THE ROLE OF CRANIAL CAPACITY, GENDER, AGE AND BODY MASS INDEX IN ACADEMIC PERFORMANCE AMONG NIGERIAN UNDERGRADUATE STUDENTS ATTENDING BAYERO UNIVERSITY, KANO

A dissertation submitted to the Department of Anatomy in partial fulfillment of the requirement for the degree of M.sc in Anatomy

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DECLARATION

I hereby declare that this work is the product of my research efforts undertaken under the supervision of Dr. M.S. Saleh and has not been presented anywhere for the award of a degree or certificate. All sources have been duly acknowledged.

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CERTIFICATION

This is to certify that the research work and the subsequent write up of (Suleiman Odidi Muritala, SPS/12/MAN/00001) were carried out under my supervision.

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APPROVAL

This research work titled **"The Role of Cranial Capacity, Gender, Age and Body Mass Index in Academic Performance among Nigerian Undergraduate Students Attending Bayero University, Kano''** has been examined and approved for the award of Masters Degree in Anatomy.

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DEDICATION

This work is dedicated to God Almighty.

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ABSTRACT

Cranial capacity, Body Mass Index, Age and Gender of various population groups have always been estimated in numerous research but are hardly pull together to study their relationship with academic performance of students. This study was carried out on undergraduate students of Bayero University, Kano in the northern part of Nigeria. Random sampling was used to select the 9 participating faculties in the research where students from 19 Departments of the selected faculties participated. The subjects were 250 male and 150 female students drawn from 19 Departments of the Faculties. T-test analysis also showed that the mean cranial capacity and age of the males was significantly higher than the females while the body mass index of the females was significantly higher than males. However, there was no significant difference in the Cumulative Grade Point Average (CGPA) of the male and female group. The BMI classification shows no obese groups in the males but very little percentage of obese groups in the females with a greater percentage of normal weight in both female and male samples. Also, separate data analysis of the two groups revealed a non-significant correlation of cranial capacity and body mass index on academic performance of males and females separately but age has a significant correlation on academic performance. The trend was also the same on the analysis of all the students (males and females together) even after inclusion of gender where only age was significantly correlated with academic performance. The individual contribution of cranial capacity, body mass index and gender on academic performance was also not significant on regression analysis. Although, only age contributed significantly to academic performance but the sum of individual contribution to academic performance still remain insignificant. Cranial capacity, body mass index, age and gender all have 7.3% non-significant influences on academic performance of the undergraduate students in Bayero University, Kano. Hence, it was concluded that cranial capacity, body mass index and gender has no significant influence on academic performance of undergraduate students in Bayero University, Kano but age however has a significant influence on the academic performance.

CHAPTER ONE

INTRODUCTION

1.1 Cranial Capacity

Cranial capacity is a measure of the volume of the interior of the cranium (also called the braincase or brainpan or skull) of those vertebrates who have both a cranium and a brain and the most commonly used unit of measurement is the cubic centimetre or cm^3 (Carne *et al*., 2006). The volume of the cranium is used as a rough indicator of the size of the brain, and this in turn is used as a rough indicator of the potential intelligence of the organism (Allen *et al.*, 2002). 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 adaptive features for life in a colder environment (Allen *et al.*, 2002).Brain volume has a close relation with skull volume and is related to racial characteristics (Bayat *et al.*, 2012). Brain dimension can be measured by weight and sometimes by volume estimation(via MRI scans or by skull volume)and brain size is one aspect of animal anatomy and evolution(Allen *et al.*, 2002).

Brain volume grows from birth to childhood with the most rapid growth before the fifth year (Sgouros *et al*., 1999). Between the ages 16-20, brain volume reaches its maximal amount and will not grow after that through life (Knutson *et al.*, 2001). Other subject evolving brain size includes the effect that it may have on substructure, functioning and intelligence of the brain. Neurological functions are determined more by the organization of the brain rather than the volume (Egan *et al.*, 1995).

Cranial capacity, which is in close correlation with brain volume, reflects racial characteristics and thus has been thought to be one of the commonest items in physical anthropological studies (Von Bonin, 1934; Hwang *et al.*, 1995; Mehrdad and Reza, 2008). Cephalometry is one of the important parts of anthropometry, in which the dimensions of the head and face are measured (Grau *et al*., 2001; EL-Feghi *et al*., 2004).

The assessment of growth in general and more particularly the measurement of the head circumference is an integral part of the paediatric neurological examination (Angeliki, 2011). Very important clues can be revealed from the head size and shape which will guide the differential diagnosis and the need for further investigations as the head grows through to adulthood (Angeliki, 2011). In infants, anomalies like macrocephaly which denotes a large head and microcephaly (small head) could be observed.

Furthermore, study of skull volume and brain size is very important in anthropometry and the significant amount of studies is allocated to this field in Asia region and these studies have entered a new area utilizing modern technologies such as magnetic resonance imaging and brain scans and measurement of skull through the head surface (Bayat *et al.,* 2012). Skull length, width and height are used for calculation of brain volume (Lee and Pearson, 1901). Today there are several measurement methods approved by anthropologist (Relethford, 1994; Manjunath, 2002). But in terms of medicine, analysis of data regarding skull volume reveals the status of growth and development, and the prognosis of development disorders such as disorders in size of skull and related deformities and abnormalities (Manjunath, 2002). Anthropologists are searching to find out what factors are affecting skull size (Haack and Meihoff, 1971; Manjunath, 2002) however, there is still no definite answer (Hwang *et al.,* 1995). Ethnic diversity is always a significant factor that may affect the anthropometric data and the scopes of its applications (Rushton and Osborne, 1995).

Data on the size of head compartments have been provided by numerous studies using different technology: autopsy studies have been carried out systematically for more than 100 years (Svennerholm *et al.*, 1997).A few investigations have also been made on living subjects (Dekaban, 1977) using the linear dimensions of the heads measured by a classic cephalometry method (Lee and Pearson, 1901). This method is easy and economical to carry out, but is not so accurate since the skull and scalp thickness varies between individuals (Haack and Meihoff, 1971). Any amount of corrections and allowances do not remove the inaccuracies associated with this method and a mean error of 3–4% for the computing formula applied is reported (Haack and Meihoff, 1971). Cosgrove *et al.,* (2007) postulate that in general, men have 10% bigger brains than women and the adult human brain weighs on average about 1.5 kg (3.3 lb) with a volume of around 1130 cubic centimetres (cm^3) in women and 1260 cm^3 in men, although there is substantial individual variation.

1.2 Body Mass Index (BMI)

Body mass index or Quetelet index is a measure of relative weight based on an individual's mass and height (WHO, 2006). The BMI is used in a wide variety of contexts as a simple method to assess how much an individual's body weight depart from what is normal or desirable for a person of his or her height (WHO, 2006). BMI value of ≥18.5 - <25 is normal, ≥25 - <30 is overweight, and ≥30 is obese (WHO, 2006).A growing body of research has demonstrated the deleterious health effects of obesity on childhood health status and across the life course (Sandra *et al.*, 2014). Moreover, obesity is likely to influence all aspects of children's development, including schooling (Sandra *et al.,* 2014).

There are several reasons to expect a negative relationship between body weight and academic performance (Ogden *et al.*, 2006). First, it may be that poor academic performance causes higher body weight (Taras and Potts, 2005). This may be the case if, for example, adolescents choose to eat excessively to psychologically compensate for doing poorly in school (Taras and Potts, 2005). Second, obesity could cause a decline in academic performance (Taras and Potts, 2005). This could occur if teachers discriminate against overweight students by giving them poorer grades or if obesity has adverse psychological and physiological effects that impede productive studying (Taras and Potts, 2005). Finally, it may be that there is no causal link between body weight and academic performance, but rather an association that is explained by unobserved individual-level characteristics, for example, it may be that those with the least personal disciplines expend the least amount of effort exercising and the least amount of effort studying (Taras and Potts, 2005). Child obesity has become a leading health concern in recent decades. In the United States, estimated child obesity rates increased from 5% in the 1970s to 15% in the 1990s, and over this same time period the heaviest children have become heavier (Anderson and Butcher, 2006).

Alternatively, there may be a positive relationship between body weight and academic performance. Poor academic performance may cause psychological stress, which reduces one's appetite and resultant body weight. Or, there may be a positive relationship between body weight and academic performance due to an unobserved heterogeneity (Sabia, 2007). For example, if individuals must allocate their time between efforts to improve (or maintain) their physical well-being and efforts to enhance academic performance, then individuals with the least to gain from physical health investments (or the most to gain from investments in academic pursuits) may choose to devote more time and efforts toward academic endeavors and less toward monitoring and maintaining their weight (Sabia, 2007). Being overweight or obese is associated with low self-esteem, negative body image, depression, and being teased or bullied (Friedlander *et al.*, 2003; Storch *et al.*, 2007; Strauss, 2000). The effect of children's weight on their intellectual development is less clear. Previous research has reached mixed conclusions about the effect of weight on measures of academic success (Kaestner and Grossman, 2009; Sabia, 2007).

1.3 Age and Gender

Age has played a considerable part as regards to education, like entry age of students to a school; hence age could be a predictor of success (Abubakar and Dokubo, 2011). From the study of Abubakar and Dokubo (2011) in Federal College of Education (Technical), Omoku, Rivers State, Nigeria, age and gender are predictor of academic performance of students using the Cumulative Grade Point Average (CGPA) but gender was a better predictor. Abubakar and Dokubo (2011) evidently revealed that age is insignificant as it relates to CGPA. Research in education provides mixed theories and evidence on the optimal age at which children should start school (Stipek, 2002). According to the proponents of late school starting age, starting school at an older age ensures that children have sufficient time to acquire the human capital necessary for educational success. In addition to the intellectual competencies of concentration and the ability to follow instructions, which children gain as they age, emotional aspects, such as being able to be apart from the parents, and social ones, such as being able to share with other children, play a significant role in success in school (Stipek, 2002). Fredriksson and Ockert (2005) using Swedish administrative data find that children who start school at a younger age achieve both lower outcomes and have less years of education than their older peers.

