

Estimation of Stature From Hand and Foot Measurements in a Rare Tribe of Kerala State in India

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ABSTRACT

Introduction: The present study has been undertaken on the Vettuvar group of tribes in Kasargod district of Kerala state, and explores the usability of dimensions of hands and feet as predictors of stature in the tribal population of Kasargod District of Kerala, India. The present study is the first ever documented anthropological work on the tribes of Kasargod district, Kerala, India.

Materials and Methods: Two hundred subjects comprising of 100 males and 100 females in 20-30 years age group were included in the study group. Dimensions of hands and feet viz: hand length, hand breadth, foot length and foot breadth were measured independently on left and right side of each individual using a Sliding calliper. Stature of individuals was measured with the help of a Stadiometer.

Results: Statistical analysis indicated that the bilateral variations were insignificant for all the measurements except foot breadth among females ($p < 0.001$). The paired sample t-test showed that the statistical difference between males and females was highly significant for all the measurements ($p < 0.001$). The correlation between the stature and various parameters studied in males and females were found to be positive and statistically highly significant. Linear and multiple regression equation for stature estimation were calculated separately for males and females.

Conclusion: The significant positive correlation between the study variables and the stature indicates that these variables can be successfully used to predict stature.

Keywords: Foot breadth, Foot length, Hand breadth, Hand length, Tribal population

INTRODUCTION

Literature is replete with studies that have dealt with estimation of stature from dimensions of hands and feet in the past and have documented that these parameters can be successfully used for stature estimation [1-19]. Due to strong influence of genetic and environmental factors on the height of the individual, homogeneity of the study population is vital in formulating the regression equations.

The present study is undertaken on the Vettuvar group of tribes in Kasargod district. Tribals are known to be socially, environmentally, culturally and even genetically secluded communities. This is a sub group of MalaiVedan tribes, residing in Adur, Panathady, Nekraje and Mavinakatte villages of Kasargod District, Kerala. Kasargod is one of the districts in Kerala State situated along the Western side of Southern Indian Peninsula.

The primitive inhabitants of Kerala, the tribal people, are only about two hundred thousand. MalaiVedan tribes are quite significant and stand apart amongst other tribal communities of Kerala. Hunting as well as gathering of forest products is their main occupation. The MalaiVedan tribes have followed the life style of nomads and kept on migrating from place to place. The topography of this region is dominated by Western Ghats, a medium height mountain range running along the western coastline of Indian Peninsula, draped by dense forests [20].

The present study is unique in its sample selection as regards to homogeneity of study population and selection of a rare tribe. Also, there is no existing anthropological data on the estimation of stature from hands and feet measurements in this tribal group of population of Kasargod District of Kerala, India.

MATERIALS AND METHODS

Source of Data: A cross-sectional sample of 200 tribals (100 males and 100 females) between the age group of 20-30 years

from Kasargod District of Northern Kerala who are culturally and linguistically similar.

Method of Collection of Data: The study was conducted in community halls nearby the tribal colonies. The objectives and the methods of the study were explained to the sample population, and informed consent was obtained by taking their signatures or thumb impression. All the measurements were taken in a reasonably well lit room, at a fixed time between 3 pm and 5.30 pm to eliminate diurnal variation. It was measured and recorded only by one of the authors, to avoid inter-observer error in methodology.

1. Anthropometric measurements viz: hand length and breadth, were measured separately, of the left and right sides of each individual. Stature of each individual was recorded.
2. All the measurements were recorded thrice and then their mean was calculated for accuracy.

Land marks and technique involved in taking anthropometric measurements [2]:

- Stature (S): It is the vertical distance between highest point on vertex and the platform of stadiometer. The subject should stand erect, barefoot on a level platform against the stadiometer bar with his back and hips touching the bar, the feet should touch each other and the heels touching the bar, arms hanging by the side. The head of the subject should rest without any strain in the eye-ear plane or Frankfurt plane i.e., tragion and the infraorbital margin of both the sides must lie in the same plane.
- Foot length (FL): It is the distance from the most prominent part of the heel to the most distal part of the longest toe (great or second toe).
- Foot breadth (FB): It is the distance between the most prominent point on the medial aspect of head of first metatarsal and the most prominent point on the lateral aspect of head of fifth metatarsal.

