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Iodine Content of Household Salt and Urinary Iodine of Primary School Pupils in Commercial Towns in Nsukka Senatorial Zone, Enugu State, Nigeria

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Abstract: This study was designed to determine the iodine content of household salt and urinary iodine of primary school pupils in commercial towns in Nsukka Senatorial Zone, Enugu State, Nigeria. Two commercial towns (Orba and Ibagwa-aka) in Nsukka senatorial district were purposely selected. Iodine content of salt was measured at household level as well the nutritional iodine status of 200 school aged children (6-12 years) was assessed by measuring their urinary iodine concentration. Validated questionnaire was used to test the Knowledge, Attitude, Practice and Behaviour (KAPB) of 40 household salt consumers and 15 salt retailers in the two communities. Statistical Package for Social Sciences (SPSS) version 17 was used to analyze the data into frequencies, percentages and mean. More than half (58.3%) of the household salt at Orba and 70% at Ibagwa-aka were iodized to an adequate level of $\geq$ 15 ppm, while 12.5% at Orba and 3.7% at Ibagwa-aka, had no iodine (0 ppm). The proportions of the primary school children that were mildly iodine deficient at Orba and Ibagwa-aka were 43.3 and 56.2%, respectively. The factors that affect the iodine status of school children in the study areas include poor use of salt, unhygienic method of handling and storage of salt and cultural practices. There is need to increase awareness of both the retailers and consumers in Orba and Ibagwa-aka regarding the consequences of poor use, unhygienic handling and storage of salt.

Key words: Household salt, urinary iodine, primary school pupils, Nigeria

INTRODUCTION

Iodine Deficiency Disorder (IDD) is a serious public health problem in developing countries (Ajayi and Ogundahunsi, 2012). Iodine deficiency is defined as endemic when it affects more than 10% of the population (ACC/SCN, 2001). An estimated 1571 million people worldwide live in iodine-deficient environments and are at risk of IDD (United Nations Children's Fund (United Nations Children's Fund (UNICEF), 1998). A national goitre rate of 20% was reported by UNICEF (1993) and 20 million Nigerians were affected by IDD. The causes of IDD include inadequate amount of iodine in soil, water, food and consumption of foods that contain cyanogenic glycosides (ACC/SCN, 2001). IDD have multiple and serious adverse effects including cretinism, goitre, impaired cognitive function, impaired growth, infant mortality, low birth weight and still births in a large proportion of the world's population (ACC/SCN, 2001). Marginal degrees of iodine deficiency have a measurable impact on human development. The most commonly used indicators for prevalence of IDD are enlarged thyroid volume, prevalence of goitre or Total Goitre Rate (TGR), enlarged thyroid gland, urinary iodine and elevated neonatal serum levels of Thyroid Stimulating Hormone (TSH) (Delange, 1999). Urinary iodine excretion is the most reliable indicator of IDD at field level (Pardede *et al*., 1998). Imtiaz *et al*. (2009) reported that reduction in IDD would contribute significantly to the attainment of the Millennium Development Goals. The Universal Salt Iodization (USI) Programme is effective in overcoming IDD. The success was first observed in 1995 when it was reported that 97% of all food grade salt manufactured in Nigeria was iodized. In 1999, 98% of Nigerian households were using the salt (Olayiwola *et al*., 2003). Many previous works that assessed the prevalence of iodine deficiency did not investigate the handling, storage and cultural practices that might affect effective use of iodized salt. This study was designed not only to determine the prevalence of iodine deficiency among school children but also to have a clear picture of the factors that affect the relationship between salt iodization and population iodine status.