Gender difference in student academic achievement has been a heated research and policy topic for decades, because of its significant wage effect for adult life (Rose, 2006) and the equity concern for reducing gender gap in education (Marks, 2008).For example in China, available evidence indicates that girls have higher achievements in Chinese and English, and the gender gap in math is mostly not significant (Lu and Du, 2010; Zhang *et al.,* 2010; Zhang and Tsang, 2012). However, some studies did found a negative gender gap in math (Wang *et al.,* 2012).Most studies in United States found a positive gender gap (female better) in language art; and a traditional negative gap in STEM (Science, Technology, Engineering, and Mathematics) that might have decreased over time and across countries in recent years (Zhang and Tsang, 2012). It has often been proposed that timed tests are exceptionally stressful for women (Voyer, 2011). This might inadvertently disadvantage women because of their well-researched greater tendency to be more anxious than men (Voyer, 2011). The positive gender gap in language seems to be enlarging over time while the negative gender gap in math is narrowing (National Center for Education Statistics, 2004; Holmlund and Sund, 2008; Marks, 2008). Also, the degree of decrease in the gender gap in math over the time period seems to vary by country (Bedard and Cho, 2010; Holmlund and Sund, 2008); the gender gap in math was actually found to be positive in some countries such as Hungary and Sweden (Schmidt and Kifer, 1989). More interestingly, some studies found that math gap occurred early in early elementary school years and grew with the grade, on the basis of longitudinal samples of children in the U.S. (Fryer and Levitt, 2010).

1.4 Academic Performance

Academic achievement or academic performance is the outcome of education — the extent to which a student, teacher or institution has achieved their educational goals (Annie *et al.*, 1996). Academic achievement is commonly measured by examinations or continuous assessment but there is no general agreement on how it is best tested or which aspects are most important — procedural knowledge such as skills or declarative knowledge such as facts (Annie *et al.*, 1996). Academic performance is usually measured by grading system known as the cumulative grade point average (CGPA) which is a calculation of the average of all of a student's grades for all of his or her educational career (Annie *et al.*, 1996). This system of grading considers a CGPA of 4.5-5.0 as first class, 3.5-4.49 as second class upper, 2.4-3.49 as second class lower, 1.5-2.39 as third class and 1.0-1.49 as pass (National University Commission, 2000).

Individual differences in academic performance have been linked to differences in intelligence and personality (Von *et al.*, 2011). Students with higher mental ability as demonstrated by IQ tests and those who are higher in conscientiousness (linked to effort and achievement motivation) tend to achieve highly in academic settings and recent metaanalysis suggested that mental curiosity (as measured by typical intellectual engagement) has an important influence on academic achievement in addition to intelligence and conscientiousness (Von *et al.,* 2011).

Children's semi-structured home learning environment transitions into a more structured learning environment when children start first grade. Early academic achievement enhances later academic achievement (Bossaert *et al.*, 2011). Parent's academic socialization is a term describing the way parents influence students' academic achievement by shaping students' skills, behaviors and attitudes towards school (Magnuson, 2007). Parent influence students through the environment and discourse parents have with their children (Magnuson and Katherine, 2007). Academic socialization can be influenced by parents' socio-economic status. Highly educated parents tend to have more stimulating learning environments (Magnuson, 2007). Children's first few years of life are crucial to the development of language and social skills. School preparedness in these areas help students adjust to academic expectancies (Lassiter, 1995).

Another very important enhancer of academic achievement is the presence of physical activity (Tomporowski *et al.*, 2008). Studies have shown that physical activity can increase neural activity in the brain and exercise specifically increases executive brain functions such as attention span and working memory (Tomporowski *et al.*, 2008).

1.5 Significance of the Study

1. Evaluation of the role of cranial capacity, gender, age and body mass index may provide insight into the nature of academic performance of the students.

2. To help policy makers in future decision making regarding education.

3. The result may be useful in proffering appropriate recommendation towards better guidance and counseling in education.

1.6 Research Hypotheses

1. Null Hypothesis ($\boldsymbol{H_0}$): That cranial capacity, gender, age and body mass index has no influence on the academic performance of students in Bayero University Kano, Nigeria.

2. Alternative Hypothesis **($\boldsymbol{H_a}$)**: That cranial capacity, gender, age and body mass index is certainly going to affect academic performance of students in Bayero University Kano, Nigeria.

To the best of my knowledge, there is paucity of published data on the relationship between cranial capacity, body mass index and academic performance in Bayero University, Kano.

1.7 Justification

1. Paucity of data on the study of craniometric indices of the students of Bayero University, Kano.

2. To establish data base line on the role of cranial capacity, gender, age and body mass index on academic performance among students in Bayero University, Kano.

3. To complement other similar researches done elsewhere.

4. To debunk the mythical belief of big headed individuals perform better in school than their peers with average or small head.

1.8 Aim of the Research

To critically evaluate the role of cranial capacity, age, gender and body mass index on academic performance among students in Bayero University, Kano.

1.9 Specific Objectives:

1. To determine the cranial capacity (head length, width and height) of the students who fulfill the inclusion criteria.
2. To determine the BMI of students in Bayero University, Kano.
3. To assess students individual academic performance and correlate it with cranial capacity, gender, age and BMI.
4. To proffer appropriate recommendations.

CHAPTER TWO

LITERATURE REVIEW

2.1 Cranial capacity and Academic performance.

The relationships between head circumference, brain development and intelligence had been studied since the time of Broca and Galton, who concluded that variations in brain size (estimated indirectly by measuring head circumference) are related with intelligence (Vernon *et al.*, 2000). Throughout the 19th century, many investigators tried to establish the biological basis of human intelligence. In the past, various IQ models were used to assess the intellectual endowment of an individual that also qualify the academic outcomes in an educational setting, hence the birth of various researches on head size and intelligence (Rushton and Ankney, 1996). The findings of several of these studies demonstrated a positive and significant correlation between head circumference, brain size and intelligence (Nelson and Deutschberger, 1970; Desch *et al.,* 1990; Dolk, 1991; Botting *et al.,* 1998; Ivanovic *et al.,* 2000; Rushton, 2000). Even in the elderly, head circumference has been found to positively and significantly correlate with intelligence (Schofield *et al.,* 1997; Tisserand *et al.,* 2001). In this context, some authors have emphasized that bigger heads or brains may protect people against intellectual impairment (Schofield *et al.*, 1997; Tisserand *et al.,* 2001). Some authors have reported a non-significant association between brain size and intelligence (Schoenemann *et al.,* 2000). Many of these studies provided controversial evidence about the relationship between brain size and intelligence and some of them, carriedout in monozygotic twins or sisters, did not find any association between these variables (Yeo*et al.,* 1987; Teasdale and Pakkenberg, 1988; Schoenemann *et al.,* 2000). Nevertheless, recent findings from other investigators, also in monozygotic and dizygotic twins, found a positive correlation between brain size and intelligence (Anderson, 1999; Pennington *et al.*, 2000). The brain volume–GMA (general mental ability) correlation is equally strong in males and females (Andreasen *et al.*, 1993; Wickett *et al.*, 2000). It is also found in people of East Asian, East Indian, European, Turkish, African, South American, and Amerindian descent (e.g., Andreasen *et al.*, 1993; Ivanovic *et al.*, 2004; Tan *et al.*, 1999). Age, although it plays a role in brain size and GMA, does not confound the results. Studies using a narrow age range of younger or older samples show the same magnitude of correlation (Deary *et al.*, 2007a; Egan *et al.*, 1994). Several studies have examined whether different regions of the brain would show differential correlations with GMA. Many appear to show that the size effects are manifest throughout the brain and not specific to any particular region (Andreasen *et al.*, 1993; Reiss *et al.*, 1996). However, other studies show GMA centered in the frontal brain regions (Jung and Haier, 2007).In national cohorts, a general cognitive ability factor (g), measured from childhood psychometric test scores, is strongly predictive of academic achievements (Bartels *et al.*, 2002; Deary *et al.*, 2007a). The effect size of the association between intelligence and educational attainment is often reported as moderate-large (correlation of around 0.50; Neisser *et al.*, 1996), and increases as samples become more representative of the general population (Sternberg *et al.*, 2001) or advance in school years (Bartels *et al.*, 2002). Recently, in a national cohort of United Kingdom schoolchildren with well standardized reasoning ability scores at 11 years and national exam scores in 25 subjects at 16 years, a large effect size was reported for the correlation between g and a latent trait of educational attainment (correlation of 0.81) (Deary *et al.*, 2007b).

Therefore, genetic and environmental factors could affect brain development, intelligence and head circumference, besides; this could determine prenatal and postnatal nutritional status and educational attainment (Baker *et al.,* 1996; McGue and Bouchard, 1998; Strauss and Dietz, 1998). Several communications have described that head circumference in the first year of life may predict later intelligence (Nelson and Deutschberger, 1970; Botting *et al.,* 1998). In this respect, the interrelationship between intelligence and nutritional background, reflected by a decreased head circumference, can be affected by birth weight and other variables (Botting *et al.,* 1998; Ivanovic *et al.,* 2002). Intelligence has been described as the best predictor of school achievement (Ivanovic *et al.,* 2000; 2004) and significantly explained by maternal intellectual quotient (IQ), by brain volume and nutritional status during the first year of life (Ivanovic *et al.,* 2000).Studies using Chilean school children revealed that head circumference, the anthropometric index of both nutritional background and brain development, is the most relevant physical index associated with scholastic achievement and intellectual ability. Data regarding skull volume and brain size, and their relation with other measurements are used in phylogenic studies (Relethford, 1994; EL-Feghi *et al*., 2004). A racial/ethnic variation in the cranium is also recorded in Gray's Anatomy (Susan, 2005).

