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ARAŞTIRMA / RESEARCH

Cranial measurements and pattern of head shapes in children (0-36 months) from Sokoto, Nigeria

Sokoto, Nijerya'da 0-36 ay arası çocukların kranial ölçümleri ve kafa şekillerinin modelleri

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Abstract

Purpose: This study investigated the pattern of head shapes in children using cranial index values.

Material and Methods: Cranial length, cranial width and cranial index of 210 normal growing children (100 males and 110 females) aged 0 - 36 months old seen at the Institute of Child Health Center, Usmanu Danfodiyo University Teaching Hospital, Sokoto, Nigeria over the period of one year were determined using standard cranial landmarks and procedures. The pattern of head shapes was determined using the cranial index values obtained from the study participants.

Results: The overall mean and standard deviation values for cranial length, cranial width and cranial index were 13.79±1.79 cm, 10.95±1.39 cm and 79.49±3.42 respectively. A statistically significant increase was observed in the cranial width values of males when compared to that of females. Meanwhile, there was no statistically significant difference observed in the mean cranial length and mean cranial index values between the sexes. As per the present study, the predominant head shape type in males was Mesocephaly (31.90%) and in females, Brachycephaly (26.19%) while the least observed head shape pattern was Hyperbrachycephaly (1.42%) in males and Dolicocephaly (0.47%) in females.

Conclusion: Cranial parameters evaluated in this study are good indicators of skull and brain growth, thus can be of clinical importance in determining the timing and etiology of brain insults, especially in the first three years of postnatal life.

Key words: Cranial measurements, head shapes, children, Nigeria

Öz

Amaç: Bu çalışmada, çocukların kafa şekilleri, kraniyal indeks değerleri kullanılarak araştırıldı.

Gereç ve Yöntem: Bir yıl boyunca, Çocuk Sağlığı Merkezi, Usmanu Danfodiyo Üniversitesi Eğitim Hastanesi, Sokoto, Nijerya'da, 0-36 aylık 210 normal çocuğun (100 erkek ve 110 kadın) kraniyal uzunluk, kraniyal genişlik ve kraniyal indeksleri standart kranial işaret ve prosedürleri kullanılarak belirlendi. Kafa şekilleri paterni, çalışma katılımcılarından elde edilen kranyal indeks değerleri kullanılarak belirlendi.

Bulgular: Kranial uzunluk, kraniyal genişlik ve kraniyal indeks için ortalama ve standart sapma değerleri sırasıyla 13.79 ± 1.79 cm, 10.95 ± 1.39 cm ve 79.49 ± 3.42 idi. Erkek çocukların kraniyal genişlik değerlerinde kız çocuklarına göre istatistiksel olarak anlamlı bir artış gözlenmiştir. Bu arada, cinsiyetler arasındaki ortalama kranial uzunluk ve ortalama kraniyal indeks değerlerinde istatistiksel olarak anlamlı bir fark yoktu. Bu çalışmaya göre; erkek çocuklarında baskın kafa şekli tipi Mezosefali (% 31.90), kız çocuklarında Brachysephaly (% 26.19), en az gözlenen kafa şekli ise erkeklerde Hiper-brakisefali (% 1.42) ve kızlarda dolikosefali (% 0.47) idi. **Sonuç**: Bu çalışmada değerlendirilen kranial parametreler, kafatasının ve beynin büyümesinin iyi bir göstergesidir, bu nedenle özellikle doğum sonrası yaşamın ilk üç yılında beyin haraketlerinin zamanlaması ve etyolojisini belirlemede klinik öneme sahip olabilir.

Anahtar kelimeler: Kranial ölçümler, kafa şekilleri, çocuklar, Nijerya

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INTRODUCTION

The study of human head growth begins with an understanding of the normal skull, brain and cranial sutures. The skull, which is formed from the embryonic mesoderm, later differentiates into the neurocranium and viscerocranium[1] Accurate physical head measures as well as close monitoring of children's growth (especially during infancy) can help clinicians and health care givers detect deviations from normal, thus allowing early intervention[2,3,4,5] Identification of abnormal growth patterns of the head can lead to early diagnosis of treatable conditions such as hydrocephalus, or identification of disorders associated with slowed head growth, such as craniosynostosis[6,7]

