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Social Determinants of Anthropometric Outcomes: A Differentiation and Correlation Study in South Indian Children aged 8 – 12 years

Anatomy

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ABSTRACT

Background: Several extrinsic factors interact with intrinsic factors to regulate and affect growth during childhood. Of the several extrinsic factors, social and cultural factors appear to be significantly linked with growth and nutrition.

Methods: The study was conducted over a period of 6 months over 400 school children from 8 different schools in the twin cities of Hyderabad and Secunderabad. Height and head length were taken as anthropometric measurements to represent general and regional growth patterns. Social factors were assessed and recorded from school records to the extent possible and through questioning.

Results: Significant differences were noted in children with greater calorie deficit children showing slower growth. Maternal and Paternal educational appeared to positively affect anthropometric outcomes. No significant differences were noted between children of joint and nuclear families whereas elder siblings of the same family appeared taller than their younger siblings. Childhood illnesses appeared to adversely affect anthropometric assessment of nutritional status

Conclusions: Height and head length appeared to correlate well with each other and social factors are documented to affect anthropometric outcomes.

KEYWORDS

Height, head length, maternal education, paternal education, family structure, birth order, calorie deficit, childhood illness, social

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. Height apart from being an impressive factor for personal identification and an area of immense interest to anatomists, anthropologists and forensic experts is also an important anthropometric tool in paediatrics.

Height 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 height of an individual and the measurements of other parts of the body which have stood the test of time.

Social and cultural factors are established to be important determinants of nutritional status in population. The standard method of nutritional assessment in by taking anthropometric measurements [1]. Height is described as a reliable method of anthropometry as it reflects growth over the past several months, contrary to weight which is an immediate marker [1]. Jelliffe while describing the ecology of malnutrition mentioned food habits, customs, beliefs, traditions and attitudes as deep rooted psychological beliefs associated with love for family and self image. He also described the role of family as an important institution in shaping these food habits [2]. The World Health Organization in its repost in 1977 mentioned that the nutritional status of an individual is determined by the very nature of society and the socioeconomic and political structure at national and international levels [3].

Length of the clavicle [4], foot length [5] and length of forearm bones [6] have been correlated consistently well with the height since a long time. Earliest reports correlating craniofacial anthropometry in terms of head length, and height appear to come from Saxena et al. who studied and correlated head length and height in Indian population in Agra [7]. Cranofacial anthropometry appears to be the best correlated with height [8].

The study was taken up with a primary objective of statistically analyzing the factors which affect height and head length and the effect of these factors on the correlation between their growths in South Indian children between 8 to 12 years age.

This study is expected to generate academic interest in public health domain with a translational ability to bring positive but acceptable changes in existing socio-cultural practices prevalent in our country to ensure appropriate measures are selectively diverted to the children who need them the most. It is of interest to the paediatrician in understanding the effect of several factors which impede or promote growth in children. It will also help in correlating the growth of the head which essentially represents regional growth patterns and height which is a generalized growth process. It also brings out the uniformity or irregularity in the growth patterns of different parts of the body.

Materials & Methods:

The study was conducted at eight schools in Hyderabad and Secundrabad. Of the 20 private schools, 83 government schools and 57 Zilla Parishad schools who consented for the study, four private, two government and two 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.

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 Center	Secunderabad	Private	40,000/-

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, parental literacy, socioeconomic status and morbidity 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 a stadiometer with spine held straight. The child's height was measured from vertex to the floor after 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 using a spreading caliper. Each anthropometric variable was measured twice by 2 investigators separately and noted down. If the average of both these investigators was 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. Hands were washed or sanitizing with isopropyl alcohol while taking measurements of consecutive children.

