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Iodine status and academic performance of school age children (6-12 years) in Umuahia North local government area, Abia state Nigeria

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Abstract
Iodine is a trace element required in minute quantities for proper growth and development of human brain and body. Iodine deficiency is recognized as the most preventable cause of brain damage in the world. The study assessed the iodine status and academic performance of school aged children in Umuahia North Local Government Area, Abia State. Urine samples were obtained from 130 children, 70 males and 60 females. Background and socio-economic information, food consumption pattern and academic performance were all determined using validated questionnaire. Urinary iodine concentration analysis, using Sandell-Kolthoff reaction was used to determine the iodine status of the children while the average of a session's result was used to assess their academic performance. Pearson correlation was used to determine the relationship between academic performance and iodine status among male and female children. The result showed that 39.2% of the children were 6-7 years, 34.0% were 8-9 years, and 23.1% were 10-11 years, while 3.8% were 12 years. All the respondents claimed that they have heard about iodized salt; 50.8% heard about iodized salt at the market, 3.8% heard it from their relatives while 34.6% heard about iodized salt from the media (TV and Radio). Majority of the respondents (91.5%) claimed they consume iodized salt while 8.5% said they use salts that are measured in cups which is not iodized salt. The study indicated that 6.9% had moderate iodine deficiency, 24.6% had mild iodine deficiency, and 50.8% had optimal status while 17.7% had more than adequate iodine sufficiency. For academic performance scores, 31.5% scored average, 47.0% above average, 21.5% scored excellent. There was a significant relationship between mothers' income and fathers' education and iodine status ($p< 0.05$). Nutrition education should be aimed at mothers, caregivers, and school children to promote consumption of iodine rich foods.

Keywords: iodine status, school age children (6-12 years), academic performance, Umuahia north L.G.A, Abia state, Nigeria

Introduction
Iodine is a trace element required in minute quantities by our body (Shubhangini, 2002) [12]. It is required essentially for normal growth and development of human brain and body (Srilakshmi, 2011) [13]. It is needed for the production of thyroid hormone which are necessary for the development of brain during foetal development, postnatal life and for proper functioning of the body (Okoli, 2009) [10]. Good brain development is of importance for other body functions thus children need iodine to maintain bodily growth and functions (Okoli, 2009) [10]. Iodine deficiency during early foetal life can adversely affect neurological development causing impaired cognitive functions or learning disabilities of varying degrees, hearing deficits, diverse illnesses and death (Zimmermann, 2009) [16]. Iodine deficiency is now recognized by World Health Organization as the most preventable cause of brain damage in the World today (Srilaskshmi, 2011). About one third of school children worldwide have insufficient iodine intake (Srilaskhmi, 2011). Iodine Deficiency Disorder (IDD) has substantial effects on growth and development and is the most common cause of preventable mental impairment worldwide. Mild iodine deficiency impairs cognition in children, and moderate to severe iodine deficiency in a population, reduces intelligent quotient (IQ) by 10-15 points thereby leading to poor academic performance in school (Zimmermann, 2009) [16]. Academic performance is the outcome of education, that is, the extent to which a student, teacher or institution has achieved their educational goals. It is commonly measured by examination or continuous assessments but there is no general agreement on how it is best tested or which aspect are most important- procedural knowledge such as skills or declarative knowledge such as facts (Annie *et al*., 1996) [1]. Iodine deficiency still constitutes the single greatest cause of preventable brain damage and mental retardation, which in turn makes the child not to attain optimal performance; despite the teaching he gets (Delange, 2000) [2].

Fortification and consumption of locally available sources of iodine rich food are useful steps that have influenced the quality of food, processing and storage and improved education on consumers, which have helped to adopt better preparation practices (Okoli, 2009) [10]. This study is an attempt to assess the Iodine status and academic performance of school age children in Umuahia North local government area in Abia State.

