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Mesocephalic Head Shape Observed in Children with Neuro-Developmental Disorders (NDDS): A Comparative Study.

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Research Article

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ABSTRACT

Head shape and head size classifications are very useful tool used by pediatricians and other caregivers of infants and young children as it helps them to recognize common cranial abnormalities at an early stage. This study investigated the pattern of head shapes in children with neuro-developmental problems and compared findings with that of other normal growing children. A total of 300 children (218 normal growing children and 112 children with neuro-developmental problems) aged between 0 and 18 years were recruited for this study. The head length and head width of the children were measured and cephalic Index (CI) calculated. The mean cephalic index (CI) in both groups was 79.82±3.35 and 77.78±2.95 respectively and this difference was not statistically significant (p = > 0.05). However, a statistically significant difference (p=0.0008) was observed in the CI of males between the two groups which was not the same case in females (p=>0.05). Mesocephalic head shape type had the highest overall distribution of 71.43% while Hyperbrachycephaly had the least distribution of 1.79%. The dominant head shape as per the present study could be classified as mesocephalic in the two groups of normal growing children and children with neuro-developmental disorders, thus it can be deduced that head shape tends not to be affected by some neuro-developmental problems.

INTRODUCTION

Head measurements and assessments such as cephalometry is a very important measure for physical examination in living, cadaveric and radiological specimen [1]. Craniometry also referred to cephalometry is a very useful tool in pediatric neurology. Biologic variation allows the unique craniofacial character and the many asymmetries found in each individual. The human face has more basic, divergent craniofacial patterns than most other species [2]. By altering its own environment, the human species may have been able to reduce its own natural selection pressures and homogeneity and thus increase its phenotypic variability [3]. The importance of conducting craniometric or cephalometric studies cannot be over emphasized especially in the areas of pediatrics, plastic surgery, oral surgery and forensic medicine [4, 5]. Cranial Index (C.I) is one of the clinically recognized anthropometric parameter in the investigation of craniofacial skeleton because of its validity and practicability [6]. Cranial index is the most investigated craniofacial parameter as it utilizes the length and breadth of the head which are very helpful in the study of secular trends [7, 8, 9].Cranial Index is used in determining the variations in shape of the head and face in newborns [10] and in determining head dimensions in fetuses [11]. Furthermore, understanding the patterns of head growth, especially within the first early years of life, may identify neurologic abnormalities as well as malnutrition [12, 13]. Neurodevelopmental disorders (NDDs) are impairment of the growth and development of the brain or CNS. A narrower use of the term refers to disorders of the brain function that affects emotion, learning ability and memory and that unfolds as the individual grows [14]. Disorders considered as neurodevelopmental in origin, or have neuro-developmental consequences when they occur in children include; autism & autism spectrum, fetal alcohol syndrome, traumatic brain injury, communication, speech & language disorders, Down syndrome and genetic disorders such as fragile X-syndrome [15].

Below are the four international categories of head shapes identified using cephalic index [4, 16].

Dolicocephaly ("Long head" type)

Type of head shape that describes an individual that has a narrower cranial width and usually presents with a long, narrow shape and high mandibular plane angle. The calculated cephalic Index for this group is <74.9% [4, 16].

Mesocephalic Head Shape ("Medium head" type)

Type of head shape describing an individual that falls between the brachycephalic and dolicocephalic types and has an average cranial width. The calculated Cephalic Index is usually between 75-79.9% [4, 16].

Brachycephalic Head Shape ("Short broad head" type)

This describes an individual with a larger than average cranial width and usually presents with a broad, square head shape and low mandibular plane angle. The calculated Cephalic Index ranges between 80-84.9% [14, 16].

Hyperbrachycephalic Head Shape ("Very short broad head" type)

Sometimes is also considered to be part of brachycephaly. This describes a larger than average cranial width. Also presents with a broader, square head shape than in brachycephaly. Here the calculated cephalic index is above 85% [4, 16].

However, due to paucity of data on the head shape pattern of children generally, this study investigates and compares the pattern of head shapes as seen in normal growing children without NDDs and in children with neuro-developmental disorders (NDDs).

MATERIALS AND METHODS

A total of three hundred and thirty (330) children aged 0- 18 years old were recruited for this study. 218 (66.1%) were normal growing children without any neuro-developmental disorder while 112 (33.94%) of the children were diagnosed with at least one form of neuro-developmental disorder. The 218 normal growing children (12 males and 97 females) without NDDs were recruited during their post-natal check-ups while the 112 children (72 males and 40 females) with NDDs were recruited during their visit to the Neurology Unit of the Usmanu Danfodiyo University Teaching, Sokoto. Verbal informed consent was obtained from parents/guardians of the study participants and the study procedure explained to them before recruitment. The bio-data of the subjects was obtained from their parents/guardians who brought them to the clinic.

Measurements of the head length and head width were taken using standard internationally recognized anatomical landmarks so as to ensure great accuracy and reproducibility. The head length (greatest antero-posterior diameter) and head width (maximum transverse diameter between two fixed points) were measured with the help of a spreading caliper [17]. The head length was measured from glabella to inion. All measurements were taken to the nearest 0.1cm. The cranial index was calculated as the ratio of head width to head length multiplied by 100.

The data were analyzed using the Statistical Package for Social Sciences (SPSS) version 17 for Windows. Descriptive Statistics presented in Tables 1, 2, and 3. Student-*t*-Test was used for comparison between means and statistical significance set at p= <0.05.

RESULTS AND DISCUSSION

Table 1: Showing distribution table of head shape types in children with NDDs and those without NDDs.