- Hand length [HL]: It is the projected distance between the midpoint of a line joining the styloid process of radius and ulna bones of forearm and the tip of third finger.
- Hand breadth [HB]: It is the distance between the most prominent point on the lateral aspect of head of second metacarpal and the most prominent point on the medial aspect of the head of fifth metacarpal.

Instruments used

1. Sliding calliper was used for hand and feet measurements. The measurements were recorded in millimeters.
2. Stadiometer was used to measure vertical height for stature estimation. The measurements were recorded in centimeters.

Inclusion Criteria: Apparently healthy, asymptomatic males and females of age group 20-30 years.

Exclusion Criteria

1. Males and females with physical deformities and history of systemic illness affecting stature, hand and foot measurements were excluded from the study.
2. Age group below 20 years and above 30 years.

STATISTICAL ANALYSIS

The data were subjected to statistical analysis using statistical package for social sciences (SPSS-20).

RESULTS

The following observations were tabulated after statistical evaluation of the observations recorded in the study. The age of study population ranged between 20 and 30 years for both males and females. [Table/Fig-1] shows the distribution of age in the study population. The mean age of females was 25.4 years and that of males was 25.9 years.

	MALES	FEMALES
NUMBER	100	100
MEAN	25.90	25.47
MEDIAN	26.00	26.00
STD. DEVIATION	3.07	2.99
RANGE	10.00	10.00
MINIMUM	20.00	20.00
MAXIMUM	30.00	30.00

[Table/Fig-1]: Showing distribution of age among study population

	RHL	RHB	LHL	LHB	RFL	RFB	LFL	LFB	STATURE
NUMBER	100	100	100	100	100	100	100	100	100
MEAN	182.45	83.43	182.62	83.19	245.20	95.72	245.28	95.66	157.95
MEDIAN	183.4	84.34	183.44	84.20	243.76	95.50	246.39	95.65	158.00
S.D	10.87	5.16	11.00	5.30	14.68	8.76	14.61	8.81	6.42
RANGE	49.66	26.61	49.77	26.87	87.46	40.66	87.14	40.80	33.50
MIN	155.44	68.82	155.29	68.71	207.28	74.45	207.29	74.38	142.50
MAX	205.10	95.43	205.06	95.58	294.74	115.11	294.43	115.18	176.00

[Table/Fig-2]: Descriptive statistics of parameters studied- males

	RHL	RHB	LHL	LHB	RFL	RFB	LFL	LFB	STATURE
NUMBER	100	100	100	100	100	100	100	100	100
MEAN	169.10	75.74	169.10	75.88	226.80	87.14	226.72	87.15	148.70
MEDIAN	169.29	75.38	169.28	75.62	225.22	85.36	225.21	85.37	146.05
S.D	8.25	4.84	8.25	4.81	10.74	5.81	10.67	5.81	7.57
RANGE	44.21	33.95	44.25	33.96	76.69	27.45	76.70	27.44	33.10
MIN	144.69	54.24	144.66	54.23	198.42	74.54	198.42	74.54	136.00
MAX	188.90	88.19	188.91	88.19	275.11	101.99	275.12	101.98	169.10

[Table/Fig-3]: Descriptive statistics of parameters studied- females

[Table/Fig-2] shows descriptive statistics for the various parameters studied in males. The average stature of males was 157.9±6.4 cm and ranged between 142.5 cm to 176 cm. The hand lengths measured 182 mm (approx) and hand breadth measured approximately 83 mm. Similarly foot lengths and foot breadths approximately measured 245 and 95 mm respectively.

[Table/Fig-3] shows descriptive statistics for the various parameters studied in females. The average stature of females was 148.7±7.5cm and ranged between 136cm to 169cm. The hand lengths measured 169 mm (approx) and hand breadth measured approximately 75mm. Similarly foot lengths and foot breadths approximately measured 226mm and 87mm respectively.

