International Journal of Current Advanced Research
ISSN: O: 2319-6475, ISSN: P: 2319 – 6505, Impact Factor: SJIF: 5.995
Available Online at www.journalijcar.org
Volume 6; Issue 9; September 2017; Page No. 6170-6174
DOI: http://dx.doi.org/10.24327/ijcar.2017.6174.0887

Research Article

DETERMINING STATURE FROM HEAD LENGTH: A CORRELATION AND SEXUAL DIMORPHISM STUDY ON 8 – 12 YEAR CHILDREN IN SOUTH INDIA

Mohammad Abdul Moeed[1]*., MK Salman[2]., Farheen Naaz[3] and Mohammed Ibrahim Azam[4]

[1]Department of Anatomy, Shadan Institute of Medical Sciences, Teaching Hospital and Research Centre, Peerancheru, Hyderabad
[2]Department of General Medicine, Shadan Institute of Medical Sciences, Teaching Hospital and Research Centre, Peerancheru, Hyderabad
[3]Department of Obstetrics and Gynaecology, ESIC Medical College, Sanathnagar, Hyderabad
[4]Department of General Medicine, Shadan Institute of Medical Sciences, Teaching Hospital and Research Centre, Peerancheru, Hyderabad

A R T I C L E I N F O

Article History:

Received 26th June, 2017
Received in revised form 4th July, 2017 Accepted 18th August, 2017
Published online 28th September, 2017

Key words:

Height, stature, head length, sexual dimorphism, correlation

A B S T R A C T

Background: Several anthropometric measurements correlate consistently well with the stature of an individual. Though reliable and applicable for medico-legal investigations, they vary considerably among different regions and races. It is hence of paramount academic interest to anatomist to describe and define such regression equations which can be used to deduce stature in a defined population.
Materials & Methods: The study was conducted over a period of 6 months on 400 school students aged 8 – 12 years. Informed consent was obtained from the principals of all the 8 schools where the study was conducted. Using standard techniques height was measured using a stadiometer and head length was measured using a spreading calipers. Data was analysed by using student's t test and Pearson's regression correlation.
Results: Average height in girls was 135.85 ± 8.12cm compared to 137.62 ± 8.45cm in boys ($P < 0.05$). Head length did not show gender dependent difference statistically. Head length and height correlated significantly ($r = +0.722$ and $r^2 = 0.521$). Sexual dimorphism was noted with r values being slightly higher in female subjects compared to males with $r = +0.749$ compared to r value of +0.704 in male subjects. Both were determined above 0.5.
Conclusion: Head length appears to be positively correlated with height and hence the regression formula derived can be used in our population for medico-legal investigations.

INTRODUCTION

Children essentially differ from adults by procession of the vital process of growth in addition to maintenance of various body functions. Normal growth is of prime significance in a child health perspective as it represents attainment of full genetic potential. Nevertheless growth can be affected by several extrinsic factors and their interaction with intrinsic factors. Several anthropometric measurements are instrumental in monitoring growth. Stature apart from being an impressive factor for personal identification, an important anthropometric tool in paediatrics, is also an area of immense interest to anatomists, anthropologists and forensic experts.

Stature, essentially and remarkably represents a sum total of lengths of several bones of axial and appendicular skeleton and their proportional contribution in its constitution. These lengths and proportions are affected by age, race, gender, environment and nutritional status. Several relations have been established between the total stature of an individual and the measurements of other parts of the body which have stood the test of time. Length of the clavicle [1], foot length [2] and length of forearm bones [3] have been correlated consistently well with the stature since a long time. Earliest reports correlating craniofacial anthropometry in terms of head length, and stature appear to come from Saxena *et al*. who studied and correlated head length and stature in Indian population in Agra [4]. Though cranofacial anthropometry appears to be the best predictor of stature [5] the formulae derived from regression analysis varies with the race as different races have different individual proportional contributions to stature. It is hence advisable to imply and interpret these formulae with reference to the race or population from which they have been derived [6]. Several studies have correlated craniofacial anthropometry with stature in North and South India populations[7, 8], but a study

Corresponding author:* **Mohammad Abdul Moeed
Department of Anatomy, Shadan Institute of Medical Sciences, Teaching Hospital and Research Centre, Peerancheru, Hyderabad

done by Asha KR *et al* appears to be significant in describing the differences between these two populations in context to the correlation between head length and stature[9]. The study was taken up with a primary objective of establishing a correlation between head length and stature in South Indian children between 8 to 12 years age.

