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ANTHROPOMETRIC PARAMETER COMPARISON BETWEEN AUTISTIC AND NORMAL HEALTHY CHILDREN

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ABSTRACT

Aim: *The aim of this study was to assess and compare the differences in anthropometric measures between autistic and healthy children. The differences in anthropometric measures between autistic males and females were also assessed and compare.*

Method: *Purposive/deliberate or snowball sampling method was used due to limited availability of autism centers and obtain-ability of the consent of caregivers, parent and directors of these centers. This study was carried out in autism centers, primary and secondary schools across Port Harcourt, Rivers State, Nigeria with a total number of 100 subjects (children and adolescents); 50 normal healthy subjects (comprised of 37 males and 13 females) and 50 subjects with autism (comprised of 37 males and 13 females) within the ages of 5 to 18 years. The measured parameters include; height, weight, body mass index (BMI), craniofacial circumference (CFC) and Mid-Upper Arm Circumference (MUAC). The data collected was analyzed using descriptive statistics and independent sample T-test with p-value at 0.05.*

Result: *A statistical difference in BMI and MUAC between normal and autistic female children was obtained (t-value = -4.390 and -9.875 and at p-value =0.012 and 0.001 respectively), no statistical difference in CFC between normal and autistic female children with a t-value of 0.544 at a p-value of 0.615. Also, there was a statistical difference in BMI and MUAC between normal and autistic female adolescents (t-value = 3.361 and -2.965 and at p-value =0.003 and 0.008 respectively). There were significant differences in both parameters at $p<0.05$ significance level whilst there was no significant differences in the craniofacial circumference (CFC). This is the same for the female adolescents with autism. In comparison of mean differences in body mass index (BMI), mid-upper arm circumference (MUAC) and craniofacial circumference (CFC) of male and female children with autism, there was a significant difference in MUAC between male and female children with autism with a t-value of -2.597 at p-values of 0.02 respectively and for male and female adolescents with autism, there was a significant difference in BMI between male and female children with autism with a t-value of -2.136 at p-values of 0.041 respectively.*

Conclusion: *The increase in fat component which is more predominant in females is a factor responsible for the increase in MUAC and BMI in the study, due to increased carbohydrate and fat intake as well as sedentary life style. The crainofacial circumference and its variance significantly increased especially in male adolescents, suggesting the relative overgrowth of the brain in a substantial percentage of adolescents in Port Harcourt with autism.*

KEYWORDS: *Autism, Mid Upper Arm Circumference, Craniofacial Circumference, Children, Adolescents*

INTRODUCTION

Autism is the fastest rising developmental disorder in the world today. The centers for disease control released that the incidence of autism is rising at about 12% each year. The lack of successful therapy, etiological heterogeneity, and the increasing incidence make autism one of the most challenging neuro-developmental disorders. Autism is a developmental disorder characterized by difficulties with social interaction and communication, and by restricted and repetitive behavior [1]. Parents often notice signs during the first three years of their child's life [2]. These signs often develop gradually, though some autistic children experience regression in their communication and social skills after reaching developmental milestones at a normal pace [3]. Autism is associated with a combination of genetic and environmental factors [4]. Risk factors during pregnancy include certain infections, such as rubella, toxins including valproic acid, alcohol, cocaine, pesticides, lead, and air pollution, fetal growth restriction, and autoimmune diseases [5]. Autism affects information processing in the brain and how nerve cells and their synapses connect and organize; how this occurs is not well understood [6]. The Diagnostic and Statistical Manual of Mental Disorders (DSM-5)

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combines forms of the condition, including Asperger syndrome and pervasive developmental disorder not otherwise specified (PDD-NOS) into the diagnosis of autism spectrum disorder (ASD) [7]. No treatment has been proven to cure ASD, but several interventions have been shown to reduce symptoms and improve the ability of people with ASD to function and participate independently in the community [8]. Behavioral, psychological, education, and/or skill-building interventions may be used to assist people with ASD to learn life skills necessary for living independently, as well as other social, communication, and language skills. Therapy also aims to reduce challenging behaviors and build upon strengths. Some autistic adults are unable to live independently [9]. An autistic culture has developed, with some individuals seeking a cure and others believing autism should be accepted as a difference to be accommodated instead of cured [10].

