Estimation of stature from morphometric measurements of hand length and breadth

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Abstract

Introduction: Stature is an important element in identifying an individual, especially in cases where only fragmentary remains of the human body are available. Hand dimensions are useful in predicting stature. The aim of this study is to estimate stature using hand dimensions. The findings will be useful in estimating height in malformed bodies, bedridden patients, and in forensic investigations.

Method: A cross-sectional study was conducted in 96 attendants of patient admitted in different wards of Patan Hospital, Patan Academy of Health Sciences. In this study stature, hand length and hand breadth was measured. Stature and the hand dimensions were compared across male and female applying t-test. Correlation of stature with various hand dimensions was assessed using pearson's correlation coefficient. Linear regression was applied to see the relation of each of the hand dimensions and sex with stature, and multivariable linear regression was applied.

Result: Stature was significantly higher in males than females, and all hand dimensions were larger in males, reflecting clear sexual dimorphism. Left hand length showed the strongest correlation to stature (r=0.658, p<0.001) and emerged as an independent predictor in multivariable analysis.

Conclusion: This study confirms that hand dimensions, particularly left-hand length, are significant predictors of stature among adults in Nepal reinforcing the reliability of hand length as an anthropometric tool. The study contributes important baseline data for Nepal and highlights the practical application of hand measurements in both forensic and clinical contexts.

Keywords: Hand length and Hand breadth; Stature

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Introduction

Stature is an important element in identifying an individual, especially in cases where only fragmentary remains of the human body are available.[1] Measurement of body shape and size can be done through anthropometric methods, and among these, hand dimensions have been shown to be useful in predicting stature. Previous studies have consistently reported that hand measurements are statistically significant indicators of height.

Research among Montenegrin adolescents found that hand dimensions reliably predicted stature in both sexes.[2,3] Similar findings have been reported in studies from India and Bangladesh, which confirmed hand dimensions as reliable parameters for stature estimation.[4,5] Evidence from Australia also demonstrated a strong correlation between hand size and height.[6] Likewise, similar study conducted among medical students in Nepal showed that stature can be estimated from hand dimensions, supporting the relationship between these variables.[7] However, most research in Nepal has focused on parameters such as upper arm length and foot length for estimation of stature.[8,9] Although these have proven useful, only limited studies have explored the role of hand dimensions in height estimation, and these were largely confined to medical students. To date, no studies have been carried out on the general population. The aim of this study is to estimate stature using hand dimensions among attendants of patients admitted in different wards of Patan Hospital. The findings will be useful in estimating height in malformed bodies, bedridden patients, and in forensic investigations.

Method

A cross sectional was done at Patan Academy of Health Sciences, Patan Hospital from August 2024 to January 2025. All the patient attendant visiting the orthopedic ward, medicine ward and surgery ward were enrolled in the study. Attendants under 18 years of age, those who did not give consent and individuals with hand or spine deformities were excluded from the study.

A convenience sampling was used and sample size was calculated as 96 based on the similar previous study.[5]

The list of eligible attendants in each ward was collected along with bed number and serial number. Eight random serial numbers were generated through computer for each ward, and attendants with the corresponding serial numbers were included in the study. Participants were selected using computer-generated random numbers. Eight participants from each ward were selected randomly in a week, and the selection was repeated four times in different weeks.

Participants who were eligible for the study were enrolled. All measurements were taken from Sunday to Friday, except Wednesday and Saturday, between 8 am to 4 pm by the principal investigator and co-investigators. Before data collection, informed written consent was obtained from the attendants of patients admitted in medicine, orthopedic, and surgery wards. Consent and measurements were taken in the nursing stations of the respective wards.

During measurement, the hand was kept straight in supine position and measured using a Vernier caliper. Hand length was measured from the distal crease of the wrist to the tip of the middle finger. Hand breadth was measured from the most prominent point on the lateral aspect of the head of the 2nd metacarpal to the most prominent point on the medial aspect of the head of the 5th metacarpal.

For stature measurement, participants were asked to stand straight in the Frankfurt horizontal plane with palms facing anterior and heels together, barefoot. Stature was measured from the vertex of the head to the sole of the foot using a wall-mounted height chart placed in different wards. Before performing measurements, the Vernier scale and main scale were checked and calibrated at zero reading.

For the categorical variable such as sex, it was presented in frequency and percentage. For continuous variables such as stature and dimensions of hand, data was presented in mean and standard deviation. Stature and the hand dimensions were compared across male and female applying t-test. Correlation of stature with various hand dimensions was assessed using Pearson's correlation coefficient. Linear regression was applied to see the relation of each of the hand dimensions and sex with stature, and finally multivariable linear regression was applied.

Result

A total number of participants were 96 of which female were 57(59.4%) and male were 39(40.6%). A mean height of participants was 159.83 ± 10.07 cm, mean right hand length and breadth were 16.81 ± 1.40 cm and 7.61 ± 0.47 cm respectively. Likewise, mean left hand length and breadth were 17.03 ± 1.08 cm and 7.48 ± 0.49 cm respectively.

