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**STUDY ON CEPHALIC INDEX RATIO WITH ACADEMIC
PERFORMANCE SCORES IN 1ST YEAR PROFESSIONAL GRADUATE
STUDENTS: A CROSS-SECTIONAL STUDY**

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ABSTRACT

Background: The human brain is the seat of cognitive function, which plays an important role in the existence of humans on earth. The cranial volume capacities will facilitate an increase in brain size, which played an important role in the process of evolution. The cephalic index (CI) ratio of the skull bone will indicate the relatively proportional size of the brain. Postnatal brain growth and development is an important factor that play role in achieving academic learning excellence. Based on this professional students' cephalic index ratios and their academic performance scores were studied.

Methodology: a total of 150 (male 67+ females 83) students of either sex who are studying at JSS academy of higher education and research, Mysuru, Karnataka were included in the study. Their CI ratios were measured by using a spreading. Data were analyzed to verify the level of significance in a different category of CI ratio with marks of male and female separately by using one-way ANOVA and Chi-squared test were used to determine if there's a significant association between gender and cephalic index ratios at 5 % level of significance.

Results: Among 150 participants of either sex, there is a dispersed distribution pattern of CI ratios was seen. There is no statistical significance obtained between the type of CI pattern with higher scores neither in theory nor practical scores in the same groups or on comparison between male and female groups. Hence there is no consensus obtained regarding high score significance in dominating a particular cephalic index pattern among these professional students. **Conclusion:** The present study results suggested that the higher cephalic index ratios are not on par with student academic performance with high scores. Hence the outcome of this study is suggestive of mere CI ratio (skull size) may not be the entity that drives cognitive abilities, especially in the professional student community.

Keywords: Cephalic Index, Cognition, Analysis of Variance (ANOVA)

INTRODUCTION

The anthropometric studies involve non-invasive parameters, which are used to assess the morphological features of an individual which ultimately yield a quantitative set of data. These parameters can be used to monitor an individual's health or growth status by taking measurements of various body parts at various points in time. These measurements are involving different physical parameters like body mass index (BMI), CI ratios, skin thickness, etc. It also includes the measurements of other Anatomical (morphological) features that are routinely stressed including the carrying angle of the forearm, femoral neck-shaft angle, sacral index, and male and female pelvic measurements [1]. Human body growth is influenced by the factors like nutrition, biology, race, ethnicity, gender, etc. the brain may not be not an exceptional organ without any differences. There are drastic biological, functional, and structural modifications that take place in the brain soon after birth. The brain despite being a

static organ undergoes phenomenal remodeling after birth. It is showing dynamic changes in several regions. The human brain evolved with a greater number of neurons and synaptic contacts along with complex connections, when compared with animals of other species, hence it has imbibed qualities of intelligence through natural selection for its survival [2-4]. A conducive environment and structural entities will complement each other to attain better cognitive learning abilities which are gradually expressed in the childhood milestones. They deal with higher functions of the brain like memory, attention, cognition, emotions, etc. are important prerequisites in achieving effective learning capabilities. Brain size and extensive intricate connections with subcortical linkage will influence the higher order of brain functions exhibited through student academic learning abilities [5]. The brain is the seat of intelligence, and the intelligence quotient (IQ) indicates the cognitive ability

of an individual, it has a link with academic performance and professional accomplishments. IQ is just not representing a mere functional entity; it is generally believed that it is having a strong organic basis that can be correlated with the volume of brain tissue, particularly the portion of the cortical grey matter. Despite these assumptions, a study on the brain in the post-mortem cadavers compared with earlier assessment questionnaires has shown no synchronizing results [6]. Studies correlating the CI ratio with the academic score is scarce. A study was conducted in an African university on basic medical science students who belong to age group ranging from 17-33 years. Their cephalic index ratios were tallied with the academic performance matched through comparing their cumulative grade point average (CGPA) scores. But the study results haven't shown any correlation between CI ratios with their CGPA score of performances [7]. Hence, a possible correlation of brain size measured in terms of the cephalic index was correlated with the functional outcomes considered in terms of academic performance (score) among the professional students was made.

