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Correlation of Body Mass Index and Intelligence Quotients of Primary School Children Aged 6-12 Years in ILORIN North Central Nigeria

Bello S.O[1], Adeboye M.A.N[2], Saka A.O[2], Ojuawo A[4]

[1]Consultant Paediatrician, Department of Paediatrics, Dalhatu Araf Specialist Hospital, Lafia, Nasarawa State

[2]Consultant Paediatrician, Associate Professor, [2]Department of Paediatrics and Child Health, University of Ilorin Teaching Hospital, Ilorin, Kwara State

[3]Consultant Paediatrician, Senior Lecturer, [2]Department of Paediatrics and Child Health, University of Ilorin Teaching Hospital, Ilorin, Kwara State

[4]Consultant Paediatrician, Professor, [2]Department of Paediatrics and Child Health, University of Ilorin Teaching Hospital, Ilorin, Kwara State

Abstract: ***Background: Malnutrition is a disorder of public health importance that ranks high among the leading causes of morbidity and mortality. Under-nutrition influences the growth potential, cognitive ability as well as the overall well being of the child. Assessing the nutritional status of children that survived the onslaught of early childhood and determining the intelligence quotient of children that survived the delicate first 1000 days of life is highly imperative. This study was carried out to determine the BMI, IQ and the correlation between BMI and IQ of school children in Ilorin. Methods: A descriptive cross-sectional study conducted among school children aged 6 – 12 years selected via a multistage sampling technique. A total of 480 primary school pupils were selected from eight public and eight private schools. Anthropometric measurements were taken to determine the nutritional indices, while IQ was determined using the Draw A Person Test. Data were analyzed using the statistical package for social sciences (SPSS) version 20. Results: There were 259 (54.0%) females with a M:F of 1:1.2. The mean BMI of the study was 15.7 ± 2.4 kg/m², while the mean IQ was 98.0 ± 14.1. There is a significant positive correlation between BMI and IQ. More under-nourished children had impaired IQ, compared with the higher proportion of the over-nourished children having superior IQ. The positive correlation between IQ and BMI is affected by the age, school type and socio-economic status. Conclusion: There was a significant positive correlation between BMI and IQ. Improving the nutritional status which will impact positively on the IQ of primary school children is advocated.***

Keywords: Body mass index, cognition, obesity, overweight, underweight, stunting

1. Introduction

Malnutrition is the most common health disorder among school-aged children, linked with various diseases causing death in developing countries.[1] It affects the child's physical and mental health during the period of rapid growth and development.[2,3] Curtailing malnutrition during this critical period (first 1000 days) of life will prevent irreversible impairment in cognitive development.[4]

Body mass index, defined as weight in kilograms divided by height in meter square, is a reliable indicator of body fat and is sex and age dependent in children.[5] BMI growth chart percentiles categorize underweight as BMI less than the 5th percentile, healthy weight as BMI between 5th and 84th percentile, overweight as BMI of 85th percentile to < 95th percentile and obesity as BMI of ≥ 95th percentile.[6]

Intelligence quotient is a highly reliable measure of general intellectual functioning that captures overall ability across differentiable cognitive functions, often used to define one's intelligence level.[7] The extent to which malnutrition affect developmental and cognitive outcome remain under-reported in this environment and among children.[7] The global prevalence of intellectual deficit is estimated to be 1 – 4%.[8] A study among primary 5 and 6 school children in Akure Nigeria, reported intellectual disability (Mental Retardation MR) in 64.2%.[9] Studies in India found a prevalence of MR in 30.6%[10] and 50.7%[11] of the subjects.

This study therefore aimed at assessing the nutritional status of primary school children in Ilorin using the BMI, determine intelligence quotient using the Draw-A-Person Test (DAPT) and determine the relationship (if any) between BMI and IQ.

General Objective

To determine the correlation between body mass index BMI and intelligence quotients IQ among school age children.

