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The Status Of Iodine Nutrition Among Pupils Aged 6-12 Years of Hillcrest Schools In Cape Coast In The Central Region Of Ghana – Analysis of Urine Samples

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Abstract

The incidence of iodine deficiency among school-age children is a global concern due to its negative effect on their brain development and academic performance. Such, necessitated this study among the pupils of Hillcrest Schools aged 6-12 years during the 2016/17 academic year in the Cape Coast Metropolis. One hundred and ninety-six (196) urine samples were collected for their iodine concentrations using the Sandell-Kolthoff reaction. The median urinary iodine concentration obtained for the population was 102.14 µg/L at 95% CI. The lower (Q1) and the upper (Q2) quartiles were respectively 81.33 and 138.51. Forty- eight percent (48%) of the samples had urinary iodine concentration below 100 µg/L, and none below 50 µg/L. In addition, one percent was above 300 µg/L. The median value suggests that the pupils had adequate iodine intake and optimal iodine nutrition. This notwithstanding, the inter quartile range (IQR) suggests a polarity of mild iodine deficiency and adequate iodine intake. The study therefore shows that the universal salt iodization programme and the schools' initiative on consumption of iodized salt are having the required impact.

Keywords: iodine deficiency; iodized salt; school-age children.

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1. Introduction

Iodine, which is present mainly in the thyroid gland in minute amount, is for the synthesis of thyroid hormones. The synthesis of the hormone is impaired when iodine intake is inadequate, this inadequacy results in functional and developmental abnormalities called iodine deficiency disorders (IDDs). These disorders can be prevented by the consumption of iodised salt [1, 2].

In children, intakes consistently lower than 50 µg/day especially among school-age children (SAC) usually results in iodine deficiency which manifests as intellectual and developmental disabilities [1, 3].

Iodine deficiency affects negatively the productive and reproductive status of populations. About 90% of the ingested iodine excretes through the urine [3], and the results from the chemical analysis of the urinary iodine gives the extent of the dietary iodine intake and the severity of IDDs for SAC [1].

In 2013, SAC were variously classified as moderately iodine deficient (Ghana), mildly iodine deficient (Russian Federation) and excessive iodine intake (Brazil) [4]. In Africa, SAC surveyed had insufficient iodine intake with a prevalence of 41.1% for Western Africa children [1]. Then in Ghana, population iodine status among SAC in the south was 255 µg/L (adequate iodine intake) whilst the north recorded 79 µg/L (iodine deficient) [5]. Ghana previously classified as mildly deficient [1, 4] was reported to have reached sufficient iodine nutrition at the national level and that the national MUIC of SA [1] ranged from 100-299 µg/L [6].

The Government of Ghana is committed to fighting IDDs among SAC of Ghana with intellectual and developmental disabilities, as they suffer from public discrimination, an attitude that undermines Ghana's commitment [7]. The aim of this study therefore is to find out the status of iodine nutrition among the pupils aged 6-12 years of Hillcrest Schools in Cape Coast Municipality in the Central region of Ghana. The results shall contribute to the baseline data for iodine deficiency disorder (IDD) control programmes in the metropolis. It will also help policy makers in their decisions.

2. Methods

Study Design

The study analyzed the urine samples from the participants for their urinary iodine. Prior to that ethical clearance was obtained from the University of Cape Coast (UCC) Institutional Review Board (IRB), after which consent of volunteers was sought for through their parents and guardians before samples were collected. The statistical instrument was used to analyze the data was SPSS version 21.0.

The Study Site and Participants

The Cape Coast metropolis, the regional capital has many schools ranging from basic to tertiary institutions. These schools attract people from all over the country and the West Africa sub-region who pursue various levels of academic and professional education. Has high density of school - age children [8].

The Calvary Hillcrest School, which is the sampling location is within the metropolis at the bearing of $1^{o}170^{o}$W $5^{o}60^{o}$N. The School was selected for the study because it practices an in-house feeding program for the pupils. In addition, it organizes public lectures for parents, guardians, staff and pupils about IDDs and its prevention.

