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A Comparative Analysis between Normal, Down Syndrome Children and Adolescents

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ABSTRACT

Down's syndrome affects a baby's normal physical development and causes mild to moderate learning difficulties. It is a life-long condition that develops while the baby is still in the uterus. It is characterized by a variable degree of intellectual disability (ID), some effects on health and development, as well as peculiar physical features. This study was carried out in Rivers State, Nigeria and a total of 101 subjects within the age of 5 to 18 years were selected and measured. Anthropometric parameters were measured; Height, Weight, Body Mass Index (BMI), mid upper arm circumference (MUAC) and craniofacial circumference (CFC). Data was analyzed using statistical package for the social sciences (SPSS IBM version 23.0). Values were expressed as Mean±SD in descriptive statistics and independent sample t-test. Confidence interval was set at 95% and therefore $p<0.05$ was considered significant. The result obtained showed a statistically non-significant ($p<0.05$) difference in BMI, MUAC and CFC were observed between male Down syndrome and male normal children (age 5 to 9 years). A statistically significant ($p<0.05$) difference in BMI was observed, while a statistically non-significant difference in MUAC and CFC were observed between male Down syndrome and male normal adolescent (age 10 to 18 years). No statistical difference ($p<0.05$) in BMI, MUAC and CFC were observed between female Down syndrome and female normal children (age 5 to 9 years). No statistical difference in BMI, MUAC and CFC were also observed between female Down syndrome and female normal adolescent (age 10 to 18 years). The MUAC and CFC measured showed no significant difference between male and female Down syndrome, while that of their BMI showed a significant difference within the age range at $p<0.05$. The BMI and MUAC measured showed no significant difference between male and female Down syndrome, while that of their CFC showed a significant difference within the age range at $p<0.05$ and a significant difference in mean between male and female Down syndrome population was observed. A significant difference between male and female Down syndrome children using t-test indicated sexual dimorphism. Some anthropometric parameters were found to be significant markers to differentiate children with Down syndrome and normal with the different age ranges and as such, should be considered imminent in checking for occurrences of the disorder. This study also evaluates the difference in anthropometry existing between children with Down syndrome following the measurement parameters.

Keywords: Down syndrome, Mid Upper Arm Circumference, Craniofacial Circumference, Children, Adolescents

INTRODUCTION

Down syndrome is a genetic disorder and the most common chromosomal abnormality named after John Langdon Down, who first recognized it as a distinct condition in 1866. Down syndrome affects a baby's normal physical development and causes mild to moderate learning difficulties. It is a life-long condition that develops while the baby is still in the uterus. Down syndrome is characterized by a variable degree of intellectual disability (ID), some effects on health and development, as well as peculiar physical features [1]. A wide range of co-morbidities can be present in these people, affecting the respiratory, cardiovascular, sensory, gastrointestinal, hematological, immunological, endocrine, musculoskeletal, renal and genitourinary systems, as well as at the neurological level [2]. Despite the much co-morbidity that may co-exist in individuals with DS, the survival rate has increased substantially from less than 50% in the mid-1990s to 95% in the early 2000s [2]. This improvement in the survival rate can be attributed to the advancement of medicine in general [3].

According to Bull [4], children with Down syndrome experiences growth retardation which commences prenatally and after birth, growth velocity is reduced between 6 months and 3 years of age. Foerste *et al*. [5] also noted that children with Down's syndrome are more likely to be obese than their peers. A study by Zemel [6] shows that growth and final height differs

markedly between children with Down's syndrome and healthy children. Many authors have described a high prevalence of increased weight in adults with Down syndrome using general BMI [7]. A study carried out by Yahya-Graison *et al*. [8] shows that the head circumference of children with Down syndrome from age 6 to 13years old were smaller than the regular children in the same age and gender. In another study by Palmer *et al*. [9], it was stated that the head circumference of male children is larger than that of females and growth velocity of the head is normal until 5 to 6 months of age. Since Down syndrome is characterized by physical and developmental disabilities and the rising population of individuals with this disorder, the aim of this research is to ascertain whether body parameters of children with Down syndrome differ with that of normal population using anthropometric measurements.