Globally, autism is estimated to affect 24.8 million people as of 2015. In the 2000s, the number of people with autism worldwide was estimated at 1–2 per 1,000 people [11]. In the developed countries, about 1.5% of children are diagnosed with ASD as of 2017 [12], from 0.7% in 2000 in the United States. It is diagnosed four-to-five times more often in males than females. The number of people diagnosed has increased dramatically since the 1960s, which may be partly due to changes in diagnostic practice [11]. The question of whether actual rates have increased is unresolved.

MATERIALS AND METHOD

This study was carried out in autism centers, primary and secondary schools across Port Harcourt, Rivers State, Nigeria with a total number of 100 subjects (children and adolescents); 50 normal healthy subjects (comprised of 37 males and 13 females) and 50 subjects with autism (comprised of 37 males and 13 females) within the ages of 5 to 18 years.

For the children subjects:

- The children with autism comprised of 15 males and 2 females;
- The normal healthy children comprised of 8 males and 4 females.

For the adolescent subjects:

- The adolescents with autism comprised of 22 males and 11 females;
- The normal healthy adolescents comprised of 29 males and 9 females.

Materials Used: The materials used for carrying out this study were a measuring tape, which was used for measuring the height, mid-upper arm circumference and craniofacial circumference; and a weighing balance or weight scale, which was used for measuring weight as the name implies.

Data Collection: The method of data collection was a type of sampling technique known as purposive/ deliberate or snowball sampling. Snowball sampling is a sampling technique that is based on recommendation from different sources. It is called a purposive/ deliberate sampling method because of the limited availability of autism centers and obtain-ability of the consent of caregivers, parent and directors of these centers.

CRITERIA FOR DATA COLLECTION

Inclusive criteria

The following were the criterions for the selection of the student subjects:

- All the subjects were within the age range (5 to 18 years);
- The subjects were selected from autism centers across Port Harcourt;
- The selected subjects must be children and adolescents with autism and autism spectrum disorders only;
- The subjects were healthy free, of congenital abnormalities and defects.

Exclusive criteria

The following criterions lead to the exclusion of some subjects:

- Subjects below the age of 5 and above 18 years;
- Subjects from centers outside Port Harcourt district;
- Subjects with other disorders such as Down Syndrome, Cerebral Palsy, etc.;
- Subjects with congenital abnormalities such as malformation of the face, bone structure etc.

Parameters Measured: The following are the parameters that were measured:

- Craniofacial circumference (CFC): Known as Head Circumference, is an important measurement as it is closely related to brain size. It is used with other measurements to detect other conditions.
- Weight: This is one of the most important measurements in nutritional assessment. It is an important variable used in equations predicting macronutrient and fluid requirements and a variable index in acute malnutrition.
- Height: This measurement is important for calculating certain indices such as height-for-age, weight-for-height, body mass index (BMI), and the creatinine height index and for estimating basal energy expenditure.
- Body Mass Index (BMI): BMI (a weight-for-height measurement) can also be used to determine nutritional status and is calculated by dividing weight in kilograms by the square of height in meters (kg/m^2). It can be influenced by age, gender and race.
- Mid-Upper Arm Circumference (MUAC): The arm contains both subcutaneous fat and muscle; therefore, a decrease in MUAC (also referred to as mid arm circumference MAC) may reflect either a reduction in muscle mass, subcutaneous tissue of both. It is a simple, low-cost, objective method of assessing nutritional status. It can also be obtained quickly and non-invasively and can provide a more accurate assessment of nutritional status

Method of Data Analysis

The data collected was analyzed using descriptive statistics and independent sample T-test with p-value at 0.05.