This is of academic importance to the anatomists with a translational ability to forensic where it would help in matching body parts and assigning proper identities in cases of obscured identities and would also help in determining the body parts of common origin where body parts may be severed and stewn over places as in bombings, plane crashes or stampedes.

MATERIALS AND METHODS

The study was conducted at eight schools in Hyderabad and Secunderabad. Of the 20 private schools, 83 government schools and 57 Zilla Parishad schools, 4 private, 2 government and 2 Zilla Parishad schools were randomly selected. Fifty students in the age group of 8 to 12 years were selected from each school by simple random sampling to a total sample size of 400 students. The Principals of all these schools were explained about the purpose and procedure of the study and written informed consent was obtained for the purpose. The study was approved by the institutional ethics committee of Shadan Institute of Medical Sciences.

The study was conducted over a period of 6 months from 1/12/2016 to 31/5/2017 on 400 apparently normal looking children. Children with known congenital anomalies, facial dysmorphism, deformities of spine or limbs and children who absented themselves for more than 10 days over the past 3 months were excluded from the study and an equal number of randomly selected children were recruited for the study.

Data regarding age, demographic details, family structure and socioeconomic status were recorded from school records. The child was made comfortable in a playful environment and any hair adornments were removed and plaits were opened. Foot wear was removed and the child was made to stand in anatomical position with feet held close on the base board of the stadiometer with spine straight. The child's stature was measured by gently placing the head in Frankfurt's plane. The measurement was noted to the nearest 0.1cm. Head length was measured from the glabella to opisthocranion by a spreading caliper. Each anthropometric variable was measured once by 2 investigators separately and noted down. If they were found to be discrepant by more than 10% a third reading was taken and the average of two readings close to each other was taken for analysis. All measurements were taken after donning sterile gloves and hands were sanitised with isopropyl alcohol between children. Data was statistically analysed by using SPSS software (Version - 19). Correlation was analysed using Pearson's correlation co-efficient. Statistical analysis of differences between groups were analysed for significance using students t test and Z test as applicable.

RESULTS

Over a period of 6 months, 400 school children randomly selected from 8 schools in the twin cities of Hyderabad and Secunderabad. Characteristics of the study population are described below in table 2

Body mass index (BMI) was calculated for all children and marked on a centile graded chart and the data hence obtained is tabulated below in Table -3

Table 1 Place of Study

S.No.	School	City	Administration (Admn.)	Annual Fee in Rupees
1.	Government High School, Meerpet	Hyderabad	Government (State Admn.)	Nil
2.	Zilla Parishad High School, Jillelguda	Hyderabad	Government (Local Admn.)	Nil
3.	Silver Drop HighSchool, Jillelaguda	Hyerabad	Private	30,000/-
4.	KVR Pragathi Grammar School, Gayathrinagar	Hyderabad	Private	12,000/-
5.	Government High School, Picket	Secunderabad	Government (State Admn.)	Nil
6.	Zilla Parishad High School, Secunderabad	Secunderabad	Government (Local Admn.)	Nil
7.	Sarojini Devi Model High School, Picket	Secunderabad	Private	15,000/-
8.	Fitzee World School, AOC Cente	Secunderabad	Private	40,000/-

