interphalangeal Crease Distance by Gender

The overall mean height is 166.93 cm, with a median of 167.52 cm and a standard deviation of 9.44 cm. The height range is 142 to 183 cm. The mean stature of males is greater at 170.63 cm, with a median of 172 cm and a range of 154 to 183 cm. The average height of females is Females are 166.18 cm tall on average, with a median of 164.17 cm and a range of 149 to 180.06 cm. The average IPC distance for the total sample is 6.15 mm, with a median of 6.16 mm and a standard deviation of 1.29 mm. The values range from 4.07 mm to 9.35 mm. Among males, the mean IPC distance is 6.30 mm (range: 4.15–9.35

mm), while in females, the average is 6.01 mm (range: 4.07–8.64 mm). These findings suggest that males generally have slightly higher values in both stature and IPC distance than females as shown in **(Table 1)**

Table 1 Descriptive statistics of stature and IPC crease distance by gender.

Variable	Gender	N	Mean	Median	SD	Minimum	Maximum
Strature(cm)	Overall	100	166.9329	167.515	9.441753	142	183
	Male	50	170.6284	172	6.832	154	183
	Female	50	166.183	164.165	8.833	149	180.06
Interphalangeal Crease(mm)	Overall	100	6.1544	6.16	1.29044	4.07	9.35
	Male	50	6.2988	6.345	1.2412	4.15	9.35
	Female	50	6.01	5.98	1.3346	4.07	8.64

Scatter Plot Analysis of Stature and IPC Distance by Gender

Scatter plot analysis evaluates the relationship between IPC distance (independent variable) and stature (dependent variable) for both genders. Each gender is analyzed separately using a linear trendline to determine the strength of the relationship.For male participants, the data points are widely scattered, and the R^2 value is 0.00005, indicating an almost nonexistent correlation. The trendline appears nearly flat, showing no predictable pattern. Similarly, for females, the scatter plot also displays a random distribution of points, with an R^2 value of 0.000, confirming no measurable correlation. These plots suggest that IPC distance does not serve as a strong predictor of stature based on visual distribution alone as shown in **(Table 2 and 3)**

Table 2 Scatter plot-based comparison of stature and interphalangeal crease length in males

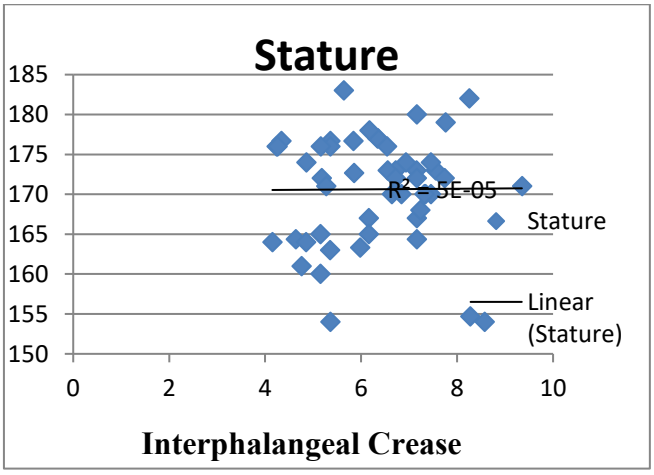
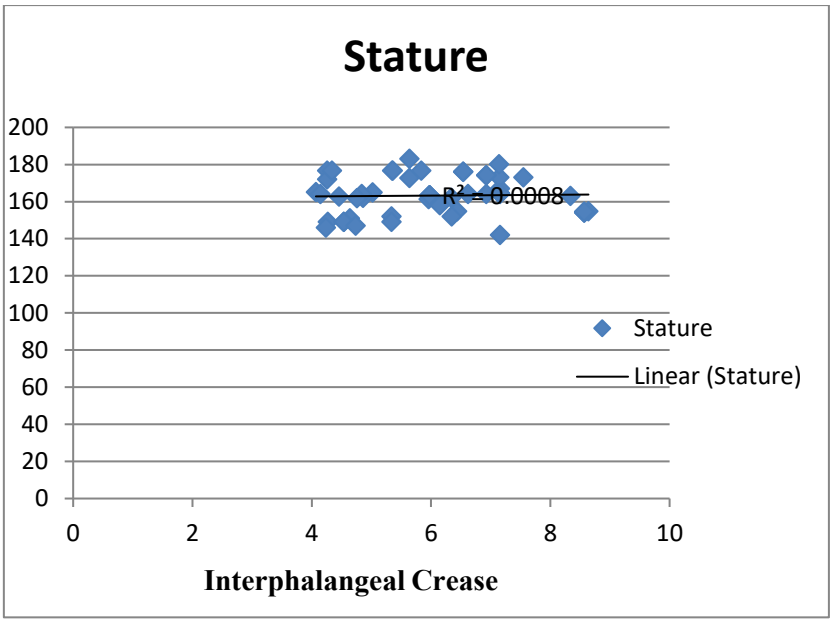