MATERIALS AND METHODS

This research was carried out in Rivers State, Nigeria. A total of 101 subjects within the age of 5 to 18 years were selected and measured, 50 subjects (male and female) which includes 9 children and 21 adolescents for male subjects and 2 children and 18 adolescents for female with Down syndrome while 51 subjects (male and female) which includes 9 children and 28 adolescents for male and 4 children and 10 adolescents for female were normal and acted as the control. The materials used during the study include; weighing scale; measuring tape, pen and notebook.

Measured Parameters: The following anthropometric parameters were measured: Height, Weight, Body Mass Index (BMI), Mid Upper Arm Circumference (MUAC) and Craniofacial Circumference (CFC). The formula adopted for the sample size collection was the Taro Yamane formula for sample size determination;

$$n = \frac{N}{1 + N\,(e)^2}$$

Where;

n = Sample size
N = Population under study
e = Margin error (0.10, 0.05, 0.01)

Data Collection: Height was measured by asking subjects to stand straight without slouching against a wall already placed with a measuring tape in order to obtain an accurate measurement.

- The weight of subjects were obtained using a weighing scale
- The body mass index (BMI) was obtained using the formula; weight/height
- Mid upper arm circumference: it is a measure to assess nutritional status. It is measured on a straight arm, midway between the tip of the shoulder and the tip of the elbow.
- Craniofacial circumference was obtained by instructing participants to stand straight, looking ahead and using a measuring tape, the circumference of the head was measured.

Inclusion criteria for Data collection: Children with down syndrome, Children aged 5-18 years old, Right arm in obtaining the mid upper arm circumference and Both male and female subjects

Exclusion Criteria for Data Collection: Children with Autism or other developmental disabilities, Children less than 5 years of age and more than 18years of age, Left arm in obtaining the mid upper circumference, One gender for data collection

Statistical Analysis: Data was analyzed using statistical package for the social sciences (SPSS IBM version 23.0). Values were expressed Mean ± SD in descriptive statistics. Independent sample t-test was used to determine and differentiate the male and female children with and without Down syndrome in measured parameters and confidence interval was set at 95% and therefore $p<0.05$ was considered significant.

RESULTS

The study was conducted on 101 subjects, 50 subjects with Down syndrome and 51 subjects without Down syndrome.

Table 1: Descriptive characteristics of study population

Group Statistics	Number (%)	Mean ±S.D
Male Children		
Normal	9(50.0)	7.00±1.58
Down Syndrome	9(50.0)	7.33±1.32
Male Adolescent		
Normal	28(57.1)	14.46±2.46
Down Syndrome	21(42.9)	14.10±2.45
Female Children		
Normal	4 (57.1)	7.50±1.29
Down Syndrome	3 (42.9)	9.00±0.05
Female Adolescents		
Normal	9 (33.3)	15.00±2.83
Down Syndrome	18 (66.7)	12.89±1.94

Table 1 above simply represents and shows the study population of participant with and without Down syndrome differentiated into male and female category.

Table 2: Mean difference in BMI, MUAC and CFC of normal and Down syndrome male children (age 5 to 9 years)

Group	Parameters	N	Mean ± S.D	t-value	p-value	inf
	BMI (kg/m^2)					
Normal		9	17.76±4.66	0.957	0.353	NS
Down Syndrome		9	16.06±2.60			
	MUAC (cm)					
Normal		9	19.56±5.27	0.116	0.909	NS
Down Syndrome		9	19.33±2.24			
	CFC (cm)					
Normal		9	53.22±2.17	1.997	0.063	NS
Down Syndrome		9	51.11±2.32			

Table 2 shows the mean difference in BMI, MUAC and CFC of normal and Down syndrome male children (age 5 to 9 years). A statistically non-significant ($p<0.05$) difference in BMI, MUAC and CFC were observed between Down syndrome and normal.

Table 3: Mean difference in BMI, MUAC and CFC of normal and Down syndrome male adolescents (age 10 to 18 years)

Group	Parameters	N	Mean ± S.D	t-value	p-value	inf
	BMI (kg/m^2)					
Normal		28	19.52±3.31	-2.364	0.022	S
Down Syndrome		21	22.31±4.97			
	MUAC (cm)					
Normal		28	23.79±3.89	-1.549	0.128	NS
Down Syndrome		21	25.48±3.63			
	CFC (cm)					
Normal		28	54.64±1.89	1.099	0.281	NS
Down Syndrome		21	53.71±3.51			

Table 3 shows the mean difference in BMI, MUAC and CFC of normal and Down syndrome male adolescent (age 10 to 18 years). A statistically significant ($p<0.05$) difference in BMI was observed, while a statistically non-significant difference in MUAC and CFC were observed between Down syndrome and normal.