To assess the statistical differences between the observations of right and left sides, in males and females, paired sample t-test was performed. Statistical analysis indicated that the bilateral variations were statistically insignificant for all the measurements except foot breadth among females which was found statistically significant ($p < 0.01$) [Table/Fig-4].

The comparison of respective readings of various parameters studied shows that all parameters have higher values in males than in females. Statistical differences between male and female observations were assessed by performing paired sample t-test. The results of t-test, as shown in [Table/Fig-5], indicates that the differences between males and females were statistically highly significant ($p < 0.01$). [Table/Fig-6] shows correlation between the stature of individual and various parameters studied. All the parameters exhibit statistically highly significant ($p < 0.001$) positive correlation with the stature except female foot breadth.

Correlation co-efficient of the length measurements is higher than that of breadth measurements. It is also observed that in males the highest correlation is exhibited by right foot length ($r=0.554$) and the lowest by right hand breadth ($r=0.388$). In females highest correlation co-efficient is exhibited by right hand length and left hand length ($r=0.949$). Regression analysis of the observations was performed separately for each sex, as statistically significant differences were observed between these two groups, and also for each parameter studied.

Linear regression equations obtained for various parameters studied in males were as follows:-

$$\text{Stature} = 106.306 + .283 \times \text{hand length} \pm 5.668$$

$$\text{Stature} = 117.798 + .481 \times \text{hand breadth} \pm 5.95$$

$$\text{Stature} = 98.51 + .242 \times \text{foot length} \pm 5.375$$

$$\text{Stature} = 129.459 + .298 \times \text{foot breadth} \pm 5.888$$

PAIRED SAMPLES OF STUDY PARAMETERS OF RIGHT AND LEFT SIDE		t	df	Sig(2-tailed)
PAIR 1	MALE HAND LENGTH	-1.270	99	.207
PAIR 2	MALE HAND BREADTH	1.536	99	.128
PAIR 3	MALE FOOT LENGTH	-.898	99	.371
PAIR 4	MALE FOOT BREADTH	.685	99	.495
PAIR 5	FEMALE HAND LENGTH	-.064	99	.949
PAIR 6	FEMALE HAND BREADTH	-1.333	99	.186
PAIR 7	FEMALE FOOT LENGTH	.881	99	.380
PAIR 8	FEMALE FOOT BREADTH	-3.985	99	<0.001**

[Table/Fig-4]: Paired samples t-test showing statistical difference between right and left side
**Statistically highly significant

PAIRED SAMPLES OF STUDY PARAMETERS OF RIGHT AND LEFT SIDE		t	df	Sig(2-tailed)
PAIR 1	RIGHT HAND LENGTH	10.866	99	p<0.001**
PAIR 2	RIGHT HAND BREADTH	11.318	99	p<0.001**
PAIR 3	LEFT HAND LENGTH	10.986	99	p<0.001**
PAIR 4	LEFT HAND BREADTH	10.886	99	p<0.001**
PAIR 5	RIGHT FOOT LENGTH	10.452	99	p<0.001**
PAIR 6	RIGHT FOOT BREADTH	9.325	99	p<0.001**
PAIR 7	LEFT FOOT LENGTH	10.613	99	p<0.001**
PAIR 8	LEFT FOOT BREADTH	9.141	99	p<0.001**

[Table/Fig-5]: Paired samples t-test showing statistical difference between males and females
**Statistically highly significant

STUDY PARAMETERS	MALES		FEMALES	
	PEARSON CORRELATION	Sig.(2-tailed)	PEARSON CORRELATION	Sig.(2-tailed)
RIGHT HAND LENGTH	.479**	p<0.001	.949**	p<0.001
RIGHT HAND BREADTH	.388**	p<0.001	.470**	p<0.001
LEFT HAND LENGTH	.468**	p<0.001	.949**	p<0.001
LEFT HAND BREADTH	.390**	p<0.001	.454**	p<0.001
RIGHT FOOT LENGTH	.554**	p<0.001	.417**	p<0.001
RIGHT FOOT BREADTH	.411**	p<0.001	.138	.170
LEFT FOOT LENGTH	.550**	p<0.001	.412**	p<0.001
LEFT FOOT BREADTH	.408**	p<0.001	.138	.171

[Table/Fig-6]: Showing correlation between the stature and various parameters studied in males and females
**Statistically highly significant

The equations also exhibit standard error of estimate (SEE). The SEE predicts the deviations of estimated stature from the actual stature. It ranges between ± 5.375 to ± 5.95 . A low value indicates greater reliability in the estimated stature. Foot length exhibits a lower value in males and gives better reliability in prediction of stature.

