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CEPHALIC GROWTH PATTERN AND NUTRITIONAL STATUS AFTER 5 YEARS OF AGE: A CROSS SECTIONAL STUDY AMONG GIRLS AND BOYS OF A CENTRAL INDIAN CITY-SAGAR (MP)

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ABSTRACT

The present cross-sectional study was designed to find out the correlation between cephalic growth and nutritional status of 612 girls and boys aged 5 to 18 years, residing at Sagar town in District Sagar, Madhya Pradesh. Head length, head breadth, head circumference, height and weight were measured using Spreading caliper, Anthropometer rod, tape and portable digital weighing machine. Cephalic indices and body mass indices were calculated in MS Excel. Results showed that head length and head breadth increased with advancing age among girls and boys. It was also found that boys have longer and broader head than girls. The mean cephalic index showed a decreasing trend. A total of 75% girls and boys have mesocephalic and dolichocephalic type of head. The association between head circumference and nutritional status was found significant among girls (t-value are significant at 0.5% level).

Key words: Cephalic index, Body mass index, Z score, Underweight, stunted, undernourished.

INTRODUCTION

India is one of the countries where child malnutrition is severe and also malnutrition is a major underlying cause of child mortality. All the three National Family Health Surveys (NFHS) reveal that malnutrition is not the result of a single cause; the problem is multifaceted, the causes acting singly or in combination with other complex factors like poverty, purchasing power, health care, ignorance on nutrition and health education, female illiteracy, social convention etc.

Growth studies have demonstrated that malnutrition may cause serious impairment of growth. Malnutrition may also result from diseases which decreases the appetite and interfere with digestion and assimilation processes. In developing countries malnutrition in children is one of the inherent health problems. According to

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National Nutrition monitoring Bureau the incidence of severely malnourished children in our country was as high as 20%.

The changes in body dimensions and proportions during broad phases of growth take place as a result of differential rate of growth. It is evident from present study that an individual has different body proportions at different ages. In order to attain adult proportions different parts of the body must grow at different rates and at different time and each part must reach its mature dimensions at different stages.

Population of different ethnic stock is significantly varied in their cephalic features like head length, head breadth, head circumference and also in cephalic index. Approximately 70-80% growth of head and brain is gained before 5-6 year of age after that very slow growth can be seen in head length and breadth. The length, breadth and circumference of head grow slowly after 5 year of age (Maiti et al., 2012).

The head length, breadth and circumference are a reflection of cranial growth and are also considered to be an indicator of nutritional status. Head Circumference is a valuable indicator for the assessment of growth and undernutrition among children (WHO, 2007, Anzo *et al.*, 2002; Zaki *et al.*, 2008). To determine physical growth and nutritional status of children head circumference is an important parameter (Savage *et al.*, 1999).

Anthropometry is the universally applicable, inexpensive and non-invasive technique available to researchers for the assessment of the size and proportion of the human body, and is a very useful tool in the assessment of growth and nutrition (Hamieda and Billot 2002). The technique of anthropometry has been successfully utilized by different researchers to assess and document the growth and nutritional status of various human communities, including those from India (Adak *et al*. 2006, Gautam *et al.* 2006; Gautam 2007a; Gautam *et al.* 2014 & 2015 Bisai *et al.* 2008 and 2010; Gautam and Thakur 2009; Thakur and Gautam 2014 and 2015).

In the present study, an attempt has been made to find out correlation between nutritional status and head circumference and types of cephalic growth pattern among boys and girls of 5-18 years of age.

SUBJECT AND METHOD

The sample of the present study were recruited from fourteen schools of Sagar Town, District Sagar, Madhya Pradesh. A total of 612 samples consist of 312 girls and 300 boys, aged 5-18 years of age. The anthropometric measurements were taken during the month of September 2013 to February 2014.

