Nutritional status and intelligence quotient of primary schoolchildren in Akure community of Ondo State, Nigeria

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Abstract: A cross-sectional survey was conducted among 402 children (10-15 years) randomly selected from twelve public and private primary schools in Akure community of Ondo State, Nigeria. Self-administered questionnaire was used to collect information on children's demographic features and parent's socio-economic characteristics. The subject's weight, height, height-for-age and weight-for-height z-score were measured and determined respectively. Raven Standard Progressive Matrices consisted of 60 questions was administered in a quiet classroom within 60 minutes to assess intelligence quotient (IQ) of the children. The means of measured parameters were: age, 11.5± 0.08 years; weight, 33.3±0.35kg; height, 1.4±0.0m; height-for-age z-score, -0.003±0.04; weight-for-height z-score -7.2E-7±0.1 and IQ, 20.9±0.56 (34.8%). The occupations of the children's parents were civil service (43.3%), petty business (21.9%), farming (15.8%), vocational jobs (16.0%) and none (3.2%). The majority of the parents (31.8%) had secondary school education. Parents with no formal education, primary education, tertiary education and higher degrees accounted for 7.2%, 30.6%, 22.9% and 7.4%, respectively. Monthly incomes ranged between $38.5 and 230.8. Weight-for-height z-score of the children showed that 49.8% were normal, 40% mildly wasted, 9.7% moderately wasted and 0.5% severely wasted. Height-for-age z-score was 50% normal, 35.1% mildly stunted, 13.4% moderately stunted and 1.5% severely stunted. IQ scores were 5% superior 11.2% above average, 11.4% average, 8.2% below average and 64.2% intellectual deficit. The interrelationship between height-for-age, IQ and socio-demographic characteristics showed that there were insignificant differences between the age groups, gender and socio-economic status of the pupils. Conclusively, this study showed that the proportion of malnourished and intellectual deficit among the studied population were high. However, it is not clear whether the findings are specific to the studied population alone or applicable to other parts of Nigeria. Further studies are therefore needed to confirm these findings.

Keywords: nutritional status, intelligence quotient, schoolchildren, Nigeria

Introduction

Nutrition is a fundamental pillar of human life, health and development across the entire life span. From the earliest stages of foetal development, at birth, through infancy, childhood, adolescence, and into adulthood and old age, proper food and good nutrition are essential for survival, physical growth, mental development, performance and productivity, health and well-being (FAO/WHO, 1992; WHO, 2000). Evidence has shown that physical growth and cognitive development in children are faster during early years of life, and that by the age of four years, 50% of the adult intellectual capacity has been attained and before thirteen years, 92% of adult intellectual capacity is attained (Vernon, 1976).

Evidence has shown that 4% of the total children born in developing countries die of malnutrition before they are five years old (Toriola, 1990); and that the most affected are usually the children of illiterate parents in low socio-economic brackets that have low purchasing power in the economy (Adekunle, 2005). Quite a number of studies have shown that poor feeding and or recurrent infections as a result of poverty leads to stunted growth, substantial brain impairment, low intellectual competence and capacity to learn of children (Kerr & Black, 2000; Ivanovic *et al.*, 2002; Chang *et al.*, 2002; Braveman & Gruskin, 2003; Liu *et al.*, 2003;).

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Strong evidence exists that poor feeding practices is associated with stunted growth and delayed mental development (Mendez & Adair, 1999); and that there is a relationship between impaired growth status and both poor school performance and intelligence quotient (PAHO, 1998). The relationship between timely and quality dietary intake, brain size and intelligence has been documented (Strupp & Levitsky, 1995; Florey *et al.*, 1995), and that a significant correlation exists between head circumference and intelligence quotient (1Q). This suggest that difference in human brain size could be relevant in explaining the differences in intelligence and academic performance, although genetic and environmental factors like socio-economic, socio-cultural and psychological factors could be direct or indirect co-determinants of both intelligence and school performance (Vernon *et al.*, 2000; Wickett *et al.*, 2000). The head circumference is a physical index of both past nutrition and brain development and a good predictor of later intelligence of a child (Botting *et al.*, 1998), and it is used as the most sensitive anthropometric index of prolonged under nutrition during the infancy, associated with intellectual impairment (Ivanovic, 1996). The objective of this study was to investigate the prevalence of malnutrition and intellectual deficit among primary school children in Akure community, Ondo State, Nigeria.

