PACIFIC JOURNAL OF MEDICAL SCIENCES

{Formerly: Medical Sciences Bulletin}

ISSN: 2072 – 1625

Pac. J. Med. Sci. (PJMS)

www.pacjmedsci1625.com. Email: managingeditorpjms1625@gmail.com.

STATUS OF IODINE NUTRITION AMONG SCHOOL-AGE CHILDREN (6-12 YEARS) IN EGOR LOCAL GOVERNMENT AREA, EDO STATE, NIGERIA

[1]ISEMOBITA C. AIGBE, [1*]DANIEL A.N. ONYIRIUKA & [2]AYEBOH E. SADOH

1. Endocrinology and Metabolism Unit, Department of Child Health, University of Benin Teaching Hospital, Benin City, Nigeria.
2. Infectious Disease Unit, Department of Child Health, University of Benin Teaching Hospital, Benin City, Nigeria.

***Correspondence Author**: alpndiony@yahoo.com

Submitted: October 2024; Accepted: December 2024

STATUS OF IODINE NUTRITION AMONG SCHOOL-AGE CHILDREN (6-12 YEARS) IN EGOR LOCAL GOVERNMENT AREA, EDO STATE, NIGERIA

[1]ISEMOBITA C. AIGBE, [1]*DANIEL A.N. ONYIRIUKA & [2]AYEBOH E. SADOH

3. Endocrinology and Metabolism Unit, Department of Child Health, University of Benin Teaching Hospital, Benin City, Nigeria.
4. Infectious Disease Unit, Department of Child Health, University of Benin Teaching Hospital, Benin City, Nigeria.

***Correspondence Author**: alpndiony@yahoo.com
Submitted: October 2024; Accepted: December 2024

ABSTRACT:
Iodine deficiency continues to pose a global public health problem despite international efforts to eliminate it. Spot-urine iodine concentrations collected from a population are currently the internationally accepted criteria for determining and monitoring the iodine status of that population. The objective of this study was to assess the prevalence of iodine deficiency and some of the associated factors among school-age children in Egor Local Government Area (LGA) of Edo State, Nigeria, using urinary iodine concentration in spot urine sample. The study was a school-based descriptive cross-sectional study conducted over a period of 6 weeks (November to December 2022). The study involved a total of 429 school-age children (6-12 years) recruited via a multi-stage random sampling method. The urinary iodine concentration determinations were performed by the Sandell-Kolthoff method, after sample digestion with ammonium persulfate. A total of 429 children were enrolled in the study. The median urinary iodine concentration (mUIC) of all the children was 84µg/L(IQR52.0-110.0), which indicates prevalence of mild iodine deficiency and suboptimal status of iodine nutrition. Over half (66.2%) of the children had mild to moderate iodine deficiency. Iodine nutrition was adequate in one-third of the children. The prevalence of iodine deficiency varied significantly with type of school being attended by the children and the socioeconomic class of their families.

Keywords: Iodine nutrition status, iodine deficiency, school-age children, urinary iodine concentration, Nigeria

INTRODUCTION:

Dietary iodine is an essential micronutrient for the synthesis of thyroid hormones. In humans, iodine nutrition status is mainly dependent on dietary consumption of iodine. However, the iodine content of most foodstuffs is low, especially in mountainous area. One of the major natural sources of iodine is seawater fish and other marine products [1]. Inadequate dietary consumption of iodine and the resultant thyroid hormone deficiencies cause a spectrum of health problems collectively referred to as Iodine Deficiency Disorders (IDDs), the severe forms include endemic goitre, cretinism, intellectual disability, linear growth impairment, congenital hypothyroidism and increased perinatal mortality and morbidity [2]. Worldwide surveys indicate that IDDs can return anytime even after elimination, if the iodine deficiency control programmes are not sustained [3]. In addition, IDDs can occur among vulnerable population groups (women of reproductive age and children) in areas such as large cities, coastal areas and regions prone to flooding and erosion. Thus, emphasizing the need for continued vigilance despite the existence of iodine deficiency control programmes [3]. In Nigeria, Universal Salt Iodization (USI) was established by Law in 1993 to ensure effective iodization of salts for human consumption [4]. Its implementation is regulated by two bodies, Standard Organisation of Nigeria (SON) and National Food and Drug Administration Council (NAFDAC) [5,6].

