Relationship between Growth Pattern and Head Dimensions in Nigerian Children (5-15 Years)

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Citation

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Abstract

The aim of this study is to establish pattern of head dimensions of Nigerian children 5-15 years. The subjects of this study were 377 Nigerian children, boys (n = 173) and girls (n = 204) with mean age 9.87 + 3.22 and 10.11 + 302 respectively. Head dimensions traits measured were head length, head breadth and head circumference while cephalic index was calculated. Subjects height and weight were also measured all measurement were conducted following standard protocols. Student t-test was used to show significant difference while Pearson correlation was used to establish relationship between the variables considered. Of all the parameters considered only head length and cephalic index showed significant difference with P<0.001. The mean head length of boys was found to be greater than those of girls while cephalic index in girls was statistically different (P <0.001) than those of boys. Head breadth, head circumference, height and weight statistically showed no significant difference though the mean values in girls are slightly greater than those in boys. Head length was observed to increase unsteadily from 5-15 years for both sexes. Cephalic index also increased down the age classes with mean value greater in girls than in boys. The correlation matrix showed that all the head dimensions correlates significantly with height and weight in boys and girls (P <0.05, P <0.001) but cephalic index showed no correlation with boys' height and weight but it correlates with girls weight and not their height. This study shows gradual increase in the growth of head dimensions with difference between boys and girls in head length, head circumference and cephalic index. Although cephalic index showed occurrence of brachycephalic head form, mesocephalic head form is more predominant. Sexual dimorphism is clearly demonstrated between boys and girls in head length and cephalic index.

INTRODUCTION

Head dimension changes followed different pattern in different population. In the European derived and American black population the skull has become narrower and the vault has increased in height and length ([1]). The key factor in the process of head dimension changes is small increase in the growth rate in a specific direction during infancy and childhood. These increases involve the posterior cranial base and occur in a posterior inferior or lateral direction resulting in significant changes of the vault shape ([1], [2]). Head growth occurs as its most rapid rate during the first year of life. The head grows to almost 80 % of the adult size during the first year of life then grow at slower pace. If the head is too large or growing too quickly or on other hand if the head is too small or growing too slowly, these are signs of possible problems.

Age, weight, height, and cephalic variables such as head breadth, head length, head circumference and cephalic index are all anthropometric parameters which are used to deduce the pattern of growth in children. Nutritional levels and environmental conditions favour the full expression of the genetic potential for growth of the above variables ([3]). However growth in children is known to be population specific especially head dimension ([4]). This specificity is associated with industrialization nutritional habit, good social economic environment, improvement of living condition etc. Thus it was observed that in industrially underdeveloped rural regions significant secular changes of body height and craniofacial proportion failed to take place ([5]).

There is paucity of anthropometric data in growth of children in Nigeria, especially data that relate to head dimension. In the present study we seek to investigate the pattern of growth on head dimension and relationship between head dimensions and body stature.

MATERIALS AND METHODS

SUBJECTS

The study was a cross sectional study consisting of 374 (boys n = 173 and girls n = 204) from ages 5 to 15 years, with mean age 9.87 ± 3.22 and 10.11 ± 3.02 respectively. The children sampled were from three different schools in Zaria namely: Demonstration Secondary School Ahmadu Bello University, Zaria, Staff School of the Ahmadu Bello University, Zaria and God's Time Secondary School Samaru, Zaria. With the aid of questionnaire the following variables were measured on each subject; weight, height, head length, head breadth, head circumference.

ANTHROPOMETRY

Measurements were taken following standard protocols as described by Lohman et al ($_6$). Body height and weight was measured to the nearest 0.1cm and 0.1kg respectively using a stadiometer with subject on bare foot wearing minimal clothing. Head length was measured using a spreading caliper (Holtain Ltd, UK). The measurement was taken at the distance between the most prominent point between the eyebrow (glabella) and the backward projection of the head to the nearest 0.1cm. Head breadth was also measured using a spreading caliper. The measurement was to the greatest transverse diameter of the head located just over the parietal bones to the nearest 0.1cm. Head circumference was measured using a nonflexible tape measure. The measurement was taken around the occiput or posterior aspect of the skull to the most anterior portion of the frontal bone to the nearest 0.1cm. Cephalic index was calculated as head breadth/head length x 100.