MATERIALS AND METHODS

Study area: This study was carried out in two commercial towns (Ibagwa and Orba communities both in Nsukka senatorial district of Enugu State, Nigeria. Ibagwa, popularly known as Ibagwa-aka is located north of the University of Nigeria, Nsukka. It is the Local Government Head Quarter of Igbo-Eze South Local Government Area (LGA) of Enugu State, Nigeria. It is a heavily populated community made up of three semi autonomous villages. Currently, Ibagwa-aka is the

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economic emporium of Igbo-Eze region and beyond with its flamboyant "Nkwo" market. Orba is a community located in the southern part of Nsukka and under Udenu LGA of Enugu State. It has a population of 43, 661 (National Population Commision, 2009). It serves as the major economic point of the locality with its flamboyant "Orie" market popularly called "Orie orba". These two communities are engaged in agriculture and various businesses. Yam *(Discorea spp)*, maize *(Zea mays)*, cassava *(Manihot esculenta)*, cocoyam *(Colocasia esculenta)* and plantain *(Musa paradisiaca)* are their staple foods.

Sampling technique: A cross-sectional study was conducted during January to May, 2012. Primary school pupils were purposely selected from the two communities. A multi-stage sampling technique was adopted. In the first stage, the communities were stratified into villages. Three and two villages nearer to the popular markets were purposely selected from Orba and Ibagwa communities. A list of schools in the selected villages was obtained from the State Education Commission. Five schools (three from Orba community and two from Ibagwa community) were purposely selected due to their proximity to the popular markets. The classes used were randomly selected by balloting among six levels of classes in each school. Forty pupils from each school were randomly selected to give a total number of (200) subjects. Both urine and salt samples were collected from the selected pupils.

Informed consent: A visit was made to the selected schools to discuss the objectives and the significance of the study with the teachers and the representatives of the schools' Parent Teachers Association and to obtain approval for the study. Approval was given by the individual school authorities and the parents/guardians of the selected pupils.

Collection of samples: The pupils were asked to bring salt (about 20g) from their various homes and to package them in small polyethylene bags. A total of 120 samples were collected from the three schools in Orba community. Eighty samples were collected from two schools in Ibagwa-aka community. The urine samples were collected from the selected pupils who brought the salt samples. A casual urine sample was collected from each of the subjects, under the supervision of the researchers using screw-cap containers placed in an ice pack. The samples were taken to the laboratory within an hour for analysis.

Distribution of questionnaire: A validated questionnaire was used to test the knowledge, attitude, practice and behaviour (KAPB) of both household consumers and the salt retailers in both communities. A total of 40 household salt consumers participated in this study. They provided information on salt consumption, purchasing, storing habits, salt use, awareness of iodine, iodized salt and media contribution. Fifteen salt retailers participated in this study. The information they provided includes salt availability, purchasing and storing habits, awareness of iodine and iodized salt and media contribution. The household consumers' questionnaire was given to the pupils whose salts were collected as a take-home assignment so that the salt managers at home will fill. The questionnaire for the retailers was taken to the popular markets in both communities (Orie orba and Nkwo Ibagwa-aka) by the researchers for data collection.

Analysis of samples: The level of iodine in the salt samples was determined using a test kit, produced by MBI chemicals, Chennai (India). The starch-based test kit was used semi quantitatively to measure iodine in salt samples at 0, 7, 15 and >30 parts per million (ppm), depending on the intensity of the colour. The procedure involved spreading a spoonful of the salt on a white paper and discharged a drop of the test solution on the surface of the salt sample. The colour change which depends on the iodine content is compared to the colour on the colour graduation chart. If the test showed "no iodine" the salt sample is acidified and tested again to confirm the result. After analysis, the salt samples were classified according to their iodine levels (0ppm, <15ppm and >15ppm).

Urine analysis: The urine samples were taken to the laboratory the same hour it was collected, where they were stored at -20°C before laboratory analysis. The iodine concentration of the urine was assayed by Zak (chloric acid) method. The principle of this method is that iodine is oxidized to iodate by chloric acid digestion in the presence of ammonium persulfate. The iodine in the urine is measured by the standard method of Benotti *et al*. (1965). This involves a manual choric acid digestion at 105-115°C to remove the interfering substances before the automated colorimetric analysis with a Technicon autoanalyzer. The persulfate method (y) correlated extremely closely with the reference cholric acid method (x) by the Pearson correlation:

$$(y = 0.923x+0.810\ \mu mol/L \text{ and } r = 0.994, Sy|x = 1.841)$$

Statistical analysis: Data obtained were coded and analyzed into frequencies, percentages and mean using the Statistical Package for Social Sciences (SPSS) version 17.