School-age children (6-12 years) represent a useful group for the assessment of status of iodine nutrition in a population because of their high vulnerability to iodine deficiency and easy accessibility in the community. This is in keeping with the recommendations of the World Health Organisation (WHO), United Nation Children’s Fund (UNICEF) and International Council for Control of Iodine Deficiency Disorders (ICCIDD) and Iodine Global Network [3]. In addition, school-based approach takes advantage of high enrolment and attendance of both boys and girls in primary schools in Egor LGA, Nigeria.

The concentration of iodine in the urine (urinary iodine concentration, UIC) is the prime indicator of an individual’s nutritional iodine status and it is the primary variable used to measure the success of iodine supplementation in a population [7]. Median urinary iodine concentrations (mUIC) of 100-199µg/L are accepted as indicative of adequate iodine intake and optimal iodine nutrition in school-age children [3,7]. In most studies, iodine nutrition status (designated as deficient or sufficient) is defined based on mUIC cut-off at 100µg/L, as recommended by WHO/UNICEF/ICCIDD and other experts [3,7]. Globally, the estimated frequency of mUIC below 50µg/L is 2.6% in school-age children [3]. Worldwide, it is estimated that the iodine intake of 36.5% (285 million) school-age children is insufficient [8].

Applying this definition in school-age children (6 to 12 years old), the prevalence rates of iodine deficiency reported in literature varied from 25.2% in China to 32.9% in Papua New Guinea [9,10]. Using the same cut-off, Rawal and Kedia [11], reported a prevalence rate of 21.43% in India. To the best of our knowledge, there is no report of iodine nutrition status among school-age children (based on urinary iodine levels) in Edo State, which includes Egor LGA. We, therefore, decided to conduct this study because environmental factors such flooding, deforestation and erosions which increase the risk of iodine deficiency due to depletion of iodine content of the soil are common in Edo State, including Egor LGA [12,13]. The purpose of this study is to determine the current iodine nutrition status of Nigerian school-age children by measuring urinary iodine concentrations.

METHODOLOGY:

This was a school-based descriptive cross-sectional study involving 429 children aged 6 to 12 years in Egor LGA, Edo State, Nigeria. The study was conducted over a period of 6 weeks (November to December 2022). The children were recruited using a multistage random sampling method. Those with known thyroid disorders, chronic diseases or history of taking any iodine-containing drug were excluded. The socio-demographic data of the children were obtained, using a questionnaire. Socioeconomic class (SEC) of the child's family was determined, using a scoring system based on mother's level of education and father's occupation as proposed by Olusanya et al [14].

All the children recruited for the study submitted 5ml of spot urine sample in clean universal bottles with the lid tightly screwed. The children were asked to void urine at the school's lavatory, while accompanied by a research assistant (a male assistant for the boys and a female assistant for the girls). The urine sample bottles were properly labeled and then transported in a cold-box containing icepacks and kept at 4 to 10^{o}C till arriving to the research biochemistry laboratory of the University of Benin Teaching Hospital, Benin City, where the urine samples were stored in a freezer at -20^{O}C until analysis. The Urinary Iodine Concentration (UIC) were determined, using the ICCIDD, UNICEF and WHO standard Sandell-Kolthoff colorimetric method after sample digestion with ammonium persulfate in a water-bath. at 100^{o}C as suggested by Pino et al [15]. The absorbance was read at 405nm, after incubating at room temperature (approx. 25^{o}C) and the urinary iodine concentrations were determined, using standard curves constructed for each plate. For the Internal bench quality control, we applied Levy-Jennings Chart and the Westgard Rules. The external quality control monitoring of the assay procedure was via "Ensuring the Quality of Urinary Iodine Procedures" (EQUIP) of the Center for Disease Control and Prevention, USA. In this study, we applied the WHO criterion, which defined iodine deficiency as mUIC less than 100µg/L [3].

Ethical approval for the study was obtained from the Research and Ethics Committee of University of Benin Teaching Hospital. A written permission was sought and obtained from the Edo State Universal Basic Education Board (SUBEB) and Egor LGA Education Authority. Verbal permission was obtained from the Heads of the selected schools. Written informed consent was obtained from parents/guardians all the selected children. Assent was obtained from children above 6 years of age.

