Original Article

Indian Journal of Forensic Medicine and Pathology
Volume 11 Number 2, April - June 2018
DOI: http://dx.doi.org/10.21088/ijfmp.0974.3383.11218.14

Estimation of Stature by Multiplication Factor using Head Length in South Indian Population: A Cross Sectional Study

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Abstract

Background: Identity of an individual is an imperative aspect in any kind of investigating procedure. There are numerous ways and means to do so in human beings (alive or dead), when a human body is in its entirety, but very few when only a part of it is available. In such cases, complete identification becomes unlikely and partial identification assumes importance to proceed into further investigations. There are various data available for identification. The height (stature) of an individual is one of them. There is scanty information regarding stature estimation by multiplication factor using head length in South-Indian population. *Material and methods:* The present study is a crosssectional study includes 200 south Indian student population of S. Nijalingappa Medical College, Bagalkot. *Aims and objectives:* To correlate head length with stature, and to derive multiplication factor that can be applied for estimation of stature in South Indian population. *Results:* The average stature in the present study is 172.44 cm for males and 159.49 cm for females and the average head length from Nasion to Inion is 18.18 cm for males and 16.77 for females and from Glabella to Inion is 18.69 cm for males and 17.28 cm for females. *Conclusions:* There is a positive correlation between the head length with that of stature. The estimation of stature by derived multiplication factors are equally valid and can be used upon the South Indian population with fair degree of accuracy.

Keywords: Stature; Head Length; Multiplication Factor; South Indians; Anthropology.

Introduction

Stature is one of the various parameters of identification for establishing individuality of the person. It is well known that there is a definite relationship between the height of the person and various parts of the body like head, trunk and lengths of upper and lower limbs. The assessment of height of an individual from measuring different parts of the body has always been of immense interest to the Anatomists, Anthropologists and Forensic experts [1].

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Received on 20.03.2018, **Accepted on** 11.04.2018

The estimation of height from various parameters has been done by various workers. They have derived their own formulae for calculating the stature from different body parts. Universally applicable formulae have not been derived because the relationship between height and different body parts (long bones or other measurements) differ according to race, age, sex and side of the body. It is proved that each race, and age group require its own formulae [2].

There is no universally acceptable formula to express relationship between stature and head length of an individual. Estimation of stature of an individual in India by using formulae given by western workers involves an error of 5-8% [3]. Various factors like race, sex, side of body, climate, heredity and nutritional status are attributed to variations in the ratios of length of different bones to that of stature[4,5,6]. It is opined that the study of residents of one state is not necessarily applicable to the residents of another state [7].

Thus this work is undertaken because, our study includes subjects from South India (Karnataka,

Andhra Pradesh, Kerala and Tamil Nadu) and the only available method for stature estimation in South Indians is by using multiplication factors derived for Mysoreans [8]. Literature regarding multiplication factors from this part of the world is scant. Our study will be useful for identification of a person by estimating stature when only a head of the dead body is available.

Aims and Objectives

To correlate the stature with head length and to derive multiplication factor using a nasion to inion and glabella to inion head length to estimate the stature.

Materials and Methods

a. Source of data and materials: The south Indian student population (Karnataka, Andhra Pradesh, Tamil nadu and Kerala) of S. Nijalingappa Medical College, Bagalkot.

b. Study design: Cross-sectional study.

c. Sample size: 200 (100 male and 100 female)

d. Methodology:

Inclusion Criteria

1. Students hailing from Karnataka, Andhra Pradesh, Tamil Nadu, and Kerala.
2. Chronological age group above 18 years.
3. Both the sexes.

Exclusion Criteria

1. Students unable to stand.
2. Any pathological conditions of bones and limbs e.g., fractures, dislocations, poliomyelitis, osteoporosis, rickets, scoliosis and kypho-scoliosis etc.
3. Congenital anomalies.
4. Dwarfism and Gigantism.
5. Steroidal therapy.

e. Data collection: The study was performed in adherence to the principles established with the declaration of Helsenki (2000) and written consent was obtained for every student and all female subjects were examined in the presence of another female. Various socio-demographic factors and the following anthropometric data were entered in the pretested proforma. The measurements were taken at fixed time between 2 to 5 p.m. in order to eliminate discrepancies due to diurnal variation.