RESULTS

General characteristics of the pupils: The general characteristics of the pupils (Table 1) showed that the

population was made of equal number (50%) of both male and female. More than half (54%) were within the age range of 6-9 years and the remaining 46% were within 10-12 years old. Majority (95%) were Christian, 1.5% were Moslems and 3.5% practiced other religion. A good number (92.5%) of them are Igbo and only 4% and 3.5% are Hausa and Yoruba, respectively.

Urinary iodine of the pupils: The urine iodine excretion of the pupils showed adequacy of iodine intake as shown in Table 2 and 3. Table 2 showed that 56.7% and 43.8% of the pupils in Orba and Ibagwa-aka, respectively had normal urinary iodine (adequate iodine intake). Up to 43.3 and 56.2% of the subjects in Orba and Ibagwa-aka had mild iodine deficiency. None of the school children in both communities had either moderate or severe iodine deficiency. The urinary iodine status by sex (Table 3) showed that in Orba 48.1 and 51.9% of the male and female pupils, were mildly iodine deficient and in Ibagwa-aka 53.3 and 46.7% of the male and female pupils, were mildly iodine deficient. More female (54.3%) than male (45.7%) in Ibagwa-aka and more male (51.5%) than female (48.5%) in Orba had adequate iodine intake. The iodine concentration of the household salts in the two communities is shown in Fig. 1a and 1b. The proportion of households consuming adequately iodized salt in Orba (58.3%) is lower than in Ibagwa-aka (70%). About 12.5% (Orba) and 3.7% (Ibagwa-aka) salt analyzed had no iodine (0 ppm) while 29.2% (Orba) and 23.6% (Ibagwa-aka) had iodine content less than 15 ppm.

The iodine concentration of the household salts by sex is shown in Table 4. In Orba, 46.7, 40 and 55.7% of the salts brought by males had no iodine, <15 ppm and ≥ 15 ppm iodine concentration, respectively. However, 53.3%, 60% and 44.3% of the household salts brought by the female school children had no iodine, <15 ppm and ≥ 15 ppm iodine concentration, respectively. In Ibagwa-aka, the male brought 33.3, 61.9 and 46.4% household salt samples which had no iodine, <15 ppm and ≥ 15 ppm iodine concentration, respectively. Another 66.7, 38.1 and 53.6% of salts brought by females had no iodine, <15 ppm and ≥ 15 ppm iodine concentration, respectively.

Knowledge, attitude, practice and behaviour: The KAPB of the household salt consumers and the retailers in Orba and Ibagwa-aka were conducted. The salt retailers in both communities (53.3% (Orba) and 46.7% (Ibagwa-aka) bought salts from wholesale shops in the same district. Nearly, the salt in the retailers' shops were iodized (93.3% in Orba and 100% in Ibagwa-aka). The retailers in the two communities had no difficulty in obtaining iodized salt. Despite this, there were still salts in the household samples that had no iodine at all (12.5% in Orba and 3.7% in Ibagwa-aka). The retailers claimed to have most of their salts in small plastic packets, small crystalline form, labeled iodized. The large crystalline form was more in Ibagwa-aka community than in Orba (33.3 vs. 6.7%). Majority of the retailers (93.3% in Orba and 100% in Ibagwa-aka) still had 10kg (HDPE) bags in stock. However, more than half (60%) of them in both communities had the bags tightly covered, as they were instructed. About 40% of the salt retailers in both communities sample their salts outside their shops and 60% sample theirs inside the shop. A large number (93.3%) of the salt dealers in both

