Estimation of Stature from head length in medical students.

Chandrakant M Kokatanur[1], Ajay V Patil[2], Vinay Bannur[3], Karan Deep Mishra[4]

[1]Professor, [2]Professor and Head, [3]Assistant professor, Department of Forensic Medicine and Toxicology, Krishna Institute of Medical Sciences, Karad, District Satara, Maharashtra. [4]II MBBS student, Krishna Institute of Medical Sciences, Karad, District Satara, Maharashtra.

Abstract

Background: Identification of an individual, living or dead is of paramount importance in forensic practice, especially when dismembered body parts or skeletal remains are received for examination. Estimation of stature is one of the important criteria in terms to determine the identity of individual. Many studies have revealed the relationship between stature and some parts of the skeleton and the body parts in consideration. This study will helpful when only skull is available for medico-legal examination. **Aim:** To estimate stature of person from head length. **Material and Methods:** A cross sectional study was conducted in Krishna Institute of Medical Sciences for a period of 2 months from April to May 2018. Data was collected by measuring stature using stadiometer and head length using spreading calliper in 200 medical undergraduate students (100 males and 100 females). **Results:** There is low statistically significant correlation between head length and stature (r=0.25 for males and r=0.22 for females). **Conclusion:** Accurate stature estimation is not possible from percutaneous head length.

Keywords: *Stature, head length, correlation, regression, identification.*

Introduction

Identification of an individual, living or dead is of paramount importance in forensic practice, especially when dismembered body parts or skeletal remains are received in mass disaster situation like plane crash, earthquake, tsunami and road traffic accidents for examination.[1] In such situations, determining stature, age, sex and race are important to identify the individual.[2] Stature is one of the most important features in identifying an individual.[3] It is determined by a combination of environmental and genetic factors.[4]

Stature is defined as "natural height of a person in standing position". It varies at different times of the day by one and half to centimetres. It is less in evening and afternoon due to reduced elasticity of the inter-vertebral disc and longitudinal vertebral muscle.[5] It increases progressively and becomes maximum at the age between 21-25 years. Later, for every 25 years, it is shortened by 2.5 cm due to thinning of intervertebral discs and some stooping posture as a result of decreased tone of muscles.[6]

There is biological relationship between stature and every part of human body which helps to estimate the stature from mutilated and dismembered body parts.[7, 8] There is no derived formula which can be applied universally to estimate stature from different body parts because the relationship between stature and different body parts vary according to age, sex, ethnicity and race.[9]

Estimation of stature from head length helps to identify an individual especially when only head/skull of the deceased is available.[10] The present study was attempted to find the correlation between head length and stature and estimate stature from head length among medical students.

Corresponding author:
Dr Chandrakant M Kokatanur,
Professor, Department of Forensic Medicine and Toxicology, Krishna Institute of Medical Sciences, Karad, District Satara, Maharashtra.
Email- chanduk2005@yahoo.com

Materials and Methods

A cross sectional study was conducted for a period of 2 months from April 2018 to May 2018 in Department of Forensic Medicine and Toxicology, on 100 male and 100 female medical undergraduate students who are born and bought up in different parts of India and of the age group of 18 to 24years. Medical student with history of accident, head injury, congenital deformity, hormonal imbalance, kyphosis, scoliosis were excluded from this study. Sample size was calculated by assuming correlation between stature and head length , r = 0.4, the minimum number of subjects to be included (n) calculated as 84 with 95% confidence and 95% power, thus, 100 males and 100 females were assessed in present study. After obtaining informed consent from students, the height of an individual was measured with help of stadiometer as a distance between vertex and standing platform.[11] Student was standing in anatomical position, with palm facing medially and head in Frankfurt plane. All measurements were taken between 9am to 11am by single observer, repeated thrice and the mean was taken to eliminate diurnal as well as inter-observer variations. All measurements were taken in centimeters up to two decimal points. The head length was measured using spreading caliper from behind in an anatomical standing position, head being in Frankfurt plane.

Data was collected in pre-structured proforma, and analysed using descriptive statistics: correlation coefficient was calculated. Regression equation was formulated to estimate the stature by using software Statistical Package for the Social Science (SPSS) 20**.**

Results

The study consists of 200 healthy subjects consisting of 100 males and 100 females. The most common age was 20 years (males 38% and females 40%) followed by 21 years (males 28% and females 23%) as shown in Table 1.