RESULTS:

The study population was 429 children, aged 6 to 12 years and consisted of 289 (67.4%) from public schools and 140 (32.6%) from private schools. There were 210 (49.0%) boys and 219 (51.0%) girls, giving male to female ratio of 1:1 (χ^2 = 0.092; p=0.76). The mean age of children from the private schools was 9.02±2.01 years while that of their counterpart in the public schools was 9.05±2.03 years (χ^2 = 0.36; P=0.972). The distribution of socioeconomic class (SEC) of the families of the children was as follows: low SEC 277(64.5%); middle SEC 42(9.8%) and high SEC 110 (25.6%). All the 277 subjects in low SEC were pupils from public schools. There was a statistically significant difference between SEC of pupils from public and private schools (χ^2 =390.011; p = 0.000).

Distribution of iodine nutrition status among the children: The median urinary iodine concentration (mUIC) of the children was 84µg/L (IQR 52.0-110.0). As shown in table 1, over half (66.2%) of the children had iodine deficiency (mild and moderate) but none had severe iodine deficiency. Iodine nutrition was adequate in one-third of the children.

Median urinary iodine concentration according to socio-demographic characteristics of the children.

The median urinary iodine concentration (mUIC) of males was 80.0ug/L ((IQR 52.0-110.0) compared to 86ug/ L in females. As shown in table 2, there was no statistically significant difference in mUIC in relation to gender (Mann W = 1.077; p=0.282). The children from public schools had significantly higher mUIC compared to their counterparts from private schools (Mann W= 9.484; p=0.000). With regard to socio-economic class, the mUIC was significantly higher in children from families of low SEC compared to their counterparts from high and middle SEC (Mann W= 84.976ug/L; p=0.000). The influence of age on mUIC was not significant.

Iodine nutrition status according to socio-demographic characteristics of the children

Table 3 shows the distribution of the prevalence of iodine deficiency according to socio-demographic characteristics of the children. Although the prevalence of iodine deficiency was slightly higher among the male children (68.0%) than the female children (64.8%), the difference was not statistically significant (χ^2 = 0.370; p =0.543). Comparing the prevalence of iodine deficiency in children in private and public schools, more children in private schools had iodine deficiency compared to their counterparts in public schools (χ^2 = 73.261; p=0.000). The prevalence of iodine deficiency was significantly higher among children from families in high SEC compared to their counterparts in middle or low SEC (χ^2 =3.098; p=0.000). The influence of age and gender on prevalence of iodine deficiency were not statistically significant.

Table 1: Distribution (%) of the iodine nutrition status of study participants

Median Urinary Iodine Concentration µg/L	Iodine Status	Frequency (%)
< 20	Severe Iodine Deficiency	0
20-49	Moderate Iodine Deficiency	96 (22.4%)
50 – 99	Mild Iodine Deficiency	188 (43.8%)
100 – 199	Optimal	145 (33.8%)
200 – 299	More than adequate (At risk of 1IH)	0
≥300	Excessive intake (At risk of adverse health consequences)	0

Table 2: Median urinary iodine concentration according to socio-demographic characteristics of family

	Median UIC (µg/L)	Iodine status	IQR	Test statistic	p-value
School type					
Public	96.00	Mild	67.5-118.0	9.484+	0.000*
Private	54.50	Mild	42.0-80.8		
Gender					
Male	80.00	Mild	51.0-108.0	1.007+	0.283
Female	86.00	Mild	51.0-112.0		
Age groups (years)					
6 - 9	85.00	Mild	54.0-108.0	0.235+	0.814
10 - 12	81.00	Mild	51.0-112.0		
SEC.					
High	54.00	Mild	41.5-78.0	84.976++	0.000*
Middle	57.00	Mild	47.3-98.8		
Low	96.00	Mild	67.5-117.0		

*P< 0.05= Statistically significant; +Mann Whitney; ++Kruskal Wallis
UIC = Urinary Iodine Concentration; SEC = Socio-economic class; IQR=Interquartile Range

Table 3: Distribution (%) of iodine nutrition status according to socio-demographic characteristics of children