1. Standing height (Stature)

The subjects were made to stand bare foot on a base-board of a stadiometer in the Frankfurt plane where his/her head will be parallel to the floor with heels together and the weight evenly distributed between both feet. The height is measured in centimetres from the ground to the highest point on the subject's head with the head piece of stadiometer firmly contacting the scalp.

2. Head Length

Subjects were made to sit on a chair keeping head looking straight and measurement will be taken with spreading calipers between two points nasion to inion and glabella to inion. Head length is measured in centimetres.

Multiplication factor for the individual head length were calculated for each person and mean of all was calculated. The following equation was used to get the multiplication factor:

$K=H/L$

Where, H= Height, L = Length of head

K= A constant multiplication factor which was specifically determined for individual head length from the various data so obtained. After taking the measurements, statistical analysis is done using statistical regression equations as given below:

$\sum y = Na + b\sum x$

Where, $\sum$ = Sum value, y = Value of stature, N = Number of cases studied, x = Value of Head length, a = Unit greater than x value by y value, b = Regression coefficient.

From the above equations, regression formulae, standard errors and co-efficient of correlations were developed to fulfil the aims and objectives of the study. The multiplication factors so obtained were tested on a fresh sample (100) of south Indian population in order to validate the outcomes.

Results

The average stature in the present study is 172.44 cm for males and 159.49 cm for females and the average head length from Nasion to Inion is 18.18 cm for males and 16.77 for females and from

Glabella to Inion is 18.69 cm for males and 17.28 cm for females. The results are presented in the form of Mean ± SD (Min-Max). (Table 1).

Table 1: Showing average standing Height and Head Length (HL)

	Height	Nasion-Inion(N-I)	Glabella-Inion (G-I)
Male	172.44 5.34 (160 – 184)	18.18 1.05 (15.9 – 20.5)	18.69 1.05 (16.3 – 21)
Female	159.49 6.19 (136 – 178)	16.77 1.29 (13.2 – 19.8)	17.28 1.29 (13.7 – 20.3)

Head length from Nasion to Inion (N-I) and Glabella to Inion (G-I) shows a positive correlation (Karl Pearson's) with stature for male, female and combined (both male and female) with p-value < 0.001 (Table 2).

Table 2: Showing correlation coefficient(r) between height &Head Length (HL)

Head Length	Male		Female		Combined	
	R	P	R	P	R	P
N-I	0.507	< 0.001	0.440	< 0.001	0.651	< 0.001
G-I	0.530	< 0.001	0.428	< 0.001	0.652	< 0.001

The multiplication factors for head length for both males, females and combined were derived. (Table 3)

Table 3: Showing Multiplication Factors

	Male	Female	Combined
N-I	9.51(0.46)	9.55(0.64)	9.53(0.56)
G-I	9.24(0.43)	9.26(0.61)	9.25(0.52)

When the estimated stature by derived multiplication factors was compared with the estimated stature by regression equation, the average difference is < 1cm. this difference was statistically insignificant (p > 0.05). Thus, the derived multiplication factors are equally valid.(Table 4).

Table 4: Showing comparison between the estimated stature by Regression Equation (R.E.) and stature estimated by Multiplication Factors(M.F)

	Head length	Mean difference between predicted height and estimated height(in cms)	Standard Deviation	Degree of freedom	Paired t	P
Male	NI	0.41	7.31	99	0.564	0.574
	GI	0.38	6.89	99	0.552	0.582
Female	NI	0.71	9.63	99	0.743	0.459
	GI	0.66	9.28	99	0.717	0.475
Combined	NI	0.58	7.43	199	1.105	0.271
	GI	0.53	6.99	199	1.071	0.286

Discussion

We have estimated the stature amongst the South Indian student population of S.Nijalingappa Medical College, Bagalkot. The students were an admixture of equal number of population from South India (Karnataka, Andhra Pradesh, Kerala and Tamil Nadu), i.e. 50 students from each state

In present study, we have observed positive correlation between head length and height in the age group of 18-29 years with correlation coefficient of 0.507 (N-I) and 0.530 (G-I) in males and 0.440 (N-I) and 0.428 (G-I) in females. Head length was measured from nasion to inion and glabella to inion according to Ashley Montagu [1] and Indera P Singh.