A variety of modern research procedures (MRI, autopsies, endocranial volume, external head measures) have confirmed these early studies of racial differences in brain size. Using MRI, Harvey *et al.,* (1994) found that 41 Africans and West Indians had a smaller average brain volume than did 67 Caucasians. Using endocranial volume, Beals *et al.,* (1984) analyzed about 20,000 skulls from around the world and found that East Asians, Europeans, and Africans average cranial volumes of 1415, 1362, and 1268 cm3 respectively. Using external head measurements from a stratified random sample of 6325 US Army personnel, Rushton (1992) found that Asian Americans, European Americans, and African Americans averaged 1416, 1380, and 1359 cm3, respectively. A study of 46 adults aged 22–49 years and of mainly European descent, found an average brain volume of 1273.6 cm^3 for men, ranging from 1052.9 to 1498.5 cm^3, and 1131.1 cm^3 for women, ranging from 974.9 to 1398.1 cm^3 (Allen *et al.*,2002).From birth through the early months, Rushton and Ankney (1996) found the sex difference held across several autopsy studies and at birth, boys averaged a cranial capacity 5 cm^3 larger than girls, a difference that increased to 40 cm^3 by 4 months and 50 cm^3 by age 1 year, and then remained stable through to age 7 years (Rushton, 1997; controlling for body size). From 7 to 17 years, sex differences in cranial capacity were in the range of 60-100 cm^3 (Lynn, 1993; Rushton and Osborne, 1995). Studies using MRI have also confirmed the sex difference in adult brain size (Good *et al.*, 2001; Harvey *et al.*, 1994; Reiss *et al.*, 1996; Willerman *et al.*, 1991). Thus, Ivanovic *et al.* (2004) carried out a study that controlled for body size in 96 18-year-old male and female high school graduates in Chile and found that the males averaged 1,480 cm^3 (SD = 125) before body size adjustments and 1,470 cm^3 (SD = 40) after adjustments, while the females averaged 1,394 cm^3 (SD = 89) before and 1,404 cm^3 (SD = 37) after adjustments. Modern research employing magnetic resonance imaging (MRI) which creates, in vivo, a three dimensional image of the brain, confirms the correlation between brain size and IQ. Rushton and Ankney (1996) reviewed the evidence and found an overall correlation of 0.44 between MRI measured brain size and IQ in eight separate studies. Additional MRI studies have since confirmed the relationship (Flashman *et al.*, 1998; Gur *et al.*, 1999; Tan *et* *al.*, 1999; Wickett *et al.*, 2000). Lower, but still significant correlations are found between external head size and IQ (r=0.20).

Also, environmental factors and variant eco- logical conditions can cause changes in head dimensions, such as cranial capacity and head shape. Odokuma *et al.*, 2010 compared the cranial capacity of three ethnic groups in Southern Nigeria (Edo, Ibo and Urhobo) and discovered that the mean cranial capacity of males is higher than the females. Maina *et al.*, 2011 with his study of cranial capacity in North Eastern Nigeria confirms that the cranial volume of males is higher than that of females (mean±SD of cranial capacity were 1424.4±1379cm^3 and 1331.3±201.8cm^3 in males and females respectively) and also suggests that the cranial capacity of adult males and females were slightly higher than those similar studies carried out in some ethnic groups (Edo, Ibo and Urhobo) indigenous to the southern part of Nigeria by Odokuma *et al.*, 2010. Bayat *et al.*, 2012 revealed that means skull volume of students of Arak University of Medical Sciences (150 female and 136 male) in 2009-2010 educational year was significantly higher in males (1393.31±111 cm^3) compared to females (1168.71±102 cm^3). Nakashima's (1986) investigations on the diameters of the heads and craniums of Japanese immigrant children in Hawaii reported that the dimensions of the head and cranium were changed after the passage of 30 years. The fact that environmental pressures produce noticeable differences between people with respect to the cranial capacity is an important factor in enabling man to adapt to life in diverse environmental conditions (Irmak *et al.*, 2004).

2.2 BMI and Academic performance

The association between physical fitness and academic performance has received understandable attention in response to the growing prevalence of children who are overweight and out-of-shape (Ogden *et al.,* 2006), as well as demands placed on schools to produce students who meet academic standards (Castelli *et al.,* 2007). A potential relationship of fitness to cognitive functioning may be explained by both physiological and psychological mechanisms (Chomitz *et al.,* 2009) as physical activity stimulates neural development (Studenski *et al.,* 2006), enhances circulation, increases blood flow to the brain, and raises levels of nor epinephrine and endorphins–which collectively may decrease stress, improve mood, stimulate a calming effect after exercise, and as a result possibly improve academic performance (Morgan, 1994; Taras and Potts, 2005).

There are several pathways through which children's weight could affect their academic performance. Overweight children are more likely to have sleep apnea and asthma, which may interfere with cognitive performance (Luder *et al.,* 1998). Obese children also are more likely to have an iron deficiency, which reduces cognitive performance (Nead *et al.,* 2004; Taras and Potts, 2005). If being overweight lowers children's self-esteem, as indicated by Hayden-Wade *et al.* (2005) and Strauss (2000), it may indirectly lead to poorer academic performance. Bias among peers, parents, or teachers against overweight children could worsen their academic performance if those children receive fewer academic opportunities or less encouragement. The relationship between weight and academic ability may not be causal but rather reflect common factors. For example, children who spend lots of time watching television may be more likely to both become overweight and do worse in school, or children whose parents closely supervise their activities may eat better and spend more time studying (Strauss, 2000). Birth weight, breast feeding duration, maternal smoking during pregnancy, and maternal age are related to both childhood overweight and cognitive outcomes, while poor nutrition and physical inactivity may adversely affect both weight and school performance (Veldwijk *et al.*, 2012). Greater physical activity at school appears to boost children's academic performance and reduce their weight gain (Donnelly and Lambourne, 2011). Underweight children may have health problems that affect both their weight and academic ability. Being underweight can affect a student's academic performance in a similar fashion. First, Kaplan *et al.* (1988) found that adolescents of normal weight are less depressed than those who thought they were underweight (or overweight), and a higher level of body satisfaction is associated with a higher level of self-esteem, which is subsequently beneficial to learning. Second, being underweight is associated with physical, functional, and psychological impairment, increased hospitalization risk, and delay in recovery from illness (Corish *et al.*, 2000; Elia *et al.*, 2000; Schenker, 2003). Such bad health conditions are associated with more sick days, missed classes or less cognitive development, which in turn all lead to inferior educational achievement. A negative relationship between weight and academic performance also could reflect reverse causality, with poor academic outcomes increasing the likelihood that children overeat or spend less time exercising. Finally, the effect on academic outcomes could be positive if heavier children opt to spend more time studying instead of playing sports or socializing with peers.

The work of Douglas and Shingairai, 2013 on Biochemistry students of University of Nebraska-Lincoln, USA shows that students in the normal BMI category ($\geq$18.5 kg/m^2 - <25 kg/m^2) had significantly better CGPA than students in the overweight category ($\geq$25 kg/m^2 -

<30 kg/m^2), indicating better academic performance (mean differences for CGPA of 0.24 ($p < 0.01$).

Franz and Nkangude (2014) of University of Uyo, Akwa Ibom State, Nigeria from their research conclude that BMI is not related to academic performance, so there is no basis to judge a student generally by body mass profile rather conducive learning environment (science and technology) and genetic (typology and mental) endowments would continue to influence academic performance in Physical and Health Education and Sports Courses. Hoffman *et al.* (2006) also reported a negative significant correlation between body weight and academic performance indicating that obesity may have adverse effect on academic performance. Oketayo *et al.* (2010) reported that for overweight and obese subjects, a negative correlation was observed between academic performance and body and body weight respectively. Seyi (2012) from his research on students of three senior secondary school in Ekiti State Nigeria, shows that body mass index, daily breakfast consumption and fruit intake had significant correlation with academic performance of in-school adolescents. Body mass index had a negative correlation with academic performance indicating that the lesser the body mass index the better the academic performance of these adolescents. Yusuf and Adigun (2010) reported low level of academic performance among in-school adolescents in Ekiti State.

Previous research has reached mixed results on the relationship between children's weight and academic ability. Kaestner and Grossman (2009) report that being overweight or obese has little effect on children's scores on standardized tests in math and reading. Zavodny (2013) showed that children who are overweight are generally no different in terms of standardized test scores in reading, math, and science. Crosnoe and Muller (2004) find a negative effect of being overweight on adolescents' grades at a point in time but not on the change in their grades over time. Datar *et al.,* (2004) report a similar finding for children's math and reading test scores. However, Sabia (2007) concludes that there is a significant negative relationship between the change in adolescent white girls' body mass index and the change in their grades; Ding *et al.,* (2009) also report a negative effect of obesity on grades, particularly among girls. Looking at standardized test scores, Averett and Stifel (2010) find evidence of negative effects of being obese on reading and math scores and of being underweight on math scores. Datar and Sturm (2006) report that girls who become obese experience a drop in their reading and math test scores compared with other girls. Eide *et al.,* (2010), in contrast, conclude that being overweight is, if anything positively associated with math and reading test scores for boys while being underweight is negatively associated with boys' test scores. Mo-suwan *et al.,* (1999) in their work on primary school children shows that School performance (GPA) lower in overweight children in grades 7 through 9 (low language and math scores) but found no association in children in grades 3 to 6, hence more overweight, greater risk of low GPA. Mikkila *et al.,* (2003) has also observed that Good school performance was inversely associated with being obese for both boys and girls. Campos *et al.,* (1996) with his study in Brazil found that Children with normal height/weight ratios had significantly better performance in IQ, had a wider range of interests, better capacity for social adaptability, and greater speed and dexterity than those in the obese group.

Tershakovec *et al.,* (1994) also found in Philadelphia children that no association between obesity and classroom failure, but obese children twice as likely to be placed in special education or remedial class

2.3 Academic performance and gender and age.

Female students and women generally have higher educational attainment than boys and men in secondary schools and higher education (Goldthorpe, 2000). Abubakar and Dokubo (2011) evidently revealed that age is insignificant as it relates to CGPA (as indicator of academic performance). It was responsible for 0.1% of variance in performance of Mathematics and Science students while gender was responsible for 1.2 % of the variance. Owolabi and Etuk-Iren (2009) recorded a similar result where gender was responsible for 1.3% of the variance in the performance of two hundred and thirty-three (231) Pre-NCE Mathematics students of F.C. E (Technical), Akoka, Lagos state. Abubakar (2010) however recorded a 0% variance contribution in the CGPA of Mathematics students of F.C.E. (Technical), Omoku, Rivers state, Nigeria. For example, in England, the higher proportion of men than women at Oxford and Cambridge universities receiving first class degrees in their final university examinations has been present for many years (e.g. Leman and Mann, 2003; McCrum,1997; Spurling, 1990). This is the case even when it is taken into account that more men take degrees such as Physics which award a higher proportion of firsts than some arts subjects in which there is a higher proportion of women (Ogg *et al.*, 2009; Surtees *et al.*, 2002). It has often been proposed that timed tests are exceptionally stressful for women (Voyer, 2011). This might inadvertently disadvantage women because of their well-researched greater tendency to be more anxious than men. Mellamby *et al.*,

(2013) from their study among undergraduate students of Oxford University deduced that despite equal or better performance in school examinations and equal verbal intelligence, the women obtain lower marks in the first year examinations and hence expect to do less well in final examinations too.

