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

ABSTRACT.

Background.

Iodine deficiency is a serious medical condition, fraught with dire consequences. Iodine sufficiency in a population is defined as median urinary iodine of 100 to 199ug/l in school age children.

Objective.

This study set to determine the iodine status of children aged 6-12 years 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 urine Iodine concentration was assayed using ammonium persulphate technique of the Sandell-Koltkoff reaction method.

Result.

The urine iodine concentration in the study participants ranged from 65 – 490μg/l with a median of 160μg/l. While median urine iodine concentrations (UIC) of 160μg/L and 156μg/L, respectively, were observed in urban-dwelling and rural-dwelling school children respectively. 30 participants had a concentration of < 100μg/L therefore giving an iodine deficiency prevalence of 7.8%. The difference between Iodine status of children in rural and urban areas of Imo state was not statistically significant .

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, Imo state.

INTRODUCTION.

Iodine deficiency is a serious medical condition, fraught with dire consequences. Globally, more than 2.2 billion people are iodine deficient and school age children represent 31% of this number**. 1.** In stable iodine conditions, the amount of iodine excreted in the urine correlates well with iodine intake and serves as an estimate of iodine status.

Iodine sufficiency in a population is defined as median urinary iodine of 100 to 199ug/l in school age children. **2**

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.

Studies in different parts of Nigeria have shown a wide variation in prevalence of iodine deficiency with values ranging from 10% – 82%. **3-8**

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**. 9**

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.

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.

MATERIALS AND METHODS.

Study Area.

This was a cross sectional study carried out between July 2018 and January 2019. 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.

Sample size.

The sample size was determined using the table proposed by the Research Advisor Sample Size Table in 2006. **10.** 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.

About 5mls of urine sample was collected into a clean and sterile universal bottle from each participant after their anthropometries have been taken.

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.

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 insufficient sample provision; 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 socio-economic class, 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 were resident in urban areas while 191 (49.5%) resided in urban areas.

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. These are shown in **Table 1**

Median iodine levels and iodine status of study participants

Overall, urine iodine 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 is shown in **Figure 1**. Thirty (7.8%) of the study participants were iodine deficient (< 100μg/L), 256 (66.3%) had normal iodine levels (100 – 199μg/L), 75 (19.4%) were at risk of iodine excess (200 – 299μg/L), while 25 (6.5%) had excess iodine (≥

300μg/L).

Iodine status of study subjects according to place of residence

Table 2 shows the iodine status 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, 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 iodine status between the urban and rural centres ($p = 0.68$) as well as comparable 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 ($\chi^2 = 0.10$: $p = 0.75$).

DISCUSSION

The urine Iodine concentration in the study participants ranged from 65 – 490μg/l, with a median of 160μg/l while median urine iodine concentrations (UIC) of 160μg/L and 156μg/L, respectively, were observed in urban-dwelling and rural-dwelling school children. 30 participants had a concentration of < 100μg/L therefore giving an iodine deficiency prevalence of 7.8%.

This prevalence is comparable to 8.9% and 10% reported by Onyeaghala *et al* and Sanusi **(3,4)** 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**.(3,5,12)**

It is however, higher than 3.8% and 1.7% reported by Nwamara *et* **(8)** and Azubuike *et al (***13)** 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. **(14)** 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 of (160ug/dl and IQR 120 – 200ug/l) which is considerably higher than what was reported from studies in Cross river State Nigeria **(6)** , Cambodia **(15)** and Pakistan. **(16)** but consistent with figures from earlier studies in Anambra state **(7)** , Enugu state**(8),** Ebonyi state in South-east and Ilorin in North-central Nigeria.**(13,17)**. 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.

Additionally , the difference in median UIC 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 urinary Iodine concentration of pupils living in urban and rural areas in Imo State. This finding is similar to earlier studies by Onyekwelu *et al* (**7**)in South-east Nigeria, Mehdi *et al* **(18)** in Iran and Hamza *et* al(**19)**in Malaysia. However, there are other studies that reported higher iodine levels in urban dwelling school children (20-22).. It may also be argued that the consumption of similarly prepared staples among pupils 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 UIC in urban areas (Orlu and Owerri) which may be due to easy access and consumption of over iodized salt and dietary supplements containing iodine.

Conclusion.

We conclude that while there was a prevalence of iodine deficiency of 7.8% in our study, there was no statistically significant difference between iodine status of children in rural and urban areas of Imo state.

REFERENCES.

1. Universal salt iodization (USI) in Nigeria. Global Alliance for Improved Nutrition (GAIN) [internet] Accessed 2017 March 30. Available from www.gainhealth.org..

2. Pearce E.N, Anderson M and Zimmerman M.B. Global Iodine Nutrition: Where do we stand in 2013. Thyroid. 2013; 23: 523-28.