The mean height of male was 166.92 ± 7.60 cm, mean right hand length and breadth were 17.31 ± 1.83 cm and 7.89 ± 0.45 cm respectively. Likewise, mean left hand length and breadth was 17.67 ± 1.20 cm and 7.75 ± 0.47 cm respectively. The mean height of female was 154.98 ± 8.90 cm, mean right hand length and breadth were 16.48 ± 0.87 cm and 7.41 ± 0.37 cm respectively. Likewise, mean left hand length and breadth were 16.59 ± 0.88 cm and 7.29 ± 0.42 cm respectively, Table 1.

## Table 1. Comparison of height and hand dimensions in male and female participants, N=96

SN	Parameters	Male (mean ± SD)	Female (mean ± SD)	p-value
1	Stature	166.92 ± 7.60	154.98 ± 8.90	<0.001
2	Right hand length	17.31 ± 1.83	16.48 ± 0.87	0.003
3	Right hand breadth	7.89 ± 0.45	7.41 ± 0.37	<0.001
4	Left hand length	17.67 ± 1.20	16.59 ± 0.88	<0.001
5	Left hand breadth	7.75 ± 0.47	7.29 ± 0.42	<0.001

Table 2. Correlation between stature and hand dimensions

	Measured Dimensions	Correlation coefficient (r)	p-value
Stature	Right hand length	0.421	<0.001
	Right hand breadth	0.513	<0.001
	Left hand length	0.658	<0.001
	Left hand breadth	0.473	<0.001

Table 3. Multivariable linear regression for estimation of stature from sex and hand dimensions

SN	Variables	Beta coefficient (Adjusted)	95% CI (Lower, Upper)	p-value
1	Sex (female =1, male = 2)	6.745	3.235, 10.255	<0.001
2	Right hand length	0.101	-1.299, 1.502	0.886
3	Right hand breadth	3.804	-2.824, 10.431	0.257
4	Left hand length	4.573	2.412, 6.734	<0.001
5	Left hand breadth	-3.528	-10.057, 3.002	0.286
	Constant	68.227	39.910, 96.544	<0.001
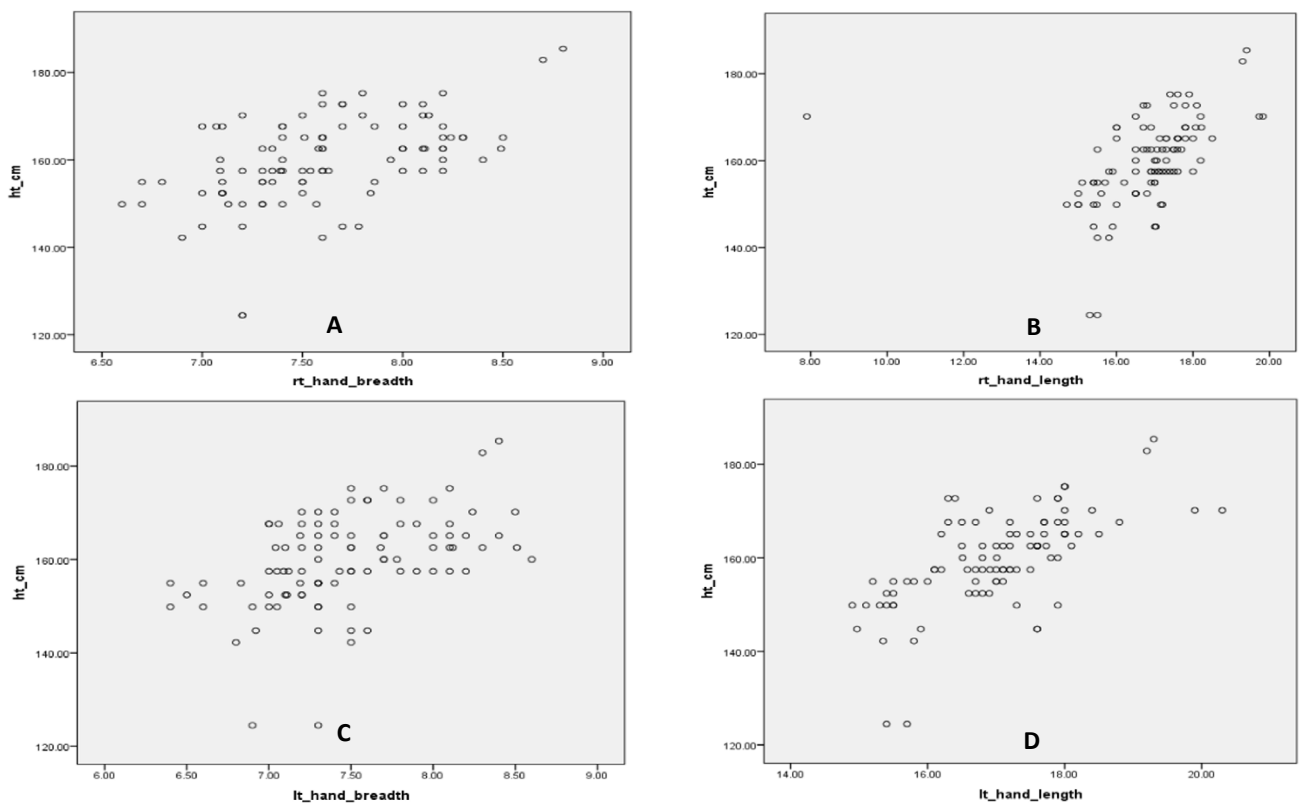
Figure 1. Relationship of stature with a) right hand breadth b) right hand length c) left hand breadth and d) left hand length

