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Human Anatomy

Radio-Anatomical Evaluation of Cephalic Index amongst Nigerians Using Computed Tomography (CT)

Erekosima, B. U[1], Robinson, E.D[2], Oparaodu, U. A[3*], Ikenga, V. O[3], Biibaloo, L. L[3], Horsfall A.U.[3], Chukwu, C. D[1]

[1]Department of Human Anatomy, Faculty of Basic Medical Sciences, College of Medical Sciences, Rivers State University, Port Harcourt, Nigeria
[2]Department of Radiology, Rivers State University Teaching Hospital/ Faculty of Clinical Sciences, College of Medical Sciences, Rivers State University, Port Harcourt, Nigeria
[3]Department of Ear Nose and Throat (Head and Neck) Surgery, Rivers State University Teaching Hospital/ Faculty of Clinical Sciences, College of Medical Sciences, Rivers State University, Port Harcourt, Nigeria

*Corresponding author: Oparaodu, U. A
Department of Ear Nose and Throat (Head and Neck) Surgery, Rivers State University Teaching Hospital/ Faculty of Clinical Sciences, College of Medical Sciences, Rivers State University, Port Harcourt, Nigeria

Abstract	Original Research Article

***Background*:** Cephalic Index (CI), also known as cranial index is the ratio of maximum breadth to length of the head multiplied by 100. It is a commonly used anthropometric parameter in determining the racial variation and sex differences. The aim of this study was to determine the cephalic index amongst Nigerians, using computed tomography (CT). ***Objectives*:** To measure the length and breadth of the skull, to determine the cephalic index of the skull, and to check for sexual dimorphism. ***Methods*:** This retrospective study was carried out in the Radiology department of the Rivers State University Teaching Hospital Port Harcourt with ethical approval. One hundred and fifty CT images (2021-2022) of 150 patients (75 males and 75 females), 18 years and above were used in this study. The maximum length of the skull was measured as the distance between the glabella and the most projecting point at the back of the head (inion), and the maximum breadth of the skull was also measured as the distance between the most projecting points at the sides of the head (parietal tuber), both length and breadth were measured at the level of the lateral ventricle of the brain. ***Results*:** Data was analyzed using the Statistical Package for the Social Sciences (SPSS IBM version 23.0) and Microsoft excel 2019 edition. The mean values for the measured parameters include length [male (185.64±6.40); female (179.60±6.54)], breadth [male (138.56±5.10); female (135.66±5.81)] and cephalic index [male (74.70±3.30); female (75.60±3.68)]. Cephalic index was not statistically significant (t-value = -1.57; P = 0.12). ***Conclusion*:** Three major head types were found in this study; doliocephalic (52.6%), mesocephalic (37.3%), and brachycephalic (10%), therefore doliocephalic head type (long head) is the most dominant in the sampled population. There was no sexual dimorphism in cephalic index.

Keywords: Cephalic index, doliocephalic, mesocephalic, brachycephalic, computed tomography.

INTRODUCTION

Background to the Study

Cephalic Index (CI) is also referred to as cranial index, it is the ratio of maximum breadth to length of the head multiplied by 100 [1]. It is a widely used anthropometric parameter in determining the racial variation and also may be used to determine sex differences, especially in individuals whose identities are unknown [2]. Cephalic index explains how genetic characters are transmitted between parents, offspring and siblings [2]. Thus CI is one of the clinical anthropometric factors that can be used in the investigation of craniofacial skeletal deformities. The cephalic index was first described by a Swedish professor of anatomy, Anders Retzius (1796-1860), who invented the cephalic map, which was first used in physical anthropology to classify ancient human remains found in Europe.

According to Likus *et al.*, [3] cephalic index can be determined using anthropometric measurements, dry skull measurements and radiological methods (taking measurements on computed tomography scans or using ultrasound in obstetrics). From the archaeologist point of view, the most likely used set of bones measured for the purpose of ethno-anthropological researches is the bones of the head. According to Enwunonu [4] CI is classified into; **Dolichocephalic** ($\leq 75\%$; long head) which are found in Australians and local Southern Africans,

Mesocephalic (75–79.9%; medium skull) which are common with the Chinese and Europeans, and **Brachycephalic** (≥ 80%; short skull) which are found in Andaman Islanders and Mongolians (Singh, 1989).

Dolicocephalic head (also referred to as long head type): This is a 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 of individuals is <74.9% [5].