Head Shape Type	Children with NDDs N (%)	Children without NDDs N (%)
Dolicocephaly (CI = <74.9%)	8 (2.42)	10 (3.03)
Mesocephaly (CI = 75-79.9%)	80 (71.43).	105 (31.81)
Brachycephaly (CI = 80-84.9%)	22 (19.64)	87 (39.91)
Hyperbrachycephaly (CI = >85%)	2 (1.79)	16 (7.34)
TOTAL	112 (33.94)).	218 (66.1)

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Table 2: Table comparing the cranial index of male children with NDDs and normal growing males without NDDs.

Age Group (years)	Males with NDDs		Males without NDDs		
	N	Mean ± SD	N	Mean ± SD	p-value
0-3	32	76.19±2.24	66	79.17±2.91	3.4007
4-7	11	77.38±1.96	17	78.43±3.33	0.3033
8-11	17	78.45±2.63	21	79.04±3.11	0.5359
12-15	10	79.74±5.08	17	80.05±4.21	0.8739
16-18	2	81.17±6.31	------	--------	<0.05*
TOTAL	72		121		

N = Sample Size.SD=Standard Deviation
*= Statistically significant difference

Table 3: Table comparing the cranial index of female children with NDDs and normal growing females without NDDs.

Age Group (years)	Females with NDDs		Females without NDDs		
	N	Mean ± SD	N	Mean ± SD	p-value
0-3	19	77.99±2.26	75	80.86±3.31	6.7215
4-7	12	77.91±2.56	14	80.17±3.84	0.4171
8-11	4	79.17±1.25	3	80.08±0.52	0.2559
12-15	5	78.96±3.57	5	78.72±3.73	0.9207
16-18	----	--------	------	-------	------
TOTAL	40		97		

N = Sample Size.SD=Standard Deviation
*= Statistically significant difference

DISCUSSION

The four types of head shapes (Dolicocephaly, Mesocephaly, Brachycephaly and Hyperbrachycephaly) reported in this study (Table I) had also been reported in previous studies [10, 16, 18, 19].

The present study shows that cranial index values in children with NDDs are similar to those of the normal growing children without NDDs in every age group. Generally, the children with NDDs had a lower cranial index (mean CI=77.78±2.95) than those of normal growing children (mean CI=79.82±3.35).

For the group of children with NDDs, the overall head shape distribution as per this study is dolicocephaly (2.42%), mesocephaly (24.24%), brachycephaly (6.67%) and hyperbrachycephaly (1.79%) while the second group of children without NDDs also had mesocephaly as the highest (31.81%) and dolicocephalic head shape was the least with 3.03%. Brachycephaly 26.36% and hyperbrachycephaly with 4.84%.

In this study, the overall mean cephalic index was 79.48±3.40 and 79.48±3.40 in group of children with NDDs and those without NDDs respectively. Thus, this showed that the predominant head shape as per the present study is mesocephalic as evident in the cranial indices of both groups. This does not agree with reports from other similar studies who reported most dominant head shape type of brachycephaly (43.2%) seen in Bangalore children [18], dolicocephalic head shape predominant (66.82%) in Ogbia children from Nigeria [19]. Using the Banister classification of head shape, a study on the cephalic index of normal growing children from Port Harcourt, Nigeria showed mesocephaly as the dominant head shape [20, 21] and these agree with our findings. Dominant head shape type from our study is similar to mesocephalic head shapes reported from other studies [16, 22].

In the normal growing children without NDDs with respect to sex, the dominant head shape as per the present study is mesocephalic (20.91%) in males and brachycephalic (14.55%) in females.

The dominant mesocephalic head shape found in males in this study resembles results from similar findings in males such as 38.1% in Turkman males and 36.5% in Fars male children [23], 40% in Iranian male children [24]. but did not resemble brachycephaly in South African male children [25], dolicocephaly in Indian children [26] and 29.7% dolicocephaly in Abia males [27]. The report of mesocephalic head shape dominant in male children [23, 28] is consistent with our findings of mesocephalic head shape dominant in normal growing male children.

The dominant brachycephalic head shape (14.55%) seen in females from the present study agrees with brachycephaly in Bangalore female children [18] and 32.0% brachycephaly found in Abia female children [27] but does not agree with mesocephaly dominance in Iranian female children [10] and Nigerian female children [28]. A persistent reoccurrence of the brachycephalic head shape (short head) was observed throughout the age ranges in the females but the mesocephalic head shape (medium head) was maintained in males. Brachycephalization observed in females from the present study is an evidence of continuous brain growth in a lateral direction [29] and this does not agree with findings in children aged 5-15 years where the females head shape pattern changed from brachycephaly to mesocephaly [28]. Genetic factors may act in determining the dominant direction of the growth vectors [30].

However, the dominant head shape in male children from the present as observed in both groups is mesocephalic while females in both groups had more of brachycephalic head shape type. This head shape pattern in females agrees with study from Japanese population where brachycephalic head shape was reported for age ranges between 0 to 3 years [31].

The total number of normal growing children (218) used in this study is higher than the sample size for children with normal brain development used in other works such as 125 subjects [18], 104 subjects [31].

The exact mechanism behind the differences in head dimensions is still a subject of scientific debate, it can be deduced that variations in head shapes are due to hereditary factors or environmental which may act as secondary effect [5]. Also affecting head shape pattern are climatic, genetic, ecological, biological, geographical, racial, gender and age factors [5, 10, 11]. The kind of diet taken could also play a role in influencing the dominant head shape [30] as well as the factor of time [9]. Head shape changes are observed from one generation to the other as observed in the first generation of Japanese immigrants in Hawaii and their parents [33].

CONCLUSION

The dominant head shape as per the present study could be classified as mesocephalic in males for the two groups of normal growing children and children with neuro-developmental disorders, while their females in both groups of children had the brachycephalic head shape type as dominant. Thus it can be deduced that head shape tends not to be affected by some neuro-developmental disorders as observed in this study.

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