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Assessment of the relationship between cranial capacity and intelligent quotient

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ABSTRACT: *Background:* Craniometric study is an important fraction of anthropometry that can be employed in the determination of cranial capacity of an individual. It indirectly reflects the volume of the brain and predicts mental ability. The aim of this research is to asses, compare and contrast sexual dimorphism in craniometric parameters and its relationship to intelligence, among Igbos resident in Enugu state. *Materials and method:* Two hundred and seventy-five (275) persons (148 males 127 females) aged 16-34 years were randomly selected. Cranial dimensions (cranial length, width and height) and weight and height of the individuals were taken and analyzed using descriptive statistics, Pearson correlation coefficient and chi square test of independence. *Result:* Cranial capacity has no significant correlation with intelligence quotient for all subjects ($p>0.05$). The male subjects in our cohort were observed to have higher cranial length, breadth, height, cranial capacity and intelligence quotient than the females. *Conclusion:* Findings from this study show that sexual dimorphism exists in craniometric parameters and there is no significant relationship between craniometric parameters and intelligence quotient among Igbos resident in Enugu metropolis. The findings from this study could aid forensic facial reconstruction and portrait sculpture. Hence, it would be found useful by the maxillofacial and plastic surgeons and even forensic experts.

KEYWORDS: Craniometry, craniometric parameters, intelligent quotient, sexual dimorphism, Igbos.

1 INTRODUCTION

Intelligence quotient (IQ) is a total score derived from a set of standardized tests or subtests designed to assess human intelligence [1]. In research contexts, it has been studied as predictor of job performance [2] and income [3]. They are also used to study distributions of psychometric intelligence in populations and the correlations between it and other variables.

Cranial capacity is the volume of the interior of the cranium of vertebrates that possess a cranium and a brain [4]. Cranial volume is used to approximate the size of the brain, which is also suggestive of the intelligence of the organism [4].

Majority of magnetic resonance imaging studies have reported moderate correlations around 0.3 to 0.4 between brain volume and intelligence [5], [6]. The most consistent associations are observed within the frontal, temporal, and parietal lobes, the hippocampus and cerebellum, but only accounts for a relatively small amount of variance in IQ, which suggests that while brain size may be related to human intelligence, other factors also play a role [6], [7]. Research measuring brain volume, p300 auditory evoked potentials, and intelligence have also shown a dissociation, such that both brain volume and speed of p300 correlate with measured aspects of intelligence, but not with each other [8].

Christof [9] pointed out that crude brain size is unlikely to be a good measure of IQ, [9] for example brain size also differs between men and women, but without well documented differences in IQ [8]. However, larger cranial capacity is not always indicative of a more intelligent organism, since larger capacities are required for controlling a larger body, or in many cases are an adaptive feature for life in a colder environment. For instance, among modern homo sapiens, northern populations have a 20% larger visual cortex than those in the southern latitude populations, and this potentially explains the population differences in brain size (and roughly cranial capacity) [10].

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Extensive researches estimating cranial capacity, have been conducted in different populations in Nigeria [11], [12], [4], [13] and other countries [14], [15], [16]. Despite the numerous reports on craniometry, there is a paucity of data correlating cranial capacity and intelligent quotient of Igbos. This study therefore investigated sexual dimorphism in craniometric parameters, and intelligence among Igbos resident in Enugu state.

2 MATERIALS AND METHODS

This study was conducted on 275 volunteers whose ages ranged between 16-34 years. They were randomly selected from persons whose parents and grand-parents were of igbo origin and showed no obvious physical craniofacial deformity or previous cranial surgeries and are resident in Enugu metropolis, south eastern nigeria. Informed consent was obtained from the individuals in accordance with the revised helsinki declaration (world medical association declaration of helsinki ethical principles for medical research involving human subjects, 2015) [17].

2.1 MEASUREMENTS

Standardized measurements of cranial length, cranial breadth, cranial height and head circumference were taken with the individual relaxed and sitting on a chair, with the head in anatomical position using a spreading caliper (vintage machinist, USA) [18] and measuring tape.

All measurements were carried out after careful palpation of the head for anatomical landmarks and measurements were taken to the nearest 1mm by a single investigator thrice and the average recorded for computation and subsequent analysis [19].

The subjects were asked to stand barefooted and heels together in anatomical position with the head in frankfort plane and back straight as possible so that the heels, buttocks, shoulders and the head touched the wall. The arms were hung freely by the sides with the palm facing the thighs. They were asked to take deep breaths [20] and holding it, the heights of the subjects were measured between the vertex and floor [21] using a measuring scale (steel plate) placed against the head and wall to determine maximum height on the wall, and this was marked. They were then told to resume normal breathing and to step away from the wall. The height was then measured from the floor to the mark on the wall with steel tape which represents the stature in centimeters to the nearest 0.1 centimeters using the metric system [22].