Table 2 Characteristics of Sampled Population

S.No.	Characteristic	Variable	Frequency	Percentage
1.	Gender	Female	220	55
		Male	180	45
2.	Age (yrs)	8 – 9	91	22.75
		9 – 10	112	28
		10 – 11	109	27.25
		11 – 12	88	22
3.	Socioeconomic Status (Kuppuswamy)	Upper Class	55	13.75
		Upper Middle Class	146	36.5
		Middle Class	169	42.25
		Lower Middle Class	30	7.5
		Lower Class	0	
4.	Family Structure	Joint Family	82	20.5
		Nuclear Family	318	79.5
5.	Birth Order	1st	108	27
		2nd	209	52.25
		3rd	61	15.25
		4th	22	5.5

Table 3 BMI of sampled children

Characteristic	Variable	Frequency	Percentage
BMI (centiles)	< 10^{th}	12	3
	10^{th} – 25^{th}	62	15.5
	25^{th} – 50^{th}	100	25
	50^{th} – 75^{th}	149	37.25
	75^{th} – 90^{th}	56	14
	> 90^{th}	21	5.25

Differences in the stature of girls and boys have been tabulated below. Average stature in females was 135.85cm compared to 137.62cm in males. This appears to be statistically significant with a P value of 0.035 calculated by student's t test. The same is highlighted in Table -4. Similarly the mean and SD in head length has been analysed and differentiated in males and females with boys showing 17.29cm and girls showing an average of 17.52cm head length, which appeared statistically insignificant which is tabulated in Table -5.

Table 4 Gender dependent stature differences

Characteristic	Statistical Measure	Female	Male	P
Stature (cm)	Mean	135.85	137.62	0.035
	SD	± 8.12	± 8.45	
	SEM	0.55	0.63	

Table 5 Gender dependent head length differences

Characteristic	Statistical Measure	Female	Male	P
Head Length (cm)	Mean	17.52	17.49	0.638
	SD	± 0.55	±0.54	
	SEM	0.04	0.04	

Table 6, 7 and 8 illustrate the correlation between head length and stature and the sexual dimorphism which characterises this correlation. Table 5 correlates head length and stature and the study population which shows a positive correlation of + 0.722 which appears to be well determined at 0.52. Graph 1 illustrates the regression analysis results with head length on X-axis and stature on Y- axis.

Table 6 Correlation between stature and head length in study sample

S.No.	Variables (cm)	Coefficient of correlation (r)	Coefficient of determination (r^2)
1.	Head Length (x)	+ 0.722	0.521
2.	Stature (y)		
	y = 11.055(x) – 56.903		
	Stature = 11.055 (Head Length) – 56.903		

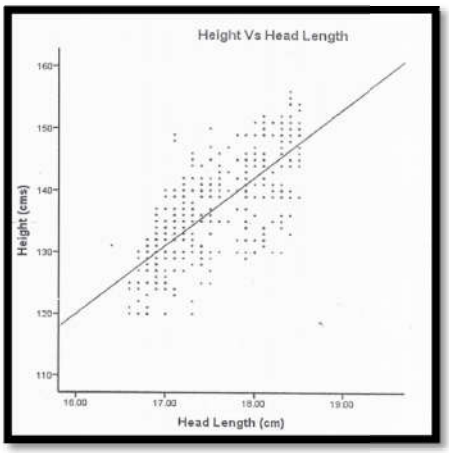

Figure 1 Regression analysis of sample by Pearson's correlation method

Table 7 and Figure 2 show the correlation between stature and head length by Pearson's coefficient in female subjects which shows a positive correlation between both the variables with coefficient of correlation being +0.749 and coefficient of determination being 0.561. Table 8 shows the correlation of stature with head length in male subjects which shows a positive r value of 0.704 with well determined r^2 of approximately 0.5 which rules out correlation by chance alone. The same is also illustrated in the graph shown in Figure 3

Table 7 Correlation between stature and head length in female study sample

S.No.	Variables (cm)	Coefficient of correlation (r)	Coefficient of determination (r^2)
1.	Head Length (x)	+ 0.749	0.561
2.	Stature (y)		
	y = 11.155(x) – 59.582		
	Stature = 11.155(Head length) – 59.582		

