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Impact of Cranial Capacity on the Academic Performance of the Students of Igbos of Nigeria

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Abstract: The brain which is the organ for memory and cognitive functions is housed in the cranium and the capacity of the cranium has been used to indirectly assess the volume of the brain and to predict mental ability. The aims of this study were to determine the cranial capacity of the Igbos of Nigeria at the College of Medicine University of Nigeria and its' impact on their academic performance. The study involved 613 Igbo students of the Faculties of Medical Sciences, Dentistry and Health Sciences and Technology. The academic performance was based on the students' end of course examination. Cranial capacity was calculated from head length (L), width (W) and height (H) using Lee-Pearson's formula: males: 0.000337 (L-11) x (W-11) x (H-11) +406.01; females: 0.000400 (L-11) x (W-11) x (H-11) +206.60. The data were analyzed using SPSS version 20 and associations between academic performance and the cranial capacity were determined using student's t-test, Chi-square test and Pearson's correlations. The mean values of the cranial capacity of the students were 1384.2 ± 106.2cm^3 in males and 1200.8 ± 109.4cm^3 in females and males had higher mean values than females, ($p< 0.001$). The females were predominantly microcephalic (91.3%) while males were fairly distributed into microcephalic (39.3%), mesocephalic (36%) and macrocephalic (24.7%). There was no significant correlation between the cranial capacity and the academic performance of the students. In conclusion, cranial capacity did not have impact on the academic performance of Igbos' in the College of Medicine.

Key words: Capacity of Cranium · Academic Performance · Igbos of Nigeria

INTRODUCTION

Academic performance measures the extent to which a student has performed in specific goals that are his/her focus of activities in school. It has been stated that the social and economic development of a country is directly linked with students' academic performance [1]. The latter plays an important role in producing the quality graduates who will be responsible for the country's economic and social development [2, 3]. Factors affecting students' academic performance have received considerable attention [1]. A number of studies have identified and analyzed some of these factors, including but not limited to the capacity of the cranium, admission criteria and parents' socioeconomic status [4-7]. Cranial Capacity is a measure of cranial volume and in turn it is related to brain size [8]. They noted that from the early nineteenth century, craniometry has been used as one of the most important means of investigating human variety. It is not only for delimiting racial groups but also in predicting the levels of intellectual attainment achieved by different people. It was argued that the dimensions of the skull reflected the contours of the brain [9]. Douglas [9] stated that man's brain is relatively larger than other animals and it is natural for man to conclude that the brain is the hallmark of man and the measurement of it must be the key to the understanding of his unique intellectual capacity.

Brain size and cranial capacity are receiving attention because of technologies available to scan the brain and because a significant relationship has been established between academic performance and brain size [10]. They reported that the correlation between academic performance and brain size estimated from magnetic resonance imaging (MRI) ranges from 0.35 to 0.47 with an average of about 0.40 [10]. Other studies have corroborated that there is a positive correlation between brain size, cranial capacity and one's intelligence and general mental ability [4, 11, 12]. Rushton and Ankney [13] reported that Galton (1888) was the first one to quantify the relationship between brain-size and cognitive ability

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in humans. His subjects were Cambridge undergraduate males who were divided into two: those who achieved first-class honors degree and those who did not. He computed head volume by multiplying head length by breadth and height and plotted the results against age (19 to 25 years) and class of degree (A, B, C). He reported that cranial capacity continued to grow after the age of 19 and those who obtained high honors degree had a brain size of 2 to 5% greater than those who did not. Rushton and Ankney [13] also reported that Pearson (1906) re-examined Galton's data using his correlation coefficient and noted a small positive relationship between head size and academic performance. They noted that cognitive abilities and intelligent were correlated with brain size, age, sex, social class and race.

However, some researchers reported that brain size is not an indicator of intelligence and they are not correlated [14, 15].

The aims of the study were; to determine the cranial capacity of the Igbos of Nigeria at the College of Medicine, University of Nigeria and to determine the impact of the cranial capacity on their academic performance.