Material and Methods

Study area and subjects

A cross-sectional study was conducted among the primary 5 and 6 schoolchildren in Akure community of Ondo State, in south-western Nigeria. Four hundred and two (199 were females and 203 were males) pupils were randomly selected by simple random sampling technique from 12 primary schools out of 36 primary schools in the communities. The subjects were recruited from both public and private primary schools. The sample size consisted of subjects, who belong to families of different ethnic groups and are considered to be typical of average Nigerian children.

Study design and data collection

Structured questionnaires were used to collect information on socio-economic characteristics of the subjects' parents. The questionnaire was given to the children to take home for their parents to fill and these were collected in the following days. The questionnaire as described by Alvarez *et al.* (1985) was modified by considering items such as education attainment, type of occupation of the head of the household and income. The dietary intake of the children at their respective homes was evaluated through 24-hour dietary recalls method (Basch *et al.*, 1990; Lytle *et al.*, 1998).

Anthropometric measurements (heights and weights) of the children were measured using standard techniques (WHO, 1983). All measurements were performed between 8.00 and 12.00hr. Height was measured to the nearest millimetre, with a portable direct reading stadiometer, while the subjects were shoeless. Body weight was measured with light clothing and shoes off, using Seca digital scale (German) to the nearest 100g. The weight-for-height z-score (an index of body wasting) and height-for-age z-score (an index of stunting) were determined as nutritional indicator for present and past nutritional status respectively.

The IQ was assessed using Standard Progressive Matrices (Raven, 1958). The instrument consists of sixty problems divided into five sets of twelve. The testing was administered in a separate, quiet classroom with which the children were familiar. The researcher spent few minutes to explain mode of answering the question before the test booklets and answer sheets were distributed to the pupils. The children, whatever his or her age was given 60 minutes to answer the questions without interruption.

Data analysis

Data were processed using the statistical software package SPSS for Windows 12 (SPSS, Chicago, Ill, USA). The mean and standard error of the mean (SEM) values of age, weight, height, height-for-age z-score, head circumference, and IQ were determined. The classifications of nutritional status of the subject (height-for-age z-score and weight-for-height z-score) and intelligence quotient of the subjects were expressed in percentages. The Pearson correlation coefficients were calculated in order to decide if inter-correlated variables may be included as predictor variables. Chi-square was used to establish the association between IQ and nutritional status. Stepwise multiple logistic regression analyses

were performed between socio-demographic characteristics (independent variables) and the nutritional status and IQ (dependent variables) of the pupils.

Ethical issues

The study protocol was approved by the Ethics Committee of Science and Human Nutrition, Federal University of Technology, Akure, Nigeria.

Results

A total of 402 school children were involved in the study. The mean values of the measured attributes were: age, 11.5± 0.08 years; weight, 33.3±0.35kg; height, 1.4±0.0m; height-for-age z-score, -0.003±0.04; weight-for-height z-score -7.2E-7±0.1 and IQ, 20.9±0.56 (34.8%) (Table 1).

The socio-economic attributes of the parent of the children showed that the majority of them (44.1%) were public servants, followed by businessmen (21.9%), farmers (15.8%) and vocational workers including carpenters and tailors (16.0%). The remaining 3.2% had no specific socio-economic activities. The educational background of the parents showed that 7.2% had no formal education; 30.6.0% primary school leaving certificate, 31.8% secondary school education, while the remaining subjects, 22.9% and 7.4% attained tertiary and higher education level respectively. The monthly incomes of the parents showed that 25.1% earned less than $38.5 monthly, 37.9% earned $38.5-76.9, 18.9% $76.9-115.4, while others 12.8%, 1.2%, 1.1% and 1.6% earned between $115.4-153.8, $153.8 - 192.3, $192.3–230.8 and $230.8–307.7, respectively, and 2.5% were uncertain about their monthly income.