Mesocephalic head (also referred to as the medium head type): This is a type of head shape that describes an individual that falls between the brachycephalic and dolicocephalic types and has an average cranial width. The calculated Cephalic Index for this group is usually between 75-79.9% [5].

Brachycephalic head (also referred to as 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 for this group of individuals ranges between 80-84.9% [5].

MATERIALS AND METHODS

This study was a cross-sectional retrospective study conducted in the Radiology department of the Rivers State University Teaching Hospital. Ethical approval was obtained from the ethical committee of the Rivers State University Teaching Hospital. Data was gotten using GE evolution 64 slice 2018 version CT machine. One hundred and fifty CT images (2021-2022) of 150 patients (75 males and 75 females), 18years and above were used in this study. The maximum length of the skull was measured as the distance between the glabella and the most projecting point at the back of the head (inion) and the maximum breadth of the skull was also measured as the distance between the most projecting points at the sides of the head (parietal tuber), both length and breadth were measured at the level of the lateral ventricle of the brain. Data was analyzed using Statistical Package for the Social Sciences (SPSS IBM version 23.0) and Microsoft excel 2019 edition. Individuals below 18 years and those with craniofacial defects were excluded.
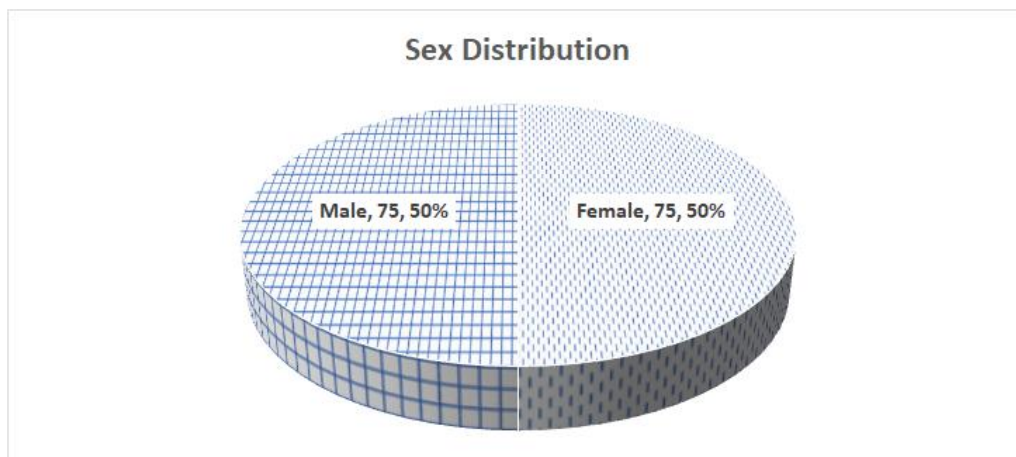
RESULTS

Figure 1: Distribution of the subjects according to sex

Figure 1 is a pie chart showing the distribution of the subjects according to sex. It shows that 75 (50%) of the subjects are males, while 75 (50%) are females. They are equally distributed.

Table 1: Descriptive statistics of the measured parameters

Measured Parameters	Male [N = 75]			Female [N = 75]			Total [N = 150]		
	Min	Max	Mean±SD	Min	Max	Mean±SD	Min	Max	Mean±SD
Age (years)	21.00	87.00	55.32±16.07	22.00	82.00	53.99±16.39	21.00	87.00	54.65±16.19
Length (mm)	172.40	199.00	185.64±6.40	167.20	194.50	179.60±6.54	167.20	199.00	182.62±7.13
Breadth (mm)	124.00	149.30	138.56±5.10	121.70	150.00	135.66±5.81	121.70	150.00	137.11±5.64
Cephalic index	67.10	82.90	74.70±3.30	68.26	87.11	75.60±3.68	67.10	87.11	75.15±3.51

*N = Number of subjects, **Min** = Minimum, **Max** = Maximum, **SD** = Standard Deviation*

Table 1 shows the descriptive statistics of the measured parameters. The mean values for the measured parameters include; length [male (185.64±6.40); female (179.60±6.54)], breadth [male (138.56±5.10); female

(135.66±5.81)] and cephalic index [male (74.70±3.30); female (75.60±3.68)].