Nuclear family was considered as a family with parents and siblings and grand parents. Families where uncles and aunts live was considered as a joint family. Literacy was considered as having passed matriculation or 10th Class. Morbidity was defined as any absence for more than 3 days due to illness which warranted a visit to the hospital. Calorie deficit was calculated by orally questioning the child about the previous day's calorie intake. Caloric values of common Indian foods were calculated using the Indian Council for Medical Research (ICMR) – National Institute of Nutrition's (NIN) dietary guidelines for Indians [9]. Daily caloric requirement was considered with reference to ICMR expert group report 2010 designed for Indian population [10].

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 was analysed for significance using students t test and Z test, as applicable.

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

Table 2: Sample Characteristics

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.	BMI (centiles)	< 10th	12	3
		10th – 25th	62	15.5
		25th – 50th	100	25
		50th – 75th	149	37.25
		75th – 90th	56	14
		> 90th	21	5.25

Table 3 stratifies children based on their family structure and birth order. 20.5% came from joint families whereas 79.5% came from nuclear families. Maximum children were 2nd birth order (52.25%) followed by 37.5% belonging to 1st order and the least were 3rd order or more (10.25%). Table 4 illustrates the relative percentages of children based on their maternal and paternal educational status. Only 38% of the mothers were literate whereas 72.75% of fathers were literate.

Table 3: Distribution of children based on family type and birth order

S.No.	Characteristic	Variable	Frequency	Percentage
1.	Family Structure	Joint Family	82	20.5
		Nuclear Family	318	79.5
2.	Birth Order	1st	150	37.50
		2nd	209	52.25
		3rd and above	41	10.25

Table 4: Distribution of children based on parental literacy

S.No.	Characteristic	Variable	Frequency	Percentage
1.	Maternal Education	Literate	152	38
		Illiterate	248	62
2.	Paternal Education	Literate	291	72.75
		Illiterate	109	27.25

Table 5 below shows classification of children based on morbidity. 82.25% children showed no significant morbidity whereas 11.5% showed one spell of disease sufficient to cause absence for more than three consecutive days. 4.75% and 1.5% showed 2 and 3 spells of significant morbidity respectively in the past one year.

Table 5: Characteristics of children based on hospital visits warranting more than 3 days continuous absence from school in last one year

S.No.	No. of hospital visits	Frequenc	Percentag
1.	No visits warranting > 3 days absence	329	82.25
2.	One visit with > 3 days absence	46	11.5
3.	Two visits with > 3 days absence	19	4.75
4.	Three visits with > 3 days absence	6	1.5

Based on oral questioning all children were found to have some degree of calorie deficit. 35.75% showed mild calorie deficit whereas 49.25% showed moderate calorie deficit. 15% of the children showed severe calorie deficit with more than 850 Kcal/day. The same is tabulated in Table 6 below.

Table 6: Distribution of children based on calorie deficit

S.No.	Grade of deficit	Calorie Deficit (kcal/day)	Frequency	Percentage
1.	Mild	Up to 600	143	35.75
2.	Moderate	601 – 850	197	49.25
3.	Severe	>850	60	15

Table 7 shows general and gender specific correlation between head length and height. Altogether a positive correlation was observed between head length and height with a Pearson's correlation coefficient of 0.722. Females showed a higher correlation with an r value of 0.749 and males showed a slightly lower correlation with a correlation coefficient of 0.704.

Table 7: Correlation between height and head length

S.No.	Variables (cm)	Sample	Female	Male
1.	Head Length (x)	$r = +0.722$ $r^2 = 0.521$	$r = +0.749$ $r^2 = 0.561$	$r = +0.704$ $r^2 = 0.495$
2.	Height (y)			

Table 8 shows the statistical differences in the head length and height with reference to family structure.

There was no statistically significant difference based on family structure though height was slightly more in children from nuclear families. Head length and height correlate well with each other with a higher correlation in children with joint families and a slightly lower value in children from nuclear families.