Table1. Frequency of males and females according to age.

Age (years)	Male		Female	
	Frequency	Percent	Frequency	Percent
18.00	8	8.0	5	5.0
19.00	18	18.0	27	27.0
20.00	38	38.0	40	40.0
21.00	28	28.0	23	23.0
22.00	7	7.0	4	4.0
23.00	1	1.0	1	1.0
Total	100	100	100	100.0

The mean age of males was found to be 20.11±1.072 years, ranging between 18 years and 23 years and mean age of females was found to be 19.97±0.979 years, ranging between 18 years and 23 years (Table 2). The mean length of head of males was found to be 18.34±0.667, ranging between 16.7cm and 20 cm and mean length of head of females was found to be 17.22±0.726, ranging between 15.6 cm and 18.6 cm. The mean stature of males was found to be 173.71±6.259 cm, ranging between 157.5cm and 189 cm and mean stature of females was found to be 158.75±6.578 cm, ranging between 141 cm and 175 cm as shown in Table 2.

Table 2. Descriptive statistics for age, head length and stature.

Parameter		Minimum	Maximum	Mean± Std. Deviation
Age(yr)	Male	18	23	20.11±1.072
	Female	18	23	19.97±0.979
Head length (cm)	Male	16.7	20	18.34±0.667
	Female	15.6	18.6	17.22±0.726
Stature(cm)	Male	157.5	189	173.71±6.259
	Female	141	175	158.75±6.578

Table 3. Regression equations for estimation of stature from head length

	Correlation Coefficient(r)	p value (2-tailed)	Regression Equation	SEE
Male	0.255	0.010	Stature=129.848+2.391x head length	16.811
Female	0.222	0.026	Stature=124.106+2.011x head length	15.380

The present study showed low significant positive correlation between stature and head length for males with correlation coefficient (r) 0.255 which is statistically significant at 0.01 level (p value 0.01) as shown in table 3.

Regression equation for males is calculated as follows –

Stature (in cm) = 129.848+2.391x head length (in cm).

The present study showed low significant positive correlation between stature and head length for females with correlation coefficient (r) 0.229 which is statistically significant at 0.05 level (p value 0.026) as shown in table 3.

The regression equation for females is calculated as follow –

Stature (in cm) = 124.106+2.011x head length (in cm).

Figure 1: Scatter diagram showing correlation between stature and head length in males.