Five Anthropometric measurements namely height, weight, head length, head breadth and head circumference were taken on each individual following the standard procedure as described by Gibson (1990). All measurements were taken with all possible caution maintaining uniformity and accuracy in the techniques, after undergoing extensive training. Portable digital weighing machine,

anthropometer rod, tape and spreading caliper were used to measure the anthropometric measurements. Body mass Index (BMI), cephalic index, Z-score for height for age, weight for age and Body mass Index (BMI) for age were computed. The detail of methodology is already described elsewhere (Thakur and Gautam 2014 and 2015).

RESULT

Age wise mean and S.D. of head length, mean head breadth and mean cephalic index of sample boys and girls are presented in Table 1. It is apparent that among girls and boys head length and head breadth has increased with age. It is also notice that boys have longer and broader head than girls. Minimum mean head length was 16.7 cm and 15.8 cm for 5 year of age boys and girls respectively; whereas maximum mean head length of boys at 7 years of age is 18.8 cm and among girls is 17.2 for 18 year of age. Among boys minimum mean head breadth is 12.6 cm for 5 and 6 year of age and maximum head breadth is 14.1 cm for 17 and18 year of age. Among girls minimum mean head breadth is 12.7cm at 5 year of age and maximum head breadth is 13.5cm for 17 year of age. For better elucidation of growth pattern, age wise measurements of cephalic region are plotted in Figure 1.

The distribution of girls and boys as per cephalic type is presented in Table 2. It was found that majority (75%) of girls and boys are mesocephalic and dolicocephalic. It is apparent from Table that 42.6% girls and 33% boys are Mesocephalic, 43% boys and 26.6% girls are Dolicocephalic, 22.4 % girls and 7.64% boys are Brachycephalic, 5.8% girls and 3% boys are Hyperbrachycephalic and 13.33% boys and 2.6% girls are hyper dolicocephalic (Figure 2).

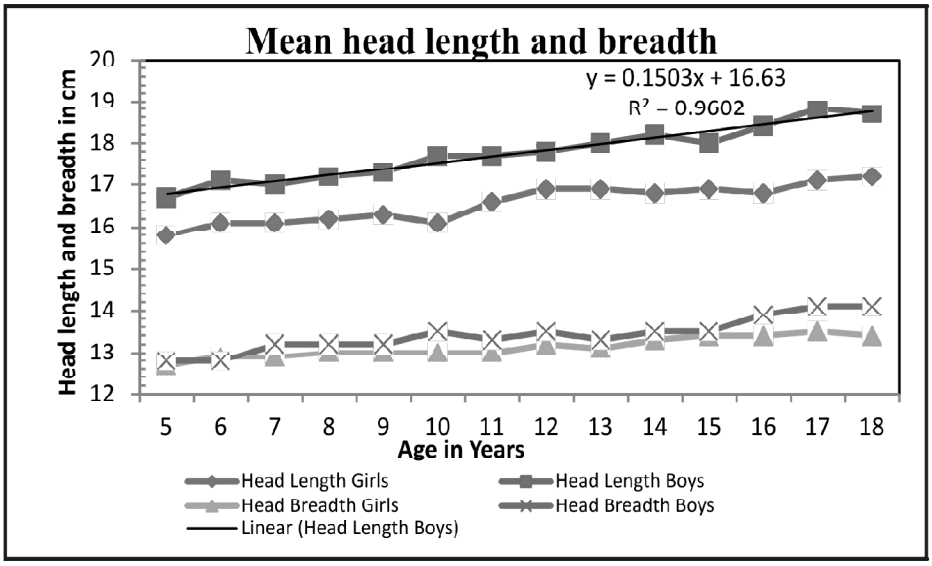

Figure 1: Age wise mean head length and head breadth of school going girls and boys of Sagar (M.P.)