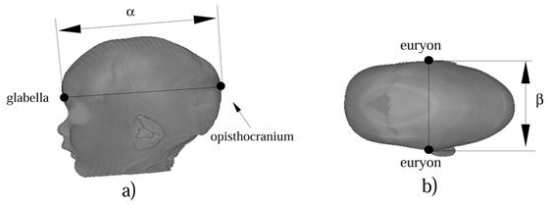
Cranial dimensions and shapes are very useful tools in evaluating the health and development of children with or without disease conditions[6,8-10] Reports have it that for supine sleeping infants, the present norm for cephalic index is closer to a cephalic ratio of 84%, and he differentiated his orthotic treatment group as those babies with a cephalic ratio that exceeded 90% in his study[11, 12,13].

This study is therefore crucial and significant considering the fact that to recognize and make proper diagnosis of craniofacial abnormalities, it is helpful for the paediatrician to understand the normal embryology and phenotypic variations. Four international categories of head shapes had been identified based on cephalic index and these are dolicocephalic (CI=<74.9), mesocephalic (CI=75-79.9) brachycephalic (CI=80-84.9) and hyperbrachycephalic (CI=>85)[8,14,15]. This study investigated the pattern of head shapes in children aged 0 – 36 months using cranial index values.

MATERIALS AND METHODS

A total of two hundred and ten (210) children aged 0 to 36 months old without craniofacial anomaly or history of craniofacial anomaly and that presented at the Institute of Child Health (ICH) Unit of the Usmanu Danfodiyo University Teaching Hospital, Sokoto (UDUTH) for routine post-natal check-up or any other reason and whose parents or guardian gave informed consents to participate in the study were recruited for this study. Children aged above 36 months and children aged between 0 – 36 months old but with an emergency of life threatening condition or any form of craniofacial disfiguration were excluded from this study. Also children whose parents or guardian did not give informed consent to participate in the study were excluded.

This study was approved by the Institute of Child Health (ICH) Unit, Usmanu University Teaching Hospital (UDUTH) Sokoto and the Department of Anatomy, College of Health Sciences, Usmanu Danfodiyo University, Sokoto, Nigeria. Ethical consideration included taking informed consent from parents and guardians of study participants, using Hospital card numbers to maintain confidentiality.



Figures 1a and b. Diagram illustrating the anatomical landmarks considered when measuring cranial length (a) and cranial width (b) on a surface mesh representing the skin of subject [16].

The cranial length (greatest antero-posterior diameter) and cranial width (maximum transverse diameter between two fixed points) were measured using a spreading caliper. All the measurements were taken to the nearest 1 mm. The cranial length was measured with a spreading caliper from glabella to opistocranium. While the Cranial Width (CW) was measured as the maximum transverse diameter between the two euryons. (Figure 1a, 1b)[8,14, 15, 16].

Cranial Index (C.I) is defined as the ratio of the cranial width to the cranial length (i.e. cranial width / cranial length multiplied by 100).[14]The head shapes pattern were classified using the CI based on the four international categories identified as dolicocephalic (CI=<74.9), mesocephalic (CI=75-79.9) brachycephalic (CI=80-84.9) and hyperbrachycephalic (CI=>85)[8,14,15].

Statistical analysis

Data collected were entered into Microsoft Excel Windows version 2007 and analyzed using Statistical Package for Social Sciences (SPSS) version 20.0 after exportation from Microsoft Excel to SPSS.

The mean (±SD) for cranial length (CL), cranial width (CW) and cranial index (CI) were determined using descriptive statistics. Comparison of mean values in relation to sex distribution of the subjects were done using Student *t*-test, proportions were compared using chi-square test (with Yates correction applied)[17,18].

RESULTS

The minimum values for Cranial Length, Cranial Width and Cranial Index were 10.50 cm, 8.30 cm and 68.39% respectively. While the maximum values were 17.20 cm, 14.30 cm and 89.29% respectively. The mean Cranial Length for all subjects involved in this present study was 13.79±1.79 and the Cranial Width was 10.95±1.39. The mean Cranial Index was calculated to be 79.49±3.42 (Table 1).

Table 1. Cranial measurements and cranial index of study participants.