Hypothesis: The individual's head size measurements are directly proportional to his or her academic performance scores in professional students.

Objective: correlating cephalic index ratio with the academic scores of first-year professional students.

METHODOLOGY

Study subjects: Professional students of JSS academy of higher education and research, Mysuru.

Place of study: JSS Academy of higher education, Bannimantap, Mysuru, Karnataka.

Type of study: cross-sectional

Sample size: it includes a total of 150 (Female 83+ Males 67) students of either sex.

Sampling technique: convenient sampling

Sample allocation: conveniently chosen subjects who are voluntarily willing to participate.

Ethical Clearance: clearance was obtained by Institutional Ethical Committee (IEC) IREC registration ECR/387/Inst/KA/2013/RR-19

Informed Consent: voluntary informed consent was obtained from the participants.

Inclusion criteria:

1. The subject should be above the age of 18 years.
2. The subject must be an undergraduate professional student of the JSS Academy of higher education
3. Students who are voluntarily willing to participate by giving informed written consent
4. Students who appeared for both theory and practical examinations

Exclusion criteria:

1. It will not include any participants who have had head injuries in the past.
2. Person with a known chronic ailment.

Parameters: Biparietal diameter (BPD), anteroposterior diameter (APD)/fronto-occipital

Calculating Cephalic Index Ratio:

$$\frac{\text{Biparietal diameter}}{\text{Occipitofrontal diameter}} \times 100$$

Measurement of CI ratio: Students who volunteered their consent for the study were explained in detail the purpose of the study. Based on inclusion criteria 150 students studying in 1st-year professional courses were involved in the study. Among them, 83 were female and 67 were male. The

average(mean) age of the participants was 18 and above years. A spreading caliper was used to measure the study parameters. BPD was measured by considering the biparietal distance from the summit of the external parietal eminence on either side and APD was measured from the glabella of the frontal bone to the summit(inion) of the external occipital protuberance (Photo:1 and Photo:2). All measured parameters were tabulated in an excel sheet. The cephalic index ratio (CIR) was calculated using an online electronic calculator after confirming the accuracy of its ratios with the manual calculations [8]. Students were classified into different groups based on the CI ratio (**Table 1**).

Table 1: Standardized Anthropometric Classification of Type of Cephalic Index Ratio [9]

Category	Type of Cephalic Index	Cephalic Index Ratio
A.	Dolichocephalic	<74.5
B.	Mesocephalic	75-79.5
C.	Brachycephalic	80-84.9
D.	Hyper-brachycephalic	> 85

Examination marks: The retrospective collection of practical and theory marks was obtained from the Anatomy department office, JSS Medical College, Mysuru.

Statistical analysis

A Normal Quantile plot and Histogram are used to assess a set of data follows a normal distribution. Descriptive statistics often include summary tables presenting critical measures like Mean, Standard Deviation, Standard Error, CV (%), Minimum, Maximum and 95% CI from Mean. The

present data on CIR for both "Theory" and "Practical" categories, stratified by gender (Male, Female, Total) which includes the number of observations (n), Mean ± SD, and p-values for the comparison between "Theory" and "Practical" for each category using one way ANOVA at level of 5 % significance. Chi-squared test used to determine if there's a significant association between gender and cephalic index ratios. This test assesses whether the observed distribution of individuals across cephalic

index ratios is significantly different for females and males. Data was compiled and analysed using SPSS version 22.

RESULTS

A total of 150 participants were considered for this study. Of these, 45% were male and 55% were female. The normal quantile plot with a histogram is a visual tool for assessing the normality of the data. **Figure 1** shows the distribution of theory percentage scores. All the values of the distribution are lying between two curves, which indicates that the data is normally distributed. From the results, there are no statically significant values obtained in the present study, in male participants the average theory score of the Dolichocephalic (A) and Hyper-brachycephalic (D) CI pattern cohort is showing considerably higher average scores when compared with the CI pattern of groups B and C. And an average of the practical score is considerably higher in Hyper-brachycephalic (D) group when compared with remaining scores of A,B. and C groups. In the case of female groups, the theory score average is higher in the Dolichocephalic (A) CI pattern when compared with other B, C, and D groups. And the average practical score was considerably higher in the Brachycephalic (C) pattern of CI when compared with A, B, and D groups.