2. Methodology

A descriptive cross-sectional, school-based study where subjects were public and private primary school children aged 6 – 12 years.

The study was conducted in Ilorin, the capital of Kwara State which is situated in the North Central zone of Nigeria. The State shares borders with Niger State in the North, Kogi State in the East, Oyo, Osun and Ekiti States in the South and an international boundary with the Republic of Benin in the West. It has 3 Local Government Areas (LGA); Ilorin East, Ilorin West and Ilorin South.[14]

The number of private and public primary schools in Ilorin at the time of the study was 668 across the three LGAs.[15] Ilorin West had 205 private and 55 public primary schools. Ilorin South had 176 private and 55 public primary schools and Ilorin East had 98 private and 79 public primary schools.[15] Ilorin West had 20,517 pupils in private and 29,780 pupils in public primary schools, Ilorin South had 18,903 versus 12,707 and Ilorin East had 11,562 versus 16,023. The total population of primary school pupils in both private and public primary schools in the 3 LGA was 109,492 as at the time of this study.[15] The number of schools recruited per LGA was based on population size in a ratio 2:1:1 in Ilorin West, South and East respectively.
The minimum sample size was calculated using the Yamane formula[16]was 480.

A multi stage stratified sampling technique was used for subject's selection for the study. A total number of 16 primary schools were then selected for the study, recruiting 30 pupils from each of the selected schools to make a total of 480 pupils
All apparently healthy primary school children aged 6 – 12 years whose parents gave consent were included. Children with the following conditions; Cerebral palsy, history suggestive of sickle cell disease, seizure disorders, renal, cardiovascular diseases, visual and hearing impairment without corrective measures in place and upper limb anomaly (skeletal or neurological) were excluded from the study.

Research Instruments
The research instruments include the Draw-A-Person Test (DAPT), weighing scale and the stadiometer.

Draw-A-Person Test
The 'Draw-A-Person' test, also called 'Draw-a-Man test, is a standardized method of assessing the intellectual and emotional state of children.[17] In the test, the subjects are asked to draw the picture of a man and the drawing is scored using Ziler's test.[18] In Ziler's test there are 52 items for scoring (see appendix VII). This served as the checklist with which each drawing was assessed.[19] The child scores 1 for each item drawn on the scoring sheet. Example of a selected pupil drawing is shown in Appendix XI.

Body mass index: This was calculated from weight and height in kg/m² as follows.

BMI= weight (kg)/height (m²). BMI was interpreted as underweight once the BMI from WHO growth chart is less than the 5th percentile, healthy weight as BMI between 5th and 84th percentile, overweight as BMI of 85th percentile to 95th percentile and obese as BMI of greater than 95th percentile. The Z scores for height-for-age, weight-for-age and BMI-for-age were calculated for each child by comparing the height, weight and BMI of the subjects to the standard reference values for the age and sex using the WHO Anthroplus soft-ware. A child was adjudged undernourished if his measured anthropometric values were below -2 Z score and over nourished when the value for BMI Z score is ≥+2.

Data analysis
The data analysis was done using the IBM Statistical Package for the Social Sciences (SPSS) version 20 Program. Tables and charts were used to report descriptive statistics. Mean, standard deviation and range were provided as appropriate. The student's t-test was used to analyze continuous variables and to identify the significance between two means while the analysis of variance (ANOVA) test was used when there were more than two means. Discrete variables were compared using the Chi-square test. For correlation, Spearman's rank correlation test was used for categorical variables while Pearson's correlation test was used for continuous variables. The level of significance was established at P-value of < 0.05.

Ethical approval
Ethical approval was obtained from the Ministry of education and the school proprietors / principals. Written informed consent was gotten from parents / guardians, assent was also obtained from children aged ten years and above.