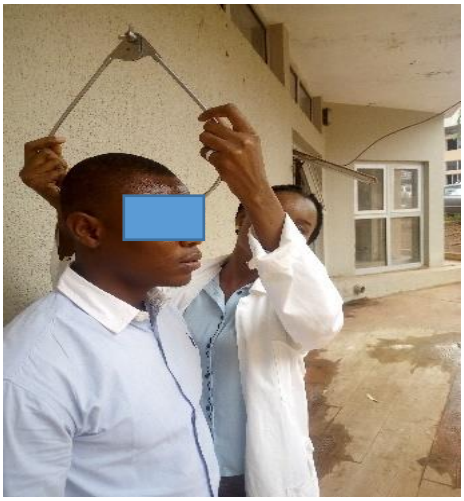

Fig. 1. Cranial length: taken as the linear length from glabella to the inion

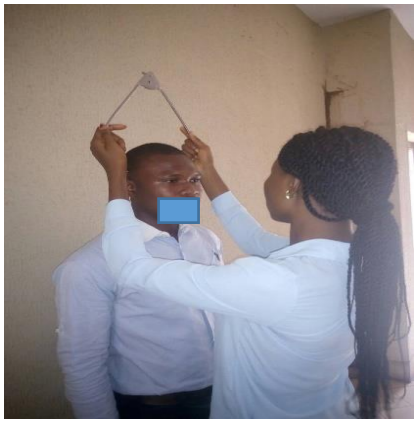

Fig. 2. Cranial breath: taken as the linear distance between the parietal eminences

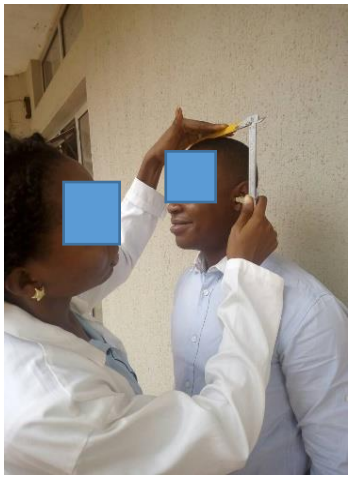

Fig. 3. Cranial height: taken as the distance from the nasion to the highest point of the head (vertex)

Fig. 4. Weight measurement

Fig. 5. Measurement of height

Cranial capacity in males and females were then calculated according to the following formulae [23].

Males: 0.00033 (l-11) (w-11) (h-11) + 406.01

Females: 0.000400 (l-11) (w-11) (h-11) + 206.6

2.2 Determining Intelligence Quotient

After measurement of the parameters of the individuals, every participant was given the specialized IQ test application to undergo the intelligence quotient testing. This application is automatically timed and scored with an overall score of 1000 which is then approximated to a 100.

A standardized questionnaire was distributed to all participants. Sex, age, cranial dimensions (cranial length, height and breadth), height and weight of the participants along with their IQ score were taken and recorded in their respective questionnaires using standard techniques.

intelligence quotient range	intelligence quotient classification
0 – 38	poor
39 -100	average

Intelligent quotient range and classification

2.3 Statistical Analysis

Data obtained from the measurements of the parameters were recorded and then transferred into spss version 21 for analysis. $P<0.05$ was considered significant.

3 RESULTS

Table 1. Descriptive statistics of the studied variables for all participants. Shows the mean and standard deviation of height, weight, craniometric parameters, age, IQ score and cranial capacity of all the students

variables	N	Minimum	Maximum	Mean±stddev
Height (m)	275	1.52	1.94	1.71±0.09
Weight (kg)	275	36.00	126.00	64.21±10.48
Cl (cm)	275	16.25	23.50	20.57±0.68
Cb (cm)	275	13.00	20.00	16.92±0.84
Ch (cm)	275	9.46	15.30	12.38±0.84
Iq (%)	275	1.80	96.00	34.93±18.10
Age	275	16.00	32.00	21.45±2.51
Capacity (cm^3)	275	206.42	406.11	314.05±99.50

Cl= cranial length, cb= cranial breadth, ch= cranial height, c. Capacity= cranial capacity, n= total number of students. (p<0.05).

Table 2. Descriptive statistics of the studied variables (for male subjects). Shows the mean and standard deviation of height, weight, craniometric parameters, age, IQ score and cranial capacity of all males

variables	N	Minimum	Maximum	Mean±std. Dev
Height (m)	148	1.61	1.94	1.77±0.06
Weight (kg)	148	42.00	126.00	67.64±9.72
Cl (cm)	148	20.00	23.50	20.85±0.61
Cb (cm)	148	13.75	20.00	17.24±0.76
Ch (cm)	148	10.76	15.30	12.51±0.80
Iq (%)	148	1.80	96.00	38.14±19.07
Age	148	16.00	32.00	22.02±2.83
Capacity (cm^3)	148	406.01	406.11	406.04±0.02

Cl= cranial length, cb= cranial breadth, ch= cranial height, c. Capacity= cranial capacity, n= total number of students. (p<0.05).