Table 2 presents Descriptive Statistics for the "Theory" and "Practical" datasets

Cephalic Index Ratio. The mean for the "Theory" category is 52.78, while for the "Practical" category, it is 65.00. This suggests that, on average, the scores for the "Practical" category are higher than those for the "Theory" category. The standard deviation for the "Theory" category is 12.90, indicating a relatively higher variability in scores compared to the "Practical" category, which has a standard deviation of 9.82. The "Theory" category has a CV% of 24.45%, indicating a higher relative variability compared to the "Practical" category, which has a CV% of 15.10%.

Table 3 shows the gender distribution for each cephalic index ratio (A, B, C, D). Overall, females appear to have a higher representation (55.33%) compared to males (44.67%) in the dataset. For each cephalic index ratio, the gender distribution varies: In ratio A, males have a slightly higher representation (29.85%) compared to females (25.30%). In ratio B, females have a higher representation (44.58%) compared to males (35.82%). In ratio C, females have a slightly lower representation (24.10%) compared to males (26.87%). In ratio D, females have a slightly lower representation (6.02%) compared to males (7.46%) shown in **Figure 2**. The Chi-squared test is used to compare the gender and cephalic index ratios, a p-value of 0.75 suggests that there is no statistically significant association

between gender and cephalic index ratios at the significance level of 0.05.

The **Table 4** provides Descriptive Statistics for Cephalic Index Ratios categorized as A, B, C, and D, differentiating between "Theory" and "Practical" measurements. The mean of cephalic index varies across the different ratios (A, B, C, D) and between "Theory" and "Practical" measurements. "Practical" measurements generally have lower variance, standard deviation, and standard error compared to "Theory," indicating less variability. The 95% confidence interval provides a range within which the true population mean for each cephalic index ratio are likely to fall with 95% confidence.

The means of the four CIR grades i.e A, B, C, and D are compared with percentages of

theory and practical using one way analysis of variance with 5 % level of significance shown in table5. The theory and practical Mean \pm SD scores in cephalic index for male was as follows A = 54.33 \pm 14.79 & 64.4 \pm 10.13, B = 48.00 \pm 8.55 & 63.97 \pm 9.93, C=52.56 \pm 12.73 & 62.17 \pm 6.07, D= 54.93 \pm 18.69 & 68.00 \pm 12.33 and for Females was A = 57.74 \pm 10.54 & 65.90 \pm 9.19, B = 51.63 \pm 15.07 & 65.08 \pm 10.65, C=53.14 \pm 12.84 & 67.89 \pm 11.89, D = 54.26 \pm 4.18 & 63.53 \pm 2.71 and for total A = 56.08 \pm 12.74 & 65.17 \pm 9.57, B = 50.20 \pm 12.94 & 64.64 \pm 10.30, C = 52.86 \pm 12.62 & 65.18 \pm 9.89, D = 54.60 \pm 12.77 & 65.76 \pm 8.73 respectively shown in **Table 5**. From the results, there was no statistically significant difference between the theory and practical scores in Cephalic Index Ratio for both gender and total.

