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Studies of the Relationship Between Intelligent Quotient and Head Circumference among Secondary Schools Students in Bichi Local Government, Kano State, Nigeria

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Abstract

Individual differences exist among human beings in terms of their reasoning, learning and the ability to comprehend complex ideas in order to adapt effectively to their environment. Anthropometrically, cephalometry could be a very useful tool to assess these differences as it has been widely used to study nutritional background and brain development. Hence, the is aimed at finding out the relationship between head circumference and intelligence quotient (IQ) among secondary school students in Bichi Local Government Area of Kano State. The sample size consists of 386 students with age range age range between 11-21 years and 13-20 years among which are 196 males and 190 females respectively, socio-demographic data were collected through self-administered pro-forma. Intelligence assessment was done using intelligence quotient test questionnaire, while the head circumference was measured using measuring tape. Data was analyzed using SPSS version 20.0 (IBM). Statistical significance was considered at $p \leq 0.05$. The head circumference was observed to be higher in males than females ($P<0.001$). However, the difference in the IQ score was higher in females than males ($P=0.001$). In conclusion, the study shows significant correlation in head circumference and IQ.

Keywords: Intelligence, Head circumference, Intelligent Quotient, Sexual dimorphism

INTRODUCTION

Intelligence is one's capacity for logical reasoning, abstract thoughtfulness, self-awareness, communication, learning and memory (Goldstein *et al.,* 2015). Through intelligence, human being possesses cognitive abilities for various activities in the form of conceptual reasonings which includes; the capability to distinguish pattern, understand concepts, solve problems, retain information and use of language to communicates (Tirri, 2017). Individual differences

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exist in the capacity to appreciate complex ideas, thereby making human beings to acclimatize successfully to their environment (Reader *et al*., 2011).

Human intelligence exceeds all forms of measure by intelligent quotient (IQ) score even though within the context of research by most studies, performance on IQ test or similar tests are often the most appropriate and available form of measure to define intelligence in human (Ivanovic *et al*., 2004).

Cephalometry which is the scientific measure of head dimension (EL-Feghi *et al*., 2004), is useful for forensic analysis of head for craniometric differentiation from existing photographic and radiological records. Complex interaction between genetics and environmental factors had been noticed to cause variation in cephalic index within and between population (Kasai *et al*., 1993). Anthropometric index arising from both nutritional and brain development together with head circumference from the previous studies have shown important index associated with educational achievement and intellectual capability in Chilean school-age children (Ivanovic, *et al*., 2000; Ivanovic *et al*., 1989, 1996; Toro *et al*.,1998). Normal head circumference can be related to statistical normality function, which may not be the case for educational achievement or psychological functions (Ivanovic *et al*., 2000). Even though, micro and macrocephaly which are indicators for brain abnormality that are related to size of the brain or head circumference, values of head size below the mean are often associated with increased incidence of lower intellectual capabilities (Ivanovic *et al*., 2000; Menkes, 1995).

Changes in head dimension follows different pattern among population. Europe and American blacks' population, have narrow skull with vault that have increased height and length. In Nigeria, there is paucity of anthropometric data on intelligence of children, especially data that relate to their head dimension. Therefore, the aim of the present study was to find out the relationship between head circumference and intelligence quotient (IQ) among secondary school students in Bichi Local Government Kano State.

MATERIALS AND METHOD

Study Area

The research was conducted in four (4) secondary school of Bichi local government area of Kano State, Nigeria. The secondary schools include Government Senior Secondary School Bichi, Government Girls' Secondary School Bichi, Government Secondary School Buden gari and Government Girls' Arabic Secondary School Bichi. According to report of Nigeria's National Population Commission, (2006), Bichi has an area of 612km^2 with population of about 277,099 comprising Hausa and Fulani ethnic groups as major inhabitants.

Study Design

Random sampling technique was adopted and questionnaires were distributed randomly among the various secondary school students comprising of both left handers and right handers selected from both male and female students. The sample size was approximately 386 [(1.96^2×0.5×0.5)/0.05^2], with 196 male and 190 females, derived using the formula: $n = (Z^2PQ)/d^2$ (Naing *et al*., 2006). Where (n) is the Minimum Sample Size, (Z) as Standard Normal Deviation with (±1.96, Cl (95%), P =50% of the total population (0.5) and Q as 1 – p, while d is the Standard error 5%.