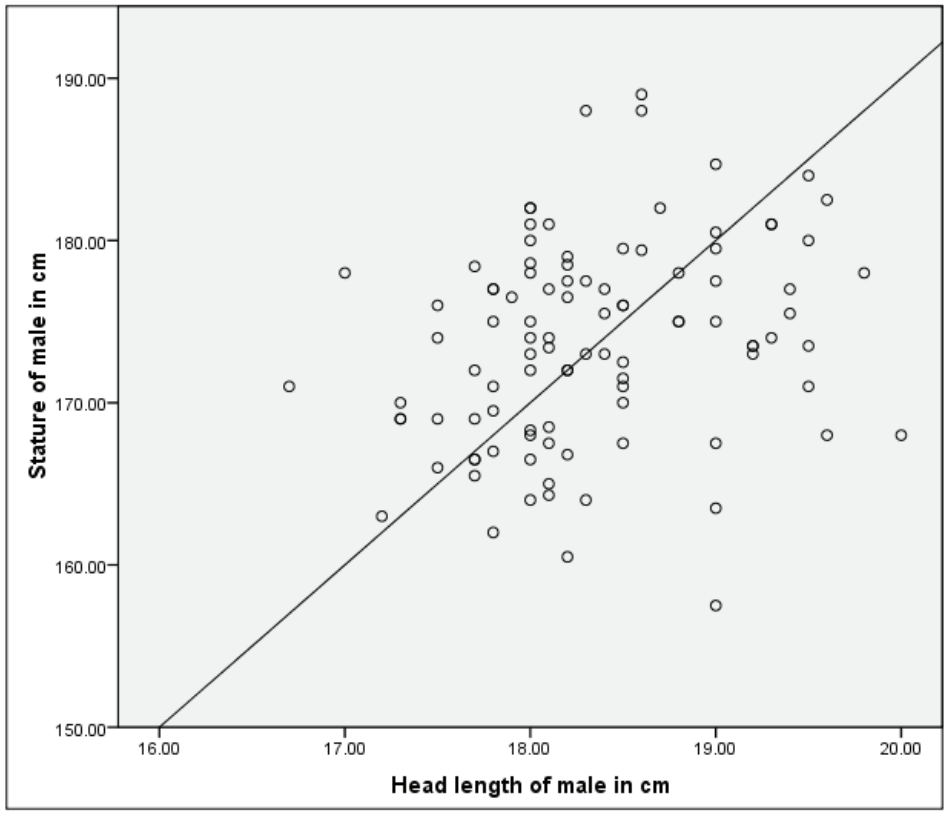
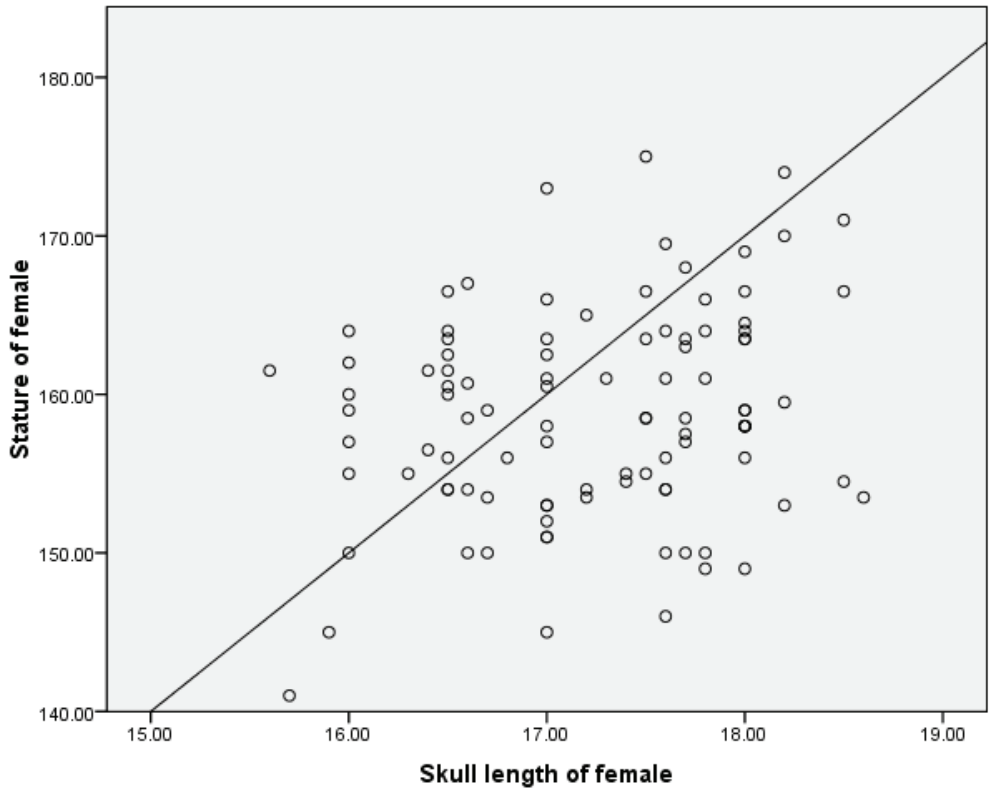


Figure 2: Scatter diagram showing correlation between stature and head length in females.



Discussion:

Identification of the deceased is one of the main aims in forensic practice. It becomes extremely difficult when incomplete skeletal remains or highly decomposed bodies are brought for examination. In such situations, the main aim is to determine the stature, age, sex, and race. Estimation of stature is of great importance in forensic practice especially when head/skull is only available. The regression analysis is considered as the best and the most reliable method for such estimation.[12]

In the present study, it was observed that head length is more for males than females. Similar observation was found in a studies conducted by Kamal R with mean head length 18.43±1.05 cm in males and 17.63±0.86 cm in females, Reddy M with mean head length 19.6±0.9296 cm in males and 18.926±0.644 cm in females, Mani DR with mean head length 20.41±0.68 cm in males and 17.84±0.67 cm in females, Agnihotri AK with mean head length18.66±0.79 cm in males and 18.13±0.91cm in females, Shah RK with mean head length 18.553±0.604 cm in males and 17.841±0.547 cm in females and Rajani Singh with mean head length 17.0±0.7 cm in males and 16.0±0.8 cm in females because the male cranium is bigger than the females.[2,3,4,12-17.]