Cranial Parameters	Minimum	Maximum	Age Range (mo)	Mean ± SD
Cranial Length (cm)	10.50	17.20	0 – 36	13.79± 1.79
Cranial Width (cm)	8.30	14.30	0 – 36	10.95± 1.39
Cranial Index (%)	68.39	89.29	0 – 36	79.49± 3.42

N - Number of Study Participants; **SD** – Standard Deviation

Table 2 (A) shows the minimum and maximum values of cranial length, cranial width and cranial index according to sex while table 2 (B) compares the mean values of cranial length, cranial width and cranial index between male and female children 0 to 36 months. Overall, there was statistically significant difference between males and females cranial width with a p value of 0.0203. The overall mean cranial index in male was 78.26±3.15 and that of females was 80.61±3.27 and this difference was not statistically significant ($p > 0.05$).

Table 2 (A). Minimum and maximum values for cranial measurements in relation to sex.

Cranial Parameters	Males (N = 100)		Females (N = 110)	
	Min	Max	Min	Max
Cranial Length (cm)	10.7	17.2	10.5	17.1
Cranial Width (cm)	8.3	13.9	8.5	14.3
Cranial Index (%)	68.39	86.96	71.43	89.29

N - Number of Study Participants; **Min** - Minimum Value; **Max** - Maximum Value

Table 2 (B): Comparison between the overall mean(SD) of cranial measurements and cranial index in relation to sex.

Cranial Parameters	Males (N=100)	Females (N=110)	p-value
Cranial Length (cm)	14.30±1.53	13.33±1.89	>0.05
Cranial Width (cm)	11.18±1.15	10.73±1.55	0.0203*
Cranial Index (%)	78.26±3.15	80.61±3.27	>0.05

N - Number of Study Participant**;** * Statistically significant

For head types, mesocephalic head form was predominant in males (31.90%) while brachycephalic head shape was predominant in females (26.19%). Dolicocephaly was least in females (0.68%) and hyperbrachycephaly was least in males (1.43%). Mesocephalic head shape has the highest frequency (52.86%) while Dolicocephalic head shape had the least (3.81%). (Figure 2).

Table 3. Head shapes pattern in relation to sex.

Head Shapes	Males O (E)	Females O (E)
Dolicocephaly	7 (3.85)	1 (4.25)
Mesocephaly	67 (54.83)	44 (59.17)
Brachycephaly	23 (36.07)]	55 (38.93)
Hyperbrachycephaly	3 (6.25)	10 (6.75)
Total	100	110

O – Observed count; **E** – Expected count;

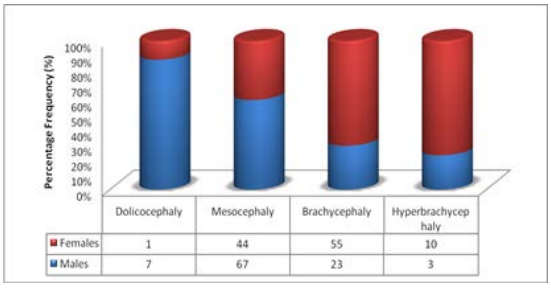


Figure 2. Distribution of head shapes pattern in relation to sex of study participant.

Furthermore, table 3 shows the chi-square distribution of head shapes according to sexes and the chi-square statistics (23.21) and was statistically significant ($p < 0.05$). The largest contributions to the chi-square were observed in Brachycephalic head shape in males ($\chi^{2(3df)} = 5.49$) and females ($\chi^{2(3df)} = 5.09$). None of the chi-square statistics for each cell count produced statistically significant contribution to the chi-square distribution ($p>0.05$).

DISCUSSION

Craniofacial measurements and assessments especially within the early years of life (0 – 36 months old) are important measures for physical examination in children and useful in evaluating the health and development of children (Musa et al., 2014a; 2015) just as they are integral in the evaluation of craniofacial defects. Therefore, we need to establish norms and standards based on ethnic or racial data so as to reflect the potentially different patterns of craniofacial growth resulting from racial, ethnic, tribal, genetic, diet and sexual differences as suggested by previous researchers such as Evereklioglu et al., (2002).

In the present study, the mean cranial length was 14.30±1.53 in males and 13.33±1.89 in females respectively. The mean value in males was slightly higher than that of females and this difference was not statistically significant $p > 0.05$ (Table 2B). This difference in mean values between sexes is speculated to be due to fact that the cranial length is related to the posterior growth of the brain[19] as suggested in a study conducted on brachycephalization process of the Japanese where the author reported attainment of adult size in children reduces the time used for posterior cranial growth, thus leading to shorter cranial length[20] which is probably what brought about the higher cranial length value in males than females. Also, females tend to attain adult brain size earlier than in males of the same age, and that could reduce the time used for later posterior growth of the head, thus suggesting early closure of lambdoid suture in females than males[20].