Catherine *et al.,* 2010 from his study on pupils in UK found that girls performed ahead of boys in English and, whereas boys' mean scores were significantly above those of girls in science and math subjects, the statistical effect sizes were negligible. Government statistics report a continuing trend, evident since the 1990s (Spinath *et al.*, 2008), that girls outperform boys in English or reading from nine years or older (UK National Statistics, 2009; Perie *et al.,* 2005). Furthermore, nationally representative data from at least two countries indicate that, by the age of 15– 16 years, girls on average attain higher grades in the large majority of academic subjects (Deary *et al.*, 2007c; Gustaffson and Balke, 1993). In a recent five-year longitudinal study, verbal residual scores measured at 11 years were significantly higher for girls than boys, with an effect size of d=0.25 (Deary *et al.*, 2007b). Cohorts of schoolchildren that demonstrate valid representative sampling methods report negligible sex differences for either mean IQ scores (Deary *et al.*, 2003). One recent review reported that, on average, girls achieve higher total scores than boys on verbal reasoning tests, while more boys than girls are among the highest performers in quantitative and visual–spatial tests (Halpern *et al.,* 2007). Studies of sex differences on mean scores of intelligence sub-tests, which reflect performance in specific cognitive domains, show diverse findings (Reynolds *et al.,* 2008). One recent review reported that, on average, girls achieve higher total scores than boys on verbal reasoning tests, while more boys than girls are among the highest performers in quantitative and visual–spatial tests (Halpern *et al.,* 2007).

Intellectual status was more positive among children from professional or managerial homes while children from immigrant families and those with a learning disability had more negative academic self-concepts than their peers. Children attending schools in an urban area had more positive views of their school performance but school mix, teacher experience and class size were found to have non-significant effects (Amanda and Emer, 2014).

Amanda and Emer, 2014 from their study in 9 year-old school children in Ireland discovered that in relation to academic outcomes, girls in classes with older children scored significantly worse in reading and maths tests than those in single-grade classes, no such effects were evident for boys. However, there was a marginally significant negative effect on reading test scores for boys of being in a class with younger children and boys also appeared to have poorer behavioural outcomes when they were taught in classes with younger peers (Amanda and Emer, 2014). For girls, the pattern was quite different, with more negative behavioural adjustment found in classes with older peers. Overall, being taught in a multigrade class was found to have little impact on academic outcomes among children, with other factors, such as teacher experience, playing a much stronger role (Amanda and Emer, 2014).

Age is a barrier to learning because of its link to cognitive development as well as its influence on classrooms interactions (Huitt *et al.,* 2009).The optimal age at which pupils in specific grade achieve the best results is unknown. Taking primary school as a case study, understanding the optimal age at which pupils achieve their best is critical because of implications for age at school entry and delayed grade progression (Njora *et al.,* 2014). Additionally, information on optimal age that produces best results can guide teachers on selecting learning and teaching materials that are age sensitive. Relatively younger pupils for their grade experience age-related learning difficult perhaps because they are cognitively not ready for the curriculum content and this is because the curriculum is implemented in hierarchal way with pupils in the initial grades who are supposed to be younger being exposed to easy content (Njora *et al.,* 2014). As pupil progress to higher grades they become older and the content also becomes difficult. Relatively older pupils for their grade also experience age-related learning difficult perhaps because of poor social adjustment, being slow learners and missed learning opportunities in the past (Njora *et al.*, 2014).

Educational economists have recently analyzed for a number of countries the effects of school entry age on scholastic achievement and on individual labor market performance (Michela and Vincenzo, 2014). A first stream of the empirical literature focuses on the relationship between school entrance age and pupils' achievement. These studies use variations in birth date and school entry cut-off dates as an exogenous source of variations in entrance age in order to study the outcomes of children that are in the same grade but have different birth dates (Datar, 2006; Elder and Lubotsky, 2009). Findings from these studies suggest that younger kindergarten entrants face a disadvantage over older entrants which tend to fade away as children progress through school. Elder and Lubotsky (2009) also show that having older classmates increases the probability of grade repetition and the probability of a special education diagnosis. Bedard and Dhuey (2006) using TIMSS (Trends in International Mathematics and Science Study) data for 19 OECD (Organization for Economic Cooperation and Development) countries show that the youngest members of the fourth and eighth grade levels obtain lower scores than the oldest members in the same cohort.

Significant effects of school entry age on educational outcomes in primary or secondary schools are also found by Puhani and Weber (2007) for Germany, by McEwan and Shapiro (2008) for Chile, by Smith (2009) for Canada and by Strøm (2004) for Norway. On the other hand, Fertig and Kluwe (2005) find no relationship between entrance age and educational performance for Germany. A second stream of the literature examines how age differences in school entrance affect longer-term outcomes such as educational attainments and earnings. Some works have examined how the choice of the secondary school track depends on relative age: Puhani and Weber (2007) show that in Germany older students in a cohort have a higher probability to attend a more academic and prestigious secondary school track (Gymnasium); similarly, Jürges and Schneider (2007) find that older pupils are more often recommended to attend the Gymnasium. Other findings suggest that early disadvantages held by relatively young children persist into adulthood by affecting higher education participation decisions and performance (Bedard and Dhuey, 2006; Crawford *et al.,* 2010). On the contrary, Black *et al.,* (2011) using Norwegian administrative data document that starting school younger has little effect on educational attainments, but a significant positive effect on IQ score measured at age 18 and on the probability of teenage pregnancy. Dobkin and Ferreira (2010) for the states of California and Texas find a modest relationship between school entry age and educational attainment and no effects on job market outcomes, such as wages or the probability of employment. Relative age effects have been found extremely important for professional players in some sports: for example, Barnsley *et al.,* (1985) have shown that a disproportionate fraction of players in the National Hockey League are born in the earliest months of the year.

Sharp *et al.,* (2009) reviewed 18 studies that examined the effects of relative age on achievement which were carried out in Australia, Chile, the United Kingdom and the USA and published from 2000 to 2008. The most common finding of the studies reviewed by Sharp and her colleagues was that pupils who were older in the grade did better than younger counterparts in almost all subjects including reading, numeracy and writing. Datar (2006) examining test scores of over 13000 pupils collected at the commencement of preschool and at the end of the first grade in USA showed that pupils who started preschool a year older than their classmates attained better learning scores. Interestingly, Datar's study also showed that the learning scores of the older pupils increased at a faster rate across grade levels than scores of their younger counterparts, meaning that older pupils made more progress than younger pupils. Another American study by Yesil-Dagli (2006) found that older pupils outperformed younger pupils regardless of ethnicity, gender and socio-economic status. Furthermore, another study carried out in the USA found that age was a stronger predictor of reading and mathematics scores than gender or ethnicity (Oshima and Domaleski, 2006)

Low SES and its correlates, such as lower education, poverty, and poor health, ultimately affect our society as a whole (APA, 2010).Research done in America with school children indicates that children from low-SES households and communities develop academic skills more slowly compared to children from higher SES groups (Morgan *et al.,* 2009). Initial academic skills are correlated with the home environment, where low literacy environments and chronic stress negatively affect a child's pre academic skills (Aikens and

Barbarin, 2008). Children's initial reading competence is correlated with the home literacy environment, number of books owned, and parent distress (Aikens and Barbarin, 2008). When enrolled in a program that requires adult support, students from low-SES groups reported higher levels of effort towards academics (Kaylor and Flores, 2008). Children from low-SES environments acquire language skills more slowly, exhibit delayed letter recognition and phonological awareness, and are at risk for reading difficulties (Aikens and Barbarin, 2008). Children with higher SES backgrounds were more likely to be proficient on tasks of addition, subtraction, ordinal sequencing, and math word problems than children with lower SES backgrounds (Coley, 2002). Children from lower SES households are about twice as likely as those from high-SES households to display learning-related behavior problems (Morgan *et al.*, 2009).A mother's SES was also related to her child's inattention, disinterest, and lack of cooperation in school (Morgan *et al.*, 2009). Perception of family economic stress and personal financial constraints affected emotional distress/depression in students and their academic outcomes (Mistry *et al.*, 2009).

Studies in elementary school children in United State of America have also shown an association between obesity and poorer school performance (Crosnoe and Muller, 2004; Datar *et al*., 2004; Sabia, 2007). Increased academic achievement may be due to an increase in neurotransmitters related to exercise, such as serotonin (Field *et al.*, 2001). Accelerated psychomotor development, increased cerebral blood flow, heightened arousal, changes in hormone levels, changes in body build, and increased self esteem (Shepherd *et al.,* 1997; Lambourne *et al.,* 2006). It has been established that overweight and obese children are more likely to have low self-esteem and that they have higher rates of anxiety disorders, depression, and other psychopathology (Villa *et al.,* 2004; Zametkin *et al.,* 2004; Mustillo *et al*., 2003).

CHAPTER THREE

MATERIALS AND METHOD

3.1 Study Area

This research was conducted in the various faculties of Bayero University Kano, Nigeria.Bayero University is situated in North-Western part of Ngeria. It was established in 1977. It has three campuses and presently has 10 Faculties and runs 37 programs/courses with a population of about 37,747 undergraduate students (MIS unit, BUK, 2013).

3.2Sample Size Determination

Using Michael Sloven's formula and taking my margin of error as 5% (Sloven, 2003) with the population of Bayero University Kano being 37,747 (MIS unit, BUK, 2013).

n (sample size) = $\frac{37747}{1+37747(0.05*0.05)} = \frac{37747}{95.3675}$= 396

Therefore my sample size was 400 students to the nearest hundred. The formula is expressed as: n = $\frac{N}{(1+Ne^2)}$ Where: N= population, n= sample size, e= margin error i.e. 5%.