Socio-demographic Parameter	Adequate iodine nutrition No (%)	Median UIC (µg/L)	χ^2	p-value
Gender				
Male	68(32.4)	96.00	0.370	0.543
Female	77(35.2)	54.50		
Age groups (years)				
6-9	82(34.5)	80.00	0.102	0.749
10-12	63(33.0)	86.00		
School type				
Private	8(5.7)	85.00	73.261	0.000*
Public	137(47.4)	81.00		
Socio-Economic Class				
High	3(2.7)	54.00	73.098	0.000*
Middle	10(23.8)	56.00		
Low	132(47.7)	96.00		

*P<0.05 = statistically significant;

DISCUSSION:

We found a low median urinary iodine concentration ((84µg/L) among the school-age children which according to World Health Organisation (WHO) criteria, suggest mild iodine deficiency and suboptimal iodine nutrition at the time of the study [3]. This is despite the existence of universal salt iodization programme in Nigeria since 1995. The low mUIC observed in the present study is noteworthy because Egor LGA is traditionally not regarded as iodine deficiency zone in Nigeria. Therefore, there might be the need to re-draw the map of iodine deficiency belt in Nigeria [16]. In addition, mandatory iodization of bread might be beneficial in improving iodine nutrition status of these children. The quality as well as the iodine content of table salt consumed in Egor LGA needs to be assessed to determine the cause of low mUIC in this LGA. A similar finding of low mUIC (65ug/L) was reported by Abua et al [17] in Cross River State, Nigeria. On the other hand, two previous Nigerian studies reported higher values (124.7µg/L and 117.0µg/L, respectively) [18,19]. In contrast, the mUIC found in the present study was higher than 39.8µg/L and 51.2µg/L reported from Dhakar, Bangladesh and Southern Tajikistan, respectively [20,21]. In a study in Papua New Guinea, Temple et al [22], reported a low mUIC 48 µg/L. Lomutopa et al

[10], in Papua New Guinea and Katongo et al [23], in Zambia reported mUIC higher than that found in our study. The result of a study in Saudi Arabia revealed mUIC that is 5-fold higher than that found in the present study [24]. The reason for the wide variations in mUIC reported from different studies is not clear but may be related to differences in iodine content of food items consumed daily by the children in the various locations and iodine content of ground water used for drinking purposes. This view is supported by the results of a study in Nepal which found that consumption of uncooked instant noodles has been associated with higher urine iodine concentration [25]. In addition, absorption of iodine from the intestinal tract can be reduced by the presence of goitrogens (such as cassava, cabbage and lima beans) present in some food items. The results of some studies indicate that deficiency of other micronutrients, such as selenium and iron, respectively impairs the metabolism of iodine [26,27]. Indeed, it is estimated that globally, over 2 billion people suffer from hidden hunger, which is a chronic deficiency of micronutrient [28]. In addition, environmental factors such flooding, deforestation and erosions increase the risk of iodine deficiency due to depletion of iodine content of the soil. Such environmental risk factors are known to be common in Egor LGA, Edo State, Nigeria [12,13]. Furthermore, the results of a study by Macedo et al [29] showed that the method of storage of table salt, duration of storage and environmental factors affect its iodine content, thereby influencing median urinary iodine concentration in different communities, even within the same region.

In the present study, the mUIC varied significantly according to type of school being attended by the children, being higher in children from public schools compared to their counterparts from private schools. Similarly, we found that children from families in the low socioeconomic class (SEC) had a higher mUIC than their counterparts from either middle or high socioeconomic class. In Dhakar, Bangladesh, Atiqur-Rahman et al [20], observed similar higher mUIC in children from families in low SEC. The reason for this finding may be that children from private schools are more likely to come from families in high SEC and hence are more likely to consume fast food which are known to be poor in iodine content. In this regard, Ozdemir et al [30] reported that iodine content and quality in fast foods varied widely. In that study they reported a decrease in iodate content and conversion to other iodine species which is influenced by acidity, moisture content, heating during cooking process, type of cooking spicies and raw materials used. On the other hand, children from families in low SEC being more likely to consume natural food with higher iodine content. In keeping with previous studies in Papua New Guinea [10] and Bangladesh [20], we did not observe significant difference in mUIC with regards to gender.

