Original Research Article.

Iodine status of school children aged 6 to 12 years in rural and urban communities in Imo state, Southeast Nigeria.

ABSTRACT.

Background.

Iodine is a trace element essential for the synthesis of thyroid hormones, thyroxine and triiodothyronine, which in turn play a crucial role in the growth and development of most organs, especially the brain. Iodine deficiency is therefore a serious medical condition fraught with dire consequences. Median urinary iodine concentrations of 100–199 mcg/L in children and adults, 150–249 mcg/L in pregnant women and >100 mcg/L in lactating women indicate iodine intakes are adequate

Objective.

This study set to determine the Iodine status of children aged 6-12 years using MUIC in selected urban and rural communities of Imo state, South East Nigeria.

Methods.

It was cross sectional in nature and was carried out between July 2018 and January 2019. It involved 386 children aged 6-12 years who were selected from primary schools in both urban and rural local areas within the three educational zones of Imo State. Their urinary Iodine concentration was assayed using Ammonium persulphate technique of the Sandell-Koltkoff reaction method.

Result.

The median urine iodine concentration (MUIC) in the study participants ranged from 65 – 490mcg/l with a median of 160mcg/l. While median urine iodine concentrations (MUIC) of

160mcg/L and 156mcg/L, respectively, were observed in urban-dwelling and rural-dwelling school children respectively. Of the 386 participants, 30 had a MUIC of < 100µg/L therefore giving an iodine deficiency prevalence of 7.8%. They consisted of 14 participants from the urban areas and 16 from the rural areas. The difference between MUIC of children in rural and urban areas of Imo state was not statistically significant . (χ^2 = 0.10: p = 0.75).

Conclusion.

While there was Iodine deficiency prevalence of 7.8%, there was no statistically significant difference between the Iodine status of pupils in urban and rural areas of Imo state.

Key words. Urinary Iodine , Iodine deficiency, Rural , Urban Imo state.

INTRODUCTION.

Iodine is a trace element essential for the synthesis of thyroid hormones, thyroxine and triiodothyronine, which in turn play a crucial role in the growth and development of most organs, especially the brain. [**1**] Thyroid hormones regulate cell migration, differentiation and myelination in the central nervous system. [**2**] In conditions of iodine deficiency, the important regulatory functions of iodine are adversely affected. Thus, iodine deficiency has emerged as an enormous problem that is highly associated with physical and mental retardation, poor attention span, low educability, poor school performance, social handicap, and disfigurement.[**3**]

Globally, more than 2.2 billion people are iodine deficient and school age children represent 31% of this number**. [1]** Urinary iodine level is a standard and reliable index of the Iodine status of the body. [**4**] In stable iodine situations, the amount of Iodine excreted in the urine correlates well with Iodine intake and serves as an estimate of Iodine intake**. [5]**

Iodine deficiency is a community diagnosis because of the nature of the determining factors such as the geography (soil content, highland versus lowland, coastal versus non-coastal), socio-economic (urban versus rural) and dietary factors. With community diagnosis, interventions aimed at educating the community, investigating soil content for iodine, and promoting the use of iodized salt can be initiated.

Median urinary iodine concentrations of 100–199 mcg/L in children and adults, 150–249 mcg/L in pregnant women and >100 mcg/L in lactating women indicate iodine intakes are adequate [**6**]. Values lower than 100 mcg/L in children and nonpregnant adults indicate insufficient iodine intake, although iodine deficiency is not classified as severe until urinary iodine levels are lower than 20 mcg/L.

A School-based study is recommended for urinary iodine estimation. It is an efficient and practical approach as this group is usually easily accessible and can be used as a proxy for the general population**. [7]**

Studies in different parts of Nigeria have shown a wide variation in prevalence of iodine deficiency with values ranging from 10% – 82%. **[8-13]**

There is a dearth of studies on current Iodine status of school children in Imo State south-east Nigeria . Additionally, the impact of place of residence whether rural or urban on Iodine status is also not fully established in the State.