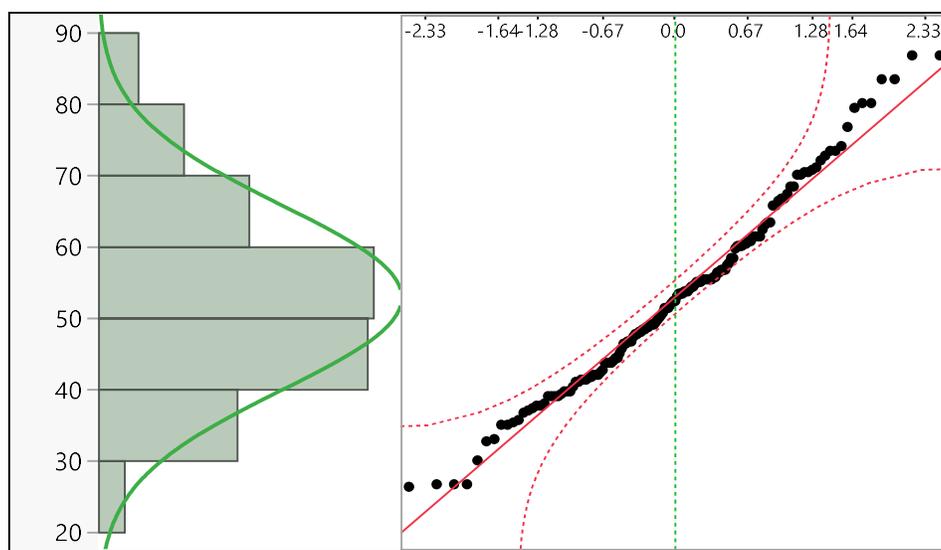


Figure 1: Normal quantile plot for theory percentage

Table 2: Descriptive Statistics for theory and practical percentages

Descriptive	Theory	Practical
Mean	52.78	65.00
Std Dev	12.90	9.82
Std Err Mean	1.05	0.80
95% CI	Upper	54.86
	Lower	50.70
CV (%)	24.45	15.10
Variance	166.46	96.39
Minimum	26.33	40.00
Maximum	86.67	90.00

Table 3: Distribution of CIR with Gender

Cephalic Index Ratio	Gender		Total n (%)	p-value
	Female n (%)	Male n (%)		
A	21(25.30)	20(29.85)	41(27.33)	0.75
B	37(44.58)	24(35.82)	61(40.67)	
C	20(24.10)	18(26.87)	38(25.33)	
D	5(6.02)	5(7.46)	10(6.67)	
Total	83(55.33)	67(44.67)	150(100.00)	