3. Results

Demographic characteristics of the study population
A total of 480 primary school pupils were recruited, 240 from the public and 240 from private schools. There were fewer proportion of children aged 11 and 12 years among the private school pupils 23 (9.6%) compared with the public school pupils 101 (42.1%). The public school pupils 18 (7.5%) on the other hand that has fewer children within the age brackets of 6 and 7 years when compared to the private school pupils 89 (37.1%). The gender distribution of children between the public and private schools were comparable. Of the total study population, 221 (46.0%) were males while 259 (54.0%) were females, with a male to female ratio of **1:1.2** (**Table I)**.

Table I: Demographic characteristics of the study population

Parameters	Public schools n (%)	Private schools n (%)	Total n (%)
Age (years)	n=240	n=240	n = 480
6	5 (2.1)	41 (17.0)	46 (9.6)
7	13 (5.4)	48 (20.0)	61 (12.7)
8	34 (14.2)	38 (15.8)	72 (15.0)
9	38 (15.8)	45 (18.8)	83 (17.3)
10	49 (20.4)	45 (18.8)	94 (19.6)
11	43 (17.9)	18 (7.5)	61 (12.7)
12	58 (24.2)	5 (2.1)	63 (13.1)
Gender	n=240	n=240	n=480
Male	111 (46.3)	110 (45.8)	221 (46.0)
Female	129 (53.7)	130 (54.2)	259 (54.0)

Figures in parentheses (percentages) were added up across columns. The mean age (±SD) of study population was 9.2 ± 1.8 years.

Anthropometric parameters of public and private school children
The mean weight and height of public school children were significantly higher than that for the private school pupils. There was however no significant difference in the mean

body mass index of the two school categories (p=0.0910)**Table II**.

Table II: Anthropometric parameters of public and private school children

Anthropometry	*Public schools Mean±SD*	*Private schools Mean±SD*	*t*	*p value*
Weight (kg)	27.9 ± 8.0	25.3 ± 7.3	3.7	**0.0001**
Male	27.1 ± 7.1	26.6 ± 7.7	0.5	0.6280
Female	28.7 ±8.7	24.3 ± 6.7	4.6	**0.0001**
Height (cm)	131.3 ± 12.3	126.7 ± 10.9	4.4	**0.0001**
Male	129.9 ± 12.0	128.4 ± 11.1	0.9	0.3590
Female	132.5 ± 12.5	125.2 ± 10.5	5.1	**0.0001**
BMI (Kg/m^2)	15.9 ± 2.3	15.5 ± 2.4	1.7	0.0910
Male	15.8 ± 2.0	15.8 ± 2.4	-0.0	0.9700
Female	15.9 ± 2.5	15.3 ± 2.4	2.2	**0.0280**

The mean age (SD) of the study population was 9.2 ± 1.8.

The effect of socio-demographic factors on Intelligence Quotient

There was a significant difference between the mean IQ based on age, school type and socio-economic status (***p*=0.0001**). There was no significant difference in IQ based on gender (p=0.3830)**Table III**.

Relationship between Intelligence Quotient and Body mass index categories

A higher proportion 13 (30.9%) of overweight / obese children, had superior IQ compared with 2 (4.8%) underweight children ***p* = 0.0030**. None of the pupils within the overweight or obese categories had mental retardation. Of the 34 children with borderline IQ, only one (2.9%) of those with overweight and obesity belonged to this category (***p* = 0.0030)Table IV**.

Table 3: The effect of socio-demographic factors on Intelligence Quotient

Parameters	IQ Mean±SD	*t / F*	*p* value
Age (years)			
6 – 9	95.2 ±12.3		
10 – 12	101.7 ±15.5	-5.0	**0.0001**
School type			
Public	96.5 ±12.9		
Private	99.6 ±15.2	-2.4	**0.0170**
Gender			
Male	98.6 ±15.0		
Female	97.5 ±13.4	0.9	0.3830
Socio-economic status			
Upper (1 & 2)	102.4 ± 14.7[a]		
Middle (3)	97.8 ± 13.3[b]		
Lower (4 & 5)	94.5 ± 13.4[c]	13.0*	**0.0001**

** is the Analysis of Variance (ANOVA). Mean ± SD IQ of the study subjects 98.0 ± 14.1.*

[a, b, c]: Tukey Post Hoc test of significance shows that means with different superscript alphabet implies that the significance of the ANOVA is across each of the socio-economic classes with p < 0.05.