MATERIALS AND METHODS

The study adopted a descriptive survey design and it was conducted in the Anatomy department at the college of medicine on the University of Nigeria, Enugu Campus. It involved 613 Igbo students (158 medical, 37 dentistry and 418 health sciences and technology students). Their academic performance was based on the results of the students' end of course examination.

Cephalometry: The cephalometry was performed for each student in sitting position, in relaxed condition and with the head in the anatomical position. Sliding caliper and auricular head spanner were used. Measurements were performed to the nearest 1 millimeter in 3 trials. The average of the trials was recorded.

The following cephalometric parameters were measured:

Cranial Capacity: This was calculated using the Lee-Pearson formula [16].

Males: 0.000337 (L-11) x (W-11) x (H-11) +406.01
Females: 0.000400 (L-11) x (W-11) x (H-11) +206.60

where L is the head length, W is head breadth and H is the head height in mm.

Fig. 1: Measurement of head length
The maximum head length (L) was measured as the maximum length between glabella and inion using a sliding caliper.

Fig. 2: Measurement of head breadth
The maximum head breadth (W) was measured as the maximum length between parietal eminences using a sliding caliper.

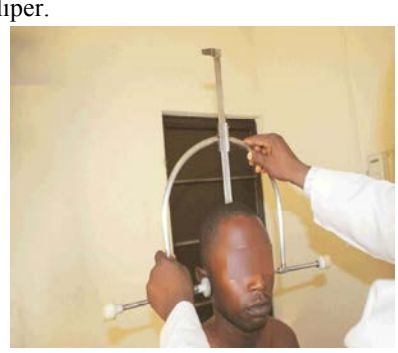

Fig. 3: Measurement of head height
The head height (H) was measured from the external acoustic meatus to the highest point of vertex using an auricular head spanner.

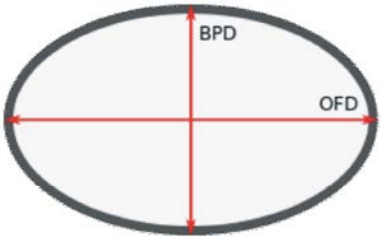

Fig. 4: Determination of cephalic index.
Cephalic index = W x 100/L

The students were classified into microcephalic, mesocephalic and megacephalic heads.

Cephalic Index: The cephalic index or cranial index is the ratio of the maximum width of the head and its maximum length multiplied by 100.

Ethics: Approval of the study protocol was obtained from the College of Medicine Research Ethics committee, University of Nigeria, Enugu Campus.

Informed Consent: The informed consent was obtained from all the participants.

Data Analysis: The data were analyzed using statistical package for the social sciences (SPSS) version 20. Descriptive analysis was used to determine the frequency, percentage and mean of the parameters. Associations between academic performance and the other variables were determined using student's t-test, Chi-square tests and Pearson's correlation.

RESULTS

Table 1 shows that the mean cranial capacity of the students was 1384.2±106.2 in males and 1200.8±109.4 in females and the cephalic index of the males and females were 80.6 and 80.7 respectively. The cephalo-cranial parameters of the students were significantly higher in males than in females, ($p< .001$) except for the cephalic index where there was no significant difference.

As shown in Table 2, the females were predominantly microcephalic (91.3%) while the males were fairly distributed into microcephalic (39.3%), mesocephalic (36.%) and megacephalic (24.7%).

Table 3 shows that there was no significant correlation between academic performance and the cephalo-cranial parameters of the students.

Table 4 shows that there was no significant difference in the academic performance of the students among the three categories of cranial capacity.

As shown in Table 5, in both gender, there was no significant difference in the academic performance of the students among the three categories of cranial capacity.

Table 1: Cephalo-cranial parameters of the students by gender

Cephalo-cranial parameters	Male	Female	p-value
Head length (cm)	193.2±7.7	184.8±6.9	0.001
Head width (cm)	155.6±6.4	149.0±5.9	0.001
Head height (cm)	121.0±7.2	114.4±6.9	0.001
Cranial capacity (cm^3)	1384.2±106.2	1200.8±109.4	0.001
Cephalic index (%)	80.6±4.0	80.7±4.0	0.663

Table 2: Categories of the cranial capacity of the students by gender

	Male	Female
Cranial capacity	No. (%)	No. (%)
Microcephalic	119 (39.3%)	283 (91.3%)
Mesocephalic	109 (36%)	23 (7.4%)
Megacephalic	75 (24.7%)	4 (1.3%)
Total	303 (100%)	310 (100%)
Microcephalic	< 1350cm^3	
Mesocephalic	1350cm3 - 1450cm^3	
Megacephalic	> 1450cm^3.	