Table 4: Mean difference in BMI, MUAC and CFC of normal and Down syndrome female children (age 5 to 9

Group	Parameters	N	Mean ± S.D	t-value	p-value	inf
	BMI (kg/m^2)					
Normal		4	16.00±1.91	-1.264	0.275	NS
Down Syndrome		3	17.82±0.30			
	MUAC (cm)					
Normal		4	17.5±1.00	-1.687	0.167	NS
Down Syndrome		3	19.5±2.12			
	CFC (cm)					
Normal		4	53.00±1.15	2.402	0.221	NS
Down Syndrome		3	48.00±2.82			

Table 4 shows the mean difference in BMI, MUAC and CFC of normal and Down syndrome female children (age 5 to 9 years). A statistically non-significant ($p<0.05$) difference in BMI, MUAC and CFC were observed between Down syndrome and normal.

Table 5: Mean difference in BMI, MUAC and CFC of normal and Down syndrome female adolescents (age 10 to 18 years)

Group	Parameters	N	Mean ± S.D	t-value	p-value	inf
	BMI (kg/m^2)					
Normal		9	18.01±2.27	-4.119	0.000	NS
Down Syndrome		18	22.08±2.49			
	MUAC (cm)					
Normal		9	22.56±2.92	-1.643	0.113	NS
Down Syndrome		18	25.00±3.94			
	CFC (cm)					
Normal		9	54.33±2.00	2.238	0.034	NS
Down Syndrome		18	51.94±2.86			

Table 5 shows the mean difference in BMI, MUAC and CFC of normal and Down syndrome female adolescent (age 10 to 18 years). No statistical difference in BMI, MUAC and CFC were observed between Down syndrome and normal.

Table 6: Sex difference in measured parameters for children within the ages of 5-9 years compared using t-test

Parameters	MD	SEMD	95% C.I of the Difference		df	t-value	p-value
			Lower	Upper			
BMI	-4.66	.28	-8.15	-1.16	-16.93	1	.038
MUAC	-2.00	1.00	-14.71	10.7	-2.00	1	.295
CFC	3.00	1.00	-9.7	15.7	3.00	1	.205

The MUAC and CFC measured showed no significant difference between male and female Down syndrome, while that of their BMI showed a significant difference within the age range at $p<0.05$

Table 7: Sex difference in measured parameters for children within the ages of 10-18 years compared using t-test

Parameters	MD	SEMD	95% C.I of the Difference		df	t-value	p-value
			Lower	Upper			
BMI	.47778	1.31185	-2.28998	3.24554	.364	17	.720
MUAC	.88889	1.40933	-2.08453	3.86231	.631	17	.537
CFC	2.38889	1.02943	.21698	4.56080	2.321	17	.033

The BMI and MUAC measured showed no significant difference between male and female Down syndrome, while that of their CFC showed a significant difference within the age range at $p<0.05$

Table 8: Comparison of the mean for males and females Down Syndrome population

	t-test for Equality of Means				
Parameters	Mean Difference	Df	t-value	p-value	Inference
BMI	-3.062	47	-2.924	0.01	Sig
MUAC	-5.725	47	-4.63	0.00	Sig
CFC/HC	-1.619	47	-2.723	0.01	Sig

Table 8 shows the comparison of the mean for male and female Down syndrome population. A significant difference in mean between male and female Down syndrome population was observed.

DISCUSSION

Studies have shown that children with DS are characterized by reduced body weight during the first years of life [10,11]. Low birth weight may be related to genetic factors which may influence growth restriction and food intake disorders [12,13]. Zemel *et al*. [10] reported higher values of BMI age among US children with DS after some years when compared to CDC standards and are likely to have higher prevalence of over-weight and obesity when compared to children in the general population without DS [14,15]. Risk factors for obesity in DS include leptin hormone disorders, decreased resting energy expenditure, unbalanced diet, and low levels of physical activity [16,17]. Bertapelli *et al*. [18] in their study had a mean value 17.47±2.27mm and 17.12±2.5mm for male and females respectively in Brazil which is similar to this study for observed differences in BMI among male and female adolescents with DS and normal children when compared to the normative values established by the Center for Disease Control (CDC). The results from this study can be used to express clinical and practical implications regarding the monitoring of the nutritional status of children and adolescents with Down syndrome within the age of 5 to 9 years. The mean BMI values for male participants with DS was less when compared with normal male participants with no significant difference of Down syndrome and normal male children, while the mean value for females with Down syndrome was higher when compared with normal females and also showed no significant difference of Down syndrome and normal female children at $p<0.05$. Although there was a significant difference between male and female Down syndrome children using t-test, which indicates sexual dimorphism within the two groups at $p<0.05$.