Objectives of the study
General Objective
To assess the iodine status and academic performance of school age children (6-12 years) in Umuahia North local government area.

Specific objectives are to

1. Determine the iodine status of school age children using biochemical method.
2. Assess the Academic performance of children.
3. Determine the relationship between Iodine deficiency and Academic performance of the children studied.
4. Ascertain Information on knowledge and the level of consumption of iodized salt.

Materials and Methods

Study Design

This research is a cross sectional study.

Study Area

Umuahia North LGA is one of the 17 local government areas in Abia State. It has an area of 245km^2, its coordinates are 5^{o}32^{o}N 7^{o}29E (latitude) and 5.533^{o}N7.483^{o}E (longitude). It has a population of 220,660 as at 2006 census. Umuahia North LGA shares boundary with Umuahia South, Ikwuano, Isiala Ngwa North and South local government areas. There are two clans in Umuahia North LGA; Ohuhu and Ibeku. Members of these communities are public servants while some others are business men and women and artisans. Umuahia North has a good topography and fertile soil which encourages crop production and vegetable gardening.

Population of the study

The study population consisted of male and female school children aged 6-12 years in Umuahia North local government area.

Sampling and sampling procedure

Sample size

The sample size was calculated using the formula below

$$N = \frac{Z^2P(100- P)}{X^2}$$

Where:
N = Sample size
Z = Critical standard Z score
P = Prevalence of Iodine deficiency among children according to WHO. (2004)
= 27.5%
X = Margin of error; set at 5%

$$\frac{2^2 \text{ x } 27.5(100\text{-}27.5)}{5^2} = 319$$

Therefore 319 children were selected for the study. But for financial constraints, 40% of the children were assessed.

$$\frac{40}{100} \text{x } 319 = 127.6 = 128.$$

Therefore, 150 children were selected for this study, to make room for drop outs and incorrectly filled questionnaires. But 130 questionnaires were retrieved after the research.

Sampling Procedure

There are 17 communities in Umuahia North LGA out of which 3 communities were selected for the study using systematic random sampling. There are 64 registered primary schools in Umuahia North, out of which six (6) primary schools were selected, using systematic random sampling method. After selecting the schools, to pick out the children that were used for the study, the sample size (128) was equally divided amongst the six schools giving a total of 21 children for each school. The class register was used to select the children for the study using systematic random sampling.

Preliminary Activities

Informed consent /Ethical approval

A letter of request for research was sent to the selected schools, a letter of consent was also sent to the parents of the children selected for the survey. Ethical clearance was obtained from the Abia State Ministry of Education.

Data Collection

Questionnaire Administration

A structured and validated questionnaire was administered to parents of the selected children. The questionnaire comprised of 3 sections; data on personal and socio-economic characteristics, consumption pattern, academic performance of the child, and urinary iodine concentration.

Biochemical analysis of iodine

A trained laboratory personnel obtained 5mls of urine in 40% of the subjects. The urine samples were stored in a trace element free urine collecting tubes. 250µl of each urine sample was made up to a final volume of 259µl with deionized water in test tubes. Then 1ml of 0.1 mol ammonium persulfate was added to each of the test tubes, they were heated for 60 minutes at 100^{0}c. The test tubes were allowed to cool at room temperature. After which 2.5ml of arsenious acid solution was added, and allowed to stand for 15 minutes. 300µl of ceric ammonium persulfate solution was added to each test tube by stirring at 15-30 seconds interval, and then they were allowed to stand at room temperature. Its absorbance was read at 420nm exactly 30 minutes after addition of ceric ammonium persulfate. Iodine deficiency was defined as urinary iodine excretion below 100µg/l

Academic performance determination

For the purpose of this study, academic performance of the children was determined by computing the average of three term's (session) results.