Procedure

The intelligence quotient assessment was done using a structured questionnaire while the head circumference was measured using a tape (in elastic TR-13G-60 tailor's tape 60 in 1.5m, made in China).

The tape was wrapped snugly around the widest possible circumference- from the forehead (2cm above the eyebrow) toward the nuchal line of the back of the head. The measurement was repeated three times per student and an average was taken (Rushton and Ankney, 2009).

Fig 1.0 Picture of a Measuring tape used

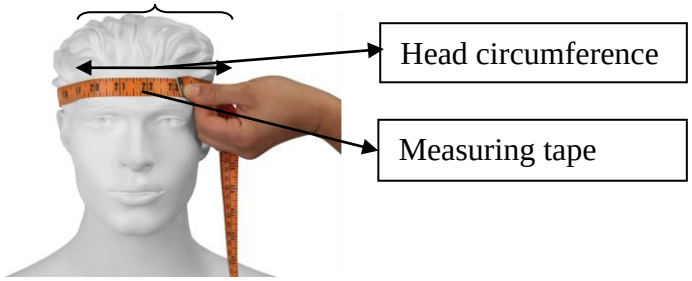

Figure 2.0 Measurement of head circumference

The intelligence quotient was assessed by using (IQ) test questionnaires, where the subjects were allowed to respond to 15 set of questions. The questionnaire consists of part I for bio data, while part II consists of space for IQ score with a set of 15 intelligence questions designed at IQTestExpert.com

Ethical Approval

Ethical clearance was obtained from Research and Ethics committee of Anatomy Department, Bayero University Kano. Inclusion criteria includes students without structural deformity in their limbs, history of head injury and mental illness. The exclusion criteria include students with previous history of mental illness, structural or anatomical anomaly and history of head injury.

Statistical Analysis

Data were analysed using (SPSS) version 20.0, results were expressed as Mean ± SD. The difference between the means was determined using independent sample t- test and Pearson correlation was used to find the strength of relationship between the variable and significance difference was observed at $p<0.005$.

RESULTS

Table 1 shows the descriptive statistics of age, head circumference and intelligence quotient (IQ) of both males and females with male have age limit of 11 and 21 years, female subjects having 13 to 20 years age limits respectively. The mean value of head circumference of males and females subject were 55.43±2.42 and 54.04±1.89 respectively, while the average value IQ score of the males and females subject were 4.38±1.59 and 5.21±1.81 respectively. Table 2 shows the independent sample t-test for sexual dimorphism of the variables. There was statistically significant difference ($P<0.001$) in head circumference of males and females. Also, there was significant statistical difference in the IQ score ($P=0.001$) of males and females Table 3 shows the relationship between IQ and head circumference of the subjects. There was statistically significance correlation between head circumference and IQ ($P=0.006$).

Table 1: Descriptive statistics of age, head circumference and IQ

Sex		N	Minimum (Years)	Maximum (Years)	Mean	SD
Male	AGE	196	11	21	15.65	1.893
	HC	196	50.4	61.1	55.43	2.42
	IQ	196	2	10	4.38	1.59
Female	AGE	190	13	20	14.77	1.56
	HC	190	48.3	59.8	54.04	2.13
	IQ	190	1	10	5.21	1.81

SD= Standard Deviation IQ = Intelligence Quotient HC=Head circumference N= Number of subjects

Table 2: Sexual dimorphism in head circumference and IQ

Variables	Sex	N	Mean	SD	t-value	P-value
HC	Male	196	55.43	2.42	-4.34	0.000
	Female	190	54.04	2.13		
IQ	Male	196	4.38	1.59	-3.43	0.001
	Female	190	5.21	1.81		

D= Standard Deviation IQ = Intelligence Quotient HC= Head circumference Correlation is significant at p< 0.05

Table 3: Pearson's correlation of the study variables

Variables	N	R	R^2	P-value
Head Circumfrane (cm) – IQ	386	0.194^{xx}	0.037^{xx}	0.006

Q= intelligence quotient n= number of subjects
^{xx}correlation is significant at 0.01 level of significance

DISCUSSION

This study revealed that head circumference has positive and significant relationship with intelligence ($p<0.001$), which explained the changes in the nutritional status together with weight and height as described by previous work which showed correlation between intelligence and academic achievements in Chilean school-age children (Olivares, *et al.*, 1996). Therefore, the significant difference observed from this work when correlating head circumference with IQ suggests that individual with larger head circumference, assuming all other factors such as genetic and environmental factors remain constant, without considering the gender, should possess higher IQ score and be able to perform better in school.