Table 2: Comparing the cranial length, breadth and cephalic index of male and female subjects

Measured parameters	Comparison				t-test for Equality of Means		
	MD	SEMD	95% C.I of the Difference		*t*-value	df	*P*-value
			Lower	Upper			
Age (years)	1.33	2.65	-3.90	6.57	0.50	148.00	0.62
Length	6.04	1.06	3.95	8.12	5.71	148.00	**0.00***
Breadth	2.90	0.89	1.14	4.66	3.25	148.00	**0.00***
Cephalic index	-0.90	0.57	-2.02	0.23	-1.57	148.00	0.12

** = Significant at P < 0.05, **MD** = Mean Difference, **SEMD** = Standard Error of Mean, **C.I** = Confidence Interval, **df** = degree of freedom*

In Table 2, the difference in cranial length, breadth and cephalic index was presented. Cranial length and breadth were larger in males compared to females, while females on the other hand have larger cephalic index compared to males. The difference in length (t-value = 5.71; P = 0.00), breadth (t-value = 3.25; P = 0.00) were statistically significant between male and female subjects. Cephalic index was not statistically significant (t-value = -1.57; P = 0.12)
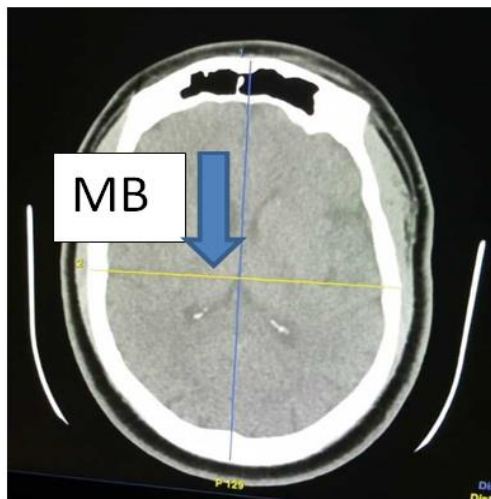

Fig 2: Axial section of a non-contrast computed tomogram of the brain showing the maximum breadth or width of the skull (see thick arrow labeled MB)
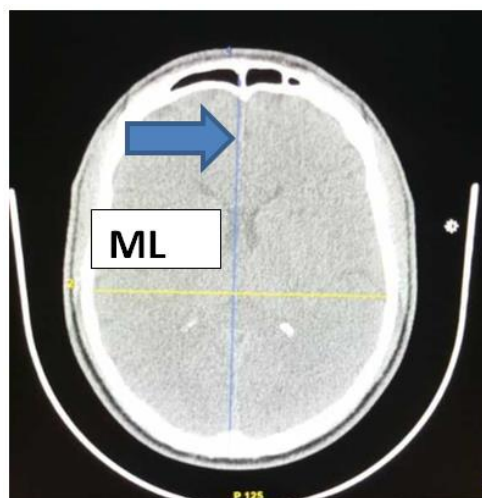

Fig 3: Axial section of a non-contrast computed tomogram of the brain showing the maximum anteroposterior diameter (length) of the skull (see thick arrow labelled ML)

DISCUSSION

Several researches have been done on the determination of cephalic index using different modalities including imaging modality (CT) for different population and also reported their findings accordingly.

From our results, three major head categories were found amongst the sampled population; 52.6% of the subjects were doliocephalic, 10% were brachycephalic while 37.3% were mesocephalic, therefore doliocephalic head type is the most dominant in the sampled population. This means that a majority of the population are long headed. This present study agrees with Jervas *et al*., [6] reported that Africans majorly fall under the dolichocephalic head type. Results from this study also proved that the sampled population were not sexually dimorphic as the results were not statistically significant. In a study carried out by Paulinus *et al*., [7] anthropometric study of cranial parameters using computed tomography (CT) to determine the cephalic index among a sampled population in Calabar, the mean cephalic index was 76.09 and 75.81 for males and females respectively. The result showed that the males and females of the sampled population were not sexually dimorphic, 95.5% of the subjects were of the mesocephalic (intermediate) head type. Thus there was no significant difference, which implies that the sampled population was of the mesocephalic head type. However, the head shape dominant in this research does not agree with this current study and this may be due to environmental factors as well as nutrition, although sexual dimorphism was also not present in this study which proves that different ethnic groups who reside in the same environment may have similar cephalic indices.