3. Sanusi R.A, Ekerette N.N. Nutrition and goiter status of primary schoolchildren in Ibadan, Nigeria. Afr J Biomed Res 2009; 12: 37-41.

4. Onyeaghala A.A, Anetor J.I, Nurudeen A. and Oyewole O.E. Assessment of urinary iodine status of primary school children in Saki, Southwestern Nigeria. Bull Envir. Pharm Life Sci. 2012; 5-9.

5. Anyiam J.O, Ogunride G.O, Raji T, Abdulkadir I, Yusuf R. Urinary iodine levels, goiter rates and intelligence quotient in primary school children in Giwa Local Government area of Kaduna State, Nigeria. J Obes Metab Res 2015; 2: 135-9.

6. Abua S.N, Olufunmike A.A, Rasaki S. Adequacy of dietary iodine in two local government areas of Cross River State in Nigeria. Pak J Nut.2008; 7: 40-3.

7. Onyekwelu K, Ezeagu I, Igbedioh S. Iodine nutrition of schoolchildren residing in area of local non-iodized salt production. Indian J Health Sci and Bio Res Kleu. 2016; 9: 250-63.

8. Nwamarah J.U, Otitoju O, Otitoju G.T, Emewulu C.U. Iodine and nutrition status of primary schoolchildren in a Nigeria community Okpuje, Nsukka LGA, Enugu State Nigeria. Der Pharmacia Lettre 2015; 7: 80.

9. Food fortification critical to food security in Nigeria – Global Alliance for Improved Nutrition. Accessed May 13 2017. Available from https://www.unicef.org.

10. Sample Size Table from The Research advisors, copyright 2006. Accessed online October 2017 from www.research-advisors.com/tools/sampleSize.htm.

11. Zimmermann MB, Kelvin M, Maksim B, Bridson J. Rohner F, Lindita G. Iodine supplementation improves cognition in iodine deficient Albania: a randomized, controlled, double-blinded study School children in Albania: a randomized, controlled double blind study. The Ame J Clini Nutri.2006; 83: 1105- 114.

12. Anyiam J.O, Ogunride G.O, Raji T, Abdulkadir I, Yusuf R. Urinary iodine levels, goiter rates and intelligence quotient in primary school children in Giwa Local Government area of Kaduna State, Nigeria. J Obes Metab Res 2015; 2: 135-9.

13. Azubuike CM, Elo Ilo JC, Egbuonu I, Ebenebe JC, Uche V. Emerging high iodine levels among primary school children: The South-east Nigeria experience. IOSR-JDMS 2021; 7: 40-46.

14. Zimmerman M, Trumbo P. Iodine advances in Nutrition 2013; 2: 262-64.

15. Laillou A, Sophonneary P, Kuong K, Hong R. *et al*. Low urinary iodine concentration among

mothers and children in Cambodia. Nutrients 2016; 8:172.

16. Subhan F, Jahangir M, Saira S, Khattak R, Haq M. Prevalence of goiter and iodine status among 6 – 12 years school children in district Kohat Pakistan, Southeast Asia J of Pub Health. 2014; 4: 42-46.

17. Olasinde TY, Adesiyun Omotayo, Olasebikan R, Olasinde A, Ibraheem R, Bilaminu AS. Areola E. Ernest S. Urinary iodine levels of primary schoolchildren in Ilorin Nigeria. Sanamed. 2020; 15: 21-23.

18. Mehdi Z, Amini A, Bidarpoor F, Tamimi M. A. survey of factors related to urine levels in elementary schoolchildren in Kurdistan Iran. Chron Dis J. 2013; 1: 30-5.

19. Hamzah Z, Azlina N, Mazlina L, Untong N. Analysis of urinary iodine level of school children aged 8 to 10 years in Perak. Accessed from https://www.academia.edu/33561449 May 10th, 2022.

20. Konrade I, Neimane L, Markrecka M, Strele I, Liepinsh E. *et al*. A cross sectional survey of urinary iodine status in Latvia. Medicina. 2014; 56: 124-9.

21. Leitre J.C, Keating E, Pestana D, Fernandes V.C, Maia M.L.*et al.* Iodine status and iodized salt consumption in Portuguese schoolchildren: The Iogeneration study. Nutr 2017; 9: 458.

22. Chandwani H.R, Shroff B.D, Prevalence of goiter and urinary iodine status in six to twelve-year-old rural primary schoolchildren of Bharuchi District India. Int J Prev Med. 2012; 3: 54-9.

Table 1: Socio-demographic parameters of study population

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: Iodine status of study subjects 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	$\chi^2 = 2.95$: p = 0.40		$\chi^2 = 2.12$: p = 0.55		$\chi^2 = 1.50$: p = 0.68	

Figure 1: Pie chart showing risk scenario