Table 1: Means (±SEM) of anthropometric parameters and intelligence quotient of schoolchildren

Parameters	Private schools		Public schools		Overall
	Male	Female	Male	Female	
Age(yr)	10.2±0.11[a]	10.3±0.13[a]	12.7±0.14[b]	12.1±0.12[c]	11.5±0.08
Weight (kg)	30.06±0.44[a]	31.3±0.80[a]	34.3±0.65[b]	36.0±0.68[b]	33.3±0.35
Height (m)	1.38±0.006[a]	1.4±0.00[a]	1.45±0.01[b]	1.45±0.01[b]	1.4±0.00
WHZ	-0.16±0.08[a]	-0.19±0.1[ab]	0.14±.11[c]	0.11±0.09[bc]	-7.2E-7±0.1
HAZ	0.007±0.1[a]	0.01±0.11[a]	-0.01±0.09[a]	-0.03±0.08[a]	-0.003±0.04
IQ	27.1±1.38[c]	21.9±1.33[b]	19.3±0.92[ab]	17.3±0.75[a]	20.9±0.56

WHZ = weight-for-height z-score; HAZ =height-for-age z-score; IQ = intelligence quotient
*Means with different letters are significantly different from each other (P<0.05)

Table 2: Classification of nutritional status of primary schoolchildren

	Public school		Private school		Overall subjects	
Classification	Size	%	Size	%	Size	%
*Weight-for-height (index of wasting)						
Normal	130	55.8	70	41.4	200	49.8
Mildly wasted	80	34.3	81	48.0	161	40.0
Moderately wasted	22	9.5	17	10.1	39	9.7
Severely wasted	1	0.4	1	5.0	2	0.5
**Height-for-age (index of stunting)						
Normal	114	48.9	87	51.5	201	50.0
Mildly stunted	82	35.2	59	34.9	141	35.1
Moderately stunted	33	14.2	21	12.4	54	13.4
Severely stunted	04	1.7	2	1.2	6	1.5

*LR X^2 = 8.697, df =3, P = 0.034; **LR X^2 = 0.543, df =3, P=0.909

The dietary intakes of the subjects showed that starchy food formed large proportions of the dietary intakes of almost three quarters (73.6%) of the children population on daily basis. About one-fifth (19.9%) of the children were able to complement their carbohydrate intakes with either plant or animal proteins, 11.6% agreed to have taken vegetables/fruits as part of their dietary intakes, and 11.5% ate snacks such as biscuits, in addition to their normal dietary intakes. Protein foods were most common during breakfast (23.8%) than lunch (16.6%) or supper (19.2%).

there was insignificant difference (P=0.909) between height-for-age (nutritional indicator for stunting) of public school children compared their counterpart in private schools.

The distribution of schoolchildren by IQ grades showed that 5% had superior IQ while about 23% were either average or above average. More than 70% of the children were either of below average IQ or had an intellectual deficit (Table 3). The children from the public schools however formed the majority of these. A significant difference (P<0.0001) was observed

Table 3: Classification of intelligence quotient (IQ) of schoolchildren in Akure community

IQ classes	Score (%)	Public school (n =233)		Private school (n =168)		Overall subjects (n =402)	
		Size	%	Size	%	Size	%
Superior	70-100	3	1.3	17	10.1	20	5.0
Above average	60-69	13	5.5	32	19.0	45	11.2
Average	50-59	22	9.4	24	14.3	46	11.4
Below average	40-49	18	7.7	14	9.0	33	8.2
Intellectual deficit	0-39	177	76.1	83	47.6	258	64.2

$X^2 = 44.54$, df = 4, P <0.0001

The present nutritional status (weight-for-age z-score) of the children showed that 49.8% were normal and 0.5% severely wasted. Height-for-age z-score (an index of stunting) showed that half (50%) of the children were normal and 1.5% severely stunted (Table 2). There was significant difference (P=0.034) between the present nutritional status (weight-for-height z-score) of public school children compared to those in private school children. However,

between the IQ of children in private school and their counterparts in public school. The scored means decreased progressively across the sets. For set A the highest and lowest scored mean was achieved by male and female children from private schools; and for set B to set E the highest scored were achieved by male children from private schools and the lowest scores were achieved by the female children from public schools (Table 4).