STATISTICAL ANALYSIS

Data were expressed as mean ± standard deviation (SD), Student t-test was used to test for significance difference in head breadth, head length, head circumference and cephalic index. Pearson correlation was used to establish relations between weight, height and head dimension variables. The difference and relationships were deemed statistically significant when $P < 0.05$. SigmaStat 2.0 (Systat Inc, Point Richmond, CA) was used for the statistical analysis.

RESULTS

The mean and standard deviation of weight, height and head dimensions in boys and girls are presented in Table 1. Head length and cephalic index showed significant difference in boys and girls with $P < 0.001$. Fig. 1, shows mean and standard deviation of head length in boys and girls from 5 years to 15 years. Age 5 showed a significant difference with $P < 0.01$. Ages 6, 11 and 14 showed that head length differed among boys and girls with $P <0.001$. Ages 7, 12 and 13 showed a significant difference considered as $P <0.05$. The mean and standard deviation of head breadth in boys and girls 5 years to 15 years is shown in Fig. 2, no significant difference was seen in any of the age classes. Fig. 3, shows the mean and standard deviation of head circumference. Only age 5, 9 and 15 showed a significant difference with $P <0.05$. Mean and standard deviation of cephalic index in boys and girls from 5 years to 15 years are presented in Fig. 4. Age 5, 6 and 12 showed significant difference with $P < 0.001$, $P <0.05$ and $P <0.05$ respectively.

Table 2 shows general correlation matrix in weight and height in boys and girls with head dimension. Majority of the variables correlated at $P <0.05$ and $P <0.001$. The correlations of the variables depend on the relationship that exists among the variables. Head length correlates with weight and height in both boys and girls. There is also relationship between the head breadth of boys and girls with their height and weight. Head circumference also correlated with weight and height of boys and girls. Cephalic index showed no correlation with the weight and height of boys but showed correlation with weight of girls but not their height

Figure 1

Table 1: Mean and standard deviation of weight, height and head dimension in boys and girls

Parameters	Boys n = 174 Mean ± SD	Girls n = 204 Mean ± SD	t	P
Weight (kg)	32.67 ± 12.19	34.01 ± 12.76	-1.034	0.30
Height (cm)	137.36 ± 17.26	138.07 ± 16.42	-0.411	0.68
Head length (mm)	182.73 ± 6.69	178.02 ± 7.30	6.462	<0.001
Head breadth (mm)	141.54 ± 6.54	142.36 ± 7.47	-1.122	0.26
Head circumference (mm)	538.05 ± 19.04	540.54 ± 27.11	-1.014	0.31
Cephalic index	77.51 ± 3.68	80.03 ± 4.06	-6.23	<0.001

Figure 2

Table 2: Correlation between weight, height and head dimension in boys (n = 173) and girls (n = 204) from 5 to 15years.

Parameters	Boys n = 174		Girls n = 204	
	Weight	Height	Weight	Height
Head length (mm)	0.47**	0.46**	0.50*	0.49*
Head breadth (mm)	0.52**	0.46*	0.55*	0.49*
Head circumference (mm)	0.67**	0.65**	0.52*	0.55*
Cephalic index	0.14	0.09	0.16*	0.10

*P < 0.05 **P < 0.001

Figure 3

Figure 1: Head length of boys and girls from 5 to 15 years. Error bars indicates standard deviation. There is statistical significant difference at age 5 (P

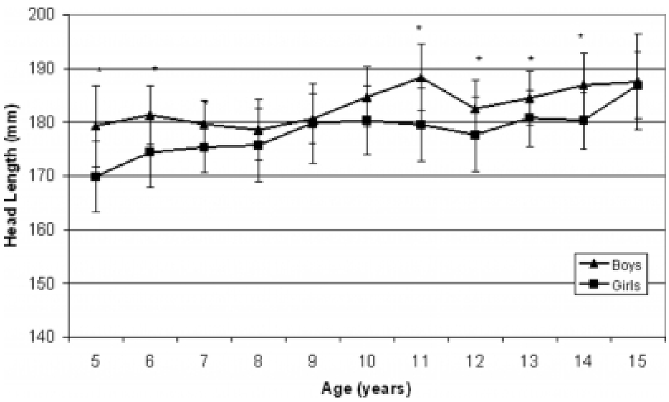


Figure 4

Figure 2: Head breadth of boys and girls from 5 to 15 years. Error bars indicate standard deviation. No statistical significant difference was obtained between boys and girls and across all ages in both sexes.