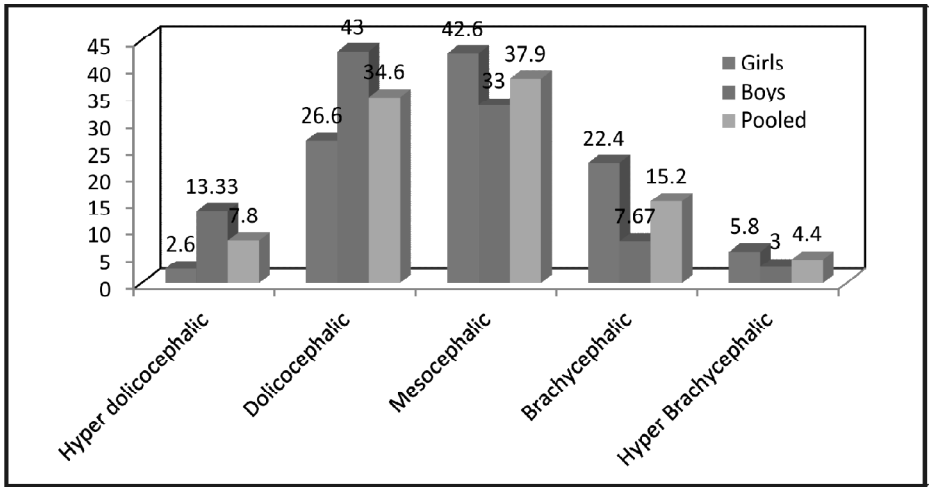

Figure 2: Types of cephalic among girls and boys of 5 to 18 year of Sagar

Table 3 presents the mean head circumference of girls and boys who were underweight, stunted, undernourished and normal. It was found that the undernourished girls have lower head circumference than normal one; whereas among boys there is no difference. The underweight girls have lower head circumference than those girls who have normal BMI whereas among boys trend is reverse underweight boys have higher head circumference than the normal weight. Similarly, the stunted girls have lower head circumference than those girls who have normal height whereas among boys, the trend is reverse; the stunted boys have higher head circumference than those boys who have normal height.

DISCUSSION

The present study provides valuable information between nutritional status and head circumference as well as head breadth, head length and cephalic types among boys and girls of 5-18 years of age.

Earlier many scholars studied cephalic region for different purposes. Likus *et al.* (2014) studied cephalic index of children under 3 years of age. Franco *et al.* (2013) studied standardization of terminology in the medical sciences, which is useful for both clinical practice and scientific research. Gujaria *et al.* (2012) studied cephalic index in normal and sickler adult population of three states Maharashtra, Andhra Pradesh and Gujarat of India. Most of scholars attempted to study the cephalic indices for determining the racial difference, because the cephalic indices constitute the most important characters for determining the racial differences (William *et al.* 1995).

In the present study it was found that 42.6% girls and 33% boys were Mesocephalic, whereas 43% boys and 26.6% girls were Dolicocephalic, 22.4 % girls and 7.64% boys were Brachycephalic. The mean cephalic indexes for girls were found

79.43±5.2cm and for boys were 75.7±6.6 cm. These finding is minutely different from the study carried out on the students of Manipur by Yagain et al (2012) where the mean cephalic index for male was 77.92±5.2 and for female was 80.85±7.71. Most of their subjects were brachycephalic. Anitha et al (2011) studied students of north Indian origin in the age group of 17 – 20 years, they found the mean cephalic index for male was 79.14±4.72 and for female it was 80.74±3.97. Mahajan et al (2009) studied students of Punjab aged 17- 23 years, the mean cephalic index for male was 81.34 and for female were 85.75. Lobo et al. (2005) studied subjects of Gurung village, Nepal; the mean cephalic index for male was 83.10±6.08 and for female was 84.60±5.14. Most of their subjects were brachycephalic. Shah and Jadhav (2004) also studied students of Gujarat; in their study the mean cephalic index for male was 80.42 and for female were 81.20. Most of their subject belongs to mesocephalic group. From all discussed studies, it seems that the value of cephalic index among male is lower than female.

In the present study, z score for stature, body weight and BMI were calculated to know the impact of delayed growth and nutritional deficiency. It was found that there is positive correlation of head circumference and nutritional status among girls whereas negative or no correlation between head circumference and nutritional status among boys. The circumference is a reflection of cranial growth and is also considered to be an indicator of past nutritional status (e.g., marginal cases of protein energy malnutrition) and development of the brain and brain size (Leiva Plaza *et al.,* 2001; Ivanovic *et al.,* 2004; Singh and Bisnoi, 2005; Laron *et al.*, 2012). It is also one of the most significant findings in physical examinations, especially in evaluation of development and early diagnosis of neurological disorders among children (Karabiber *et al.,* 2001; Elmali *et al.,* 2012; Talebian *et al.,* 2013). A rapid increase in Head Circumference is also related to the histological changes in the brain during early infancy (Talebian *et al.,* 2013). In the present study, significant difference was found in head circumference and undernourished and normal girls.