The results deduced from this study confirms that of Adejoh *et al*., [1] who carried out a research on the adult cephalic index of the Igbo people in and around Nnewi town of Anambra state in Nigeria using computed tomography on the CT scan images of 202 subjects comprising of 167 males and 35 females who were 18 years and above. The three major categories of head type were found in the population with varying degrees and dolichocephalic as the dominant group (51.5%), mesocephalic as intermediate (32.2%) and brachycephalic as least dominant (16.3%). This result also confirms a study which was similar to that of Jervas, *et al*., [6] that carried out a similar research study with anthropometry in Owerri town of Imo state in the same Southeast Nigeria. Their results showed that dolichocephalic subjects were 66.7%, brachycephalic was 21.7% and mesocephalic 11.6%, making doliochocephalic the most dominant in that study.

However in a similar study of the cephalic index among medical students of central India, it was carried out on 480 medicals students comprising of 296 males and 184 females ranging between 17-24 years using Hrdlicka's method for a period of 2 years. The measurements were taken using a spreading calliper. The mean cephalic index for male was 81.24 ± 3.66 and female was 80.31 ± 4.28. Mean cephalic index of both sexes was 81.21 ± 3.68. Thus, it shows that there was no significant difference in gender of the Cephalic Index. They were found to be of the mesocephalic head type. This result does not agree with this current study and this may be due to racial and environmental factors since it has been confirmed by Jervas *et al*., [6] and this current study that Africans are mostly of the doliocephalic head type. However the absence of sexual dimorphism shows interplay of different tribe or ethnic groups present in the sampled population.

However, some studies have proved that sexual dimorphism in skulls exists predominately amongst mesocephalic heads [8]. This may be ascribed to genetic and environmental factors, which are known to affect human dimensions. It could be possible that other factors intrinsic to the different populations may also be at play.

The estimation of cephalic index of population of central India in a research carried out by Aditi and Swapnil [9] using a spreading caliper with adjustable focuses, which was done using 296 males and 184 females, ranging between 18-50 years revealed that 43.58% of males and 42.93% of females had mesocephalic head type. This research also does not agree with this study with respect to racial and environmental differences.

Thomas Adejoh *et al*., [1] carried out a research on the adult cephalic index of the Igbo people in and around Nnewi town of Anambra state in Nigeria using computed tomography on the CT scan images of 202 subjects comprising of 167 males and 35 females who were 18 years and above. During the collection of data from the monitor, the three major categories of head type were found in the population with varying degrees and dolichocephalic as the dominant group (51.5%), mesocephalic as intermediate (32.2%) and brachycephalic as least dominant (16.3%). The variation in their work was similar to that of Jervas, *et al*., [6] who carried out a similar research study with anthropometry in Owerri town of Imo state in the same Southeast Nigeria. In the course of their research, heterogeneity was observed in the subjects who were used to carry out the research. Dolichocephalic subjects were 66.7%, brachycephalic was 21.7% and mesocephalic 11.6%. The Igbo population share this mesocephalic head shape with some close neighbours like Delta Igbo, Urhobo, Edo and Ogoni [10, 11]. The Yoruba of Ilorin and Hausa of Kano also share in this similarity [12]. This similarity between these distant tribes which are the Ilorin Yoruba and Hausa tribes does not necessarily mean they have the same or a common ancestry with the Igbos since DNA evidence clearly proves that they are distinct [13]. This may just be evidence of their common Negroid brotherhood. While the preponderance of mesocephalic

head shape amongst Negroid tribes may be justifiable, the heterogeneity in subjects during recruitment throw up some complexities. This may be one of the weak points in using cephalic indices for categorizing head shapes of diverse tribes. However, this weakness appears extenuated when CI is combined with DNA evidence in forensic investigations [13-15]. The Igbo of Abia, Owerri and Igbo adult males from Abakaliki in Ebonyi State were predominantly brachycephalic and not mesocephalic. Enwunonu [4] however, explained that a deviation from mesocephalic head shape amongst the Igbo is a result of an on-going global phenomenon of brachycephalization arising from changing BPD, influence of heredity, environment and nutrition.

Our results in this present study agree with a similar study by Olusanya *et al*., [16] on the Craniometry of Nigerian skulls: A cadaveric study and review of the literature, the most common skull type was dolichocephalic. However, the findings of this study contradict the characterization of dolichocephalic skulls as typical of indigenous African people by Jerves *et al*., [6]. These findings suggest that the mesocephalic skull type is more prominent in the Nigerian population; however, there appears to be a tendency towards dolichocephalization in Nigeria.

CONCLUSION

The result from this study may be useful to anthropologists, forensic scientists, and Head/Neck surgeons.

RECOMMENDATION

Further studies are needed on specific tribes to provide demographic data for specific populations.

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