The participants were children of school age between 6-12 years; and regarded by WHO as good indicators of IDDs in a population. The selection of the participants was made in collaboration with the school authorities.

Sample Collection

Visits and follow-ups to the Hillcrest Schools were to make presentations to the schools administrators, the staff, parents, guardians and pupils to explain the rationale behind the study. Similar outreach was made to the UCC hospital staff that were involved in the sample collection. The samples were collected in six (6) months in 2016/2017 academic year. The spot urine samples (n, 196) were obtained with the help of the University of Cape Coast hospital laboratory staff. Each volunteer was given a sterilized vial (a plain screwable red capped plastic container, BD vacutainer, USA), a pair of disposable hand gloves and plastic pouches. They were directed as to how to fill the vial with one's own urine without contamination and conceal in the plastic pouches. The vials were labeled with code numbers and not the names of the participants. The samples were registered, placed in ice chests and transported to the chemistry department laboratory of the University of Cape Coast for chemical analysis. The samples were stored at 25^{o}C immediately.

Ethical Clearance

Ethical clearance (ID No: UCCIRB/CANS/2016/01) was obtained from the Institutional Review Board (IRB) of the University of Cape Coast, Cape Coast, Ghana.

The consent of the parents/guardians of pupils were sought for after explaining to them the details of this research, confidentiality of the participants and the results; and rights to voluntarily withdraw as spelt out in the consent document.

Sample Analysis

The urinary iodine concentration was assessed by the Ammonium persulphate digestion method using the Sandell – Kolthoff reaction [1]. As a quality control measure, the interval between the time of addition of ceric ammonium sulphate (CAS) and the reading of the absorbance were all the same for all samples, standards and blanks so to rule out any systematic or random biases.

Statistical Analysis

All data were analysed using the Statistical Package for Social Sciences SPSS version 21.0. The median and interquartile range were used to measure central tendency. Simple descriptive statistics such as percentages were also used. The level of significance in all statistical tests was set at P = 0.05.

3. Results

Summary statistics of the population

The summary of the population statistics is shown in Table 1.

Table1: Summary of the Population Statistics.

Population	n	Lower quartile Q1	Upper quartile Q3	Median, µg/L Q2	% sample < 100µg/L	% sample < 50µg/L	% sample > 300µg/L
Pupils	196	81.33	138.51	102.14	48	0	1

Source: Bartels, statistical analysis, 2017

With respect to the lower quartile Q1 with the score of 81.33, not more than 25 percent of the samples is below that score. This means that 50 percent of the data has urinary iodine (UI) of 81.33 µg/L below the median of 102.14 µg/L, and that such pupils typically had insufficient iodine intake below the optimal iodine nutrition.

Not more than 25% of the sample is above 138.51 concerning the upper quartile (Q3), as shown in Table 1. This means that 50% of the data has UI of 138.51 µg/L above the median of 102.14 µg/L. The pupils typically had adequate intake of dietary iodine, and optimal iodine nutrition.

The median (Q2) suggests an optimal iodine nutrition for the population. The inter quartile range (IQR), however, indicates a polarity of insufficient iodine intake (mild iodine deficient, 81.33 µg/L) and adequate iodine intake (138.51 µg/L).

Forty- eight percent (48%) of the data is below 100 µg/L, 1% below 300 µg/L and none below 50 µg/L.

4. Discussion

Implication of the median urinary iodine concentration of the population

Dietary iodine improves the IQ of SAC [1]. Inadequacy or deficiency in the intake results in developmental abnormalities such as cretinism [4], a situation that dulls their mental capacity and could results in loss of 10-15 intelligent quotient points at population level [4]. Much of Europe is iodine deficient [9], and most SAC in Western Africa are also iodine deficient with iodine intake < 100 µg/L [1]. In Ghana, the national median urinary iodine concentration of school-age children ranged from 100-299 µg/L [6], within which the median of 102.14 µg/L of the study population falls as shown in Table 1.