It was found in the present study that mean stature for males is more compared to females because males are taller than females. This could be due to correlation of Y chromosome with stature and males attain puberty two years later resulting more growth compared to females.[18,19] Similar observations were found in studies conducted by Kamal R (164.63±6.84 cm for males and 151.01±5.4 cm for females), Reddy M (mean stature 169.9±0.571 cm in males and 158.166±0.608 cm in females), Mani R(172.23±16.55 cm for males and 159.69±8.15 cm for females), Manandhar B (169.45±7.06 cm for males and 160.27±10.38 cm for females), Agnihotri AK(173.40±7.70 cm for males and 157.36± 6.17 cm for females), Shah RK (175.94±5.91 cm for males and 161.11±5.62 cm for females), Singh R (167.2±7.8 cm for males and 157.0±6.0 cm for females), Wankhede KP (mean stature 170.97±6.80 cm in males and 156.89±5.89 cm in females).[2-4, 9, 12-14, 20.].

The present study showed that head length is not good indicator for estimation of stature of an individual both in males and females because of low significant positive correlation between stature and head length [correlation coefficient (r) for males 0.255 and females (r) 0.222] which are statistically significant at 0.01 level (p value 0.01) as shown in table 3. It could be due to the fact that the growth of skull (head length) is genetically determined.[12] Similar observations are found in studies conducted by Kamal R [male (r) 0.355 and female (r) 0.182], Agnihotri [male (r) 0.331 and female (r) 0.159], Kokatanur [male (r) 0.299 and female (r) 0.126], Chourasia R [male (r) 0.241 and female (r) 0.173] and Wube B [male 0.422 and female 0.168].[2,12, 17, 21, 22.] In contrast to this, the study conducted by Reddy M showed positive correlation between stature and head length with correlation coefficient (r) for males 0.715 and (r) 0.701 for females, by Manandhar B [(r) 0.706 for males and (r) 0.69 for females] and by Nemade P [(r) 0.745 for males and (r) 0.677 for females][3,9, 23].

The estimation of stature from long bones is better than flat bones because long bones correlate positively with the stature compared to flat bones.[24] But in forensic examination especially when head/skull is only available, head length is good predictor for estimating stature. As the correlation coefficient is considered to be significant only when it is more than 0.5, head length is not good predictor for estimating stature both in males and females because correlation coefficient for males is 0.255 and 0.222 for females which are less than 0.5 as mentioned in table 3.

The regression equations and correlation coefficients vary from one geographical location to another as stature is dependent on multiple factors such as race, nutritional, regional and geographical factors. Regression equations of one population cannot be applied to another population for stature estimation as they are population specific[25].

Conclusion

The current study showed that accurate stature estimation is not possible from percutaneous head length as low significant positive correlation between stature and head length for males as well females was found in this study. Further investigations should be carried out on large study sample.

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Compliance with Ethical standards

Ethical approval: "All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional ethics committee of Krishna Institute of Medical Sciences, Karad."