Table 3: Pearson's correlation coefficient of academic performance with cephalo-cranial parameters

	HH	HL	HW	CC	CI	AP
AP	0.012	0.007	0.056	0.077	0.052	1

HH - Head height, HL - Head length, HW - Head width, CC - Cranial capacity, CI - Cephalic index, AP - Academic performance

Table 4: Academic performance of the students by categories of cranial capacity

	Microcephalic	Mesocephalic	Megacephalic	p-value
Mean±SD	50±16	52±17	51±16	0.356
No.	402	132	79	

Table 5: Academic performance of the students by categories of cranial capacity and gender

Sex	Micro Mean±SD(No.)	Meso Mean±SD (No.)	Mega Mean±SD (No.)	p-value
Male	52±16 (119)	52±18 (109)	50±16 (75)	0.72
Female	49±15 (283)	54±16 (23)	55±5 (4)	0.217
p-value	0.059	0.579	0.596	

DISCUSSION

Cranial capacity is one of the most important characters for determining the racial difference [16]. It is a measure of cranial volume and an indirect approach to evaluate the size of the brain, thus human populations differ in brain size. The cranial capacity of the students in this study was 1384.2 ± 106.2cm^3 in males and 1200.8 ± 109.4cm^3 in females. The males had higher mean values than the females. Males and females differ from each other genotypically and phenotypically and these differences are more pronounced during puberty and adulthood [17]. The result of this study is in keeping with the findings of Rushton and Ankney [13], Salve and Gitte [18], Golalipour *et al.* [19] and Swamy *et al*. [20]. Salve and Gitte [18] reported a mean cranial capacity of 1322 ±61cm^3 in males and 1129±76cm^3 in females. The mean values reported by Golalipour *et al*. [19] were 1420.6±85cm^3 in males and 1227.4±120cm^3 in females. Swamy *et al*. [20] noted that males had significantly larger cranial capacity than females. The females were predominantly microcephalic (91.3%), while the males were fairly distributed into: microcephalic (39.3%), mesocephalic (36%) and macrocephalic (24.7%) heads. This is in consonant with the findings of the study which noted that all the females in their study were microcephalic and the males were distributed among the three categories [18]. Acer *et al.* [21] also reported that their females were predominantly microcephalic.

The capacity of the cranium has been shown in many studies to indirectly reflect the volume of the brain and to predict academic performance [4, 11-13]. These authors stated that increase in brain size is associated with more sophisticated cognitive functions and that larger cranial capacity can be an indicator of larger brain and higher intelligence. On the contrary, our result showed no significant correlation between the cranial capacity of the students and their academic performances. This implies that any student with a cranial capacity within the normal range has the potential to attain reasonable intellectual ability. This finding is in agreement with the reports of Vathsala *et al.* [8], Giedd *et al.* [10] and Tramo *et al.* [22]. Giedd *et al.* [10] noted that there was no direct relationship between the cranial capacity and academic performance of their students while Tramo *et al.* [21] reported that there was no significant correlation between intelligence and any brain measurement or head circumference. Vathsala *et al*. [8] noted that although brain size correlated with cranial capacity, there was no link between larger brain size with one's mental ability and academic performance. Nzotta and Ezejindu [15] stated that although larger capacities and brain sizes are required for controlling a larger body and as an adaptive feature in a colder environment, there is no correlation between them and academic performance.

CONCLUSIONS

The males had higher mean values of cranial capacity than the females and they were fairly distributed into microcephalic, mesocephalic and macrocephalic heads unlike the females who were predominantly microcephalic. There was no significant correlation between the cranial capacity with academic performance and mental ability.

Recommendations: More research may be needed on the relative sizes of the various parts of the brain that are responsible for learning, memory and cognitive functions.

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