Table 3. Descriptive statistics of the studied variables (for female subjects). Shows the mean and standard deviation of height, weight, craniometric parameters, age, IQ score and cranial capacity of all females

Variables	N	Minimum	Maximum	Mean±stddev
Height (m)	127	1.52	1.90	1.65±0.06
Weight (kg)	127	36.00	97.00	60.22±9.93
Cl (cm)	127	16.25	21.75	20.26±0.61
Cb (cm)	127	13.00	18.25	16.55±0.78
Ch (cm)	127	9.46	14.24	12.18±0.85
Iq (%)	127	3.60	81.80	31.20±16.19
Age	127	17.00	25.00	20.80±1.88
Capacity ($cm^{3)}$	127	206.42	235.84	206.85±2.59

Cl= cranial length, cb= cranial breadth, ch= cranial height, c. Capacity= cranial capacity, n= total number of students. (p<0.05).

Table 4. Correlations between cranial capacity and anthropometric measures in male and female all subjects. Shows that for both male and female student's, height, weight, cranial length and cranial breath do not significantly correlate with cranial capacity, but cranial height significantly correlate with cranial capacity (p<0.05). Cranial height has a positive correlation with cranial capacity

Parameters	Cranial capacity	
	Person correlation	P value
Height (h)	.683	.000
Weight (w)	.354	.000
Cl (cm)	.433	.000
Cb (cm)	.409	.000
Ch (cm)	-.045	.457

Table 5. Correlation between cranial capacity and intelligence quotient in males, females and all students. Shows that for all students, cranial capacity has no significant correlation with IQ (p>0.05), for males students, cranial capacity do not significantly correlate with IQ also for female students shows that cranial capacity do not significantly correlation with IQ (p>0.05)

Intelligence quotient	Cranial capacity		
	Pearson's correlation	P value	No of students
For all students	.191	.06	275
For male students	-.072	.385	148
For female students	-.021	.812	127

Table 6. IQ category and gender. Shows that gender has a very strong significance with intelligence. Males tend to have a higher intelligence quotient than females. (p<0.05)

IQ Category	Gender		Total	Chi Statistics	P value
	Male	Female			
Poor	68	87	155	13.239	0.000
	43.9%	56.1%	100%		
Good	80	40	120		
	66.7%	33.3%	100%		
Total	148	127	275		
	53.8%	46.2%	100%		

4 DISCUSSION

It has been noted that cranial capacity is one of the most important parameters for determining the racial difference and sexual dimorphism [24]. Several anthropometric studies carried out on the cranium as it relates to gender have shown a lot of variations with males possessing higher values than females in both adults and neonates [25], [26].

In the present study attempt was made to asses, compare and contrast sexual dimorphism and its relationship to intelligence among Igbos resident in Enugu state. The height, weight, cranial length, breadth and height in males (table 2) were 1.77±0.06, 67.64±9.72, 20.85±0.61, 17.2±0.76, and 12.51±0.80, respectively while females presented with 1.65±0.06, 60.22.±9.93, 20.26±0.61, 16.55 ± 0.78 and 12.18±0.85, respectively (table 3). The results indicate that the values were significantly (p<0.05) higher in males than in females. The male participants in our cohort were observed to be taller than the females (table 2 and 3). This height difference could be due to nutrition, heredity, environment, evolution or the influence of testosterone which causes a significant increase in bone growth and increase in the number of muscle cells than that of the average female [27]. It was also observed that males were heavier than females (table 3). This sexual dimorphism in body

composition could be attributed to the trending consciousness of females to societal perception which encourages slender shaped females [28].

Sexual dimorphism was observed in craniometric parameters in this study. Cranial capacity, cranial breadth, cranial height and brain weight was higher in males than in females (table 2 and 3). This observation was in agreement with previous works that reported significantly larger cranial capacity in their male subjects when compared with female subjects, and a significant effect of gender and body mass index on the cranial capacity [25], [12], [29]. Other anthropometric studies carried out on the cranium as it relates to gender have also shown a lot of variations with males possessing higher values than females in both adults and neonates [30], [25], [26]. Possible reason for this difference could be differences in the number of cortical neurons. Pakkenberg and gundersen [31] reported that men had about 4 billion more cortical neurons than women.

this study (table 6) also revealed a significant difference between gender in terms of IQ ($p<0.05$). This is similar to the findings of previous studies which showed that males tend to have a higher intelligence quotient than females [32], [33], [34]. Cranial capacity was observed to have no significant correlation with intelligence quotient for all the participants (table 5). This concurs with other studies on magnetic resonance imaging (mri) analysis of children and adolescents, that reported no direct relationship between cranial capacity and IQ [35], [36].

5 CONCLUSION

Findings from this study show that sexual dimorphism exists in craniometric parameters and there is no significant relationship between craniometric parameter and intelligence quotient among Igbos resident in Enugu metropolis. The findings from this study could provide invaluable data for forensic experts, facial reconstruction, maxillofacial and plastic surgeries.

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