Table 8: Differential characterisation and correlation for family structure and birth order

Parameters	Family Size				P
	Joint Family		Nuclear Family		
	Mean ± SD	Variance (Ϭ)	Mean ± SD	Variance (Ϭ)	
Height (cm)	136.45 ± 8.14	66.25	136.7 ± 8.36	69.88	0.806
Head Length(cm)	17.53 ± 0.55	0.30	17.5 ± 0.54	0.29	0.709
Coefficient of correlation(r)	0.782		0.707		

Table 9 as shown below differentiates the anthropometric measurements with reference to birth order. There is no statistically significant difference in head length and height based on the birth order. Variance is found to increase with increasing gestation. Head length appears to correlate well with height, with a tendency for stronger correlation with increasing birth order.

Table 9: Birth order and its effect of anthropometry of head length and height

Birth Order	Parameters				Coefficient of Correlation
	Head length (cm)		Height (cm)		
	Mean ± SD	Variance (Ϭ)	Mean ± SD	Variance (Ϭ)	
1st	17.5 ± 0.52	0.27	136.75 ± 7.96	63.36	0.684
2nd	17.51 ± 0.55	0.30	136.76 ± 8.48	71.91	0.733
3rd and above	17.51 ± 0.58	0.33	135.76 ± 8.77	76.91	0.783
P	0.768		0.993		

Table 10 throws light on the effect of parental education on anthropometric outcomes. Children of literate mothers were found to have slightly better growth compared to children of illiterate mothers, but this difference was not statistically significant. Variance in height was found to be more in the height of illiterate mothers. Correlation was found in both the groups. Children of literate fathers were found to have higher height which is statistically insignificant. Variance in height was noted to be higher in children of illiterate fathers. Similarly both groups had a positive correlation between height and head length but a relatively stronger correlation was observed in children of literate fathers.

Table 10: Maternal and Paternal Education as determinants of head length and height.

Parameters	Maternal Education				P
	Literate		Illiterate		
	Mean ± SD	Variance (Ϭ)	Mean ± SD	Variance (Ϭ)	
Height (cm)	136.82 ± 7.67	58.82	136.54 ± 8.68	75.34	0.738
Head Length (cm)	17.52 ± 0.56	0.31	17.5 ± 0.53	0.28	0.695
Coefficient of correlation (r)	0.71		0.73		
Parameters	**Paternal Education**				**P**
	Literate		Illiterate		
	Mean ± SD	Variance (Ϭ)	Mean ± SD	Variance (Ϭ)	
Height (cm)	136.91 ± 8.23	67.73	135.94 ± 8.49	72.08	0.307
Head Length (cm)	17.49 ± 0.55	0.30	17.56 ± 0.53	0.28	0.215
Coefficient of correlation (r)	0.751		0.663		

Table 11 shows the analysis of the effect of morbidity on growth and correlation of head length and height. No significant differences were observed between the groups and both were found to have a positive correlation. Children with a higher morbidity showed a less strong correlation whereas children with no significant illness in the past one year were found to have a better correlation.

Table 11: Differential growth and correlation with respect to morbidity

Morbidity	Parameters				Coefficient of Correlation
	Head length(cm)		Height (cm)		
	Mean ± SD	Variance (Ϭ)	Mean ± SD	Variance (Ϭ)	
No morbidity	17.5 ± 0.55	0.30	136.7 ± 8.38	70.22	0.733
Higher morbidity	17.54 ± 0.50	0.25	136.44 ± 7.99	63.84	0.666
P	0.533		0.806		

Table 12 highlights differential outcomes with reference to head length and height with different levels of calorie deficit. Children with less calorie deficit were found to have better growth and hence better anthropometric means, whereas children with less food availability having higher deficits showed lowering of growth potentials. All levels of calorie deficits showed significant positive correlation but correlation was stronger in children with mild deficit or better food availability and was less strong in children with severe deficit.

Table 12: Differential anthropometry of Height and head length in relation to calorie deficit

Morbidity	Parameters				Coefficient of Correlation
	Head length (cm)		Height (cm)		
	Mean ± SD	Variance (Ϭ)	Mean ± SD	Variance (Ϭ)	
Mild	17.67 ± 0.57	0.32	139.48 ± 8.02	64.32	0.744
Moderate	17.51 ± 0.51	0.26	136.58 ± 7.47	55.80	0.651
Severe	17.13 ± 0.38	0.14	130.13 ± 7.99	63.84	0.658
P	<0.001	<0.001			

Discussion:

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 [8]. Danborno et al also reported strong correlation between head length and stature [11].