A: Dolichocephalic B. Mesocephalic C. Brachycephalic D. Hyper-brachycephalic

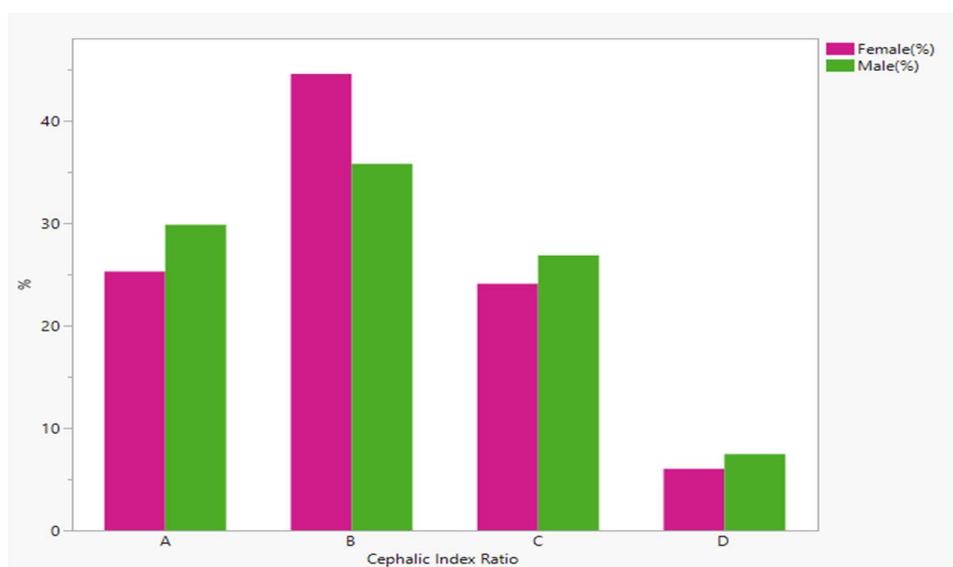


Figure 2: Bar chart of CIR with Gender

Table 4: Descriptive statistics of different grades of Cephalic Index Ratio

Descriptive	Cephalic index ratio								
	A		B		C		D		
	Theory	Practical	Theory	Practical	Theory	Practical	Theory	Practical	
Mean	56.08	65.17	50.20	64.64	52.87	65.18	54.60	65.77	
Variance	163.00	91.60	168.00	106.00	159.00	97.90	163.00	76.30	
Standard Deviation	12.75	9.57	12.95	10.30	12.62	9.90	12.78	8.74	
Standard Error	1.99	1.49	1.66	1.32	2.05	1.61	4.04	2.76	
95% CI	Upper	60.10	68.20	53.50	67.30	57.00	68.40	63.70	72.00
	Lower	52.10	62.10	46.90	62.00	48.70	61.90	45.50	59.50
CV (%)	22.73	14.68	25.79	15.94	23.87	15.18	23.40	13.29	
Minimum	35.00	46.67	26.67	40.00	26.33	50.33	41.00	50.00	
Maximum	83.33	90.00	86.67	83.33	79.33	88.00	86.67	83.33	

Table 5: Comparison of CIR grades with the theory and practical percentages

CIR	Male					
	n	Theory		Practical		
		Mean ± SD	p-value	Mean ± SD	p-value	
A	20	54.33±14.79	0.348	64.4±10.13	0.649	
B	24	48.00±8.55		63.97±9.93		
C	18	52.56±12.73		62.17±6.07		
D	5	54.93±18.69		68.00±12.33		
		Female				
A	21	57.74±10.54	0.404	65.90±9.19	0.745	
B	37	51.63±15.07		65.08±10.65		
C	20	53.14±12.84		67.89±11.89		
D	5	54.26±4.18		63.53±2.71		
		Total				
A	41	56.08±12.74	0.149	65.17±9.57	0.983	
B	61	50.20±12.94		64.64±10.30		
C	38	52.86±12.62		65.18±9.89		
D	10	54.60±12.77		65.76±8.73		