Table 4: A comparative of mean scores achieved by private and public pupils in Akure community on the five sections of the standard progressive matrices

School	Sex	Size	Mean scores				
			Set A	Set B	Set C	Set D	Set E
Public	Female	124	6.9±0.19^{ab}	3.9±0.22^{a}	2.67±0.22^{a}	2.66±20^{a}	0.96±0.10^{a}
	Male	109	7.6±0.21^{bc}	4.3±0.28^{ab}	3.3±0.29^{a}	2.8±0.2^{a}	1.33±0.15^{a}
Private	Female	97	6.5±0.32^{a}	5.1±0.35^{b}	4.4±0.4^{b}	3.6±0.31^{b}	2.2±0.15^{b}
	Male	72	7.9±0.33^{c}	6.9±0.41^{c}	5.6±0.35^{c}	4.7±0.29^{c}	2.4±0.25^{b}

Means with different letters are significantly different from each other (P<0.05)

Table 5: Relationship between nutritional status and intelligence quotients (IQ) schoolchildren

Height-for-age z-score (stunting)

IQ classification	*Normal*	*Mild*	*Moderate*	*Severe*	*Total*	*Statistic*
Superior	12 (6.0%)	7 (4.8%)	1 (2.1%)	0	20	
Above average	22 (10.9%)	16 (11.9%)	5 (10.4%)	2 (28.6%)	45	LRX^2=9.99
Average	20 (9.9%)	20 (13.7%)	5 (10.4%)	1 (14.2%)	46	df = 12
Below average	11 (5.5%)	16 (10.9%)	3 (6.3%)	1 (14.2%)	31	*P*=0.617
Intellectual deficits	136 (67.7%)	87 (59.6%)	34 (70.8%)	3 (43.0%)	260	
Column total	201 (100%)	146 (100%)	48 (100%)	07 (100%)	402	

Weight-for-height z-score (wasting)

IQ classification	*Normal*	*Mild*	*Moderate*	*Severe*	*Total*	*Statistic*
Superior	9 (4.5%)	9 (5.6%)	2 (4.8%)	0	20	
Above average	17 (8.5%)	22 (13.8%)	6 (14.3%)	0	45	X^2=15.52
Average	15 (7.5%)	22 (13.8%)	9 (21.4%)	0	46	df = 8
Below average	15 (7.5%)	15 (7.5%)	1 (2.4%)	0	31	*P*=0.05
Intellectual deficits	144 (72.0%)	92 (57.7%)	24 (57.15%)	0	260	
Total	200 (100%)	160 (100%)	42 (100%)	0	402	

Statistically, it was observed that height-for-age (stunting) as an index for past nutritional status, was not significantly (*P*=0.617) influenced the IQ of the children. However, the proportion of adequately well nourished children that had better IQ was higher than malnourished children. Also, there was slight significant difference (*P*=0.05) between the IQ of well nourished and wasted children. The proportion of malnourished (i.e. wasted) children that had better IQ was higher compared to normal children. Inverse correlations were observed between socio-economic status and age (r = -0.62; *P*< 0.05), weight (r = -0.32; *P*< 0.05), height (r = -0.33; *P*<0.05), weight-for-height (r = -0.14; *P*< 0.05) and weak positive correlation with IQ (r = 0.3; *P<0.05)* (Table 5).

Children aged 11-12 years had significantly higher odds (9.7) of not being wasted relative to other age groups (Table 6). The interrelationship between the past nutritional status (height-for-age), IQ and socio-demographic characteristics of the pupils showed that there were no significant differences between the age groups, sex and socio-economic status of the pupils.

Table 6: Odds ratios and 95% confidence intervals from multiple logistic regression analyses of the socio-demographic characteristics with nutritional status and IQs of schoolchildren

Parameters	Present nutritional status (n=402)	Past nutritional status (n=347)	IQ (n = 402)
Age			
9-10	1.000	1.000	1.000
11-12	9.729 (1.22-77.51)*	0.529(0.17-1.64)	1.620(0.42-6.22)**
13-14	6.366 (0.81-50.32)	1.664(0.58-4.78)	0.478(0.12-1.91)
15-16	5.535 (0.69-44.07)	1.735(0.61-4.96)	0.371(0.08-1.60)
Gender			
Females	1.000	1.000	1.000
Males	1.47 (0.92-2.35)	1.479(0.92-2.38)	0.758(0.43-1.34)
SES			
High	1.000	1.000	1.000
Medium	1.455 (0.71-2.99)	-	2.051(0.89-4.72)
Low	0.925 (0.55-1.56)	0.826(0.51-1.33)	1.473(0.76-2.86)