Table 3 Scatter plot-based comparison of stature and interphalangeal crease length in females



Spearman Correlation between Stature and IPC Distance by Gender

Spearman's rank correlation is used to assess the monotonic relationship between IPC distance and male and female stature.. In males, the correlation coefficient is 0.988929 for stature and 0.98974 for IPC distance, indicating a very strong positive relationship. This means that as IPC distance increases, stature also increases proportionally. Among females, the correlation coefficient is 0.989545 for stature and 0.97361 for IPC distance, which also demonstrates a strong positive relationship, though slightly lower than that observed in males. Overall, these high correlation values indicate a reliable and consistent association between IPC distance and stature in both genders, with slightly stronger predictability in males as shown in **(Table 3.4)**

Table 4 Spearman's correlation between stature and IPC crease in males and females.

Gender	Stature	Interphalengeal Crease
Male	0.98893	0.98974
Female	0.98955	0.97361

Comparing Stature and IPC Distance Between Genders Using an Independent t-Test

An independent t-test is performed to compare mean values of stature and IPC distance between male and female groups. When it comes to stature, men have a substantially greater mean value (170.63 cm) than women (163.24 cm). The calculated t-value is -4.06, and the p-value is 0.00017, which is below the 0.05 threshold. This indicates a statistically significant difference in stature between genders.For IPC distance, the mean value in males is 6.32 mm, while in females, it is 6.05 mm. The t-value is 1.27, and the p-value is 0.2076, which is above the 0.05 threshold. This suggests that the difference in IPC distance between males and females is not statistically significant as shown in **(Table 5)**

Table 5 Gender-wise t-test for IPC crease distance and stature.

t-Test: Paired Two Sample for Means		
	Stature	*Stature*
Mean	163.2374	170.6284
Variance	105.5532482	46.68863004
Observations	50	50
Pearson Correlation	-0.095653871	
Hypothesized Mean Difference	0	
df	49	
t Stat	-4.060353931	
P(T<=t) one-tail	8.80477E-05	
t Critical one-tail	1.676550893	
P(T<=t) two-tail	0.000176095	
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These results highlight that while stature differs significantly between genders, IPC distance remains relatively consistent. This consistency supports the use of IPC distance as a stable anthropometric feature with potential forensic applications.

Discussion and Conclusion

This study explores the relationship between the interphalangeal crease (IPC) distance of the right middle finger and a person's stature. The right middle finger was chosen due to its central position and structural stability, making it a reliable landmark for anthropometric measurements. The purpose of the research is to assess whether IPC distance can be used as an alternative method for estimating stature, especially in forensic cases where only partial remains, such as hands or fingers, are recovered.The descriptive statistics indicated that males tend to have a higher average stature and slightly longer IPC distances than females, reflecting normal biological differences. Although the scatter plot showed a weak visual linear trend between IPC distance and stature, Spearman's correlation revealed a strong positive association for both sexes. This suggests that individuals with longer IPC distances generally have greater height, even if the relationship is not perfectly linear. The t-test results confirmed a significant difference in stature between males and females, but IPC distance remained relatively consistent, showing no significant gender-based variation.These findings highlight IPC distance as a stable anthropometric trait, less affected by temporary or environmental factors. Its consistency makes it especially useful in forensic scenarios such as mass disasters, criminal cases, or accidents where only

parts of the body are available. The method is quick, non-invasive, and does not require expensive equipment, making it ideal for field use and in resource-limited settings.

This study also contributes valuable anthropometric data for the local population, which is often underrepresented in forensic literature. In conclusion, IPC distance holds potential as a helpful tool in stature estimation. Future studies with larger, more diverse samples and advanced measurement techniques can further enhance its application in forensic identification.

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