This study therefore set to fill these gaps by determining the Iodine status of children aged 6-12 years in selected urban and rural communities of Imo state, South East Nigeria.

In this study, the iodine concentration in the urine of the studied population was classified using the WHO, UNICEF and ICCIDD Joint Epidemiological Criteria for Assessing Iodine Nutrition. **[5]**

MATERIALS AND METHODS.

Study Area.

This was a cross sectional study carried out between July 2018 and January 2019 in Imo State. Imo State is in South Eastern Nigeria and is divided into three educational zones namely, Owerri, Orlu and Okigwe Zones. One urban area and one rural area were selected using the simple random sampling technique from each zone. The urban areas were Owerri . Municipal, Orlu and Okigwe Local Government Areas (LGA). The rural areas were Ngor-Okpala from Owerri Zone, Njaba from Orlu Zone and Isiala-Mbano from Okigwe Zone.

The criteria are used for delination of rural and urban areas was that proposed by Weeks **[14]**

Criteria for defining urban areas:

The inhabitants are mostly civil servants and businessmen and women.

It has more built-up areas, high rise buildings, streets, parks etcetera.

Infrastructures such as banks, internet facilities, good road networks, electricity and water supply are available.

The people living in urban areas are more elitist than the rural population.

Urban areas are more densely populated.

Their lives are organized around non-agricultural activities

They depend on rural areas for most of their food.

The natural environment has been transformed by the building of high-rise houses, industries, business canters, shopping malls, highways etcetera.

Refuse disposal is done by government agencies.

Criteria for defining rural areas.

Energy source – firewood, charcoal, saw dust

The disposal of refuse is done naturally by individuals

Rural areas are self-sufficient

Grows most of their own food

Sources of water are stream, river

Their lives are organized around agricultural activities

A good number of the population are subsistence farmers and petty traders

They are more closely knit than those in urban areas

Sample size.

The sample size was determined using the table proposed by the Research Advisor Sample Size Table in 2006. **[15].** The table gives sample size for different population sizes having built in the required confidence interval and acceptable margin of error. This method of determination of sample size is suited for community-based work.

Total Study Population = 74,856

Required confidence interval = **95%**

Tolerable margin of error = **5%**

The calculated sample size was 382**.** In order to accommodate possible errors in handling laboratory samples, an attrition rate of 10% was built into the sample size. Thus 38 more subjects (10% of 382) were added = **420**.

To accommodate even number of students in each selected school, this was rounded off to a total sample size of **432.**

Two primary schools were selected from each of the selected local government area using random sampling technique and a total of 72 primary school children between ages 6 to 12 years were recruited from each of the six local government areas selected.

Children on iodine containing medications like cough syrup within four weeks preceding recruitment were not chosen.

Sample collection.

Participants anthropometric assessment were first carried out.

Weight was taken (in kilograms) with each child weighed wearing only the school uniform while shoes and socks were removed and with their pockets free of objects that might add to their weight. Seca 875 flat style scale was used to measure the weight of the participants. The weight was read off to the nearest 0.1kg.

Each participant's height was measured using a stadiometer (Model 769, Seca, Hamburg, Germany) with an adjustable headpiece. Each child was asked to stand on the baseboard with feet close together. The child's knees and ankles were held to help keep the legs straight and feet flat, with heels, calves, and the back of the head, shoulder blades and buttocks, all touching the vertical board. The participant was asked to inhale and hold his breath, and then the movable part of the headpiece is brought onto the uppermost point on the head with sufficient pressure to compress the hair. The height was read off the scale and recorded to the nearest 0.1centimetre (cm).

5mls of urine sample was collected into a clean and sterile universal bottle from each participant after the measurement of weight and height. The samples were transported in vaccine rush containers to the analyzing laboratory at the Nnamdi Azikiwe University Teaching Hospital Nnewi in batches where they were stored at 4^0 Celsius until they were analysed. The Sandell-Kolthoff reaction method for measuring urinary iodine using ammonium persulfate was employed as recommended by WHO/UNICEF/ICCIDD.

Socio-economic Classification.