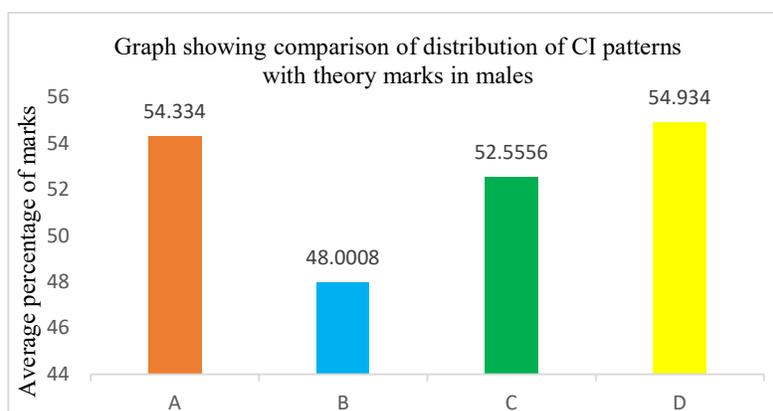


Figure 3

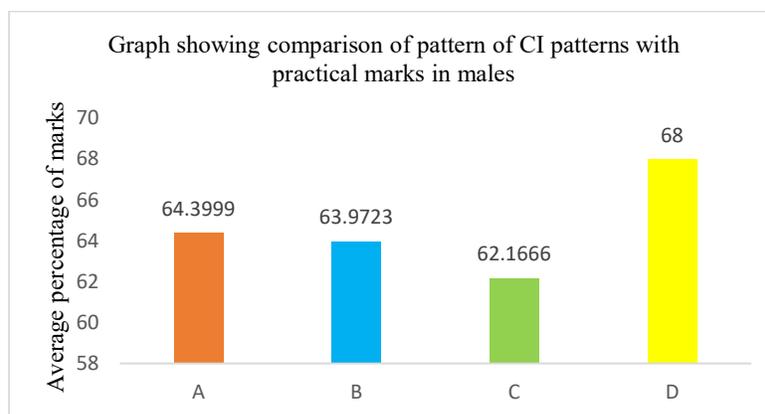


Figure 4

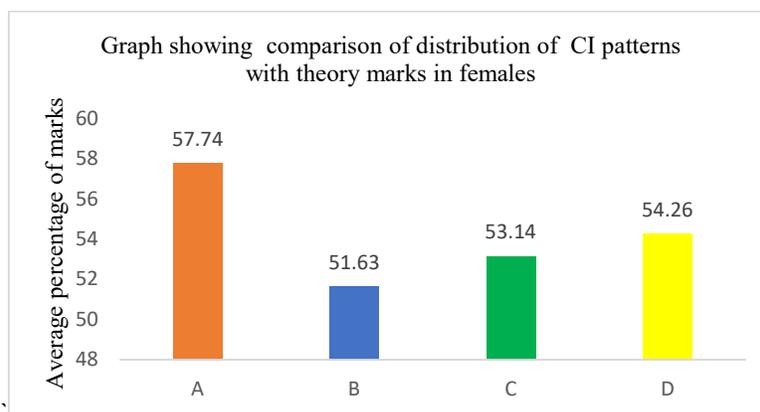


Figure 5

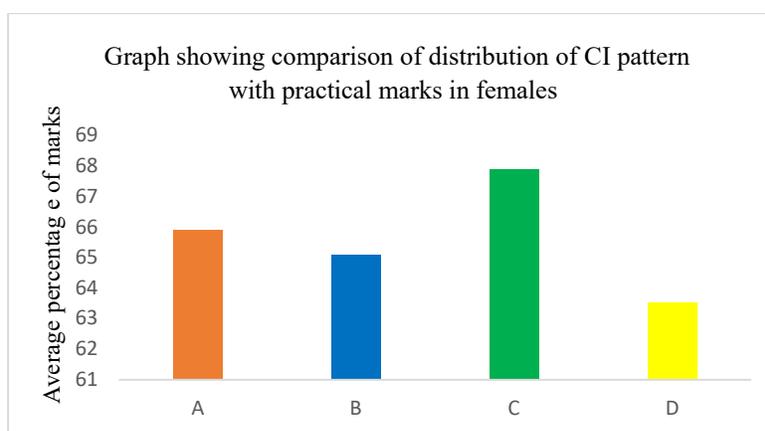


Figure 6

DISCUSSION

CI (cephalic index) is an important non-invasive anthropometric parameter used to monitor gestational fetal growth and to determine fetal age. It is having its critical implication in obstetrics, anthropometric and forensic view points [10]. A wide range of anatomical parameters was studied to correlate order and disorder of its measures, where the cephalic index (CI) ratio is one of the focused variables that can be used to match morphology with physiological parameters by measuring cognitive abilities among the students' based on their academic

scores in the present study. There are different cephalic index patterns, which are showing the following range of CI ratios are categorized as follows, Dolichocephalic < 74.9, Mesocephalic 75.0-79.9, Brachycephalic 80.0-84.9, Hyper-brachycephalic 85.0-89.9 [9] (Table 3). The present study has dominated the mesocephalic pattern of cephalic index among female (37) and male (24) student participants. Hyper-brachycephalic pattern of the cephalic index has been recorded where each 5 in the male and female group of participants, the pattern is consistent with other previous study

findings. However, the Mesocephalic index was found as the most frequent and dominant pattern of cephalic index seen among 150 participants of either sex.

Brain size is one of the important factors that continuously evolved through generations of mankind. There are limited studies correlating brain size and cognitive abilities. Our present study hypothesis was intended to resolve the ambiguity between brain size and counter balancing cognitive abilities by matching professional students' academic scores. Because it was found that the brain has a profound influence through genetic, environmental, psychological, and biological factors. It is probably suggestive of their influence on cognitive abilities in an individual. A sound human intellectual personality is attributed to his/her intricate connections between the neurons within the prefrontal cortex and constant training efforts in academics, which drives cognitive abilities, especially among student fraternity [11]. Hence a hypothesis underscoring the greater number of neurons, a greater number of synapses and larger brain size that in turn represented as larger skull size correlation was attempted to match with student academic scores.