3.3 Sampling Technique

3.3.1 Study Population

The study was done on the students of the department of various faculties that will be selected for the research using the random sampling table (Moore *et al.,* 2006). The target students must satisfy the inclusion criteria to be selected.

3.3.2 Study Design

A total of 400 participants comprising of 50 students who satisfy the selection criteria were to be selected from each of the eight (8) Faculties in Bayero University, Kano using random sampling at 5 sampling interval with the help of research assistants (Moore *et al.,* 2006). Due to the limitation as enumerated below, the 50 students per faculties could not be accomplished. The ratio of male to female is 5:3 (Sloven, 2003).

A pilot study was also conducted to reveal if any disparity exist between the value of the CGPA stated by the respondents in the pro forma and the actual in their academic record. A total of 40 students were selected from one faculty. Their craniometric measurements, body mass index, age was taken and recorded. With their consent, the respective CGPA was taken from the exam officer in custody of the academic records. Data analysis was done separately and compared with that gotten from the main research.

3.3.3 Ethical Consideration.

Ethical permit was obtained from the ethical committee of Bayero University, Kano and approval from the various departments. Informed consent of the participants was sought before taking the data.

3.4 Selection Criteria

3.4.1 Inclusion Criteria

The prospective clients must satisfy the following conditions to be included in the study:

1. He must be a registered student of Bayero University, Kano.

2. He must have at least two Cummulative Grade Point Average (CGPA).
3. He must have a normal head devoid of physical injury.

3.4.2 Exclusion Criteria

1. New students (100L) are excluded from this study.
2. Students with craniofacial anomaly or physical head injury were excluded from this research.
3. Pregnant students.
4. Female students with thick accessory hairs.
5. Non-faculty students.
6. Active athletic individuals.

3.4.3 Limitations of the study.

1. Inability to identify subjects with congenital intra-uterine brain disease.
2. Inability to identify subjects who sustained brain injury.
3. Non-uniformity of the number of courses the students take in a given semester.
4. Religious and socio-cultural believe which made it difficult to take craniometric measurement from the female subjects.
5. Postponement of the Nigeria's general election which affect the time schedule for the experiment and availability of the students.

3.5 Terminologies used in the study.

1. Body Mass Index (BMI): Individual body mass divided by the square of their height (kg/m^2) (Castelli *et al.*, 2007).

2. Cranial Capacity (CC): Measure of the volume of the interior of the cranium (cm^3) (Ivanovic *et al.,* 2000).
3. Head Length (HL): Measured between glabella and the inion (cm) (Ivanovic *et al.*, 2000).
4. Head Width (HW): Biparietal Diameter; measured between two parietal eminences (cm) (Ivanovic *et al.*, 2000).
5. Head Height (HH): Measured between the external acoustic meatus to the highest point of the vertex, i.e. the bregma (cm) (Ivanovic *et al.*, 2000).

3.6 Equipment/ Instruments/ Materials

1. Spring Weighing-Machine with **Stadiometer** (Soehnle, Germany. Model 3.6): Measures height in centimeter and weight in kilograms

2. Spreading caliper. Calibrated in centimeter.

3. Auricular head spanner. Calibrated in centimeter.

4. Proforma for taking the clients data.

5. Methylated spirit (Moko spirit), **Cotton wool** (Nosak wool).

3.7 Anthropometric Studies (Maina *et al.,* 2011).

All measurements were done after careful observation of the head for anatomical landmarks and measurements was taken thrice and the average recorded for computation and subsequent analysis.

3.8. Safety Measures (Bayat *et al.,* 2012).

1. The instruments were disinfected methylated spirit.

2. Protective gloves, lab coats and facial mask were worn by me and my research assistants.

3. The equipments were handled with utmost care to avoid damage.

3.8.1 Technique for Measuring Head Length (HL) (Hrdlicka, 1952).

Head Length was taken as the maximum anterio-posterior length between glabella and the inion using the spreading caliper with the participants sitting upright and the head in Frankfort plane. The value was recorded in centimeter (cm).

3.8.2 Technique for Measuring Head Width (HW) (Hrdlicka, 1952).

Head Width was taken as the maximum biparietal diameter between two parietal eminences using the spreading caliper with the participants sitting upright and the head in Frankfort plane. The value was recorded in centimeter (cm).

3.8.3 Technique for Measuring Head Height (HH) (Hrdlicka, 1952).

Head Height was taken as the height measured between the external acoustic meatus to the highest point of the vertex, i.e. the bregma using the auricular head spanner with the participants sitting upright and the head in Frankfort plane. The value was recorded in centimeter (cm).

3.8.4 Technique for Measuring Body Weight (Mehrdad and Reza, 2008).

The weight of the participants was taking without shoes, bags, excess clothings and any external materials that may increase the weight (Taras, 2005). The respondents stood in anatomical position i.e. Frankfort plane and the reading was taken using the Spring Weighing-Machine and recorded in the Pro Forma (Mehrdad and Reza, 2008). The value was recorded in kilogram (kg).

3.8.5 Technique for Measuring Body Height (Mehrdad and Reza, 2008).

The participants' height was obtained with the individual standing in anatomical position (Frankfort plane) facing the researcher with the back and buttocks touching the vertical plank of the instrument (Taras, 2005). The value was recorded in centimeter (cm).

3.8.6 Procedure for Calculating Cranial Capacity (Manjunath, 2002).

The value for the respective head height (HH), head length (HL) and head width (HW) were imputed in the following formula (Lee–Pearson, 1901) and the cranial capacities (cm^3) were computed:

Males: 0.000337(HL − 11) (HW − 11) (HH − 11) + 406.01 cm^3.

Females: 0.000400 (HL − 11) (HW − 11) (HH − 11) + 206.60 cm^3.

The Cranial Capacities in cm^3were recorded in the Pro forma.

3.8.7 Procedure for calculating Body Mass Index (Taras, 2005)

The value for the respective weight and height was imputed in the following formula

BMI= $\frac{mass}{height}$kg/m^2 (Adolphe Quetelet, 1850) and the BMI was computed and recorded in the Pro forma.

Plate 1. Measurement of Head width.

Plate 2. Measurement of Head Height.

Plate 3. Measurement of Standing Height.

3.8.8 Statistical Analysis.

The data was coded and recorded on a recording sheet which was transferred into SPSS Version 22 Software for analysis. Preliminary statistical procedures were performed to understand the basic characteristics of the sample. Descriptive statistics was used to describe the variables. The means obtained were subjected to Student t-test for comparison between cranial capacity, BMI and Academic performance of students. The student t-test would reveal the differences between the means of two variables (male and female in this case) as to whether the disparity is significant or not. Correlation analysis was run to analyze the relationship between cranial capacity and academic performance. Regression was also performed to analyze the effect of cranial capacity, BMI, age and gender on Academic performance. Both correlation and regression analysis was also done on the pilot study data.

CHAPTER FOUR

RESULTS AND DISCUSSION

4.1 RESULTS

Table 1. Comparison of Male and Female Students Variables in Bayero University, Kano.

Variables	Minimum	Maximum	Mean	CV	T critical
Head length (mm)					
Male	160.0	200.0	189.0±5.8	3.1	1.97**
Female	160.0	193.0	176.2±5.9	3.4	
Head width (mm)					
Male	133.0	156.5	146.4±5.9	4.0	1.97**
Female	121.0	156.0	140.1±7.4	5.3	
Head height (mm)					
Male	108.0	136.5	125.1±5.6	4.5	1.97**
Female	103.0	138.5	116.2±6.5	5.6	
Cranial capacity (cm^3)					
Male	1088.9	1507.5	1333.4±72.3	0.5	1.94**
Female	910.5	1383.2	1104.6±84.6	7.7	
Body mass index (kg/m^2)					
Male	15.4	29.1	20.5±2.9	14.1	1.97**
Female	15.4	30.4	22.1±3.1	14.0	
Age (years)					
Male	19	39	24.7±4.3	17.4	1.96**
Female	18	39	22.9±4.1	17.9	
CGPA					
Male	1.65	4.74	3.07±0.7	22.8	1.52
Female	1.65	5.00	2.98±0.9	30.2	

**$P \leq 0.05$. Number of males = 250. Number of females = 150. CV= coefficient of variation.

Table 1 shows the statistical differences in the mean value of males and females variables. The mean cranial capacity of male and female were 1333.4±72.3 and 1104.6±84.6 respectively which shows the value of males to be higher than the females. The mean BMI of male is 20.5±2.9 and the mean BMI of female is 22.1±3.1 where the female value is higher. The results also revealed the mean age of the males to be 24.7±4.3 while the female 22.9±4.1. The mean head height, head width and head length of the males are 189.0±5.8, 146.4±5.9 and 125.1±5.6 respectively while the values of the female are 176.2±5.9, 140.1±7.4 and 116.2±6.5 respectively. The average CGPA of the male and female respondents was 3.07±0.7 and 2.98±0.9 respectively.

Table 2. Socio-Demographic Characteristics of all the Students in Bayero University, Kano.

Variables	Min.	Max.	Mean
Age (years)	18.00	39.00	24.0±4.3
Head length (mm)	160.00	200.00	184.3±8.5
Head width (mm)	121.00	156.50	144.0±7.1
Head height (mm)	103.00	138.50	121.8±7.3
Cranial capacity (cm^3)	910.49	1507.52	1247.6±135.0
Standing height (m)	1.45	1.89	1.66±0.1
Body weight (kg)	40.00	81.10	58.0±8.7
BMI (kg/m^2)	15.42	30.43	21.1±3.1
CGPA	1.65	5.00	3.0±0.78

N = 400.