Mid arm circumference is closely related with birth weight and age. This present study conform with findings of Kanawati *et al*. [19] wherein steady increase in the initial phase of development followed by slow phase in the later period of first year of life in females generally. The decrease in mid upper arm circumference observed in the present equates with later period of first year of life as noted by Kanawati *et al*. [19]. The MUAC mean values within age 5 to 9 for male participants with down syndrome from table 2 was less when compared with normal male participants, with no significant difference of down syndrome and normal male children, and that of the females with down syndrome from table 4 was higher when compared with the normal female children with no significant difference at $p<0.05$. Also, there is no significant difference between male and female Down syndrome children using t-test, within the two groups at $p<0.05$. While the mean MUAC value within age 10 to 18 years for male participants with down syndrome from table 3 was higher when compared with normal male participants with no significant difference of down syndrome and normal male children, while from table 5, the mean value for females with down syndrome was higher when compared with the normal females with no significant difference of down syndrome and normal female children at $p<0.05$. There was a significant difference observed from table 8 between male and female down syndrome children using t-test, within the two groups at $p<0.05$.

The CFC mean values within age 5 to 9 for male participants with down syndrome from table 2 was less when compared with normal male participants, with no significant difference of down syndrome and normal male children, and that of the females with down syndrome from table 4 was also lesser when compared with the normal female children with no significant difference at $p<0.05$. Also, there is no significant difference between male and female Down syndrome

children using t-test, within the two groups at $p<0.05$. While the mean CFC value within age 10 to 18 years for male participants with down syndrome from table 3 was lesser when compared with normal male participants with no significant difference of down syndrome and normal male children, while from table 5, the mean value for females with down syndrome was lesser when compared with the normal females with no significant difference of down syndrome and normal female children at $p<0.05$. There was a significant difference observed from table 8 between male and female down syndrome children using t-test, within the two groups at $p<0.05$. Based on the research by NurHanis *et al*. [20], the overall head circumference measurement of children with Down syndrome gives a smaller mean value when compared to normal children in every age in both male and female, with around 3 to 5 behind the regular children head circumference which shows a similarity with this study for children with down syndrome for both male and female also between 3 to 4 less to normal children. This result is also in line with the works of Handoll [21] about head circumference of children with Down syndrome which stated the head expends slowly, about 4 to 5cm less than normal children for the age after 9 months old. Such results can appear probably because of the developmental delay noted among children with Down syndrome as stated by Len [22].

The result of this research is also similar to previous studies of anthropometric measurement done by Bagic and Verzak [23], which stated that head circumference measurement of children with Down syndrome is smaller due to their genetic abnormalities of chromosomes. The result of this study showed that the mean values of both male and female normal and Down syndrome children tend to increase in accordance with age. This result agreed with the research done by Palmer [24] which stated that head circumference never remains static given any period of years until human reaches adolescent which the human at the stage of life reaches its final growth and development. The result of head circumference measurement in children with Down syndrome in comparison to regular children was proven statistically significant in both female and male according to age.

CONCLUSION

Some anthropometric parameters were found to be significant markers to differentiate children with Down syndrome and normal with the different age ranges and as such, should be considered imminent in checking for occurrences of the disorder. This study also evaluates the difference in anthropometry existing between children with Down syndrome following the measurement parameters. This study also established that Down syndrome is sexually dimorphic and some parameters have shown statistical significance among the different age ranges studied.

Recommendation: This study measured the mid upper arm circumference of the right arm, so further research can be carry out on the left arm for future comparison. Other anthropometric parameters may be further measured as it pertains to Down syndrome to illuminate more on the differences between Down syndrome individuals and the normal population.

Contribution to Knowledge: This study established that there lies significant difference in the body mass index of males between the ages of 10-18years as it relates to Down syndrome versus normal. This study has also established statistical significance for the body mass index and craniofacial circumference in females between the ages of 10-18years for Down syndrome verses control.

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