The maximum cranial length value of females in this study was similar to findings reported by Maria and Manjunath[21] whose minimum and maximum cranial length values in some Indian females were 15.6 cm and 18.1 cm respectively. In males, the minimum and maximum cranial length values in this study (10.7 cm and 17.2 cm respectively) were not the same as that of Maria and Manjunathn[21] even though the maximum cranial length value of males in theirstudy (18.5cm) is higher than the maximum value of cranial length of males in this study (17.2cm) and the minimum cranial length reported in Indian male children by Maria and Manjunath[21](15.5 cm) is higher than the minimum cranial length value of 10.7 cm for males reported in this study. However, in both males and females, the minimum cranial length values in the present study were lower when compared to the minimum values reported in previous studies conducted in India[21] and among Nigerian children[22].

The mean value for cranial length in males (14.30±1.53) was slightly higher than that of females (13.33±1.89) and this difference was not statistically significant ($p = 0.0203$). This finding is in agreement with previous[22]. who reported no statistically significant difference was observed between the cranial length values of both sexes. The mean values found for cranial length in this study is lower than the mean cranial length values of 16.20±0.86 and 16.19±0.83 found in male and female children aged 0 – 6 years from Anambra, South East Nigeria respectively[22]. In this study, the minimum cranial length value of females was 10.50 cm and maximum value 17.10 cm respectively. The maximum cranial width value of females in this study was similar to that reported by Maria and Manjunath[21]Although, the fact that we used different age group from that of the previous studies[21, 22] might have been the reason for the higher values reported in these studies. Also, another possible explanation for the difference may probably be due to diet and other cultural or environmental factors considering the fact that the studies were conducted in different locations.

In the present study, the mean cranial width in males (11.18±1.15) was slightly higher than that of females (10.73±1.55) and this difference was statistically significant ($p = 0.0203$). This finding is not in agreement with previous reports[22] where there was no statistically significant difference was observed between the sexes. The mean values found for cranial width in this is lower than the mean cranial width values of 13.99±0.55 and 13.72±0.55 found in Indian male and female children respectively[21] and 13.01±0.95 and 12.87±0.76 found in Nigerian male and female children aged 0 – 6 years from the Eastern part of Nigeria. [22] In this study, the minimum cranial width value of females was 8.50 cm and maximum value 14.30 cm respectively. The maximum cranial width value of females in this study was similar to that reported by Maria and Manjunath, [21] whose minimum and maximum cranial width values in females were 12.1 cm and 14.6 cm, respectively. The overall mean cranial index found in this study was higher when compared to 72.96±6.12 cephalic index mean value found in children from Ogbia, Niger Delta region of

Nigeria.[23]Our values were also higher than the 78.5 cm reported by Okanlawon et al.,[24]. The cranial index value was however lower when compared to 81.45±7.06 cm seen in Polish children of Caucasian race[25]; 80.42 cm observed in Chilean children[15] ; 80.00 cm seen in 108 Italian infants[26]; 84.80 cm seen in 850 Korean children.[27]

The overall minimum value for cranial index found in this study was 68.39% and the maximum value was 89.29%, respectively. The mean value of cranial index in females (80.61±3.27) in this present study was higher than that of males (78.26±3.15), this difference was not statistically significant ($p > 0.05$). This agrees with previous study conducted[28] in Gurung community of Nepal who also reported higher values in females (84.6 cm) than males (83.1 cm) with no statistical significance. The mean cranial index values seen in this study (78.26±3.15 in males and 80.61±3.27 in females) are lower than the mean cranial index values of 83.10 in males and 84.60 in females from Gurung community of Nepal[28].