CONCLUSION

It was found that head length and head breadth increased with age among girls and boys. It was also found that boys have longer and broader head than girls. The mean cephalic index was also found to decrease with growing age. A total of 75% girls and boys were found to have mesocephalic and dolichocephalic types of head. The head circumference was found to be associated with nutritional status as there is significant difference in mean head circumference of normal and undernourished girls.

Table 1: Age wise mean and standard deviation of head Length, head breadth and cephalic index of school going girls and boys of Sagar (M.P.)

Age	*Sample size*		*Head Length*				*Head Breadth*				*Cephalic Index*			
	Girls	*Boys*	*Girls*		*Boys*		*Girls*		*Boys*		*Girls*		*Boys*	
			Mean	*SD*	*Mean*	*SD*	*Mean*	*SD*	*Mean*	*SD*	*Mean*	*SD*	*Mean*	*SD*
5	20	20	15.8	0.6	16.7	0.6	12.7	0.5	12.8	0.6	80.4	4.0	76.7	4.3
6	24	22	16.1	0.7	17.1	0.7	12.9	0.4	12.8	0.5	80.4	4.5	75.4	4.0
7	22	23	16.1	0.6	17.0	0.8	12.9	0.5	13.2	0.6	80.2	3.9	77.5	4.4
8	21	23	16.2	0.7	17.2	0.5	13.0	0.5	13.2	0.4	80.5	5.2	77.0	3.6
9	28	23	16.3	0.6	17.3	0.7	13.0	0.4	13.2	0.6	79.8	3.8	76.6	4.6
10	21	23	16.1	0.6	17.7	0.8	13.0	0.5	13.5	1.0	80.7	4.8	76.3	6.6
11	23	22	16.6	0.5	17.7	0.7	13.0	0.4	13.3	0.5	78.0	3.4	75.3	4.1
12	23	22	16.9	0.6	17.8	0.7	13.2	0.7	13.5	0.6	78.7	4.4	76.2	4.7
13	22	20	16.9	0.6	18.0	0.5	13.1	0.6	13.3	0.5	77.9	3.7	73.8	2.5
14	21	22	16.8	0.6	18.2	0.7	13.3	0.6	13.5	0.5	79.1	5.2	74.4	4.2
15	20	20	16.9	0.6	18.0	0.6	13.4	0.5	13.5	0.7	79.3	3.6	74.7	3.9
16	20	20	16.8	0.5	18.4	0.5	13.4	0.4	13.9	0.7	79.9	3.9	75.3	3.2
17	25	20	17.1	0.6	18.8	0.8	13.5	0.5	14.1	0.7	79.0	3.4	75.4	5.1
18	22	20	17.2	0.5	18.7	0.8	13.4	0.4	14.1	0.6	78.2	3.3	75.1	4.6

Table 2: Cephalic Types among girls and boys

Category	*Girls*		*Boys*		*Total*	
	N	*%*	*N*	*%*	*N*	*%*
Hyper dolicocephalic	8	2.6	40	13.33	48	7.8
Dolicocephalic	83	26.6	129	43	212	34.6
Mesocephalic	133	42.6	99	33	232	37.9
Brachycephalic	70	22.4	23	7.67	93	15.2
Hyper Brachycephalic	18	5.8	9	3	27	4.4
Total	312	100	300	100	612	100.0