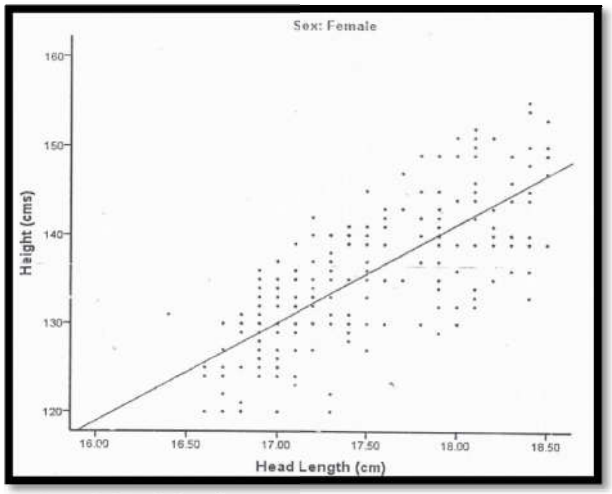

Figure 2 Graph showing strong positive correlation between head length and stature in female sample

Table 8 Correlation between stature and head length in male study sample

S.No.	Variables (cm)	Coefficient of correlation (r)	Coefficient of determination (r^2)
1.	Head Length (x)	+ 0.704	0.495
2.	Stature (y)		
	y = 11.03(x) – 55.331		
	Stature = 11.03(Head Length) – 55.331		

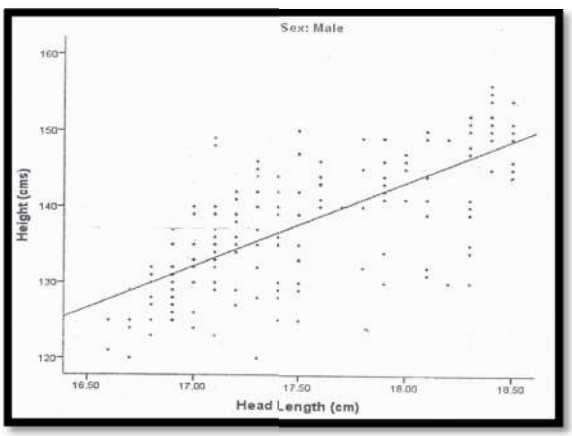

Figure 3 Positive correlation between head length on X – axis and stature on Y – axis in male subjects

DISCUSSION

Stature is defined as the natural height of a person in upright position. Stature estimation is of keen interest to forensic medicine practitioners, forensic investigators and anthropologist for biological profiling in crimes and for study of evolution and racial characteristics. Over decades relationships have been established between stature and dimensions of various bones for use in medico-legal investigations.

Head length appears to emerge as a reliable craniofacial anthropometric measure for calculation of stature [4,7]. Significant sexual dimorphisms exist in relation to anthropometric measurements in age matched controls, hence regression analysis was separately applied to female and male subjects. Mean height of male subjects was found slightly higher than female subjects (137.62 vs. 135.85) which was statistically significant with a P value of 0.03, which appears to be in consensus with the findings of Mishrikoti *et al* and Vinitha G *et al* [10,11]. Mean head length appears to be 0.3 cm higher in female sample compared to male sample, which is statistically insignificant and appears to contradict the findings of other studies done on Indian children [11, 10].

We found a strong correlation between stature and head length in the population studied with an r value of 0.722 on a positive scale. Gender dimorphism was revealed with r being higher in girls than in boys (0.749 vs. 0.704), both on a positive scale. Cozza *et al*. also reported a positive correlation between these variable in children aged 8 – 12 years which is in very close agreement with our findings [5]. Pandya *et al* reported a moderate correlation with Pearson's correlation coefficient being 0.38 [12] whereas Danborno *et al* reported strong correlation between head length and stature [14].