We observed that over half (66.2%) of the children had mild to moderate iodine deficiency, despite decades of implementation of salt iodization programme in Nigeria. The prevalence rate of iodine deficiency found in the present study is much higher than 3.8% reported by Nwamarah et al [18], in Okpuje, Nsukka LGA, Nigeria. The observed prevalence of mild to moderate iodine deficiency in this study is comparable to that found in Dhakar, Bangladesh [20]. We found that nearly one-quarter (22.4%) of the participants had mUIC below 50µg/L, indicating moderate iodine deficiency. This finding is comparable to 17.9% reported from Papua New Guinea [10] but much higher than 3.0% observed in Saudi Arabia [24]. In contrast to the observation in Papua New Guinea [10], none of the children in the present study had severe iodine deficiency as indicated by mUIC below 20µg/L. On the other hand, a study from Saudi Arabia found that nearly three-quarter of the children had mUIC ≥300 µg/L, indicative of excess iodine nutrition [24]. None of the children in our study had such high mUIC. In contrast to the results of a study in Ethiopia [31], the influence of age and gender on prevalence of iodine deficiency was not statistically significant in the present study.

CONCLUSIONS:

The iodine nutrition status of the children in this study is unsatisfactory, indicating the need for iodine supplementation as well as continuous surveillance to prevent iodine deficiency disorders (IDD). There is the need to pay more attention to school-age children from private schools as well as those from families in high socioeconomic class. Further studies to assess pattern of iodine consumption in these groups of school-age children is worthwhile.

Limitation of the study.

One limitation of the study is that we did not assess the quality and iodine content of table salt being consumed by the children's families.

REFERENCES:

1. Gropper SS, Smith JL, Groff J. Microminerals. In: Advanced Nutrition and Human Metabolism. 4th edition, Belmont, CA, Wadsworth Publishers., 2005:417-487.
2. Zimmerman MB. Iodine deficiency. Endocrine Reviews 2009; 30(4):376-408.
3. World Health Organisation/ United Nation Children's Fund/ International Council for Control of Iodine Deficiency Disorders. Assessment of iodine deficiency disorders and monitoring their elimination: A Guide for programme managers, 3rd ed., Geneva: WHO; 2007.
4. Universal Salt Iodization in Nigeria: Process, successes, and lessons. Federal Ministry of Health for Nigeria's and UNICEF's Joint Publication (2005). www.unicef.org/nigeria/ng_publications_USI_Nigeria_Report.pdf.
5. Federal Republic of Nigeria Official Gazette No 91, Volume 102. Standard Organisation of Nigeria Act, 2015; pages A563-589
6. National Agency for Food and Drug Administration and Control Act (CAP. N1. LFN), 2004. Food Grade (Cooking or Table) Salt Regulations 2021
7. Zimmerman MB, Andersson M. Update on iodine status worldwide. Curr Opin Endocrinol Diabetes Obes 2012;19(5):382-387.
8. Andersson M, Takkouche B, Egli I, Allen HE, Benoist B. Current global iodine status