The dynamic modifications in the skull size are influenced by the sutural joints of the skull. With the advancing age, it is undergoing gradual and permanent changes leading to its complete fusion. Some of the

studies have found that there is a physiological difference b/w boys and girls concerning the age of fusion of basiocciput of the skull joints. It is relatively early to see the joint fusion in girls when compared with boys. These factors can affect skull size which in turn will influence post-natal brain growth and remodeling. We have observed students' performance concerning their theoretical and practical accomplishments in both genders. Results were showing no significant differences in CI ratios with their theory and practical scores [12]. Fusion of skull sutures is a time bond phenomenon; Craniosynostosis is one such condition where there is an early incidence of premature atresia of the skull sutures that can affect cranial and facial skeleton indices. Such defective early fusion in the cranial sutures can lead to a reduction in the cranial volume capacities which in turn cause the compression of the brain by interfering with the postnatal modification of brain tissue. Measuring the skull size ratios is not only important during prenatal follow-up (gestation period) but having its critical implications in planning early surgical/therapeutic measures for skull deformities. Monitoring the head size growth pattern is essential in matching early childhood milestones [13].

The cephalic index ratios were studied to match with mental ability in mentally challenging children and were clinically

matched with a dolichocephalic cranial index pattern. In contrast, the control group has shown a mesencephalic pattern of the cephalic index. Similar cross-sectional studies by various researchers have shown variable cephalic index patterns but showed no consensus in meeting a particular common pattern of CI ratio among mentally retarded children [14]. In a study showing the differences in CI ratio among genders, the female medicos have shown slightly higher CI ratios when compared with males, which may underline the gender discrimination of anthropometric measures [15]. The cognitive abilities will differ with gender; women are good at grasping, restoring verbal memory, language function, speed of articulation, etc. whereas males dominate in spatial and mental orientation. Probably these qualities can be better differentiated with student academic milestones by considering their theoretical performances, and practical accomplishment skills among females and males in a large-scale study [16]. The neuronal basis of variations in the intellectual ability of humans remains a debatable issue. Studies done by using CT scans and MRI findings of brain volume, brain weight, and circumference matched with adult intelligence test scores have shown inconsistent results. Some of its study findings are showing a mismatch between brain size and intellectual abilities [17]. Our

study outcome is showing statistically insignificant results concerning theory and practical scores, in any of the groups involved. But only in terms of the average marks, the hyper-brachy cephalic index pattern has shown better scores in theory and practical examinations in male student groups (**Figure 3 and Figure 4**). In case of girls, the dolichocephalic CI pattern is showing better performance in theory examinations and the brachycephalic pattern was dominated in practical examinations (**Table 5**). These observations showing the diversity in the distribution of CI patterns and performance scores match has shown inconclusive remarks. Hence brain size in terms of the cephalic index ratios and academic scores among the student may strongly be dependent on synaptic neuronal connections along with efforts and interest in respective subjects rather than the cephalic index ratio alone. The study suggests that, in general, the "Practical" category seems to have higher average scores, less variability, a narrower confidence interval, and a lower relative variability (CV%) compared to the "Theory" category. The analysis focuses on comparing the gender distribution within each cephalic index ratio and provides an overview of the representation of females and males in the dataset. The mean of cephalic index varies across the different ratios (A, B, C, D) and

between "Theory" and "Practical" measurements.

CONCLUSION:

The brain undergoes considerable postnatal modifications to attain viable and competitive physical and psychological excellence independently. Which is an important factor that drives individuals' cognitive abilities especially in the student community. Our study outcome suggests that the cephalic index ratio and academic scores in these professional graduate students show no clear association. Probably academic caliber in an individual may be driven by intricate connections within the different parts of the brain along with constant fine-tuning efforts involving the higher brain functions that can support in rising student academic performances.

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