Most of the studies have highlighted the sexual dimorphism in the extent of correlation between head length and height which is as described in Table – 9. There are remarkable differences in the degree of correlation between the different variables depending upon the population from which samples were derived but most of them show higher or stronger correlation in females compared to males.

Table 9 Sexual Dimorphism in Correlation coefficient (Head length vs. Stature)

S.No.	Study	Female	Male
1.	Cozza P et al (2005) [5]	+ 0.72	+ 0.70
2.	Mishrikoti et al (2012) [10]	+ 0.490	+ 0.451
3.	Bansal Hansi et al (2013) [14]	+ 0.61	+ 0.16
4.	Vinitha G et al (2014) [11]	+ 0.416	+ 0.204

Hence the formulae obtained by regression analysis used to calculate stature from head length vary considerably depending on the gender in context. A few variations as highlighted in different studied are illustrated in table 10.

CONCLUSION

Head length correlates well with stature and can be used as a measure for calculation of height in a wide range of medico-legal investigations. It is a non invasive, inexpensive and easy to perform procedure. Since bony prominences are easily made out on the skull when compared to other parts like limbs where prominences may be obliterated due to obesity of muscle mass, head length appears to be a reliable and less cumbersome method for determination of stature. The regression analysis equations though convenient, can only be applied to populations from which they have been derived. Due to racial differences they can't be applied to a non – homogenous population hence there is a need to further investigate and derive correlations between different anthropometric measurements and stature in specified populations.

Declarations

Funding: No funding sources
Conflict of interest: None declared
Ethical approval: The study was approved by the Institutional Ethics Committee of Shadan Institute of Medical Sciences, Peerancheru, Hyderabad.

Acknowledgements

We sincerely thank the principals of all the schools for having permitted us to conduct random sampling and study on their students. We are very grateful to Dr. Mohammed Ismail Khan, Department of Obstetrics and Gynaecology, ESIC Medical College, for his painstaking efforts in repeatedly peer reviewing the article and for his valuable suggestions.

References

1. Singh B and Sohal HS. Estimation of stature from clavicle in punjabis; A preliminary report. *Indian Journal of Medical Research*. 1951;40:67-71.
2. Charnalia VM.Anthropological study of the foot and its relationship to stature in different castes and tribes of Pondicherry state. Journal of Anatomical Society of India. 1961; 10:26-30.

Table 10 Sexual dimorphism in the regression equations to correlate stature with head length

S.No.	Study	Population studied	Age group	Sample Size		Female	Male
				Female	Male		
1.	Jadhav et al. – 2004 [15]	Gujrat	17 - 22	259	468	Y = 128.03 + 1.72 (x)	Y = 138.77 +1.77 (x)
2.	Isurani I et al. – 2010 [16]	M.Stu	20 - 23	180	220	Y = 226.6 +3.86 (x)	Y = 101.83 + 3.69 (x)
3.	Mahajan et al. – 2011 [17]	M.Stu	18 - 23	190	210	Y = 127.05 + 1.81 (x)	Y = 136.88 + 1.89 (x)
4.	Asha KR et al – 2011 [9]	M.Stu (N. Indian)	20 – 30	50	50	Y = 129.85 + 1.50 (x)	Y = 145.49 + 1.30 (x)
5.	Asha KR et al – 2011 [9]	M.Stu (S. Indian)	20 - 30	107	53	Y = 132.01 + 1.42 (x)	Y = 102.10 + 3.69 (x)
6.	Mishrikoti et al. – 2012 [10]	Banglore	8 - 12	100	100	Y = 2.189 + 7.846 (x)	Y = 8.975 + 7.258 (x)
7.	Chaurasia RS et al. – 2014 [18]	M.Stu	18 - 25	251	255	Y = 1265.5 + 1.717 (x)	Y = 1478 + 1.252 (x)
8.	Agarwal S et al – 2014 [19]	M.Stu (N. Indian)	17 - 25	400	400	Y = 121.54 + 2.03 (x)	Y = 109.97 + 3.18 (x)

