Advances in Bioscience and Clinical Medicine
ISSN: 2203-1413
www.abcmed.aiac.org.au

Original Article

Sonographic Assessment of Fetal Cephalic Index in a Sampled Nigerian Population

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ARTICLE INFO

Article history
Received: June 20, 2021
Accepted: September 12, 2021
Published: October 31, 2021
Volume: 9 Issue: 4

Conflicts of interest: All the authors declare that they have no conflicts of interest regarding the authorship and publication of this article.
Funding: None.

Key words:
Cephalic Index,
Fetus,
Fetal Skull,
Cephalo-pelvic Disproportion,
Biparietal Diameter,
Occipitofrontal Diameter

ABSTRACT

Objectives: The study aimed to determine fetal cephalic index among fetuses in Cross River State, Nigeria. **Materials and Method:** Transabdominal ultrasound was carried out on 220 women attending obstetric sonography in their second and third trimesters between September and December, 2020 in Cross River State, Nigeria. Each patient was scanned in a supine position, Bi-parietal diameter (BPD) measurements were taken from the outer edge of the closer temporoparietal bone to the inner edge of the farther temporoparietal bone. The occipito-frontal (OF) measurements were taken from the occipital bone to the frontal bone, and the cephalic index determined using the formula CI = BPD/OF *100. **Results:** Mean values of cephalic index and standard deviation was calculated for the fetuses at different gestational ages. The results showed that the mean cephalic index was 76.48±11.87. Male fetuses had cephalic index of 78.18±4.11 while female had cephalic index of 74.34±16.52. There was significant difference in the cephalic index between male and female fetuses (p<0.002). **Conclusion:** The present study shows the cephalic index of fetuses of cross river state population remained mesaticephalic from 13 weeks of gestation to full term. This may be attributed to the ethnicity and race of this group of people.

INTRODUCTION

The ease of parturition depends on many factors including fetal presentation and size of the maternal pelvis (1). Although parturition is easier with the fetus in cephalic presentation, larger fetal head size relative to the maternal pelvis may make it difficult. Only a comparatively small part of the head at term is represented by the face. The rest of the head at term is composed of the firm skull which is made up of two frontal bones, two parietal bones, and two temporal bones along with the upper portion of the occipital bone and the wings of the sphenoid (2). The size and shape of the fetal head can be evaluated in-utero using ultrasound. On Ultrasound, measurement of the bi-parietal diameter (BPD) and occipito frontal diameter (OFD) of the fetal skull can be used to compute the cephalic index. This index is important in understanding fetal skull anomalies in prenatal period (3, 4) more so, since it is known that development of a child's head depends on the development of the brain (5).

Cephalic index (CI) gained significance in the early 20th century for categorizing human populations by anthropologist. This was postulated by a Swedish professor of anatomy, Anders Retzius, and first used in physical anthropology to classify ancient human remains found in Europe (6). The CI has also been applied in the categorization of head shapes into three broad categories namely dolicocephalic, mesaticephalic, and brachycephalic. Dolicochephalic refers to head with cephalic index less than 75, mesaticephalic heads have cephalic index between 75-80, and brachycephalic heads have cephalic index greater than 80. Typical example of head shape categorization based on CI is the dolicocephalic category found amongst Australian Aboriginals and native southern Africans.

In obstetrics, CI is used to discriminate between normal and abnormal head which may influence intra-uterine dating with bi-parietal diameter (BPD). Measurement of the fetal CI can be used to predict head disorders affecting the central nevous system (CNS) of developing fetuses (7). In such conditions, cephalic index can be used to assess their severity and prognosis. Thus it is clear that

Published by Australian International Academic Centre PTY.LTD.

http://dx.doi.org/10.7575/aiac.abcmed.v.9n.4p.1

intra-uterine assessment of cephalic index will allow for planning of parturition and assessment of fetal central nervous system (CNS) anomalies ranging from mild to severe anomalies.

Many of the most severe forms of cephalic disorders are fetal. The types of cephalic disorders include anencephaly, megallencephaly, colpocephaly and hydranencephaly. Cephalic disorders in most cases are caused by disturbances occurring in early fetal neurological development. Other factors that can cause cephalic disorders include hereditary or genetic conditions, exposure to certain environmental factors such as medications and environmental toxins such as maternal infection and exposure to radiation (7). The presence of plagiocephaly, brachcephaly, and scaphocephaly is generally determined by abnormal skull measurement. They can be indentified using a craniometer or a medical laser designed for the same purpose. Cephalic index gives an idea of the fetal head shape. The usual range is variable depending on various sources and different demographic groups. Often, the mean value is taken as 78 (range 74-83) (8).

Prenatal and postnatal growth is a continuous process, and is partly influenced by intra-uterine factors mostly related to the CNS which the shape and size of the fetal head is critical in decision making. This knowledge is important in obstetrical care and delivery planning. As yet, there is paucity of comprehensive data regarding fetal CI in Nigeria, and in Cross River state and so information in this regard and the impact of demographic groups on CI are lacking. The focus of this research was to determine cephalic index in normal fetuses in Cross River state, Nigeria.