The social class stratification of the recruited participants was based on the criteria set by Oyedeji. **[16]** The classification is based on the educational level and the occupation of the parents. The subjects were classified into five socio-economic classes i-v. For the purpose of the study, the classes were further grouped into upper (i-ii), middle (iii), lower (iv-v) socio-economic classes.

Ethical considerations.

Ethical approval was obtained from the Ethics Committee of the Federal University Teaching Hospital Owerri while permission to conduct the study in schools was obtained from Imo State Universal Basic Education Board (IMSUBEB).

Informed consent (signed and thumbprint) was obtained from the caregiver/guardian, while assent was obtained from study subjects seven years and older before entering them into the study. Children with low iodine or increased iodine were referred to the Children Out-patient unit of the Federal Medical Centre Owerri for further evaluation and management.

Analysis of data.

The data were collated, sorted and analysed using the Statistical Package for Social Sciences (SSPS) version 20.1. Frequency tables and charts were generated for relevant variables. Descriptive statistics (mean, median, standard deviation and interquartile range) were used to summarize quantitative variables (age, height, weight and urinary iodine level).

RESULTS

A total of 432 participants were recruited. Of these, 46 were excluded from the final analysis owing to spilled and poor urine sample management thus, 386 participants completed the study.

Socio-demographics of the study population

The ages of the participants ranged between 6 and 12 years, with a mean ± SD of 8.82 ± 2.0 years. The male-to-female ratio was 1:1.

With respect to respective socio-economic classes, 134 (34.7%) were in the lower socio-economic class, 128 (33.2%) in the middle class, and 124 (32.1%) in the upper stratum. 195 (50.5%) of the respondents resided in urban areas while 191 (49.5%) resided in rural areas. These are shown in **Table 1**

Majority of the children i.e 316 (81.9%) had normal weight-for-age compared to 43 (11.1%) and 27 (7.0%) who were underweight and overweight/obese, respectively, when evaluated by z-scores.

Median Urinary Iodine levels of study participants

Overall, urine iodine concentration in the study participants ranged from 65 – 490μg/l, with a median of 160μg/l (interquartile range 120 – 200μg/l). The iodine status of school-age children in the three zones of Imo State using the Median Urinary Iodine Concentration (MUIC) level is shown in **Figure 1**. Thirty (7.8%) of the study participants had MUIC of (< 100μg/L), 256 (66.3%) had normal levels (100 – 199μg/L), 75 (19.4%) were at risk of iodine excess (200 – 299μg/L), while 25 (6.5%) had levels that pointed to excess iodine (≥ 300μg/L).

Median Urinary Iodine Concentration of study subjects according to place of residence.

Table 2 shows the MUIC of study participants with respect to place of abode. Within the Owerri Education Zone, the overall distribution of various cadres of iodine status did not vary significantly between the urban and rural setting ($p > 0.05$). Specifically, Using the MUIC as the indicator the prevalence of low iodine status was comparable between the urban and rural settings (Fisher exact $p = 0.53$). The findings were similar in Orlu Zone with comparable distribution of iodine status between the urban and rural centres ($p = 0.55$). Also, the prevalence of low iodine status was similar between urban and rural settings (Fisher exact $p = 1.00$). Okigwe Zone followed the same pattern of findings with comparable distribution of MUIC between the urban and rural centres ($p = 0.68$).Prevalence of low iodine status was similar between urban and rural settings (Fisher exact $p = 0.35$).

Values from all three urban centres (Owerri Municipal, Orlu and Okigwe) were combined and compared with all three rural areas (Ngor-Okpala, Njaba and Mbano). No significant difference was found between them in terms of prevalence of low iodine status using MUIC ($\chi^2 = 0.10$: $p = 0.75$).

DISCUSSION

The Urinary Iodine concentration in the study participants ranged from 65 – 490μg/l, with a median of 160mcg/l and interquartile range of 120 – 200mcg/l. while Median Uurinary Iodine concentrations (MUIC) of 160mcg/L and 156mcg/L, respectively, were observed in urban-dwelling and rural-dwelling school children with IQR OF 127mcg/l – 200mcg/l for urban and 120mcg/l – 196mcg/l for rural. 30 participants had a MUIC of < 100mcg/L which gives Iodine deficiency prevalence of 7.8%.