Similarly, previous studies by some authors have revealed a significant and positive relationship between head circumference and intelligent quotient (Rushton and Skuy, 2000; Vernon *et al*., 2000), which agrees with the present study. In this context, those study that have reported an association between head circumference and low intelligent quotient (Reynolds *et al*., 1999; Vernon *et al*., 2000) did not observe did not observe statistically significant difference. The observed positive relationship between the intelligent and head size could be as a result of changes in the number of neurons. Higher brain size is known to have large brain size which contain more neurone and therefore have higher processing power according to Haier *et al.* (1995) and Vernon *et al*. (2000). Basten *et al*. (2015) and Ritchie *et al*. (2015) quantitative meta-analysis on neuroimaging studies of function and structure of brain on intelligent, revealed similar positive relationship among six brain variables (brain volume, cortical thickness, white matter structure, white matter hyper-intensity load, iron deposits and micro bleeds), and intelligent quotient. The present research showed that the mean head circumference value are higher in males than in female and this is consistent with the studies conducted by Esomonu and Badamasi, (2012) on cephalic anthropometry of

Ndi igbo's in Abia state where he found that male children have higher head circumference than their females counterparts (Esomuno and Badamasi, 2012). The sexual dimorphisms observed can be due to changes in the levels of testosterone in males, as testosterone is known to directly increase the size and mass of muscles and bones, and thus changes in the shape of the face (Osunwoke *et al*., 2011). Thus, this brought about the changes in adult males because there is increase in testosterone level in males than females at puberty stage. Kimura (2000) have also reported male having more head circumference than females in his research on sexual dimorphism in stature and head circumference among Haryanvi adults. Also, study in Hawaii by Nakashima., (1986) suggested that environmental and variant ecological conditions could cause changes in head dimensions such as cranial capacity and head shape. The noticeable differences in the cranial size and capacity among people caused by environmental pressure could be an important factor that enable human beings to adapt life in various environment conditions (Irmak *et al*., 2004). Also, Rushton and Osbome (1995) indicated that genetic factors are accounted for phenotypic variance in cranial parameters. This agrees with the work of Nooranipour and Farahani, (2008). This study showed correlation between brain (head size) and test of intelligence, which might be as a result of differences in cultural background and socioeconomic status. Jensen, (1994) reported effect of environmental factors such as nutrition and differential stress during pregnancy on brain size and cognitive ability. This suggests that population difference in cranial capacity and cranial dimension are attributed to race, age and geographical factors (Golalipour *et al*., 2003).

Intelligence quotient test results from this study showed a significant increase ($p=0.001$) in females than in males with female's scoring higher than males with average of 5.21±1.81 and 4.38±1.59 respectively. This might be because of differences in eye –hand motor coordination not in the head size. Kimura (2000) stated that women excelled better than men in eye – hand motor coordination. Also, according to Eysenk, (1999) individual brain size is affected by nutrition and early experience, this can be due to the reason that males are more subjected to physical activities and attention is given much to females. Also, closely observing the test-taking behaviour of female subjects and noted that they worked very diligently, typically more interested than male subjects and recheck their answers. Maccoby and Jacklin (1974) have also reported that verbal ability in girl are greater that in boys. They make their observation from ability of girls to have higher score in tasks related to receptive and productive language on a high-level verbal task involving analogies, comprehension and creativity in writing, so also in lower level task like fluency.

The differences between individuals and groups in general intelligence may be largely due to genetic and environment (Bouchard, 2004). Whereas, between childhood and adulthood, Plomin *et al*., *(*2001) have reported the influence of the shared home environment can alters intelligent quotient so also genetic similarity (Plomin *et al*., 2001).

CONCLUSION

The study shows a significant positive correlation in head circumference and IQ, thus suggesting that secondary school students in Bichi Local Government of Kano State in Nigeria having higher head circumference are more intelligent than those with lower head circumference. The sex differences observe in present study for the intelligent quotient test could be due to other factors like genetic, nutritional status e.t.c which we recommended for further studies but not the head circumference.

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