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RESULTS

Table 1: Descriptive characteristics of the Age of the study population

Group Statistics	N (%)	Age (years) Mean ± SD
Male Children		
Normal	8 (34.8)	6.88±1.46
Autism	15 (65.2)	7.20±1.37
Female Children		
Normal	4 (66.7)	7.50±1.29
Autism	2 (33.3)	9.00±0.00
Male Adolescents		
Normal	29 (56.9)	14.31±2.57
Autism	22 (43.1)	14.45±3.05
Female Adolescents		
Normal	9 (45.0)	14.44±2.65
Autism	11 (55.0)	13.73±2.45

This table shows the mean age differences of the children and adolescents used in this study. The mean age for male Autistic children was 7.20±1.37years and that of normal male children was 6.88±1.4years, while the mean age of female autistic children was 9.00±0.00years and that of the normal female children was 7.5±1.29years respectively. The mean age of normal male adolescents was 14.31±2.57years and the mean age of male adolescents with autism was 14.45±3.05 while the mean age of the female adolescent was 13.73±2.45years and that of the normal female adolescents was 14.44±2.65years respectively.

Table 2: Mean differences in body mass index (BMI), mid-upper arm circumference (MUAC) and craniofacial circumference (CFC) of normal and male children with autism (aged 5 to 9 years)

Group	Parameters	N	Mean ± SD	t-value	p-value	Inference
Normal	**BMI (kg/m^2)**	8	16.69±4.71	-0.617	0.544	NS
Autism		15	17.76±3.57			
Normal	**MUAC (cm)**	8	18.50±4.50	-1.274	0.216	NS
Autism		15	20.40±2.69			
Normal	**CFC (cm)**	8	53.13±1.89	0.557	0.583	NS
Autism		15	52.80±0.94			

This table represents the mean differences in BMI, MUAC and CFC of normal male children and male children with autism. In the terms of BMI, our result showed that the mean BMI of male children with autism was 17.76±3.57kg/m^2 was relatively higher than that of the normal male children with a mean value of 16.69± 4.71kg/m^2. In terms of the MUAC, the study showed the mean value of MUAC of autistic male children was relatively higher with a value of 20.40±2.69cm while normal was male children had mean value of 18.50±4.50cm. The mean craniofacial circumference (CFC), of autistic children was 52.80±0.94cm while mean of normal children was52.80±0.94cm.

Table 3: Mean differences in body mass index (BMI), mid-upper arm circumference (MUAC) and craniofacial circumference (CFC) of normal and female children with autism (aged 5 to 9 years)

Group	Parameters	N	Mean ± SD	t-value	p-value	Inference
Normal	**BMI (kg/m^2)**	4	16.00±1.91	-4.390	**0.012**	**S**
Autism		2	22.47±0.81			
Normal	**MUAC (cm)**	4	17.50±1.00	-9.875	**0.001**	**S**
Autism		2	25.50±0.70			
Normal	**CFC (cm)**	4	53.00±1.15	0.544	0.615	NS
Autism		2	52.50±0.70			

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This table represents the mean differences in BMI, MUAC and CFC of normal female children and female children with autism. The mean BMI of female children with autism was 22.47±0.81kg/m^2 and is relatively higher than that of the normal female children that was 16.00± 1.91 kg/m^2. The MUAC female children with autism had a high mean value of 25.50±0.70cm than that of the normal female children with mean value of 17.50±1.00cm. The CFC of autistic female children 52.50±0.70cm and normal female children was 53.00±1.15cm.

Table 4: Mean differences in body mass index (BMI), mid-upper arm circumference (MUAC) and craniofacial circumference (CFC) of normal and female adolescents with autism (aged 10 to 18 years).