Being the second most common method in practice, the stature so estimated from percutaneous bone length with the help of formulated multiplication factor is compared with average living stature and stature estimated by regression formula. The average multiplication factor is calculated in this study as per method proposed by Pan [13] in 1924.

These multiplication factors vary from one another. As per principles of statistics, finding a multiplication factor by considering averages is not accepted as a sound and satisfactory method.

According to Lal C.S and Lala J.K. [14] (1972) Multiplication factor (M.F) remains more or less constant in age group of 18-21 years. In present study similar age group was selected for study. Some of the authors derived the multiplication factor for long bones to get the stature, but the data regarding multiplication factor for head length is scant.

According to the textbook of Forensic Medicine by Glaister [15] (1957) head length is $1/8^{th}$ of the total height of an individual. However, the age and sex of the individual included in the study are not available.

Table 5: Coefficient of Correlation Values from previous studies regarding stature and Head length and correlation with current study

Workers and age of study group	Mean head length (Cm) Points Measured.	Correlation coefficient	Correlation with current study
Saxena9 (1981) 25-30 Yrs	18.464 Nasion – Inion	+0.2048	No
Jadhav & Shah10 (2004) 17-22 Yrs	17.65 Glabella - Inion	+0.53	Yes
Krishnan11 (2008) 18-30 Yrs	16.50 Glabella - Inion	0.78	No
Ilayperuma12 (2010) 20-23 Yrs	17.60 Glabella - Inion	0.72	No
Present study (2018) 19-28 Yrs	18.18 (male) 16.77 (female) Nasion -Inion 18.69(male) 17.28(female) Glabella-Inion	0.507 (male) 0.440 (female) 0.651(combined) 0.530(male) 0.428(female) 0.652(combined)	----

Stature estimation from Head lengths by using formulated Multiplication Factor (M.F)

Naini et al [16] computed the average proportion of the images found most attractive and reported it as the height being 7.8 times the head length. When forced to pick a single image, most selected the one with height 7.5 times the head length, followed by height 8 times the head length. The preference regarding the most attractive image didn't vary by sex or ethnicity.

The authors also cited averages among North American young adults of European ancestry, the average man had height 7.7 times head length and 9.4 times face length and average woman height 7.6 times head length and 9.4 times face length [17]. The head length (taken from top of head to bottom of chin) in their study is differs from the head length in our study. Our values of multiplication factors are nearer to the values mentioned in standard textbook of Forensic Medicine (Table 3).

According to Trotter and Gleser [4] (1952) world population is getting taller and therefore relationship between height and length of bones is changed and fresh formulae or multiplication factors are needed for each generation. Accordingly our present study has provided fresh multiplication factors for South Indians (Table 3).

The mean difference was found to be less than 1cm in all the cases ($p > 0.05$) when average stature estimated by multiplication factor was compared with stature estimated from regression equation (Table 4); hence multiplication factor can be used as a second line formula for estimation of stature. Also these multiplication factors are valid and applicable to the South Indian population.

Comparison between males and females

There is no significant difference between male and female regarding applicability of multiplication factors for stature estimation with fair degree of accuracy. Hence common multiplication factor (both for male & female) can be used to estimate the stature in south Indian population.

Conclusion

It is possible and easy to take the measurements from nasion to inion (N-I) and glabella to inion (G-I) of the head by using spreading caliper (outside caliper).

There is a positive correlation between the head length with that of stature.

The estimation of stature by derived multiplication factors 9.55 for N-I and 9.26 for G-I in female and 9.51 for N-I and 9.24 for G-I in male; are equally valid and can be used upon the South Indian population with fair degree of accuracy.

The derived common multiplication factor 9.53 for N-I and 9.25 for G-I is not only easy but also accurate in estimation of stature in South Indian population.

The multiplication factor derived from particular region cannot be used in general population. However, can be used on that one particular region of population.

Further needs similar type of studies from various parts of the country to derive a multiplication factors specific for that region.

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