Significant level: * at P < 0.05; ** at P<0.01, SES = Socio-economic status

Discussion

It was observed in the present study that large proportion of the children dietary intake was starch based foods; and that less than one fifth of the children population was able to complement carbohydrate intake with protein based foods. Similar studies elsewhere have reported that children in most developing countries are living on poor household diet made of cereal or starchy root crops; and that foods are rarely modified at the household level to increase nutrient density to meet the needs of their members, particularly children (Dewey & Brown, 2003). Traditional staple foods are usually cereals or tubers that are low in several nutrients including protein and some vital micronutrients, such as vitamin A, zinc and iron. However, findings have shown that these nutrients are of special important to the physical growth and cognitive development of children (Krebs & Westcott, 2002; Neumann *et al.*, 2002); and that inadequate or quality intake of these nutrients could result into growth faltering in children (WHO, 2001)

The distribution of children using weight-for-height, a nutritional index for present nutritional status, showed that almost half of the pupils were malnourished. This observation was not surprising as the study was carried out at a time of economic depression in the country. The purchasing power of many families had been reduced as a result of spiralling inflation of the prices of all items including food. This probably caused many of the children, particularly those that belong to the low socio-economic class, to feed on low quality foods. Several studies have similarly reported that many households in developing countries, were food insecure, and as a result, the dietary intakes of many homes are of low quality (Armstrong *et al.*, 2002; Ijarotimi & Oyeneyin, 2005; Coakley, 2001; Cole *et al.*, 1997; Fashakin, 1987). Similarly, height-for-age, a nutritional index for past nutritional status, showed that half the proportion of the children was stunted. This could be attributed to the fact that the standard of living and household food security of the average family was not better in the past compared to recent time, whereby the same proportions of children were wasted and stunted. Recent, findings have shown that many families in Nigeria are food insecure (Ijarotimi & Oyeneyin, 2005; Coakley, 2001). A number of studies have reported that stunting is the most sensible physical index of prolonged under-nutrition in children and had been used as a measure for physical growth and cognitive development in children (Scrimshaw, 1998; Chang *et al.*, 2002); and that under nutrition during the first year of life affect brain size, hence IQ of a child (Liu *et al.*, 2003; Delange, 2000; Scrimshaw, 1998).

It was observed that a large proportion of the children belonged to intellectual deficit and there was significantly higher number of children from public schools who were intellectual deficits compared to their counterpart in private schools. This could be attributed to environmental factors, such as availability of learning facilities, which are available for the children from private schools, whom the majority belonged to either high or middle socio-economic class families compared to less privileged children from public schools. It was also observed in this study that there was no significant difference between the IQs of school children who were adequately nourished and those who were malnourished. A different study has similarly reported that in urban or rural areas where external influences on a child's mental performance are available; there may be no significant difference in cognitive performance between well-nourished children and those showing signs of wasting (Cotton, 1982).

In the present study, the findings showed that age was a correlate of wasting. Children aged 11-12 years had significantly higher odds of being not wasted compared with other age groups. This could be attributed to the fact that high proportion of the pupils from this age group belonged to either middle or high socio-economic class. It is well known that children belonging to this high socio-economic class have better opportunity to quality food intakes. The other demographic variables of sex and socio-economic status did not independently predict nutritional status or IQ of the children. Several investigators have reported that there was no significant difference between female and male average IQ (Deary *et al.*, 2003). However, it was reported that female perform better on tests of memory and verbal, while male performs better on tests of mathematical and spatial ability (Benbow, 1998). Study has also shown that regardless of socio-economic class of one's parent, socio-economic status did not

cause one's IQ to be high or low, but family socio-economic status could only influence the rearing environment to which a child has been exposed (Laflamme & Engström, 2002). However, studies have reported that IQ is influenced by genetic and environmental factors; and that half of the variations in IQ among the children studied were due to variation in their genes. The remaining half was thus due to environmental variation and measurement error (McGue & Bouchare, 1998; Bouchard 1998).

In conclusion, the results of this study provide information on the socio-economic status, nutritional status and IQ of schoolchildren from low-income families in Akure community in Nigeria. It is not clear whether these findings are specific to the studied population alone or applicable to other parts of Nigeria. Further studies are therefore needed to confirm these findings.

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