Group	Parameters	N	Mean ± SD	t-value	p-value	Inference
Normal	**BMI (kg/m^2)**	9	18.85±1.89	3.361	**0.003**	**S**
Autism		11	23.00±3.27			
Normal	**MUAC (cm)**	9	22.56±2.92	-2.965	**0.008**	**S**
Autism		11	26.00±2.28			
Normal	**CFC (cm)**	9	54.33±2.00	1.360	0.191	NS
Autism		11	53.27±1.49			

Table 4 shows the mean differences in BMI, MUAC and CFC of normal female adolescents and female adolescents with autism. In the terms of BMI, findings revealed that the mean BMI of female adolescents with autism (23.00±3.27kg/m^2) was relatively higher than that of the normal female adolescents (18.85±1.89kg/m^2). In terms of the MUAC, findings revealed also that the mean MUAC of female adolescents with autism (26.00±2.28cm) was relatively higher than that of the normal female adolescents (22.56±2.92cm). Also, in the terms of the CFC, findings revealed that the mean CFC of normal female adolescents (54.33±2.00cm) was relatively higher than that of female adolescents with autism (53.27±1.49).

Table 5: Mean differences in body mass index (BMI), mid-upper arm circumference (MUAC) and craniofacial circumference (CFC) of normal and male adolescents with autism (aged 10 to 18 years).

Group	Parameters	N	Mean ± SD	t-value	p-value	Inference
Normal	**BMI (kg/m^2)**	29	19.68±3.09	-1.453	0.153	NS
Autism		22	20.84±2.43			
Normal	**MUAC (cm)**	29	24.10±4.02	-1.984	0.053	NS
Autism		22	26.22±3.44			
Normal	**CFC (cm)**	29	54.72±1.85	-0.005	0.996	NS
Autism		22	54.73±2.41			

Table 5 shows the mean differences in BMI, MUAC and CFC of normal male adolescents and male adolescents with autism. In the terms of BMI, findings revealed that the mean BMI of male adolescents with autism (20.84±2.43kg/m^2) was relatively higher than that of the normal male adolescents (19.68±3.09kg/m^2). In terms of the MUAC, findings revealed also that the mean MUAC of male adolescents with autism (26.22±3.44cm) was relatively higher than that of the normal male adolescents (24.10±4.02cm). Also, in the terms of the CFC, findings revealed that the mean CFC of normal male adolescents (54.72±1.85cm) was relatively the same as than that of male adolescents with autism (54.73±2.41cm).

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Table 6: Mean differences in body mass index (BMI), mid-upper arm circumference (MUAC) and craniofacial circumference (CFC) of male and female children with autism (aged 5 to 9 years)

Group	Parameters	N	Mean ± SD	t-value	p-value	Inference
Male	**BMI (kg/m^2)**	15	17.76±3.57	-1.806	0.091	NS
Female		2	22.46±0.81			
Male	**MUAC (cm)**	15	20.40±2.69	-2.597	**0.02**	**S**
Female		2	25.50±0.71			
Male	**CFC (cm)**	15	52.80±0.94	0.430	0.673	NS
Female		2	52.50±0.71			

Table 6 shows the mean differences in BMI, MUAC and CFC of male and female children with autism. In the terms of BMI, findings revealed that the mean BMI of female children with autism (22.46±0.81kg/m^2) was relatively higher than that of the male children with autism (17.76±3.57kg/m^2). In terms of the MUAC, findings revealed also that the mean MUAC of female children with autism (25.50±0.71cm) was relatively higher than that of the male children with autism (20.40±2.69cm). Also, in the terms of the CFC, findings revealed that the mean CFC for female children with autism (52.50±0.71cm) was relatively the same as that of male children with autism (52.80±0.94cm).