Table 4: Relationship between Intelligence Quotient and Body mass index categories

	Intelligence Quotient categories							
BMI categories	n = 480	Moderate n (%)	Mild n (%)	Borderline n (%)	Normal n (%)	Superior n (%)	χ^2	***p* value**
Underweight	74	1 (33.3)	2 (22.2)	10 (29.5)	59 (15.1)	2 (4.8)		
Normal	356	2 (66.7)	7 (77.8)	23 (67.6)	297 (75.8)	27 (64.3)		
Overweight	35	0 (0.0)	0 (0.0)	1 (2.9)	25 (6.4)	9 (21.4)		
Obesity	15	0 (0.0)	0 (0.0)	0 (0.0)	11 (2.8)	4 (9.5)		
Total	480	3 (100)	9 (100)	34 (100)	392 (100)	42 (100)	30.1	**0.0030**

Figures in parentheses (percentages) were added up across columns.

Correlation of IQ on BMI based on age, gender and school type

There were positive correlations by the socio- demographic factors (age, gender and school type) on the relationship between IQ and BMI. The strength of this association was moderately strong for male gender and private school pupils (***p* = 0.0001**). Others (age and female gender) showed a weak but significant correlation except for public schools (***p*** = 0.1070) **Table V.**

Table 5: Correlation of IQ on BMI based on age, gender and school type

Correlation of IQ on BMI		
Variables	**r**	***p* value**
Age (years)		
6 – 9	0.1	**0.0100**
10 – 12	0.2	**0.0170**
Gender		
Male	0.3	**0.0001**
Female	0.2	**0.0090**
School type		
Public	0.1	0.1070
Private	0.3	**0.0001**

The overall r: spearman's correlation coefficient between IQ and BMI was 0.3 (***p* = 0.0001**).

4. Discussion

There was a significant positive correlation between body mass index (BMI) and Intelligence Quotient (IQ) across this study population. While the mean BMI was comparable in public and private school pupils, the mean IQ of private school children was found to be significantly higher than those in public schools.

This study revealed a positive correlation between BMI (as an index of nutritional status) and intelligence quotient. This is similar to earlier reports in Baghdad and in India,[24,25] which may be due to the comparable study age group (5 – 15 years). The relationship increases with advancing age as the IQ as well as BMI increases with age. This may be due to the physical and mental maturation that comes with age, as well as the effect of other environmental factors that influence both IQ and BMI.[26,27] Another work done in Iran however, reported a negative correlation between BMI and IQ.[22]The school age used in this study may explain it

difference with the study in Iran which was among preschool age children. The present study shows that most under-nourished (underweight) children had low IQ, while most over-nourished (overweight/obese) children had superior intelligence. This finding is similar to findings in Akure Nigeria and another in India.[9,25] This is probably due to the effect of nutrition on myelination and formation of dendrites required for cognitive development which might be impaired in this category of children.[25]

5. Conclusion

There was a significant positive correlation between intelligence quotient and body mass index.

6. Recommendations

Routine body mass index check as a measure of nutritional status once or twice yearly is advocated.Similarly**,** improving the nutritional status through the introduction of a school meal will enhance the intelligence quotient of school children.

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Contributions of authors

- SOB; Conceptualisation, Data analysis, Interpretation of data and writing manuscript.
- AMAN; Conceptualisation, Data analysis, Interpretation of data and writing manuscript
- SAO; Conceptualisation, Data analysis, Interpretation of data and writing manuscript
- OA; Conceptualisation, Interpretation of data and writing manuscript

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