References

1. Eboh DE, Ohaju-Obodo JO. Height estimation from head dimensions in South-South Nigeria. Egypt J Forensic Sci. 2019 Dec 1;9(1):62.
2. Kamal R, Yadav PK. Estimation of stature from different anthropometric measurements in Kori population of North India. Egypt J Forensic Sci. 2016 Dec 1;6(4):468–77.
3. Reddy M, Reddy V, Wadhwan V, Venkatesh A. Correlation and estimation of stature from cephalofacial measurements: A study on Western Uttar Pradesh population. J Forensic Dent Sci. 2018;10(2):101.
4. Mani DR, Choudhary DP, Singh DM, Rathore DK. Correlation of stature in relation to head length in medical students in Bikaner district Rajasthan. Int J Med Biomed Stud. 2019 Jun 22;3(6):197-200.
5. Reddy KSN. The essentials of forensic medicine and toxicology. 34th ed. Hyderabad: Jaypee brother medical publisher Ltd; 2017. p. 82.
6. Patel SH, Bastia BK, Kumar L, Senthil Kumaran M. Estimation of adult human stature from measurements of inter-acromial length in Gujarati population of India. J Indian Acad Forensic Med. 2015;37(4):365–8.
7. Yadav AB, Kale AD, Mane DR, Yadav SK, Hallikerimath S. Stature estimation from regression analysis of facial anthropometry in Indian population. J Oral Maxillofac Pathol 2019; 23:311.
8. Krishan K. Estimation of stature from cephalo-facial anthropometry in North Indian population. Forensic Sci Int 2008; 181:52.e1-6.
9. Manandhar B, Shrestha R. Estimation of body height from head length among dental students of a dental college. J Nepal Med Assoc. 2018 Sep 1;56(213): 861-5.
10. Shende MR, Tirpude BH, Bokariya P, Kothari R. Significance of head length in estimation of stature in healthy individuals of central India. Indian J Forensic Med Toxicol. 2013;7(2):128–31.
11. Marko RS, Awasthi A, Jehan M, Bose A. A correlation analysis for estimation of height from head breadth and vertex height. IOSR J Dent Med Sci 2018;17(4):87-91.
12. Agnihotri AK, Kachhwaha S, Googoolye K, Allock A. Estimation of stature from cephalo-facial dimensions by regression analysis in Indo-Mauritian population. J Forensic Legal Med 2011;18:167-72.
13. Shah RK, Kanani SD, Patel BG, Tolani JN. Estimation of stature from head length in western Indian Gujarati adolescent population. Indian J Clin Anat Physiol. 2018 Mar 30;5(1):42–6.
14. Singh R. Estimation of stature and age from head dimensions in Indian population. Int J Morphol. 2013;3.1(4):1185-90.
15. Buran F, Can OI, Ekizoglu O, Balci A, Guleryuz H. Estimation of age and sex from bimastoid breadth with 3D computed tomography. Rom J Leg Med 2018;26(1):56-61.
16. Saini R, Saini V. Sexual dimorphism of North Indian Crania and its forensic application. J Forensic Med Leg Aff 2016;1(2):108.
17. Kokatanur CM, Hallikeri VR, Manjulabai KH. Estimation of stature from head length of adults belonging to Soligas-a genetically isolated tribe from southern India. Indian J Forensic Med Toxicol 2018;12(2):48-53.
18. Yamada K, Ohta M, Yoshimura K, Hasekura H. A possible association of Y chromosome heterochromatin with stature. Human genetics. 1981 Sep 1;58(3):268-70.
19. Eboh DE, Igbigbi PS. Stature estimation from cephalometric parameters of young adults in five Nigerian ethnic groups. Italian Journal of Anatomy and Embryology. 2017 Sep 21;122(2):98-109.
20. Wankhede KP, Kamdi N, Parchand M, Anjankar

V, Bardale R. Estimation of stature from maxillo-facial anthropometry in a central Indian population. J Forensic Dent Sci. 2012;4(1):34.

21. Chourasia R, Bamne A, Gohia V, Pandey R. Estimation of stature from head length. Int J Med Sci Res Practice. 2014;1(2):40-3.
22. Wube B, Seyoum G, Taye G. Estimation of stature by anatomical anthropometric parameters in first-year regular undergraduate students at Debre Markos University, North West Ethiopia. Ethiop J Health Dev. 2019; 33(3):188-97.
23. Nemade P, Ambiye M, Nemade A. Regression analysis on stature estimation from cephalic dimensions. Indian J Basic Appl Med Res. 2015;4(3):298–312.
24. Kalia S, Shetty SK, Patil K, Mahima VG. Stature estimation using odontometry and skull anthropometry. Indian J Dent Res. 2008 Apr 1;19(2):150.
25. Wankhede KP, Anjankar VP, Parchand MP, Kamdi NY, Patil ST. Estimation of stature from head length & head breadth in central Indian population: an anthropometric study. Int J Anat Res. 2015;3(1):954–7.