Table 7: Mean differences in body mass index (BMI), mid-upper arm circumference (MUAC) and craniofacial circumference (CFC) of male and female adolescents with autism (aged 10 to 18 years)

Group	Parameters	N	Mean ± SD	t-value	p-value	Inference
Male	**BMI (kg/m^2)**	22	20.84±2.43	-2.136	**0.041**	**S**
Female		11	23.00±3.27			
Male	**MUAC (cm)**	22	26.22±3.45	0.197	0.845	NS
Female		11	26.00±2.28			
Male	**CFC (cm)**	22	54.73±2.41	1.824	0.078	NS
Female		11	53.27±1.49			

Table 7 shows the mean differences in BMI, MUAC and CFC of male and female adolescents with autism. In the terms of BMI, findings revealed that the mean BMI of female adolescents with autism (23.00±3.27kg/m^2) was relatively higher than that of the male adolescents with autism (20.84±2.43kg/m^2). In terms of the MUAC, findings revealed also that the mean MUAC of female adolescents with autism (26.00±2.28cm) was relatively the same as that of the male adolescents with autism (26.22±3.45cm). Also, in the terms of the CFC, findings revealed that the mean CFC for male adolescents with autism (54.73±2.41cm) was relatively higher than that of male adolescents with autism (53.27±1.49cm).

DISCUSSION

The age of the male and female children with autism is relatively higher than that of the normal male and female children. This was due to the sampling method (purposive/deliberate sampling) used by the researcher in carrying out the study as many institutions (both of learning and of the autism centers especially) refused to give their consent to allow researcher carry out studies in their institutes. This was also the reason behind the mean age value of the normal female adolescents being relatively higher than that of the female adolescents with autism. Another prominent reason for the normal children being relatively higher was because, in the 2000s, the number of people with autism worldwide was estimated at 1–2 per 1,000 people as according to Newschaffer *et al*. [11].

The mean age of male adolescents with autism and normal male adolescents was relatively the same and this is because autism shows a striking male bias in prevalence, with approximately 4 affected males for every 1 affected female. It was observed that the BMI for the children/adolescents with autism was relatively higher than that of normal healthy children. There was no statistical difference in BMI, MUAC and CFC between normal and autistic male children with a t-value of -0.617, -1.272 and 0.557 respectively and at a p-value of 0.544, 0.216 and 0.583 respectively (Table 2). Although a statistical difference in BMI

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and MUAC between normal and autistic female children was obtained (t-value = -4.390 and -9.875 and at p-value =0.012 and 0.001 respectively), no statistical difference in CFC between normal and autistic female children with a t-value of 0.544 at a p-value of 0.615 (Table 3). Also, there was a statistical difference in BMI and MUAC between normal and autistic female adolescents (t-value = 3.361 and -2.965 and at p-value =0.003 and 0.008 respectively), no statistical difference in CFC between normal and autistic female adolescents with a t-value of 1.360 at a p-value of 0.191 (Table 4). There was no statistical difference in BMI, MUAC and CFC between normal and autistic male adolescents with a t-value of -1.453, -1.984 and -0.005 at a p-value of 0.153, 0.053 and 0.996 respectively (Table 5).

According to Anderson *et al*. [13], young people are frequently recommended to participate in leisure activities including play, sports, hobbies, and social activities, children and adolescents with autism tend to spend time in passive play and maladaptive behaviors and they are less likely to spontaneously participate in organized leisure activities such as sports as such, they are expected to have a high BMI compared to normal children/adolescents. But the findings of this study do agree with the statement by Anderson *et al*. [13] as BMI for female autistic children/adolescent was significant when compared with normal children/adolescents. In contrast, it is not in agreement with the results of this study for male autistic children/adolescent when compare with normal children/adolescents. Thus can b due to the fact that male children/adolescents tend to involve in playful activities compared to female children/adolescents. Pan [14] said in his study that social and behavioral impairments in ASD can limit children opportunity to participate in physical activity and recreation programs that eventually end to their inactivity, also Curtain *et al*. [15] opined that physical inactivity predisposes children with ASD to several comorbid conditions such as overweight and obesity. This study is slightly in conformity with these statements as this study revealed a significant difference in BMI among female autistic children/adolescents when compared with normal.