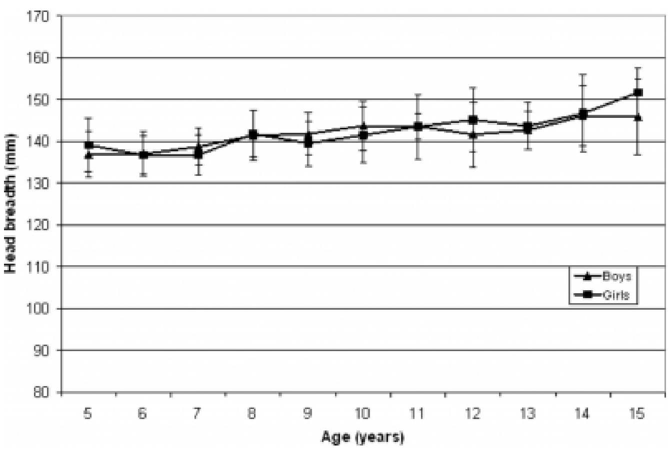


Figure 5

Figure 3: Head circumference of boys and girls from 5 to 15 years. Error bars indicate standard deviation. There is statistical significant difference at age 5 (*P < 0.001) and 9, 15 (*P

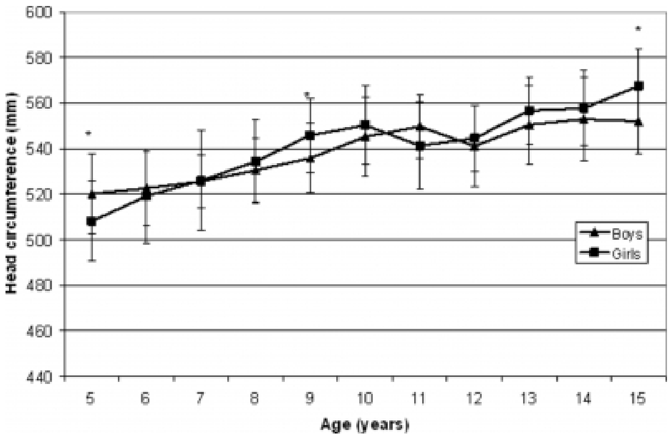
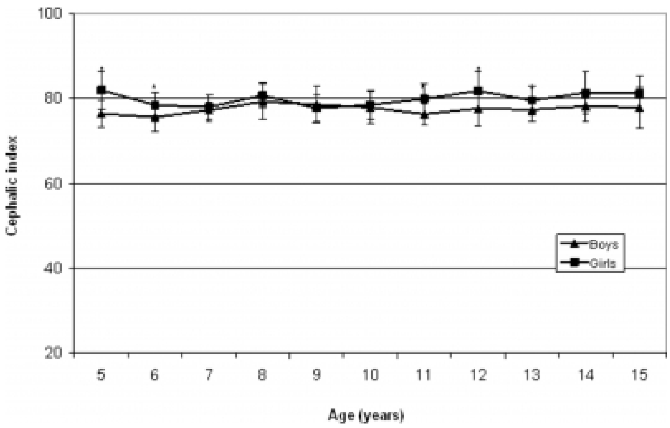


Figure 6

Figure 4: Cephalic index of boys and girls from 5 to 15 years. Error bars indicate standard deviation. There is statistical significant difference at age 5, 6 and 12 (*P



DISCUSSIONS

The result obtained revealed that head length and cephalic index showed significant difference between the boys and girls. Head length showed significant difference at ages 5, 6, 7, 11, 12, 13 and 14. The difference shown at ages 5, 6 and 7 could be due to slight increase in head growth at these ages. Differences shown in ages 11, 12, 13 and 14 could be due to changes in growth at attainment of pubertal age. There was also an unsteady increase in head length from 5 years to 15 years for both sexes and all age classes combined. However, the mean head length for boys is greater than that of girls for age classes. This is speculated to be due to the fact that head length is related to posterior growth of the brain and development of super structures ([7]).