Statistical Analysis

Data obtained from this study was analysed using descriptive statistics such as frequency, percentages and cross tabulation. T-test was used to compare mean academic performance values of the male and female children studied. Pearson correlation was used to determine the relationship between academic performance, urinary iodine concentration, and family's socioeconomic status. Statistical Package for Service Solution (SPSS), version 20 was used for statistical analysis.

Results and Discussion

Table 1 below shows the background information of the children under the study. Seventy of the children (53.8%)

were male and sixty (46.2%) were female. This finding is consistent with that of National Demographic and Health Survey (NDHS, 2013) where it was discovered that in households, there are more males (81.5%) than females (18.5%). The age of the children indicates a greater percentage of 6-7 years (39.2%) and 8-9 years (34.0%).

Table 1: Background information of the children.

Variables	No	%
Age (years)		
6-7	51	39.2
8-9	44	34.0
10-11	30	23.1
12	5	3.8
Total	130	100
Gender		
Male	70	53.8
Female	60	46.2
Total	130	100
Family size		
4-5 persons	35	27.0
6 and above	95	73.0
Total	130	100

Table 2 below shows that about 42.3% of fathers and 50% of mothers were civil servants while over 27.7% of fathers and 12.3% of mothers were traders. These findings contradict the report of NDHS. (2013) which said that 13.0% and 16.1% of fathers in the South East zone and in Abia State respectively and 11.0% and 15.6% of mothers in South East zone and Abia State respectively had occupations in professional, technical and managerial positions which covers up for civil servants. The finding from this research is consistent with NDHS. (2013), that 28.7% and 34.1% of fathers in South East zone and Abia State were traders respectively. The result contradicts the percentages for mothers who were traders (54.1% and 46.1% in South East and Abia State) as against 12.3% from the study. Majority of fathers (64.6%) and mothers (63.1%) had tertiary educations as their highest level of education; this is in contrast with the report of NDHS. (2013) where it was observed that in Nigeria, men and women between the ages of 20-65 years who had tertiary education as their highest level of education, were 7.9% for women and 11.6% for men. From the study, fathers (1.5%) and mothers (2.3%) who had no formal education was in contrast with NDHS. (2013) where it was reported that women (51.2%) and men (17.2%) had no formal education.

Table 2: Socio-economic information of the respondents.

Variables	Fathers		Mothers	
	No	%	No	%
Occupation				
Trading	36	27.7	16	12.3
Farming	-	-	3	2.3
Self employed	39	30.0	34	26.2
Civil servant	55	42.3	65	50.0
Not employed	-	-	12	9.2
Total	130	100	130	100
Education				
No formal	2	1.5	3	2.3
Primary	7	5.4	6	4.6
Secondary	30	23.1	39	30.0
Tertiary	84	64.6	82	63.1
Others	7	5.4	-	-
Total	130	100	130	100

Table 3 below shows that all the respondents (100%), claimed to have heard of iodized salt. About 50.8% of the respondents got the information from the market, 1.8% got the information through friends, and 3.8% got the information from relatives while over 30% got from TV and radio (34.6%). This result is consistent with the report of NDHS (2013) where it was observed that 43.6% and 22.8% of women and men respectively had access to three forms of media (Television, Radio and Newspaper) at least once a week which helps to create awareness on health and products trends.

More households used iodized salt (91.5%) than salts measured in cups which are not iodized (8.5%). The determinants of choice of salt used, showed that more families used iodized salt with consideration for its health benefits (66.9%) than for money available (5.4%), what is available in the market (21.5%) or what friends/relatives use (6.2%). This

can also be attributed to awareness of the implications of iodine deficiency disorders and mandatory Universal Salt Iodization. This findings are in consonance with the report of NDHS (2008) which said that generally, 52% of the of households whose cooking salts were tested for iodine sufficiency, consumed adequately iodised salt (>15ppm) while 45% consumed inadequately iodised salt (<15ppm) making it a total of 97% of households who use iodised salt. Also, a report from UNICEF indicates that as at 2011, 79.8% of households in Nigeria consumed iodised salt.