Table 1: General characteristics of the pupils

Variables		Frequency	Percentage
Sex	Male	100	50
	Female	100	50
	Total	200	100
Age range	6-9 years	108	54
	10-12 years	92	46
	Total	200	100
Religion	Christian	190	95
	Moslem	3	1.5
	Others	7	3.5
	Total	200	100
Tribe	Igbo	185	92.5
	Hausa	8	4
	Yoruba	7	3.5
	Total	200	100

Table 2: Urinary iodine status of the pupils in Orba and Ibagwa-aka

Urinary iodine status	ORBA F	(%)	IBAGWA-AKA F	(%)
Normal (100-200 µg/L)	68	56.7	35	43.8
Mild iodine deficiency (50-99 µg/L)	52	43.3	45	56.2
Moderate iodine deficiency (20-49 µg/L)	-	-	-	-
Severe iodine deficiency (<20 µg/L)	-	-	-	-
Total	120	100	80	100

F: Frequency

Table 3: Urinary iodine status by sex

	ORBA				IBAGWA-AKA			
Urinary iodine status	MF	(%)	FF	(%)	MF	(%)	FF	(%)
Normal (100-200µg/L)	35	51.5	33	48.5	16	45.7	19	54.3
Mild iodine deficiency (50-99µg/L)	25	48.1	27	51.9	24	53.3	21	46.7
Moderate iodine deficiency (20-49µg/L)	-	-	-	-	-	-	-	-
Severe iodine deficiency (<20µg/L)	-	-	-	-	-	-	-	-
Total	60		60		40		40	

MF: Male frequency, FF: Female frequency

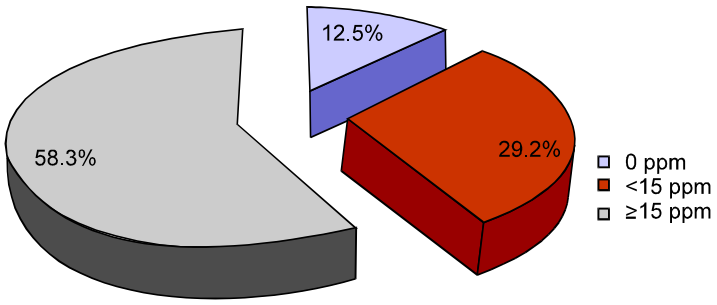

Fig. 1a: Iodine concentration of household salts (ppm) in Orba

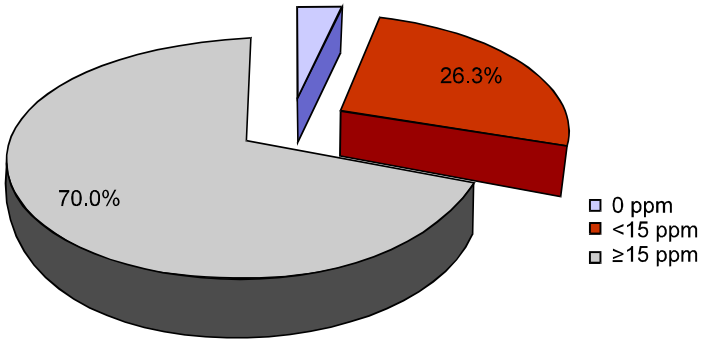

Fig. 1b: Iodine concentration of household salts (ppm) in Orba

Table 4: Iodine concentration of household salt by sex

Urinary iodine status	ORBA				IBAGWA-AKA			
	MF	(%)	FF	(%)	MF	(%)	FF	(%)
0 ppm	7	46.7	8	53.3	1	33.3	2	66.7
<15 ppm	14	40.0	21	60.0	13	61.9	8	38.1
≥ 15 ppm	39	55.7	31	44.3	26	46.4	30	53.6
Total	60		60		40		40	

MF: Male frequency, FF: Female frequency

communities were aware of regulations regarding sale of salt. However, 6.7% of them were ignorant of any regulations.