Table 2 shows the descriptive statistics of all the students (male and female). The mean age is 24.0±4.3yrs from the results. The mean head length, head width and head height are 184.3±8.5, 144.0±7.1 and 121.8±7.3mm respectively. The mean body mass index is 21.1±3.1 while the mean cumulative grade point average (CGPA) was found to be 3.0±078. The mean cranial capacity of all the respondents in the research is 1247.6±135.0 $cm.^3$

Table 3. Male Body Mass Index (BMI)

Classification of BMI	**Frequency**	**Percentage**
Under weight (< 18.5)	71	28.4
Normal weight (≥18.5-<25)	171	68.4
Over weight (≥ 25- <30)	8	3.2
Obese (≥30)	0	0
Total	250	100

From the results as shown in Table 3, 68.4% of the male students are within the normal weight of BMI classification while 3.2% of the male sample populations are overweight. Only 28.4% of the male students are underweight. From the observed results, no male student falls into the category of obese.

Table 4. Female Body Mass Index (BMI)

Classification of BMI	Frequency	Percentage
Under weight (< 18.5)	12	8.0
Normal weight (≥18.5-<25)	116	77.3
Over weight (≥ 25- <30)	16	10.7
Obese (≥30)	6	4.0
Total	150	100

From the results as shown in Table 4, 77.3% of the female students are within the normal weight of BMI classification while 10.7% of the female sample populations are overweight. Only 8% of the female students are underweight and 4% of them are obese.

Table 5. Relationship between Cranial Capacity, Body Mass Index and Age on Academic Performance of Male Students.

	CGPA	BMI	CC	AGE
CGPA	1			
BMI	0.061	1		
CC	-0.051	0.073	1	
AGE	0.294**	0.273**	-0.015	1

**. Correlation is significant at the 0.01 level (2-tailed).

Table 5 shows the relationship between cranial capacity, body mass index and age on academic performance of the male students which indicates the level of correlation among the variables. The result shows a non-significant positive relationship of 0.061 (r) between CGPA and body mass index. It also revealed a non-significant negative correlation of -0.051 (r) between CGPA and cranial capacity.

However, there is a weak significant positive relationship between age and CGPA with a value of 0.294 (r).

Table 6. Effect of Cranial Capacity, Body Mass Index and Age on Academic Performance of Male Students.

Variable	Coefficient	Standard error	p-value
Constant	2.453	0.885	0.006**
Age	0.050	0.011	0.000**
Body mass index	0.001	0.015	0.947
Cranial capacity	0.000	0.001	0.439

** P≤0.01. F = 7.953** R^2= 0 .088 Adjusted R^2= 0.077

This table (Table 6) is a regression analysis of all the variables in the male subjects. The coefficient of body mass index and cranial capacity is 0.001 and 0.000 respectively which are not significant as revealed from the table. The coefficient of age as a variable is 0.050 and is significant at p≤0.01. The value of adjusted R^2 is 0.077.

Table 7. Relationship between Cranial Capacity, Body Mass Index and Age on Academic Performance of Female Students.

	CGPA	BMI	CC	AGE
CGPA	1			
BMI	0.054	1		
CC	0.060	0.248**	1	
AGE	0.267**	0.122	0.183*	1

**. Correlation is significant at the 0.01 level (2-tailed).
*. Correlation is significant at the 0.05 level (2-tailed)

Table 7 depicts the relationship between the cranial capacity, body mass index and age on CGPA of female students. We observed a non-significant positive relationship between CGPA and body mass index with a value of 0.054 (r) and 0.060 (r) non-significance positive relationships between CGPA and cranial capacity.

Also, CGPA and age were found to be positively related with significant value of 0.267 (r).

Table 8.Effect of Cranial Capacity, Body Mass Index and Age on Academic Performance of Female Students.

Variable	Coefficient	Standard error	p-value
Constant	1.517	0.951	0.113
Age	0.055	0.017	0.002*
Body mass index	0.006	0.023	0.806
Cranial capacity	6.900E-5	0.001	0.935

***** $P \leq 0.01$. F= 3.762**R^2= 0.072. Adjusted R^2= 0.053

Table 8 is a regression analysis of all the variables in the male subjects. The coefficient of body mass index is 0.006 and that of cranial capacity is 0.000069 which is also not significant as revealed from the table. The coefficient of age as a variable is 0.055 and is significant at1%. The value of adjusted R^2 is 0.053.

Table 9. Relationship between Cranial Capacity, Body Mass Index and Age on Academic Performance of all the Students (pool).

	CGPA	BMI	CC	AGE
CGPA	1			
BMI	0.024	1		
CC	0.045	-0.107	1	
AGE	0.287**	0.113*	0.206**	1
SEX	-0.056	0.255**	-0.821**	-0.208**

** Correlation is significant at the 0.01 level (2-tailed).
** Correlation is significant at the 0.05 level (2-tailed).

Body mass index has a positive relationship with CGPA as given by the value 0.024 (r) which is not significant. Cranial capacity and CGPA also has a positive non-significant relationship of 0.045 (r). Age has a positive significant relationship with academic performance with coefficient of correlation of 0.287 (r) as revealed by Table 9 above.

Table 10. Effect of Cranial Capacity, Body Mass Index and Age on Academic Performance of all the Students (Male and Female).

Variable	Coefficient	Standard error	p-value
Constant	2.082	0.800	0.01**
Age	0.053	0.009	0.000**
Sex	-0.03	0.144	0.820
Cranial capacity	0.000	0.000	0.708
BMI	-0.002	0.013	0.885

** $P \leq 0.01$. F= 8.906** R^2= 0.083. Adjusted R^2= 0.073

Table 10 shows the effect of cranial capacity, body mass index and age on academic performance of all the students. The coefficient of body mass index is -0.002 and that of cranial capacity is 0.000 and they were also not significant as revealed from the table. The coefficient of age as a variable and CGPA is 0.053 and is significant at1%. The value of adjusted R^2 is 0.073.

Table 11. Relationship between Cranial Capacity, Body Mass Index and Age on Academic Performance of the Students (Pilot study)

	CGPA	BMI	CC	AGE
CGPA	1			
BMI	-0.076	1		
CC	0.211	0.003	1	
AGE	0.140	0.069	0.103	1

Table 11 shows the correlation between cranial capacity, body mass index and age on academic performance of the students in the pilot study. The r value for body mass index and academic performance is non-significant -0.076. Cranial capacity and CGPA has a non-significant positive relationship (r = 0.211) while age and CGPA also has non-significant positive relationship (r = 0.140)

Table 12. Effect of Cranial Capacity, Body Mass Index and Age on Academic Performance of the Students (Pilot study)

Variable	Coefficient	Standard error	p-value
Constant	2.018	1.655	0.234
Age	0.023	0.035	0.516
Body mass index	0.024	0.054	0.659
Cranial capacity	0.001	0.001	0.309

R^2= 0.066. Adjusted R^2= 0.042.

Table 12 depicts the regression analysis of the variables of students in the pilot study. The coefficients for age and body mass index are 0.023 and 0.024 respectively while cranial capacity has 0.001.

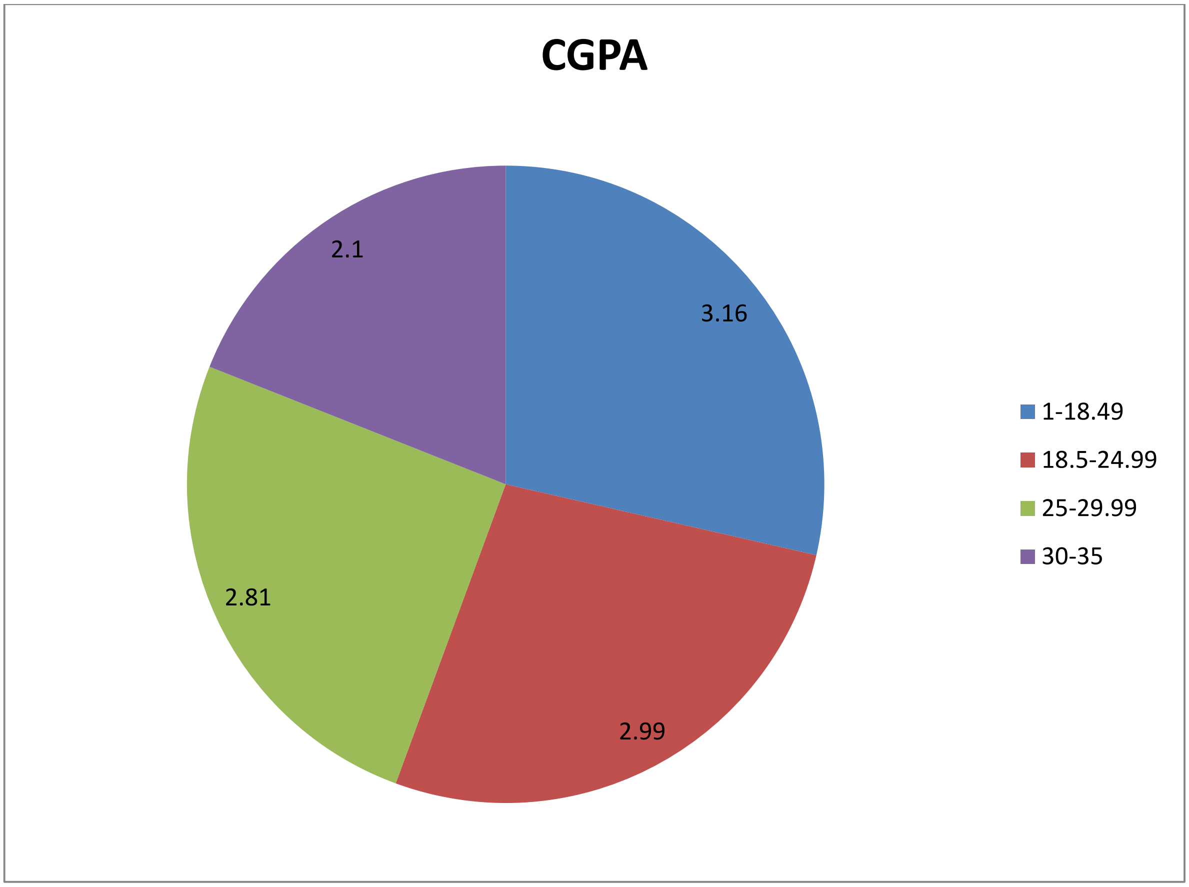

Fig. 4. The Academic Performance of the Various Groups of BMI of the Subjects in the study.