Head length did not vary much depending on the family type. Average height also did not vary much with children from nuclear families having a height of 136.7cm and those from joint family with 136.45cm. Kumari et al also opined that family type does not affect the height much [12]. Previous studies could not be found who considered family size in relation to head length.

Birth order appeared to be an important indicator of velocities of growth in height and head length. The means of heights and head lengths don't show significant variation in these anthropometric measurements when statistically analysed but the variance in the groups appear to increase with increase in the birth order thereby representing a more uniform type of growth in children born early compared to the irregular type of growth in later order children due to diminishing resources and reduced per capita expenditure on nutrition. Mikko et al reported the elder siblings to be taller than younger siblings in his study on children below 15 years of age [13]. This shows the dynamicity of social, economic and cultural factors with deteriorate with increasing family size.

Head length did not appear to be affected by the level of maternal education but height was found to be higher in children of literate parents. This appears to be contrary to the findings of Abbi et al who described statistically significant differences in craniofacial anthropometry, with greater values being noted in children of educated parents [14]. This could be attributed to low levels of maternal literacy in the population studied. Though the difference in height was statistically insignificant, the variance noted in the heights of children of educated vs. uneducated mothers was 58.82 vs. 75.32 and the variance with respect to paternal education, was found to be low in educated fathers with Ϭ = 67.73 compared to illiterate fathers whose children had a Ϭ value of 72.08. A lower variance here implicates uniform growth rather than irregular growth on a population scale. McEniry et al reported better anthropometric measurements in Asian school children whose parents were educated compared to those whose parents were not [15]. Again we have observed a huge discrepancy in the gender specific literacy rate with 72.75% of fathers having passed at least matriculation compared to 35% of mothers who were termed literate. This points towards a social factor which determines gender equality and hence literacy, which can be extrapolated to child health. Paternal literacy appeared to bring in stronger positive correlations with children of literate fathers showing an r value of 0.75 whereas children of illiterate fathers showed an r of 0.663, between head length and height, whereas such a difference in correlation was not observed with maternal literacy. If correlation between height and head length with reference to the regression formula for that population, race and age is considered as a marker for uniformity in regional and general growth parameters, we can draw conclusions that maternal literacy does not vary anthropometric outcomes, as good as paternal literacy which brings us to a conclusion that mothers play a lesser decision making role in the lives of their children regarding nutrition compared to their fathers which points towards a patriarchal society, where the father alone decides what he and his family eat.

The mean height was higher in children who didn't have serious episodes of illness in the last year compared to those children who had at least one such episodes. We have again noted that this difference is not statistically significant. Victor et al reported that childhood morbidities like diarrhea and respiratory tract infections caused significant stunning of Bangladeshi children [16]. Correlation of head length and height appears to vary depending upon childhood morbidities. An extent of +0.733 was noted by Pearson's coefficient among children who did not have a serious episode of illness in the past year compared to +0.666 on a scale of 1 for children who had one or more episodes of such illness.

Calorie deficit was seen to significantly determine anthropometric outcomes owing to its aetiological role in protein energy malnutrition. The differences in heights based on the degree to caloric deficit are found to be significant. Similarly the differences in head lengths were found to differ significantly with respect to the degree of malnutrition. Our findings appear to be in close agreement with Shrivastava et al who reported similar findings in their study [17].

Conclusions:

Several social and cultural practices affect growth in children. These are deep rooted and are very dear to every of the community that holds it. Some of these practices can be deleterious for the child in her active years of growth and stop a child from achieving her full genetic potential. There is hence a need for social intervention to bring about a gradual and sustained change to ensure the health of children in this country. Social factors also seem to affect the regularity of growth.

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