Table 3: Information on knowledge and use of iodized salt.

Variables	Frequency	Percentage
Heard about iodized salt		
Yes	130	100
No	-	-
Total	130	100
Source of information		
Friends	14	1.8
Market	66	50.8
Relatives	5	3.8
TV/radio	45	34.6
Total	130	100
Type of salt		
Non iodized (cup measured)	11	8.5
Iodized (small packs)	119	91.5
Total	130	100
Determinants of salt use		
Availability	28	21.5
Affordability	7	5.4
Health benefits	87	66.9
Fiends/relatives use	8	6.2
Total	130	100

Table 4 below. revealed that majority (50.8%) of the children had (100-199µ g/l) Iodine in urine which denotes optimal Iodine status. About 24.6% had 50 to 99 µg/L (mild Iodine deficiency), and 0% had >300 µg/L (excessive). On the other hand, 0%, 6.9%, 17.7% had <20ug/L, 20 to 49 µg/L (moderate Iodine deficiency) and 200 to 299 µg/L (more than adequate), respectively. Table 4.4 also shows that more boys (21.4%) than girls (13.3%) had 200-299 µg/l (more than adequate (hyperthyroidism)). More girls (58.3%) than boy (44.3%) had 100 to 199 µg/L (optimal) iodine I n urine. More boys (7.2%) than girls (6.7%) had 20 to 49 µg/L (moderate deficiency) Iodine in urine. However, no child under the study had <20 µg/L (severe deficiency) and >300 µg/L (excessive) iodine in their urine. The survey recorded no severe iodine deficiency (<20 µg/L). This is a welcome development in terms of public health and could attest that lots of families have massively embraced consumption of iodized salt. This is not consistent with the findings of Nwamarah and Okeke. (2012) [7] in Obukpa a community in Nsukka, who reported a prevalence of iodine deficiency of 58.3%. This finding is consistent with the findings of Onyeaghala *et al*. (2010) [11] who reported mild to moderate iodine deficiency in school children in Ibadan, Nigeria. This could be as a result of iodized salt awareness (100%), 1-3x daily intake of iodized salt (91.5%) and 3x a week intake of iodized salt (91.5%) by the children studied. However, the study recorded moderate (6.9%) and high percentage (24.6%) of mild iodine deficiency suggesting insufficient of iodine intake in some of our study population which is of great public health concern. Iodized salt is widely available commercially in this environment but the percentage in the salt need to be evaluated in further study. It is likely that household salt may not contain the recommended level of iodine. Our study showed none of the student had excess urinary iodine. This finding contradicts the report of (Delange *et al.,* 1999) [3] who reported high concentrations of urinary iodine in some African countries few years after the introduction of massive iodization.

Table 4: Urinary Iodine Status of the Children

Iodine status	Male		Female		Total	
	No	%	No	%	No	%
Moderate deficiency (20-49 µg/L)	5	7.1	4	6.7	9	6.9
Mild deficiency (50-99 µg/L)	19	27.1	13	21.7	32	24.6
Optimal (100-199 µg/L)	31	44.4	35	58.3	66	50.8
More than adequate (200-299 µg/L)	15	21.4	8	13.3	23	17.7
Total	70	100	60	100	130	100

Table 5 below shows the academic performance of the children studied. For the males, 30.0% had scores within 60-79 which is above average, while 11.5% and 12.3% had scores within 80-100 and 40-59 respectively which implied that majority of the male children had scores above average. For the females, 17.0% of them had above average scores, 10.0% and 19.2 % of them had scores within 80-100 and 40-59. This showed that majority of the female children had scores within average. The table also showed that none of the children studied had scores below 40. This is consistent with the report of Oguizu and Okoro. (2016) [9] on a study carried out on the Nutritional status and academic performance of school age children in Ikwuano Local Government Area, Abia State. The report showed academic performance of the respondents to be generally fair, as 39.1% had good academic performance, 26.2% had average performance while 15.6% had excellent academic performance. However, males in this study had better academic performance than females, in contrast to the report carried out in Ikwuano Local Government Area, Abia State (Oguizu and Okoro, 2016) [9].