Multiple regression equations for various parameters studied in males were as follows:-

Stature = $91.347 + .117 \times \text{hand length} + .185 \times \text{foot length} \pm 5.31$
 Stature = $92.878 + .203 \times \text{foot length} + .161 \times \text{foot breadth} \pm 5.23$
 Stature = $101.026 + 0.23 \times \text{hand length} + 0.180 \times \text{hand breadth} \pm 5.64$
 Stature = $85.860 + .186 \times \text{foot length} + .109 \times \text{foot breadth} + 0.018 \times \text{hand length} + .167 \times \text{hand breadth} \pm 5.24$

It was observed that the multiple regression equations reveal slightly lower values of SEE (± 5.23 to ± 5.64).

Linear Regression equations for various parameters studied in females were as follows:

Stature = $1.454 + .871 \times \text{hand length} \pm 2.394$
 Stature = $140.696 + .104 \times \text{hand breadth} \pm 7.51$
 Stature = $81.978 + .294 \times \text{foot length} \pm 6.91$
 Stature = $133.035 + .180 \times \text{foot breadth} \pm 7.54$

The SEE ranges between ± 2.394 to ± 7.54 . Hand length exhibits a lower value in females and gives better reliability in prediction of stature.

Multiple regression equations for various parameters in females are as follows:

Stature = $-6.296 + .053 \times \text{foot length} + 0.845 \times \text{hand length} \pm 2.34$
 Stature = $42.490 + 0.889 \times \text{hand length} - 0.053 \times \text{hand breadth} \pm 2.33$
 Stature = $-6.616 + 0.046 \times \text{foot length} + 0.033 \times \text{foot breadth} + 0.863 \times \text{hand length} - 0.051 \times \text{hand breadth} \pm 2.29$

DISCUSSION

The results of the present study show that the dimensions of the hands and feet show statistically significant positive correlation with stature of an individual. The presence of a positive linearity between the study variables and the stature facilitates formulation of regression equations which can be successfully utilized for stature estimation in tribal population.

The present study is unique in its sample selection. The sample was drawn from the tribal population of Kasargod district of Kerala state. Tribals are known to be socially, environmentally, culturally and even genetically secluded communities. While literature abounds with forensic anthropological studies of estimating stature with hand and foot dimensions, very few studies have selected a homogenous group as study population [11,12,19]. Due to strong influence of genetic and environmental factors on the height of the individual, homogeneity of the study population is vital in formulating the regression equations.

In the present study males showed higher mean values in all the parameters studied than among females the difference being statistically highly significant. The difference in values of correlation co-efficients of males and females for estimation of stature from hand length was remarkable in the present study (0.47 in males and 0.96 in females). Female hand length showed statically significant highly positive correlation to stature. Similar Indian studies conducted on homogeneous population groups reveal no appreciable gender difference [11,12,19]. The reason for the difference in the present study is a topic of further investigation and analysis.

There is paucity of workers who have considered hand and foot breadth for stature estimation. The correlation co-efficient obtained for these parameters for both the genders, in the present study are slightly lower but comparable to other studies. The observations of the present study suggest that these parameters can be utilized to formulate equations to predict stature.

CONCLUSION

These findings of the present study may be used to predict stature: 1) in cases when whole length of hand and foot are not available for investigation (e.g. in mutilated body parts in mass disasters). The data obtained in the present study can be used to obtain certain population specific anthropometric indices amongst the tribal population. The data and subsequently the results obtained in the present study, to the best of the knowledge of the author, is the first ever documented anthropological work on the tribals of Kasargod.

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