More than a half of the consumers in Orba (60%) and in Ibagwa-aka (62.5%) purchased salt more than once in a month. Exposed (loose) salts are purchased more in Ibagwa-aka (75%) than in Orba (35%) community. Fifty percent (50%) of the consumers in Orba and 15% in Ibagwa-aka purchased salt packaged in plastic bags. Another 10% and 15% of the households in Orba and Ibagwa-aka purchased salt in small quantity (less than 1kg). The rest purchased salt in large quantity (= 1kg). More than a half (65%) and less than a half (45%) of the consumers in Orba and Ibagwa-aka, each heard about goitre as a disease due to iodine deficiency. Some 20% in Orba and 45% in Ibagwa-aka knew that iodine deficiency caused goitre. More than a half of the consumers in the two communities (60% in Orba and 67.5% in Ibagwa-aka) were ignorant of any regulations regarding the sale of salt. Regardless of this, they had large supply of iodized salt available in their markets (Table 5).

DISCUSSION

High prevalence rate of mild iodine deficiency was observed both in Orba (43.3%) and Ibagwa-aka (56.2%) communities. The prevalence was much higher than 38.8% for Nigeria (Standing Committe Nutrition (SCN), 2004). The urinary iodine was influenced by both sex and location. More female (51.9%) and less male (48.1%) were mildly iodine deficient in Orba and in Ibagwa-aka, respectively. Total Goiter Rate (TGR), an indicator of iodine deficiency was reported to be influenced by sex but not location in a study carried out on school children in India (Dilip *et al*., 2008). No case of moderate or severe iodine deficiency was recorded in either community.

The access to iodized salt in these two communities confirmed the reports of Olayiwola *et al*. (2003) that 97% of all food grade salt manufactured in Nigeria was iodized. The 12.5 and 3.7% of uniodized salts in Orba and Ibagwa-aka contradicted the reports of Olayiwola *et al*. (2003). A total of 29.2 and 26.3% of the household salt in the two communities were inadequate (<15 ppm) in iodine. Some of the salt collected from Ibagwa-aka community were baked and this practice led to depletion of iodine because it precipitated evaporation of iodine.

Table 5: Knowledge, attitude, practice and behavior of household salt consumers

	ORBA		IBAGWA-AKA	
Variables	Frequency	(%)	Frequency	(%)
Place of purchase				
Local shop in the same town/village	18	45	6	15
Shop in nearby town	14	35	11	27.5
Wholesale shop in the district	4	10	8	20
Weekly market	4	10	13	32.5
Others	-	-	2	5
Total	40	100	40	100
Type of salt				
Large crystal salt	14	35	6	15
Small crystal salt	14	35	26	65
Powdered or highly refined salt	8	20	6	15
Others	4	10	2	5
Total	40	100	40	100
Salt iodization				
Salt iodized	32	80	32	80
Salt not iodized	8	20	8	20
Total	40	100	40	100
Method of purchase				
Loose	14	35	30	75
Small plastic bag packet	20	50	6	15
Full bag	6	15	4	10
Total	40	100	40	100
Frequency of purchase				
More than once a month	24	60	25	62.5
Once a month	12	30	6	15
Once in 2-3 months	-	-	4	10
Once in 6 months or less often	4	10	5	12.5
Total	40	100	40	100
Quantity purchased at a time				
Less than 1kg	4	10	6	15
1 kg	18	45	6	15
More than 1kg and up to 5kg	16	40	21	52.5
More than 5kg and up to 10kg	2	5	5	12.5
More than 10kg	-	-	2	5
Total	40	100	40	100
Place of storage				
In the kitchen	30	75	27	67.5
In the store room	10	25	13	32.5
Total	40	100	40	100
Method of storage				
Container with lid	30	75	22	55
Container without lid	2	5	2	5
The same bag in which its bought	6	15	11	27.5
Lying on the floor (open)	-	-	5	12.5
Lying on the floor (covered)	2	5	-	-
Total	40	100	40	100
Knowledge of ill effect of iodine deficiency				
Goitre	26	65	18	45
Cretinism	2	5	4	10
Mental retardation	4	10	-	-
Don't know	8	20	18	45
Total	40	100	40	100
Knowledge of iodized salt				
Yes	32	80	32	80
No	8	8	20	20
Total	40	100	40	100
Source of information (if yes)				
Health worker	30	75	27	67.5
Neighbor	4	10	5	12
Radio	2	5	4	10
Shop keeper	4	10	4	10
Total	40	100	40	100