M.Stu – Medical Students | N.Indian – North Indian | S. Indian – South Indian

3. Athawale MC. nthropological study of height from length of forearm bones. A Study of one hundred Maharashtrian male adults of ages between twenty five and thirty years. *American Journal of Physical Anthropology.* 1963;21:105-112.
4. Saxena SK, Jeyasingh P, Gupta AK and Gupta CD. The estimation of stature from head length. *Journal of Anatomical Society of India*. 1981; 30:78–79.
5. Cozza P, Stirpe G, Condó R, Donatelli M. Craniofacial and body growth: a cross-sectional anthropometric pilot study on children during prepubertal period. *Eur J Paediatr Dent*. 2005;6(2):90-6.
6. Kadagoudar S, Manjulabai KH, Hallikeri VR. Estimation of stature by Nasion - Inion length in South Indian Population – A cross sectional study. *Medica Innovatica.* 2014;3(2):9-11.
7. Krishnan K. Determination of stature from foot and its segments in north Indian population. *Am J Forensic Med Pathol.* 2008;29(4):297-303.
8. Rao PP, Sowmya J, Yoganarasimha K, Menezes RG, Kanchan T, Aswinidutt R. Estimation of stature from cranial sutures in a South Indian male population. *Int J Legal Med*. 2009;123(3):271-6.
9. Asha KR, Lakshmi Prabha R. Estimation of stature from cephalic dimensions in Indian population. *Anatomica Karnataka*. 2011;5(1):1-5.
10. Mishrikoti H *et al*., Estimationof Stature from length of the head in children. *Anatomica karnataka*. 2012; 6(3):90-93
11. Dr. Vinitha G, Dr. Sampada P Kadadi, Dr. Mallikarjun M, Dr. Jayprakash B R. Correlation Of Stature In Relation To Headlength In Children. *International Journal Of Healthcare Sciences*. 2014;2(2):66-71.
12. Parth M. Pandya, Suresh P. Rathod, Shamin V. Pate *et al*. Correlation and Regression Analysis of Stature In Relation To Head Length in Children. *NJIRM* 2012;3(3):44-46.
13. Dan Borno B, Elupko A. Sexual Dimorphism in Hand and Foot Length, Indices, Stature-ratio and Relationship to Height in Nigerians. *The internet Journal of Forensic Sciences*. 2008;3(1): 1 – 5.
14. Bansal, H. and A. Badiye. An estimation of correlation between the Head length and the stature of children aged between 6-10 years. *Research Journal of Forensic Science*.2013;1(2):1-5.
15. Jadav HR, Shah GV. Determination of personal height from the length of head in Gujarat region. Journal of Anatomical Society of India. 2004; 53(1): 20-21.
16. Ilayperuma I. On the prediction of personal stature from cranial dimensions. *Int. J. Morphol*. 2010;28(4):1135-1140.
17. Seema and Mahajan A. Estimation Of Personal Height From The Length Of Head In Punjab Zone. *International Journal of Plant, Animal and Environmental Sciences*. 2011;1(3):205 – 208.
18. Chourasia RS, Bamne A, Shukla SN, Gohiya V, Pandey R. Estimation of stature from head length. *International Journal of Medical Science Research and Practice*, 2014;1(2):40-43.
19. Agarwal S, Agarwal S K, Jain S K. Correlation between the stature and cranial measurements in population of North India. *Acta Med Int*. 2014;1:99-102.

How to cite this article:

Mohammad Abdul Moeed *et al* (2017) 'Determining Stature From Head Length: A Correlation And Sexual Dimorphism Study on 8 – 12 Year Children in South India', *International Journal of Current Advanced Research,* 06(09), pp. 6170-6174. DOI: http://dx.doi.org/10.24327/ijcar.2017.6174.0887

****