Table 3: Head circumference and nutritional status

Level of nutrition	*Girls*			*Boys*		
	Mean	*SD*	*t-test*	*Mean*	*SD*	*t-test*
Under nourished	50.0	1.6	-2.46*	51.8	2.4	0.00
Normal BMI	51.6	2.1		51.8	2.4	
Under weight	50.8	2.0	-1.50	52.3	2.7	0.68
Normal weight	51.5	2.1		51.8	2.3	
Stunted	50.9	2.2	-1.16	52.4	2.8	1.10
Normal stature	51.5	2.1		51.7	2.3	
Pooled data	51.5	2.1		51.8	2.4	

* t-test significant $p<0.05$

REFERENCES

Adak, D.K., Gautam, R.K., Bharati, S., Gharami, A., Pal, M. and P. Bharati., 2006. Body mass index and chronic energy deficiency of adult males of central Indian populations. *Human Biology.*, 78(2): 161-178.

Anitha, M. R., Vijaynath, V., Raju, G.M. and S.N. Vijayamahantesh., 2011. Cephalic index of North Indian population. *Anatomica Karnataka*., 5(1): 40 – 43.

Anzo, M., Takahashi, T., Sato, S. and N. Matsuo., 2002. The cross-sectional head circumference growth curves for Japanese from birth to 18 years of age: the 1990 and 1992-1994 national survey data. *Ann Hum Biol.,* 29: 373-88.

Bisai, S., Bose, K. and A. Ghosh., 2008. Nutritional status of Lodha children in a village of Paschim Medinipur district, West Bengal. *Indian J Public Health.,* 52:203-206.

Elmali, F., Altunay, C., Mazicioglu, M.M., Kondolot, M,. Ozturk, A. and S. Kurtoglu., 2012. Head circumference growth reference charts for Turkish children aged 0-84 months. *Pediatr Neurol.,* 46: 307-311.

Gautam, R., (2007a). Physical Growth and Body Composition among two female populations of Central India— Baiga (Primitive Tribe) and Brahmin. In: *Contemporary Studies in Anthropometry A.N. Sharma, (Ed).*Sarup and Sons, New Delhi. Pp 139-147.

Gautam, R.K., and R., Thakur., 2009. Biosocial correlates of Nutrition and chronic energy deficiency among adult females of two ecological zones in Madhya Pradesh and Uttrakhand. India. Mal J Nutr., 15(2):137–53.

Gautam, R.K., Adak, D.K., Gharami, A.K. and T. Datta., 2006. Body Mass Index in Central India: Inter District Variation. *Anthropologischer Anzeiger*, 64, (4):447-461.

Gautam, R.K., Adak, D.K., Pal, M. and P. Bharati., 2014. Morphometric variation among the Central Indian populations. *Human Biology Review*, 2(2), 153-175.

Gautam, R.K., Jhariya, J. and P. Kumar., 2015. Globally Declining Population of Women Folk Causing Sex Imbalance Is a Serious Concern: An Analysis of Sex Ratio around the Globe. *Journal of Anthropology,* Vol. 2015, Article ID 431458, http://dx.doi.org/10.1155/2015/431458.

Gibson, R.S., 1990. Principal of Nutritional Assessment. Oxford University Press: New York.

Gujaria, I.J. and V.M. Salve, 2012. Comperison of cephalic index of three states of India. *International Journal of Pharma and Bio Sciences, 3*(3), 304–311.

Hamieda, J. and Billot, L., 2002. Nutritional status of Libyan children in 2000 compared with 1979. *East Mediterr Health* J.,8:1–10.

Ivanovic, D.M., Leiva, B.P., Pérez, H.T., Olivares, M.G., Díaz, N.S., Urrutia, M.S., Almagià, A.F., Toro, T.D., Miller, P.T., Bosch, E.O. and C.G. Larraín, 2004. Head size and intelligence, learning, nutritional status and brain development. Head, IQ, learning, nutrition and brain. *Neuropsych*., 42: 1118-31.

Karabiber, H., Durmaz, Y., Yakinci, C., Kutlu, O., Gumusalan, Y., Yologlu, S., and K. Yalaz., 2001. Head circumference measurement of urban children aged between 6 and 12 in Malatya, Turkey. *Brain Dev*.,23: 801-804.