This prevalence is comparable to 8.9% and 10% reported by Onyeaghala *et al* and Sanusi **[8,9]** in Saki and Ibadan respectively, both in South-west Nigeria**.** It is lower than a national prevalence of 20%, a regional South-eastern prevalence of 37% **(1)** and is considerably lower than 25%, 42.2% and 43.2% reported in Ibadan, Ilorin and Kaduna in South-west and North-central , Nigeria respectively**.[8,10]**

It is however, higher than 3.8% and 1.7% reported by Nwamara *et* ***[3]*** and Azubuike *et al* **[17]**respectively. Soil erosion is more in the study area and erosion is known to wash away iodine content in the soil thus predisposing food produced in this area and the inhabitants to iodine deficiency· **[18]** It may also be argued that cooking practices and salt consumption pattern in the household of these subjects in Imo State may differ from the subjects in Giwa's study in North-central Nigeria; thus, may also account for the differences in the prevalence.

We found a median urinary iodine concentration of (160ug/dl and IQR 120 – 200ug/l) which is considerably higher than what was reported from studies in Cross river State Nigeria **[11]** , Cambodia **[19]** and Pakistan· **[20]** but consistent with figures from earlier studies in Anambra state **[12]** , Enugu state**[13],** Ebonyi state in South-east and Ilorin in North-central

Nigeria.**(17,21)**. The difference when compared with the Cross river state, Cambodian and Pakistani studies could be attributed to differences in methodology giving the fact that our study created equal chances for all the children

living in the Imo State to be recruited. The result obtained in our study would pass as a better representation of median urinary iodine concentration.

Additionally , the difference in MUIC between these other studies and our study could also be attributed to differences in the ages of subjects. Participants in our study fall within the age group (6-12 years) recommended by the WHO as proxy for monitoring the iodine status of the population.

The was no statistically significant differences in MUIC of participants living in urban and rural areas in Imo State. This finding is similar to earlier studies by Onyekwelu *et al* **[12]**in South-east Nigeria, Mehdi *et al* **[22]** in Iran and Hamza *et* al**[23]**in Malaysia. However, there are other studies that reported higher levels in urban dwelling school children **[24-26]**.. It may be argued that the consumption of similarly prepared staples among participants residents in the rural and urban communities in Imo state South-east Nigeria could have contribute to the observed result.

We found isolated number of pupils with excess MUIC in urban areas (Orlu and Owerri) . This may be due to easy access and consumption of over iodized salt and dietary supplements containing iodine.

Conclusion.

We conclude that using MUIC as the assessment tool that there was a prevalence of Iodine deficiency of 7.8% in our study but there was no statistically significant difference between iodine status of children in rural and urban areas of Imo state. This prevalence also suggests that

Iodine deficiency is not yet a public health issue in Imo State and efforts should be made to ensure that it does not become one.

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Table 1: Socio-demographic parameters of participants.

Variable	n (%)
Age (years)	
6	67 (17.4)
7	53 (13.7)
8	57 (14.8)
9	58 (15.0)
10	54 (14.0)
11	50 (13.0)
12	47 (12.2)
Gender	
Male	193 (50.0)

Female	193 (50.0)
Socio-economic class	
Upper	124 (32.1)
Middle	128 (33.2)
Lower	134 (34.7)
Residence	
Urban	191 (49.5)
Rural	195 (50.5)