and progress over the last decade towards the elimination of iodine deficiency. Bull World Hlth Org 2005;83(7):518-525.
9. Haung C-J, Tseng C-L, Chen H-S, Garabwan C, Korovo S, Tang K-T, Won J G-S, Hseih C-H, Wang F-F. Iodine nutritional status of school children in Nauru 2015. Nutrient 2016;8,520; doi:10.3390/nu8090520.
10. Lomutopa SJ, Aqaume C, Willie N, Temple VJ. Status of iodine nutrition among school-age children in Morobe and Eastern highlands provinces, Papua New Guinea. Pacific J Med Sci 2013;11(2): 70-87.
11. Rawal SV, Kedia G. A prevalence study of iodine deficiency disorder in children of primary schools in Gandhinagar district. Nat J Community Med 2011;2(3):478-482.
12. Cerilla GT, Oyalomhe FO, Adekola PO. Determinants of flooding and strategies for mitigation: A two-year case study of Benin City. Geosciences 2019;9: 136-151.
13. Momoh EO, Olotu Y, Olatunde FO, Akharia OO, Igiekhume MJ, Oseni N. Evaluation of socio-economic impact of deforestation in Edo State, Nigeria. J Forests Conscentia Beam 2021;8(1):37-44.
14. Olusanya O, Okpere E, Ezimokhai M. The importance of social class in voluntary fertility control in a developing country. West Afr J Med 1985; 4:205-212.
15. Pino S, Fang SL, Braverman LE. Ammonium persulfate: a safe alternative oxidizing reagent for measuring urinary iodine. Clin Chem 1996; 42:239-243.
16. Egbuta J. Mechanisms of planning IDD programme in Nigeria. In: Olubajo O, Ischei BN eds. Proceedings of the National Workshop on IDD, Lagos. FMOH/UNICEF; 1991:12-16
17. Abua SN, Ajayi OA, Sanusi RA. Adequacy of dietary iodine in two Local Government Areas of Cross River State in Nigeria. Pak J Nutr 2008;7(1):40-43.
18. Nwamarah JU, Otitoju O, Otitoju GTO, Emewulu CUD. Iodine and nutritional status of school-age children in a Nigerian community Okpuje in Nsukka LGA, Enugu State, Nigeria. Des Phamarcia Littre 2015.7(7):271-280.
19. Olasinde YT, Adesiyun OO, Olaosebikan RR, Olasinde A, Ibrahim OR, Ernest SK. Nutritional status and urinary iodine levels of school-age children: Is there a correlation? J Ist Faculty Med 2021;84(2):221-226.
20. Atiqur-Rahman M, Fariduddin M, Mashfiqul-Hasan, Nusrat-Sultana, Sharmin-Jahan, Rauniyan BK et al. Iodine nutrition status in school children in Dhakar City in Bangladesh. Thyroid Res Pract 2019;1 6:71-75
21. Matthys B, Daviatmamadovia M, Karimova G, Jean-Richard V, Zimmermann MB, Wtss K. Iodine nutritional status and risk factors for goitre among school in South Tajikistan. BMC Endocr Dis 2013;50: http//:www.biomedcentralcom1472-6823/13/50.
22. Temple V, Mapira P, Adeniyi K, Sims P. Iodine deficiency in Papua New Guinea (Sub-clinical Iodine Deficiency and Salt Iodization in the Highlands of Papua New Guinea) J Public Health 2004;27:45-48.http://dx.doi org/10.1093/pubmed/fdh199.
23. Katongo C, Kabaghe CG, Mubanga F, Siamusantu W. Prevalence of iodine deficiency among school children and access to iodized salt in Zambia. Afr J Agric Food Nutr Dev 2017;17(4):12628-12640.
24. Alsanosy RMA, Gaffar AM, Khalafalla HEE, Mahfouz MS, Zaid ANS, Bani IA. Current iodine nutrition and progress toward elimination of Iodine Deficiency Disorders in Jazan, Saudi Arabia. BMC Public Health 2012;12:1006 http://www.biomedcentral.co/1741-2358/12/1006.
25. Heydon EE, Thomson CD, Mann J, William SM, Skeaff SA, Sherpa KT, Heydon JL. Iodine status in Sherpa community in a village of the Khumbu region of Nepal. Public Health Nutri 2008; 12(9):1431-1436.
26. Kőhrle J. The trace element selenium and the thyroid gland. Biochemie 1999; 81: 527.

27. Zimmermman M, Adou P, Torresani T, Zeder C, Hourrel R. Persistence goitre despite oral iodine supplementation in goitrous children with iron deficiency anaemia Cӧte d' Ivoire. Am J Clin Nutr 2000; 71:88-93.
28. Godecke T, Stein AJ, Qaim M. The global burden of chronic and hidden hunger: Trends and determinants. Glob Food Sec 2018; 17:21-29.
29. Macedo M, Teixeira RA, Bonomo E, Mariano da Silva CA, Carneiro M, Silva ME, Sakurai E, Lamouneir JA. Iodine malnutrition and associated factors in school children aged 6 to 14 years in a municipality situated in semi-arid region of state of Minas Gerias, Brazil 2008. Food Nutr Sci 2014; 5:2008-2019.
30. Ozdemir Y, Olcay S, Sefik K. Estimation of iodine loss from iodized salt during different cooking and storage conditions. 3rd International Congress on Food and Nutrition, 22-25 April 2009, Antalya, Turkey.
31. Ayalew BS, Hassen SL, Marefiyaw TA, Yesuf MS, Abebe DD, Temesgen MM. Prevalence of urinary iodine concentration among school children in Dessie City, Ethiopia. BMC Pediatr 2021; 21:421 doi.org 101186/s12887-021-02887-7.