MATERIALS AND METHODS

The research employed a prospective, non-experimental and analytical aproach**.** A total of 220 pregnant women attending obstetric sonography in their second and third trimesters between September and October, 2020 in Cross River State, Nigeria were recruited for this study. Study was carried out in a referral center and had patience referred from General Hospital Calabar, Ogoja and Akamkpa all in Cross River State, Nigeria. Only singleton pregnancies were included in the research. Pregnant women with complications known at the moment of the ultrasound scan (e.g bleeding, pre-eclampsia) were also excluded. Fetuses with malformations detected during the examination, were also excluded. Only pregnant mothers who gave their informed consent and accepted to participate in the study were recruited for the study. Ethical approval was obtained from the research committee of Assurance Medical Diagnostic and Research Centre, Calabar, Cross River state.

Method of Data Collection

Trans-abdominal ultrasound was carried out on 220 pregnant women. Each patient was scanned in a supine position. The bi-parietal diameter measurements were obtained from a transaxial image of the head, at the level of the thalami. The measurements were taken from the outer edge of the closer temporoparietal bone to the inner edge of the farther temporoparietal bone. The occipito-frontal diameter measurements were taken from the occipital bone to the frontal bone. Cephalic index was obtained using a method described by Williams et al. [9]: CI = BPD/OFD x 100.

Statistical Analysis

A descriptive statistics was used to calculate the mean, the range, and standard deviation of the variables assessed. Inferential statistics State what type of inferential statistic that was used. was used to compare (chii square or students t test.) CI between male and female fetuses. Pearson correlation analysis was used to assess the relationship between cephalic index and GA, fetal weight and mother's age. Kolmogorov Sminov and Shapiro – Wilks tests were used to test for the normality of the distribution. Statistical package for social science (SPSS) version 17.0 was used for the analysis of the data. $P< 0.05$ was chosen as the level of significance.

RESULTS

A total of 220 pregnant women aged between 16 to 37 years participated in the study. The results showed that the mean cephalic index for the population was 76.48+11.87. Male fetuses had a cephalic index of 78.18+4.11 while female had a cephalic index of 74.34+16.52. The difference in the cephalic index between male and female was significant ($p<0.05$). There was no correlation between cephalic index with fetal weight, and maternal age.

DISCUSSION

Ultrasonography is useful in obstetrics and fetal morphometry (10, 11). Cephalic index (CI) is an objective and highly useful parameter for determining skull shape and assessment of cephalo-pelvic disproportion (4). It is also an important parameter for assessing sexual differences between parent, off springs and siblings (12). In obstetrics, cephalic index is used to discriminate between normal and abnormal fetal head, and for planning parturition.

In the present study, the mean cephalic index of fetuses in Cross River State was found to be majorly between 76.48+11.87. This shows that they belong to the mesaticephalic group of head classification. The mean cephalic index of male fetuses in the present study was 78.18 + 4.11 while that of female fetuses was 74.34+16.51. Cephalic index of fetuses in our studied population was lower than that reported by Ugwu et al. (13) who in their study stated that their studied population had an average cephalic index of 85.92+4.88 (for fetuses in south-eastern Nigeria). Eroje et al (14), documented a mean CI of 72.96 in their study. The difference observed in CI of the present study and other studies may be underlain by ethnicity and racial variation (15). Other factors could be environmental, genetic or nutritional causes.

Lobo et al. (16), carried out a study on cephalic index of males and females fetuses of Gurung community in Nepal, and results revealed a significant gender difference, with males having a significantly lower cephalic index of 83.1 than females with (84.6). There is discordance between result obtained by Lobo et al. (16) and those of the present study, as male fetuses had larger CI compared to their female counterparts. Oladipo & Olotu (15) determined the cephalic index for Ijaw males and females and noted it to be 80.98 and 78.24 respectively. They also worked on the cephatic index of Igbo males and females and noted it to be 79.09 and 76.83, respectively. Their findings were higher than that of the present study.

In the present study, it was observed that cephalic index varied with gestational age. The mean cephalic index was found to be 78.76 from 28-35 weeks of gestation. Above 35 weeks of gestation it decreased to 75.28. Tuli et al. (17), in their study, observed an increase in cephalic index up to the 30th week of gestation. On the contrary, Rajlakshmi et al., (18) in their study of cephalic index of fetuses of Manipuri population, observed a non-uniform increase and decrease of cephalic index during pregnancy. A constant cephalic index of 78.3+4.4 from 14-40 weeks of gestation was observed by Hadlock et al. (19) with no significant change as the fetal age increase. Jeanty et al. (20) found that cephalic index was not age dependent. However, findings of the present study were in consonant with results of Gray et al. (8) who observed a change in cephalic index with increasing age of fetus. Factors involved in suture patency and normal bone growth including hormonal factors, maternal smoking and hyperthyroidism have been linked to early fusion of sutures. Fibroblast growth factors and fibroblast growth factor receptors regulate fetal bone growth and are expressed in cranial sutures during pregnancy. Premature fusion of the sagittal suture will increase the entire length of the head antero-posteriorly, while only the length of the anterior portion is reduced in early metopic suture (21). Early fusion of bilateral coronal sutures results in increased biparietal diameter and reduced head length (classical brachycephaly). This is worse when the lambdoid sutures are affected. The growth of the face is dependent on the base of the skull and it is also affected when these sutures fuse early (21).