Although there were relative differences in the BMI, MUAC and CFC, there was no significant difference at $p<0.05$ significance level for the male children with autism. Due the relatively higher values of the body mass index (BMI) and mid upper arm circumference (MUAC) of the female children with autism, as a physical inactivity due to social impairments, there were significant differences in both parameters at $p<0.05$ significance level whilst there was no significant differences in the craniofacial circumference (CFC). This is the same for the female adolescents with autism. Also, there were relative differences in the BMI, MUAC and CFC, there was no significant difference at $p<0.05$ significance level for the male adolescents with autism. There were relatively higher values in the MUAC and BMI respectively of the female children and adolescents indicating significant differences at $p<0.05$ significance level. This was because of the increase in fat component which is more predominant in females and is the factor responsible for the increase in MUAC and BMI in the study, due to increased carbohydrate and fat intake as well as sedentary life style. The researcher also gathered from parents that most times due to the social impairments of children and adolescents with autism, they lack self-esteem and prefer solitary confinements to social interactions leading to this sedentary life cause overweight most times or obesity.

Furthermore, in comparison of mean differences in body mass index (BMI), mid-upper arm circumference (MUAC) and craniofacial circumference (CFC) of male and female children with autism, there was no statistical difference in BMI and CFC between male and female children with autism with a t-value of -0.1806 and 0.430 at p-values of 0.091 and 0.673 respectively; while there was a significant difference in MUAC between male and female children with autism with a t-value of -2.597 at p-values of 0.02 respectively. According to the study by Sheetal and Sunil [16] that did a comparison study of anthropometric measurements between autistic children and normal healthy children revealed that there was no significant difference in MUAC between male and female autistic children (t-value = 0.428 at p-value = 0.505). This is not in conformity with the findings of this study. Also, study by Sheetal and Sunil [16], showed that the mean weight of the autistic children (50.97±13.8kg) was found to be greater than the controls (44.21±5.3kg) which was found to be statistically significant (p=0.001). Although weight was not presented in the result of this present study, it is a parameter for assessing BMI. The tendencies observed from this study agrees with that of Sheetal and Sunil [16] who stated that the weight of autistic children is greater than the healthy group of children whereas there was no significant difference between the weight of males and females of the autistic group of children. So, because of the tendency of the autistic children to gain unhealthy weight, associated factors should be kept in mind while approaching a case of autism and an individualized treatment plan should be formulated for gaining maximum effectiveness, this is strongly proved by the significance in BMI obtained from this study. Finally, in comparison of mean differences in body mass index (BMI), mid-upper arm circumference (MUAC) and craniofacial circumference (CFC) of male and female adolescents with autism, there was no statistical difference in MUAC and CFC between male and female children with autism with a t-value of -0.197 and 1.824 at p-values of 0.845 and 0.078 respectively; while there was a significant difference in BMI between male and female children with autism with a t-value of -2.136 at p-values of 0.041 respectively

CONCLUSION

Body mass index and mid-upper arm circumference increased because of a significant increase in subcutaneous fat thickness in female adolescents with autism. This tendency with a probable decrease in muscle mass was more evident in male or in older children, likely resulting from sedentary lifestyle and food selectivity. The crainofacial circumference and its variance

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significantly increased especially in male adolescents, suggesting the relative overgrowth of the brain in a substantial percentage of adolescents in Port Harcourt with autism. As a result of autistic children and adolescent (especially females) proclivity for gaining unhealthy weight, relevant issues should be considered when approaching a case of autism, and a tailored treatment plan should be devised for maximum success.

RECOMMENDATIONS

It is recommended that Centers for autism should be more open to students and researchers that to enable them carry out study on autism and awareness should be created on the need for providing these children with the adequate resources for their training.

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