Laron, Z., Iluz, M. and R. Kauli. 2012. Head circumference in untreated and IGF-I treated patients with Laron syndrome: comparison with untreated and hGH-treated children with isolated growth hormone deficiency. *Growth Horm IGF Res.,* 2: 49-52.

Leiva, P.B., Inzunza, B. N., Pérez, T. H., Castro, G.V., Jansana, M.J.M., Toro, D.T., Almagiá, F. A., Navarro, D.A., Urrutia, C.M.S., Cervilla, O.J. and M.D. Ivanovic, 2001. The impact

of malnutrition on brain development, intelligence and school work performance. *Arch Latinoam Nutr.,* 51: 64-71.

Likus, W., Bajor, G., Gruszczyñska, K., Baron, J., Markowski, J., Machnikowska-Soko³owska, M. and T. Lepich., 2014. Cephalic index in the first three years of life: study of children with normal brain development based on computed tomography. *The Scientific World Journal*, 502836. *http://doi.org/10.1155/2014/502836*

Lobo, S.W., Chandrasekhar, T. S. and S. Kumar., 2005. Cephalic index of Gurung community of Nepal – an anthropometric study. *KUMJ.,* 3(3):263-265.

Mahajan, A., Khurana, B.S. and A.P.S. Batra., 2009. The study of cephalic index in Punjab students. *Journal of Punjab Academy of Forensic Medicine & Toxicology*., 9(2): 15-17.

Maiti, S., Ali, K.M, Ghosh and D, S. Paul., 2012. Assessment of head circumference among pre-school children of Midnapore town, west Bengal using WHO (2007) recommended cut-off points. *Int J Prev Med*., 3: 742-4.

Mitra, M., Kumar, P.V., Ghose, R. and P. Bharti., 2002. Growth Pattern of the Kamars – A Primitive Tribe of Chhattisgarh, India. *Coll. Antropol.*, 26 2: 485–499 UDC 572.512:612.65(540).

Mondal, N. and J. Sen., 2010. Prevalence of undernutrition among children (5-12 years) belonging to three communities residing in a similar habitat in North Bengal, India. *Ann Hum Biol.,* 37: 198-216.

Shah, G.V. and H.R. Jadhav., 2004. The study of cephalic index in students of Gujarat. *Journal of Anatomical society of India*, 53(1):25-26.

Singh, S. and I. Bisnoi., 2005. Trend of growth in mid-arm circumference and head circumference of preschool female children of Faizabad District, U.P. Indian. *J Prev Soc Med*, 36: 143-6.

Talebian, A. Soltani, B., Moravveji, A., Salamati, L. and M. Davami., 2013. A study on causes and types of abnormal increase in infants' head circumference in Kashan/Iran. *Iran J Child Neurol,* 7: 28-33.

Thakur, R. and R.K. Gautam., 2014. Prevalence of undernutrition among School going boys (5-18 years) of a Central Indian city (Sagar). *Human Biology Review*, 3 (4), 364-383.

Thakur, R. and R.K. Gautam., 2015. Nutritional status among boys and girls of a central Indian Town (Sagar). *Anthropological Review*, 78 (2):197–212.

Thakur, R. and R.K. Gautam., 2015. Assessment of nutritional status among girls of 5-18 years of age of a Central Indian City (Sagar), *4*(4), 325–336.

WHO Child Growth Standards. 2007. Head circumference-for-age, arm circumference-for-age, triceps skin fold-for-age and subscapular skin fold-for-age. Methods and Development. World Health Organization: Geneva.

Williams, P.L., Bannister, L.H., Dyson, M., Collin, Dussek J.E. and J.W.M. Ferguson., 1995. *Gray' s Anatomy*, 38th Edn, Churchill Livingstone, Edinburgh, London, 609-612.

Yagin, V.K., Pai, S. R., Kalthur, S.G. and I. Hemalatha., 2012. Study of cephalic index in Indian students. *Int. J Morphol.,* 30(1):125- 129.

Zaki, M.E., Hassan, N.E. and S.A. El-Masry. 2008. Head circumference reference data for Egyptian children and adolescents. *East Mediterr Health J,* 14: 69-81.