Table 5: Academic Performance of the Children.

Grades	Males		Females		Total	
	No	%	No	%	No	%
40-59 (average)	16	12.3	25	19.2	41	31.5
60-79 (above average)	39	30.0	22	17.0	61	47.0
80-100 (excellent)	15	11.5	13	10.0	28	21.5
Total	70	53.8	60	46.2	130	100

Table 6 below shows the relationship between iodine status and academic performance of the children studied. For the children who had average academic performance, 34.1% of them were mildly deficient, 12.2% were moderately deficient, and 48.8% had optimal iodine levels while 4.9% had more than adequate iodine levels. For the children who had above average academic performance, 26.2% were mildly deficient, 3.3% were moderately deficient, 49.2% had optimal levels while 21.3% had more than adequate. For the children with excellent academic performance, 7.1% were mildly deficient,

7.1% were moderately deficient, and 57.2% had optimal iodine levels while 28.6% had more than adequate iodine levels. Generally, a greater percentage of children who had above average academic performance, also had optimal iodine nutrition. This finding is consistent with a well-controlled observational study in Bangladesh, where it was observed that children with mild hypothyroidism had deficits in spelling and reading compared to healthy controls (Huda *et al*., 1999) [4]. Several randomized trials have been conducted to examine the impact of iodine supplementation on the cognitive performance of children in iodine-deficient areas. However, results have not been consistent. In a recent longitudinal follow-up of school-age children, all of whom received iodine; those who received iodine in utero before the third trimester had better scores on a measure of psychomotor performance than children who received iodine later in pregnancy or at age 2 years (O'Donnell, 2002) [8]. There was a similar trend when measures of cognitive performance were considered; however, the differences did not reach statistical significance. Thus, the effects of postnatal iodine deficiency on children's cognitive performance are less clear than the effects of prenatal iodine deficiency.

Table 6: Iodine status and Academic performance of the children.

Variables	Mild		Moderate		Optimal		Adequate		Total		P-value
	No	%	No	%	No	%	No	%	No	%	
Average	14	34.1	5	12.2	20	48.8	2	4.9	41	31.5	0.027
Above average	16	26.2	2	3.3	30	49.2	13	21.3	61	46.9	
Excellent	2	7.1	2	7.1	16	57.2	8	28.6	28	21.5	
Total	32	24.6	9	6.9	66	50.8	23	17.7	130	100	

Conclusion

Most of the children studied were within the ages of 6 and 7 years. A greater percentage of families had 6 persons and above. Majority of the fathers were civil servants and more of these fathers earned within N90, 000- N119, 000. Majority of the mothers were also civil servants with a lower percentage of them being self-employed and not employed. All the respondents agreed to have heard about iodized salt and a greater percentage of them got the information from the market. A greater number of the respondents said they considered health benefits to affordability and availability when considering the type of salt to use as a household. The iodine status of the children showed that none of the children studied were severely deficient and none had excessive iodine status. However, majority had optimal levels of urinary iodine with few of them being moderately and mildly deficient. Some of the children had more than adequate iodine nutrition which could place them at risk of iodine induced hyperthyroidism if not checked. The academic performance of the children was generally good as majority of the children had scored above average (60-79). However, none of the children had poor academic performance (<40). The children's pattern of consumption of iodized salt and iodine rich foods was generally adequate, as many of them consumed iodine rich foods at least once a day except for shrimps which none of the respondents agreed to have consumed at least once a day. All the respondents also consumed iodized salt at least once a day and more than three (3) times in a week, which may be attributed to proper awareness of the health benefits of iodized salt and proper handling of Universal Salt Iodization.

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