Table 5: Continued

Availability of iodized salt				
Always available	26	65	32	80
Never available	4	10	8	20
Not available within last 1 month	6	15	-	-
Not available within last 6 months	4	10	-	-
Total	40	100	40	100
Knowledge of any regulation regarding sale of salt				
Yes	16	40	13	32.5
No	24	60	27	67.5
Total	40	100	40	100

Table 6: Knowledge, attitude, practice and behavior of retail shop owners

	ORBA		IBAGWA-AKA	
Variables	Frequency	(%)	Frequency	(%)
Place of purchase				
Another shop in the same town/village	4	26.7	5	33.3
Another shop in nearby town	3	20	3	20
Wholesale shop in the district	8	53.3	7	46.7
Total	15	100	15	100
Frequency of purchase				
More than once a month	9	60	9	60
Once a month	6	40	6	40
Total	15	100	15	100
Salt availability in shops (HDPE available)				
Yes	14	93.3	15	100
No	1	6.7	-	-
Total	15	100	15	100
HDPE Salt iodization				
Yes	14	93.3	15	100
No	1	6.7	-	-
Total	15	100	15	100
Whether HDPE salt was labeled				
Yes	14	93.3	15	100
No	1	6.7	-	-
Total	15	100	15	100
Availability of small plastic packets				
Yes	15	100	15	100
No	-	-	-	-
Total	15	100	100	100
Salt iodization (small plastic packets)				
Yes	15	100	15	100
No	-	-	-	-
Total	15	100	15	100
Salt label (small plastic packets)				
Yes	15	100	15	100
No	-	-	-	-
Total	15	100	15	100
Type of salt				
Large crystal salt	1	6.7	5	33.3
Small crystal salt	14	93.3	10	66.7
Total	15	100	15	100
Knowledge of iodized salt				
Yes	14	93.3	15	100
No	1	6.7	-	-
Total	15	100	15	100
Source of information (if yes)				
Health worker	13	86.7	14	93
Radio	12	80	10	66.7
Neighbours	2	13.3	1	6.7
Another shop keeper	3	20	5	33.3
Others	1	6.7	-	-

Table 6: Continued

Knowledge of any regulation regarding sale of salt				
Yes	14	93.3	14	93.3
No	1	6.7	1	6.7
Total	15	100	15	100
Difficulty obtaining iodized salt				
Yes	-	-	-	-
No	15	100	15	100
Total	15	100	15	100
Sampling of salt outside the shop				
Yes	6	40	6	40
No	9	60	9	60
Total	15	100	15	100

The 70 and 56% adequacy in both Orba and Ibagwa-aka were at variance with 80% adequacy (≥15ppm) recorded in West Bengal, India (Dilip *et al*., 2008). The mild urinary iodine among the pupils was precipitated by the poor handling and storage as well as sale outside the shops that exposed the salt to moisture, light, heat and contaminants which deteriorates the iodine content (WHO/ICCIDD/UNICEF, 1996).

In both Orba and Ibagwa-aka communities the majority that purchased salt in larger quantity (= 1kg) was because it was cheaper and lasts longer. Large quantities of salt were packaged in jute bags or sacs. Egbuta *et al*. (2003) reported that salt packaged in sacs lose iodine due to leakages, moisture and higher temperature. Salt stored in jute bag absorbs moisture and dissolve; salt solution drip out of the porous bag along with high amount of iodine (WHO/ICCIDD/ UNICEF, 2007).

The relationship between availability of iodized salt and urinary iodine level were due to poor use of salt, cultural practices, unhygienic method of handling and storage of salt.

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