The correlation of stature with various hand dimensions was observed. The length and breadth of both the hands were found to be positively and significantly correlated with the stature. Left hand length showed the highest positive correlation (r=0.658, p<0.001) followed by right hand breadth (r=0.513, p<0.001), Table 2.

The relation of sex and the hand dimensions with stature was assessed using multivariable linear regression. Stature was found to be significantly higher in males compared to females by 6.745cm after adjusting for effect of other measurements. Similarly, left hand length was found to be a significant predictor of stature, with adjusted beta of 4.573 (p <0.001). One cm increase in left hand length increased the stature by 4.57 cm, Table 3. The relation has also been depicted in graph, Figure 1.

Discussion

The present study was conducted among the attendants of patients admitted in Patan Hospital. It demonstrated a strong correlation between hand dimensions and stature. Stature was significantly higher in males than females, and all hand dimensions were larger in males, reflecting clear sexual dimorphism. Previous study has shown that the use of morphometric features can give important data about the stature and gender of an individual.[10] The mean height of males in our study (166.9 cm) was greater than that of females (154.9 cm), which closely resembles to the studies in Nepal and neighboring South Asian populations.[11,12]

Left hand length showed the strongest correlation to stature ($r=0.658$, $p<0.001$) and emerged as an independent predictor in multivariable analysis. This is consistent with the earlier results from studies in the region, which consistently reported hand length as more reliable parameter than hand breadth for estimating stature.[11,12,13] Interestingly, a study in Bangladesh showed that the estimation of human height from hand measurements is possible and reliable, and right hand length is the most reliable parameter to estimate the stature form simple linear regression models in both sexes.[14] Similarly, Australian research reported a strong correlation between stature and hand length.[15] So, this anthropometric index is suitable across diverse ethnic groups.

Regression analysis indicated that for every 1 cm increase in left hand length, stature is increased by approximately 4.57 cm. Comparable regression slopes are available globally which indicates that population characteristics such as ethnicity, age, and nutritional status may affect the values. Studies in different parts of India and Nepal documented predictive equations where 1 cm of hand length contributed between 3.6 to 5.22 cm of stature increase.[12,13] These similarities suggest that despite population-specific variation, hand length remains a universally robust indicator for stature.

Hand breadth also correlated significantly with stature, particularly right hand breadth ($r=0.513$, $p<0.001$). However, after adjusting for other variables, hand breadth did not remain an independent predictor. This contrasts with some studies, where hand breadth improved prediction when combined with hand length. Such differences may be attributed to methodological variations: sample size, age composition, handedness, or measurement techniques. Additionally, population-specific skeletal and soft-tissue proportions could influence the relative predictive strength of breadth measures.

Most prior studies in Nepal targeted medical students or focused on other body segments such as arm span, upper arm length, or foot length.[9,16] By studying patient attendants at a tertiary care center, our research ensures data from broader section, more general adult population. This strengthens validity and contributes locally relevant data for forensic and clinical applications.

Stature is an anthropometric parameter that can be very significant and useful in determining the physical identity of an individual. In many cases identification of human remains becomes a challenge to forensic scientists, human biologists, anatomists, and anthropologists.[17] Nevertheless, this study has limitations. The sample size was modest and derived from a single hospital setting, which may not fully represent the general Nepali population. Future research should include larger, community-based, and ethnically diverse samples to develop population-specific regression models. Furthermore, evaluating other anthropometric variables in combination with hand dimensions could improve predictive accuracy.

Conclusion

Our study confirms that hand dimensions, particularly left-hand length, are significant predictors of stature among adults in Nepal. These results are consistent with both regional and international literature, reinforcing the reliability of hand length as an anthropometric tool. The study contributes important baseline data for Nepal and highlights the practical application of hand measurements in both forensic and clinical contexts.

Author Contribution
Concept, design, planning: DM, TS, PP, RPD; Literature review: DM, TS; Data collection: DM, TS, PP; Data analysis: DM, TS, PP; Draft manuscript: DM, TS, RPD; Revision of draft: DM, TS, PP, RPD; Final manuscript: DM, TS, PP, RPD; Accountability of the work: DM, TS, PP, RPD; Guarantor: DM.

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