It is reasonable to deduce that causes of secular changes are different or that reactions to common factors between boys and girls are different. It was speculated that earlier attainment of adult size reduces the time used for later posterior growth of the head and this leads to shorter cranial length (2). This is most especially seen in girls because girls attain adult size earlier than boys of the same age, and that could reduce the time used for later posterior growth of the head. It could also be deduce that the Lamboid suture in girls appears to close earlier than that in boys.

Also environmental influence on prenatal and post natal exposure may be different in boys and girls leading to higher head length in boys. It may also be attributed to differences in the dominant direction of growth vectors (2). Also, expanding neural mass by neural fibers may preferentially be in the vertical direction in boys. It may well be explained that this mainstream of thought could have been responsible for the very little difference in head length in boys and girls.

Regarding head breadth no significant difference was noted for all the age classes. Although it was observed that the mean head breadth in girls is greater than that of boys for all the ages, though statistical test showed insignificant difference between the mean head breadth of boys and girls. It could be due to dominant lateral direction of expanding neural mass by neural fibers in girls. Another interesting finding is seen in cephalic index where ages 5, 6, 11, 12 and 13 showed significant difference in boys. These differences could be attributed to increase in head growth from ages 5 and 6 but in a relatively slower pace and also pubertal changes in ages 11, 12 and 13.

It was observable that the head form in boys for all the age classes falls under mesocephalic head form (Medium head). Whereas in girls there was a gradual change in head form from brachycephally (short head) to mesocephally (Medium head) which transcends back to brachycephally. However, the predominant head form in boys and girls is mesocephally. This study is inconsistent which other findings from Japanese population where brachycephalic head form has been recorded for several decades and the European population where debrachycephalized head form has been recorded over the years (2).

This seeming discrepancy in changes of head form in different populations may be attributed to differences in the dominant direction of growth vectors. Other factors that may contribute to these differences are nutritional status in early life which may accelerate brain growth in the dominant direction. Genetic factors may act in determining the dominant direction of the growth vectors (8, 9). It is also interesting to note that brachycephalic head form is recorded in ages 5, 14 and 15. This finding is consistent with the findings of Kouchi (2) that nearly all brain growth occurs in first two years and virtually increases by four years of age and the head grows to about 80% of the adult size.

Considering head circumference ages 5, 9, and 15 showed significant difference. There was a relatively unsteady increase in head circumference in both sexes. Although, the mean head circumference of girls for all ages seem slightly greater than that of boys. Of interest in the significant differences shown is that of ages 5 and 15. It could be speculated that brachycephalic head form at age five is consistent with the finding that head growth in children reaches about 80 % of the adult head size.

Overall, there was a higher degree of significant relationship amongst the variables in the general correlation matrix. But cephalic index showed an exception where it showed no association to boys weight, height and girls height but it showed significant difference to girls weight. This could be due to the roles female hormones play in deposition of fat in the body (10, 11, 13). This finding also provides a basis why mean cephalic index of girls was relatively larger than that of boys.

Although, the exact mechanism driving this process of differences in head dimension is still a subject of debate. It was deduced that; cultural factors related to food may have played an important role, and Physical environmental factors such as climatic change may have influenced diet. Environmental effect on prenatal and post natal growth may be different. Social well being or economic development could provide reasons for this variation (11, 14) it is also believed that head forms especially brachycephally have been selected as a consequence of evolutionary forces (15).

CONCLUSIONS

This study has established that there is an association between weight, height and cephalometric traits but only girls weight showed an association with cephalic index. This study also shows that changes in head dimension were observed from 5-15 years but head breadth showed no significant difference between boys and girls. This study has also recorded some differences in pattern of head growth in children - while boys have larger head length, girls had larger cephalic index as well as head circumference due to a relative larger head breadth which statistically showed no significant difference. The exact mechanism driving this process of change in head dimension is still a subject of debate. To overrule this debate further study need to be done to elucidate the causes and mechanisms of secular change in head dimension.

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