The mean cranial index values (78.26±3.15 in males and 80.61±3.27 in females) found in this study was higher than 73.68±6.53.for males and 72.24±5.60 for females reported in Ogbia children from Niger Delta region of Nigeria[23] The mean cranial index value for females (80.61±3.27) in this study was higher than 77.23 cm and 77.15 cm reported for female infants from Babur and Kanuri regions of North East Nigeria[29] and also higher than 79.56±4.92 reported in female children from Anambra, South East Nigeria[22]. However, the mean cranial index value for females (80.61±3.27) in our study was very similar with 80.86±3.31 found in 75 female infants from Sokoto Nigeria[8] and 80.08 mean cranial index value found in females from Port Harcourt, Nigeria[30] while that of males (78.26±3.15) as found in this study is lower than 79.73 cm in males from Port Harcourt[30] and 80.35±5.42 seen in male children from Anambra South East Nigeria[22]. It is also slightly lower than the mean cranial index value of 79.17±2.91 seen in 66 male children from Sokoto, Nigeria[8]. But higher than mean cranial values of 70.03 seen in Kanuri males from North East Nigeria[29]; 73.60 reported in Babur male children from Babur, North East Nigeria[29] and also higher than the cranial index values of 77.00 and 77.97 reported in infants from Fars and Turkman in Iran[31].

The difference observed in mean cranial index values from one population to the other, may not be unconnected to environment, genetic and diet of study participants as well as the age factor. For example, the present study recorded cranial index values of children aged less than 36 months while other mentioned studies considered children aged 2 years and above. Also, the differences in methodology could be another factor responsible for the observed differences between our study and other previous works.

The four types of head shapes (Dolicocephaly, Mesocephaly, Brachycephaly and hyperbrachycephaly) reported in this study (Table 3 and Figure 2) had also been reported in previous studies such as Musa et al.,[8,9] who used these head shape classification for Nigerian children from Sokoto, Nigeria; Eroje et al.[23] who used cranial index to classify head shape types in children from Ogbia Niger Delta region of Nigeria; Del Sol,[15] among Chilean children from IX Region of Chile; Golalipour et al.,[31,32,33] in Iranian Children. The overall head shape distribution in this study was Dolicocephaly (3.81%), Mesocephaly (52.86%), Brachycephaly (37.14%) and Hyperbrachycephaly (6.19%).

The predominant head shape as per the present study was mesocephalic (52.86%). This finding agrees with Ukoha et al.,[22] who reported dominant mesocephalic (39.9%) head type in children aged less than 6 years[22] and Garba et al.,[29] who also reported mesocephaly as dominant head shape among Babur children from Maiduguri, North East Nigeria[29]. Similarly, a study on the cephalic index of Igbo children from Port Harcourt, South-South Nigeria showed mesocephaly as the dominant head shape[30,32] and these agree with our findings. Mesocephalic head forms had been reported in Chilean children from IX Region of Chile[15] and that in Polish infants of Caucasian race[25]. Our findings does not agree with reports from other similar studies such as predominant head shape type of brachycephaly (43.2%) seen in Indian children from Bangalore[21], Dolicocephalic head shape predominant (66.82%) in Ogbia children from Niger Delta Region of Nigeria[23].

In relation to sex, the dominant head shape found in the present study is mesocephalic (31.90%) in males and brachycephalic (26.19%) in females. The dominant mesocephalic head shape found in males (31.90%) in this study resembles results from similar reports in males such as 38.1% in Turkman males from Iran and 36.5% in Fars male children from

Iran[31]; 40% in Iranian male children[34], 20.3% in male children from Anambra, South East Nigeria[22] but did not resemble dominant Dolicocephaly in Indian male children35 and 29.7% Dolicocephaly in Igbo males from Abia, Nigeria[36] The reports of mesocephalic head shape dominant in male children from Zaria Nigeria[37] and from Iranian males[31] is consistent with our findings of mesocephalic head shape dominant (32.09%) in males.

The dominant brachycephalic head shape (26.19%) seen in females from the present study agrees with brachycephaly in Indian females from Bangalore[21] and 32.0% brachycephaly found in female children from Abia, Nigeria[36] but does not agree with mesocephalic dominance in Iranian female children[33], in Nigerian female children from Zaria, Nigeria[37] and and 19.6% seen in female children from Anambra, South East Nigeria[22]. The observed variations between ethnic groups and race may be associated to cultural, genetic and nutritional factors as well as age range differences used in the previous studies.

For the first time, this study has provided valuable information on the cranial measurements and pattern of head shapes of children aged 0-36 months from in Sokoto, Northwestern Nigeria using traditional craniofacial landmarks. This information could be of great clinical relevance in the diagnosis and treatment of craniofacial anomalies as well as a quick indicator of brain and cranial growth in children.

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