The pie chart above shows the academic performance of various classes of BMI according to WHO (2006). It is observed that the overweight and obesity group have the lowest mean CGPA of 2.81 and 2.1 respectively while the underweight and normal group have 3.16 and 2.99 respectively.

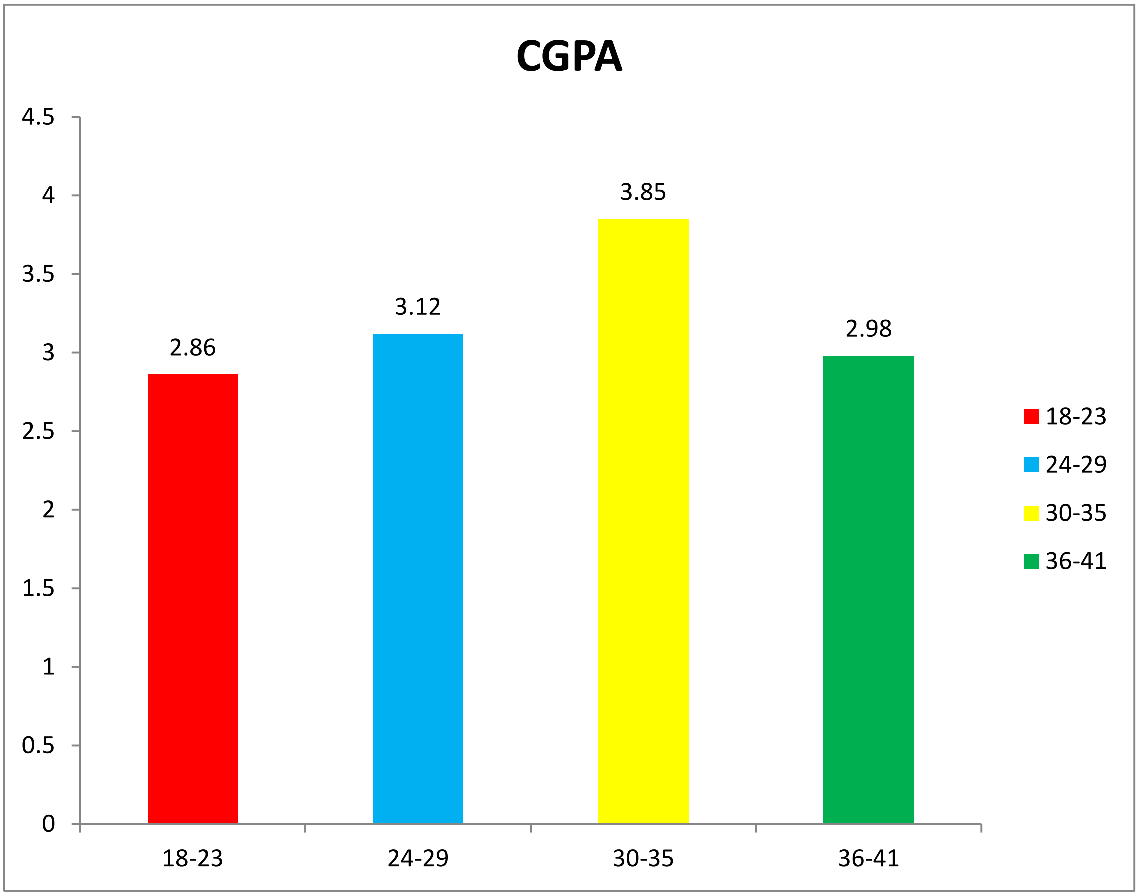

Fig. 5. The Academic Performance of the Various Age Groups of the Subjects in the study.

The age class 30-35 and 24-29 has a mean CGPA of 3.85 and 3.12 respectively. The age class 36-41 has mean CGPA 2.98 while class 18-23 has the lowest mean CGPA of 2.86.

4.2 DISCUSSION

The mean cranial capacity of male and female (1333.4±72.3 and 1104.6±84.6 respectively) as shown by Table 1 were lower than the result obtained by Maina *et al.*(2011) in North Eastern Nigeria where cranial capacities were 1424.4±1379cm^3 and 1331.3±201.8cm^3 in males and females respectively. The result of this study also shows the cranial capacity of the males to be significantly higher than that of the females with a $p \leq 0.05$. The results of Bayat *et al.* (2012) reported a positive correlation between brain volume and anthropometric indices such as height, weight, age and BMI in both genders, also revealed that the mean skull volume was significantly higher in males (1393.31±111 cm^3) compared to females (1168.71±102 cm^3) but was however close to the values we got from this study. Manjunath, (2002) reported skull volume in males and female to be 1152.813±279.16 cm^3 and 1117.82±99.09 cm^3respectively, which has the male value higher than the one obtained from this study and the female values very close. However, Golalipoor *et al.* (2005) have reported skull volume to be 1420.60± 85 cm^3 in males and 1227.2±120 cm^3 in Turkmen race of Gorgan, which is quite high than our study. Also the result of our study shows the male cranial capacity to be close to that obtained by Acer *et al.* (2007) who reported the cranial capacity of 1375.67±91.17 and 1237.32±95.12 cm^3in 17-26 years males and females in Mugla University students in Turkey.

From Table 1., the mean BMI of the male (20.5±2.9) is lower than that of the female (22.1±3.1) in this study which contrast the findings of Bayat *et al.* (2012) on students of Arak University of Medical Sciences, Iran where the mean BMI was 23.20±2.43 and 21.27±2.69 in males and females, respectively which also has higher mean values than the ones obtained in this study. The maximum and minimum values for each variable are also stated in Table 1. The corresponding value of coefficient of variation (CV) for each variable is considerably low which shows little disparity among the measurements. The components of cranial capacity which includes head length (HL), head width (HW), head height (HH) were also statistically analyzed individually to obtain the maximum, minimum, CV and mean value. The mean head length, head width and head height of the males (189.0±5.8, 146.4±5.9 and 125.1±5.6 respectively) are significantly ($p \leq 0.05$) higher than the females (176.2±5.9, 140.1±7.4 and 116.2±6.5 respectively) which conform with the study of Maina *et al.* (2012) where he also found the craniometric measurements of the males (191.11±6.4, 135.90±12.9, 145.15±7.5) to be significantly higher than the females (183.53±9.9, 135.47±14.9, 141.29±7.6). The higher mean cranial capacities of the males than the females observed in this study and in other similar works reported here could be explained by the generally bigger frame of the average male than the average female (Maina *et al.,* 2012) as a result of the genetic and hormonal differences in both sexes. Moreover, it has been shown that gender differences in brain weight could be attributed to activities in which the specific sex excelled (Andy, 1992; Rushton and Osborne, 1995). However, the observed differences that exist between the mean cranial capacity in both males and females in this study and other studies is probably due to ecological, biological, geographical, racial, gender and age factors which have been cited to influence several bodily dimensions (Golalipour *et al.*, 2003; Tuli *et al.*, 1995; Okupe *et al.*, 1984; Rajlakshmi *et al.*, 2001).

Table 2 shows the mean cranial capacity of all the respondents in the research as 1247.6±135.0 cm^3which is closer to the value of cranial capacity 1276 cm^3 obtained for Africans from a large study by Rushton and Ankney (2000) but at variance with the cranial capacity of Caucasoids (1347cm^3) and Mongoloids (1364cm^3). The differences in value account for the racial and geographical variations that exist among different population where some researchers attributed the smaller Negroids (Blacks) cranial capacity to the evolution of the thermoregulatory model of the brain such that hot climate like Africa favours smaller brain volume since it's easier to keep it cool (Beals *et al.*,1984). According to Rushton and Ankney (2000), one problem with Beals *et al.'s* (1984) thermoregulatory model is that the brain is a metabolically very expensive organ. Although the human brain represents about 2% of total body mass, the brain's energy demand is equal to about 20% of the body's basal metabolic rate. It is impossible that such a metabolically expensive organ would enlarge simply from selection for thermoregulation. It is possible; however, that thermoregulation was a force selecting against increased brain size in sub-Saharan Blacks (and in other tropical populations).

Table 3 and 4 shows the percentage distribution of the BMI classes among the male and female subjects. The two tables shows the normal weight group has the highest percentage in both male and female with the female group having 4% of their population as obese while the males has no obese group in their population. Thus, the result shows the female population to be bulkier than the male just as the overweight percentage of the female is also higher.

Table 5 shows a weak significant positive relationship between age and CGPA among the male with r value of 0.294 which could be attributed to increase mental and psychological maturity as ones age increases. Table 6 shows the effect of cranial capacity, BMI, age on the academic performance of the male subjects which shows age to have 0.050

coefficients which is also significant. Hence, age has 5% contribution to academic performance.

Table 7 also shows the correlation of cranial capacity, BMI, age on the academic performance of female students where only age has a weak significant positive relationship (0.267) between age and CGPA. Age also has a significant 5.5% contribution to academic performance in the female as revealed by Table 8.

Test of Hypothesis

Table 9 shows the relationship between cranial capacity, body mass index and age on the academic performance of all the respondents (male and female) and also confirm the hypothesis of this study. However, age has a weak positive significant relationship (correlation coefficient 0.287) with CGPA which support the claim of Abubakar and Dokubo (2011) who revealed that predictor variable of age had lower positive correlation than gender with their dependent variable CGPA which implied that both age and gender were positively related to CGPA of the students. Relative to the null hypothesis, it is only age that has significant (weak) influence on academic performance, therefore other factors such as cranial capacity, body mass index and gender have no significant influence on academic performance.

Although, gender revealed a significant correlation with student CGPA in the work of Abubakar and Dokubo (2011), this study recorded a non-significant negative correlation (r = -0.056) of gender with CGPA among the students. Since gender is a discontinuous variable, it is difficult to explain the correlation it has with academic performance when run together unless a distinction between male and female as we have done in this study where one can now study the differences in academic performance of both group. Judging from this present study as revealed in Table 1, there is no much difference in the academic performance of the male and female students as shown by their mean CGPA 3.07±0.7 and 2.98±0.9 respectively.