Successive Governments have aided the USI programme in Ghana. Programmes such as The Special Initiative on Salt by the Ministry of Trade and Industry and then The School Feeding by the Ministry of Gender and Social Protection have respectively contributed to the availability and reach of the iodised salt to school-age children and thus addresses child nutrition and cognition [10, 11, 12, 13].

The availability of, and reach of the iodised salt have helped The Hillcrest Schools to effectively practice its mode of school feeding programme. The caterers have easy access of iodised salt to prepare meals for the pupils. In addition, seminars and public lectures on the benefits of consumption of iodised salt are organised by the school for the parents, staff, and pupils [14]

This practice might have contributed to the optimal iodine nutrition status of 102.14 µg/L attained by the population as shown in Table 1. Such an MUIC, 102.14 µg/L, is within the adequate iodine intake bracket of 100-199 µg/L [1]. This placement suggests that the population has attained normal level of iodine and reflects their recent iodine intake as being adequate. The MUIC of 102.14 µg/L obtained by the population is comparable in terms of optimal iodine nutrition status to that of their counterpart in Togo a neighbouring country in West Africa with MUIC of 174 µg/L. However, their counterparts in Ethiopia (East Africa) and South Tajikistan with MUICs of only 24.5 and 51.2 µg/L respectively have moderate to severe iodine deficiency [15, 16], and are therefore relatively deficient in iodine intake.

On the other hand, colleagues in Tanzania, South Africa, India, and in the districts of Tehrathum and Morang in Eastern Nepal had MUIC between 204 and 345.65 µg/L [15, 17, 18] could be said to have consumed above the safe limit of 199 µg/L and more than them.

Implications of inter quartile range of the data

The lower quartile, Q1 with the score of 81.33, as shown in Table 1 suggests that 50 percent of the data points has urinary iodine (UI) of 81.33 µg/L below the median of 102.14 µg/L. such data points typically would have insufficient iodine intake below the optimal iodine nutrition. Concerning the upper quartile (Q3), as shown in Table 1, 50 percent of the data points had UI of 138.51 µg/L above the median of 102.14 µg/L. This is an indication that such data points typically would have adequate intake of dietary iodine, and optimal iodine nutrition. Therefore, the inter quartile range 138.31 – 81.33 (IQR), reveals a data that is polarised between insufficient (mild iodine deficient, 81.33 µg/L) and adequate iodine intake (138.51 µg/L).

Implications of critical epidemiological criteria

The critical epidemiological criteria considered are based on iodine nutrition below 100 µg/L, 50 µg/L and above 300 µg/L [1]. These are critical because they have the tendency to initiate or consummate IDDs in populations [4]. Urinary iodine concentration (UIC) below 100 µg/L, typically, 50-99 µg/L, is classified as having insufficient iodine intake with iodine status of mild iodine deficiency [1]. Many of the samples (**96**, 48%) as shown in Table 1 had UIC below 100 µg/L. This suggests that these samples do not have normal level of iodine, ie, have too little iodine, which affects normal development. These samples are prone to mild iodine deficiency, the consequences are brain damage, impaired development, intellectual disability and extremely cretinism and low IQ (Lazarus, 2015, health direct, 2022) [19, 20]. and are therefore prone to mild iodine deficiency. The volunteers are neither subscribing to the feeding programme nor fully participating in the nutritional education organised by the school. It is therefore important for the school make sure they participate fully in these programmes.

5. Conclusion

The adequacy of iodine nutrition in the population is an indication that the iodised salt program is having the desired impact. In addition, the awareness programme organised by the school is complementing the USI and needs to be sustained. However, both the school authorities and the parents/guardians must ensure the pupils do not consume excess.

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6. Data Availability

Data is available upon request

7. Conflicts of Interest

The authors do not declare any conflict of interest

8. Funding Interest

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