Table 2: MIUC levels of participants according to place of residence

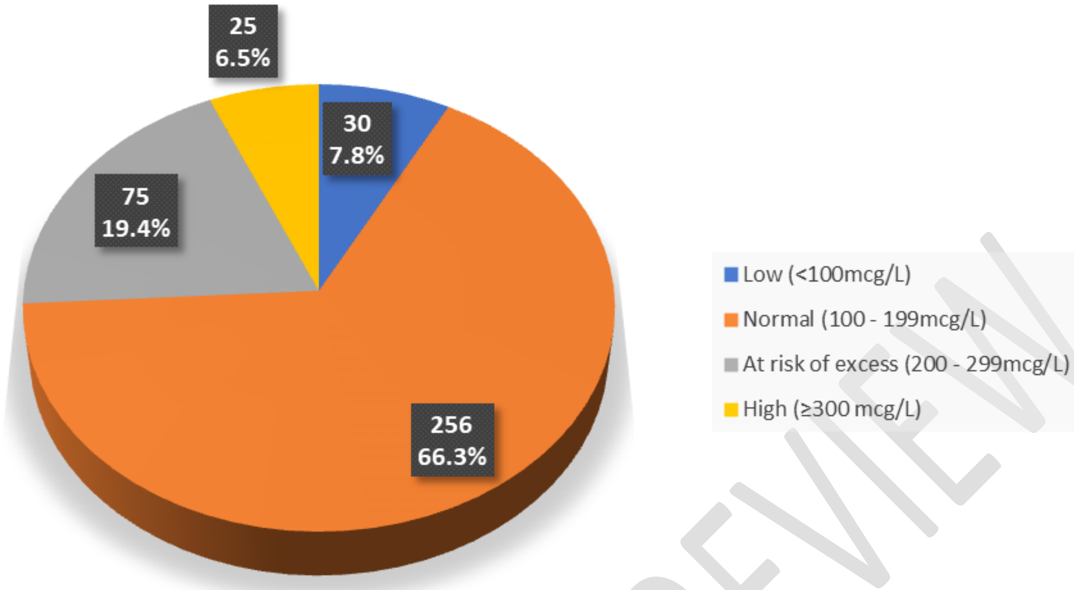
	Owerri zone		**Orlu zone**		**Okigwe zone**	
I_2 status	**Urban**	**Rural**	**Urban**	**Rural**	**Urban**	**Rural**
Low	6 (8.2)	4 (6.45)	4 (6.56)	5 (7.25)	4 (5.80)	7 (10.94)
Normal	29 (49.2)	39 (62.90)	41 (67.21)	46 (66.67)	55 (79.71)	46 (71.88)
At risk	19 (31.2)	14 (22.58)	11 (18.03)	16 (23.19)	7 (10.14)	8 (12.5)
Excess	7 (11.5)	5 (8.06)	5 (8.19)	2 (2.90)	3 (4.35)	3 (4.69)
Total	61 (100.0)	62 (100.0)	61 (100.0)	69 (100.0)	69 (100.0)	64 (100.0)
p–value	χ^2 = 2.95: p = 0.40		χ^2 = 2.12: p = 0.55		χ^2 = 1.50: p = 0.68	

Table 3: Median Urinary Iodine Level Based on Socio-Demography

Variables	N	Iodine level ($\mu g/l$) Median	Interquartile range (IQR)	Test statistic	p-value
Age (years)					
6	67	160	109 – 200		
7	53	145	110 – 180		
8	57	164	123 – 200		
9	58	162.5	124.8 – 200	7.63[a]	0.266
10	54	158	120 – 200		
11	50	165	149.5 – 200		
12	47	160	120 – 190		
Gender					
Male	193	160	122.5 – 200	17461[b]	0.287
Female	193	158	120 – 190		
Socio-economic Class					
Upper	124	165	127 – 200		
Middle	128	160	120 – 195	4.040[a]	0.133
Lower	134	156.5	120 – 188.5		
Residence					
Urban	191	160	121 – 200	18571[b]	0.962
Rural	195	156	120 – 196		
Family size					
≤ 4	155	160	130 – 200	15251.5[b]	0.013
> 4	231	156	119 – 190		

Key: a: Kruskal-Wallis test, b: Mann-Whitney U test

Figure 1: Pie chart showing Iodine status of participants using MIUC level.


25
6.5%
30
7.8%
75
19.4%
256
66.3%
Low (<100mcg/L)
Normal (100 - 199mcg/L)
At risk of excess (200 - 299mcg/L)
High (≥300 mcg/L)