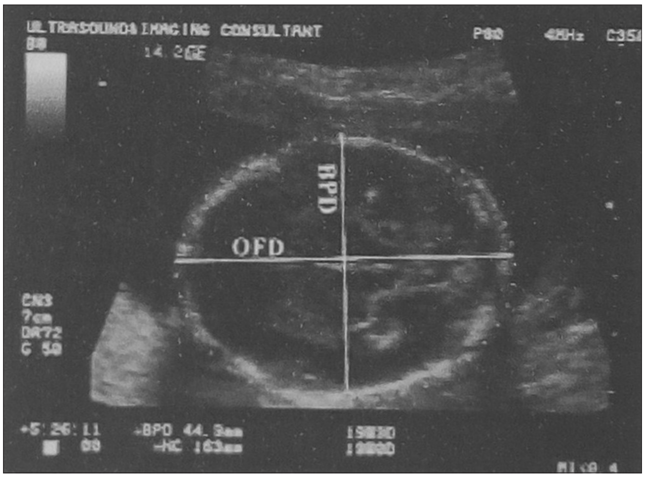

Figure 1. Measurements for biparietal and occipitofrontal diameters

Table 1. Distribution of Cephalic Index according to Gestational Age

GA	N	MEAN+SD	RANGE
Less than 28 weeks	25	78.77±6.47	69.49 – 99.22
28 – 35 weeks	50	75.96±12.70	71.35 – 92.56
Greater than 35 weeks	24	75.28±4.08	74.53 – 89.62

An essential feature of labor is the adaptation between the fetal head and the maternal pelvis. Knowledge of the size and shape of the fetal head is importance in understanding the mechanism and management of labour (22). In times past, numerous methods of radiologic cephalometry were used as indexes of fetal growth and maturity. Subsequent studies however, proved the bi-parietal diameter and CI to be the most important measurements of the fetal head because its values were significantly superior to that of the average cranial circumference (19). Sonographic assessment of fetal head before delivery plays a vital role in the management of labour and delivery. The use of ultrasound to measure the fetal bi-parietal diameter and occipitofrontal diameter has afforded the modern obstetrician to know beforehand the relationship between the size and shape of the fetal head and the pelvic brim and forecast whether or not spontaneous delivery through the vagina would be possible.

One of the most common reasons for cesarean delivery is cephalopelvic disproportion or an inadequately sized maternal pelvis relative to fetal biometry (23). Cephalo-pelvic disproportion (CPD) occurs in a pregnancy where there is mismatch in the size of the maternal pelvis and the baby's head thus resulting in difficulty of the fetuse to pass safely

Table 2. Mean Cephalic Index and other fetal parameter between males and females

VARIABLES	MALE		FEMALE	
	Mean	Range	Mean	Range
CI	78.183±4.11	70.34 – 92.56	74.34±16.51	16.06 – 99.2
BPD	78.164±14.66	39.6 – 101.0	73.99±20.85	17.5 – 96.7
OFD	99.882±17.77	52.8 – 129.0	100.59±19.83	47.5 – 134.0
FW	3.955±5.53	1.02 – 7.81	2.94±1.68	1.09 – 8.90

CI: Cephalic Index; BPD: Biparietal Diameter; OFD: Occipitofrontal Diameter; FW: Fetal weight

Table 3. Correlation between variables

	Cephalic index	Fetal weight	Gestational age	Mothers age
Cephalic index				
Pearson correlati	1	0.012	-116	0.122
P- value	100	0.917	0.254	0.236
N	220	80	99	96
Fetal weight				
Pearson correlati	0.12	1	0.28	0.029
P- value	0.917	80	0.826	0.802
N	220		80	78
Gestational age Pearson correlati				0.081
P- value	0.116	0.028	1	0.436
N	0.254	0.086	99	95
	220	80		
Mother's age				
Pearson correlation	-122	0.029	0.081	1
P- value	0.236	0.802	0.436	96
N	220	78	95	

through the cervix. Cephalopelvic disproportion can lead to prolong labour, fetal distress and a delayed second stage labour.

Many of the most severe forms of cephalic disorders are fatal. They are not necessarily caused by a single factor but may be influenced by hereditary or genetic conditions or by environmental exposures during pregnancy, such as medications taken by mother, maternal infections or exposure to radiation (7). Accurate knowledge of fetal cephalic index can be used to predict this disorders in utero. Such knowledge would guide management of the fetus, delivery route, and also in anthropologic assessment of fetuses of Cross River State ancestry.

CONCLUSION

The present study shows the cephalic index of fetuses of Cross river state population to be largely mesaticephalic from 13 weeks of gestation to full term.

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