Abubakar (2010) earlier also recorded a positive but insignificant correlation (r= 0.030) between gender and CGPA of Mathematics students of F.C.E (Technical) Omoku, Rivers State. The non-significant positive correlation of BMI and CGPA could be attributed to the fact that a sizeable proportion of the male samples are underweight as seen in Table 3, hence an increase in adequate nutritional intake will provide the body with enough dietary requirement needed for mental executive functions and body wellness which will translate into increase in academic performance. Although some researchers like Sabia (2007) finds that weight lowers test scores in children, though only for girls while Fletcher and Lehrer, (2008) and Kaestner and Grossman, (2009) found no significant differences or effects of BMI on academic performance or productivity of workers. The significant positive correlation of age and CGPA could also be attributed to the increase in mental and psychological maturity as ones age increases which might translate into increase in academic performance and other job functions.

Most studies on cranial capacity and general mental ability uses measures of cognitive ability like intelligence quotient (IQ), verbal ability, perceptual speed, motor coordination within personal space, spatial tests and tests of mathematical reasoning but this study uses CGPA as an indicator of academic performance to measure mental ability and the result revealed that the correlation of cranial capacity with CGPA is not significant. However, some researchers have also shown the correlation between cranial capacity and general mental ability (GMA) like in the results of 28 studies that used brain imaging techniques such as magnetic resonance imaging (MRI) and computed tomography (CT) in a total of 1,389 normal subjects. The correlations with GMA range from 0.04 to 0.69, with an unweighted mean of 0.40 (when weighted by sample size, 0.38) (Rushton and Ankney, 2009) and the results of 59 studies that recorded external head measurements in a total of 63,405 children, adolescents, and adults. The correlations range from 0.02 to 0.55 with an unweighted mean of 0.21 (when weighted by sample size, 0.20) (Rushton and Ankney, 2009).

Cranial capacity was responsible for 0% variance in the academic performance of the students while sex and BMI have -3% and -0.2% variance in the academic performance of the students respectively. It could be observed from Table 10 that the effect they have on academic performance is not significant, although it’s worth comparing with the result of Abubakar and Dokubo (2011) where he evidently revealed that gender was responsible for 1.2% of the variance in performance of Mathematics and Science students while Owolabi and Etuk-Iren (2009) recorded that gender was responsible for 1.3% of the variance in the performance of 231 Pre-NCE Mathematics students of F.C. E (Technical), Akoka, Lagos state. Abubakar (2010) has however recorded a 0% variance contribution in the CGPA of Mathematics students of F.C.E. (T), Omoku, Rivers state, Nigeria.

According to Table 10, age has a significant 5.3% contribution among the factors that dictate the academic performance of the students which contrast the findings of Abubakar and Dokubo (2011) in their study that revealed that age is insignificant as it relates to CGPA and it was responsible for 0.1% of variance in performance of Mathematics and Science students of F.C.E. (T), Omoku, Rivers state, Nigeria.

The academic performance of males and females are approximately the same in this study despite the difference in cranial capacity and the observation is in line with that of Rushton and Ankney (2009) that says women have proportionately smaller average brains than men but apparently have the same intelligence test scores.Ankney (1995) therefore hypothesized that the sex difference in brain size relates to those intellectual abilities at which men excel; that is, spatial and mathematical abilities require more “brain power.” Analogously, whereas increasing word-processing power in a computer requires some extra capacity, increasing three-dimensional processing, as in graphics, requires a major increase in capacity.

The non-significant negative variance of BMI and academic performance negates the findings of Seyi (2012) in his study that body mass index has a significant negative correlation with academic performance which is an indication that the lower the body mass index, the better the academic performance. The logical explanation to our findings concerning BMI and academic performance in this study is that both male and female groups have a very low percentage of overweight (Table 2 & 3) with no obese group in the male groups as seen in Table 3, hence it could not really reveal the effect of BMI on academic performance which some authors like Hoffman *et al.,* 2006; Taras and Potts, 2005; Oketayo *et al., 2010,* have reported a negative significant correlation between body mass index and academic performance which indicate that overweight and obesity may have adverse effects on academic performance.

The joint effect of cranial capacity, body mass index, gender and age on academic performance is 7.3% as given by the adjusted R^2 in Table 10 which shows that there is inter-play of so many other factors (which could not be accounted for by these variables) that affect the academic performance ranging from that of the individual to the academic environment and structure.

The regression equation $y = mx + c$ could be used to evaluate the dependent variable y (CGPA) from the mean age where c = constant, x = coefficient of age, m = the age.

$y = 0.053 \times 24 + 2.082 = 1.272 + 2.082$

$y = 3.35$ which is within the range of the mean CGPA 3.0±0.78 of the pool. Hence, age which is a significant variable in this study can be used to predict the academic performance of a student.

The result got from the pilot study data analysis as shown in Table 11 and Table 12 revealed a weak non-significant association between the independent variables and the dependent variable (CGPA) which validates the credibility of the reported CGPA in the main study.

Fig. 4 is a pie chart showing the academic performance of various classes of BMI. It is observed that the overweight and obesity group have the lowest mean CGPA of 2.81 and 2.1 respectively while the underweight and normal group have 3.16 and 2.99 respectively. This observation is in conformity with the work of Douglas and Shingairai, 2013 on Biochemistry students of University of Nebraska-Lincoln, USA where they observed that students in the normal BMI category (≥ 18.5 kg/m^2 - <25 kg/m^2) had significantly better CGPA than students in the overweight category (≥ 25 kg/m^2 - <30 kg/m^2), indicating better academic performance (mean differences for CGPA of 0.24 ($p < 0.01$). The lower performance of overweight category could partly be attributed to lower self-esteem which makes it harder for them to concentrate or be attentive in class, thereby preventing them from learning in schools (Strauss, 2000). Secondly, overweight students are more likely to have health problems such as sleep apnea, asthma, or an iron deficiency, which may further cause lower cognitive performance (Taras and Potts, 2005). Moreover, poor health impedes educational progress since such a student is not prepared to fully engage in or take advantage of learning opportunities at school or at home (Hanson *et al.*, 2004).

Fig 5 shows the academic performance of the various age groups. The age class 30-35 has the highest mean CGPA of 3.85 while the age class 24-29 has a mean CGPA of 3.12. The age class 18-23 has the lowest mean CGPA of 2.86. It could be deduced that the mental preparedness and attentiveness is higher in the age class 30-35 where youthful exuberance is reduce than the group with the lowest CGPA.

CHAPTER FIVE

5.0 SUMMARY, CONCLUSION AND RECOMMENDATIONS.

5.1 Summary

The study was done to know the role of cranial capacity, body mass index, age and gender on academic performance of undergraduate students of Bayero University, Kano. Random sampling was used to select 400 respondents (250 males and 150 females) from 9 faculties that consented to participate in the research after which their biodata, weight, height and craniometric indices were carefully taken and recorded.

Descriptive statistics revealed that the mean head length, head width and head height of the male group is greater than female group. T-test analysis also showed that the mean cranial capacity and age of the males is significantly higher than the females while the body mass index of the females is significantly higher than males. However, there is no significant difference in the CGPA of the male and female group. The BMI classification shows no obese groups in the males but very little percentage of obese groups in the females with a greater percentage of normal weight in both female and male samples.

Also, separate data analysis of the two groups revealed a non-significant correlation of cranial capacity and body mass index on academic performance of males and females separately but age has a significant correlation on academic performance. The trend is also the same on the analysis of the pool (males and females) even after inclusion of gender where only age is significantly correlated with academic performance. The individual contribution of cranial capacity, body mass index and gender on academic performance was also not significant on regression analysis. Although, only age contributed significantly ($P \leq 0.01$) to academic performance but the sum of individual contribution to academic performance still remain insignificant. According to our result, cranial capacity, body mass index, age and gender all have 7.3% non-significant influences on academic performance of the undergraduate students in Bayero University, Kano.

5.2 Conclusion

Based on the findings of this present study, it could be deduced that cranial capacity, body mass index and gender has no significant influence on academic performance of undergraduate students in Bayero University, Kano but age however has a significant influence on the academic performance. Although, in this study, I couldn't confirm the authenticity of the students claim of their CGPA but in the pilot study where I did verify the CGPA from their academic record; age, cranial capacity and body mass index have no significant relationship with academic performance.

Hence, the study refute the unconventional myth of; male perform better academically than the female, the bigger the head the better the academic output, the higher the body weight the more sluggish and inactive the individual is, which will translate into poor academic performance or those with normal weight would excel more than the overweight academically. However, mental and psychological maturity plays a role in the academic performance of the students. Since a cluster of so many factors affect student performance, it's pertinent to note that conducive learning environment, healthy socio-economic policies, enhanced academic curricula and genetic make-up of individuals should receive greater attention if students' performances are to be improved.

5.3 Recommendations

i. The study should be replicated in collaboration with the university authority using the CGPA of the students as recorded in the school academic record instead of self-reported CGPAs to increase reliability.

ii. Modern technologies like magnetic resonance imaging (MRI), computerize tomography scan (CT scan) should be employed to measure the intra-cranial dimension to have a more accurate volume of the endocranium via cranial capacity for a better representation.

iii. Similar study should be done in other academic institutions (both lower and higher) so that the result can be compared.

iv. Policy makers should focus more on guiding and counseling the younger students to help equip them with the necessary preparations to cope with the mental and psychological rigors of academics.

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Pro Forma for Data collection

A. Personal Data

Client code number……………………………. Sex….......................

Tribe…………………………………………… Age…………………

Faculty…………………………………………………..

Department……………………………..… Programme……………………….

CGPA: 200L…………..300L…………..400L………………

Average CGPA………………..

Are you pregnant…………………..

Do you have head injury…………………………..

Are you an athlete………………………………………..

B. Cranial Capacity Measurement

HL (1)……… (2)……… (3)……..…= …………….cm

HW (1)……… (2)……… (3)……..…= …………….cm

HH (1)……… (2)……… (3)……..…= …………….cm

Cranial Capacity……………………..cm^3

C. BMI Measurement

Standing Height……………m

Weight………………..……kg

BMI………………………kg/m^2

Appendix i

Consent Form

I, Suleiman Odidi Muritala of the Department of Human Anatomy humbly seek your indulgence to voluntarily participate in my M.sc Anatomy research for academic purposes. The data collected shall be kept confidential.

Thanks for your cooperation.

I am most grateful.

…………………………………

Date

Appendix ii