Qualitative Determination of Urine Iodine Concentration And Related Intelligence Quotient among High School Teenagers

Ere Diepreye, Bunu J. Samuel, and Alabo E. Celebrate

ABSTRACT

Nutritional Essential Balance is a common trend in life. Iodine is not produced in the body and it is vital in maintaining good health, therefore it is needed to be consumed regularly. Essential iodine supplies are found in the ocean's bounty such as, sea salt, and fish. On land, iodine levels in the soil are great and are sufficiently maintained by plants such as cereals, vegetables. Several of the body functions rely upon iodine, including energy production, mental development, thyroid hormones production, reproductive glands support, and maintenance of the strong lymphatic system as well as cell growth regulation. Small amounts of iodine are found in the blood, nerves, and other organs of the body, but most of the body's iodine is present in the thyroid, breasts, ovaries, uterus, and prostate glands. The study was aimed to determine and evaluate the level of iodine concentration in the urine of school-age children, and its correlation to their intelligence quotient (IQ). The Titrimetric method was used in iodine urine concentration analysis. Urine (5 ml) was measured from a universal bottle and transferred to a beaker and 20 ml of water was added. After preparing the test mixture, it was titrated with 0.001M sodium thiosulphate using a burette, and at the endpoint colorless solution was obtained, this done for all the samples. From the results, the median urinary iodine levels were 117.7μg/L which is within the adequate iodine intake range (100-199 µg/L). This suggests that iodine was not deficient in any form amongst the school children. There may also be no risk of mental impairment and goiter development among these children if iodine concentration in urine is a risk factor. Therefore, checking the iodine nutrition of a population is vital and a good marker in the assessment of iodine deficiency-related disorders.

Keywords: High school, Intelligence Quotient, Iodine, Titrimetry, Urine

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I. INTRODUCTION

Iodine is an essential trace element that belongs to the halogen group of elements (Group VII) and period 5 in the periodic table. It occurs naturally as sodium iodate and potassium iodate in soil and water, also have essential role in thyroid physiology and is necessary for the development of vertebrate. Iodine can be obtained from different kinds of seafood, iodized salt, vitamin preparation, and dairy products like milk [1]. Iodine deficiency is a global problem with a large population at risk, especially those living in an environment where the soil is deprived of iodine due to glaciations by the leeching effects of snow, water, and heavy rainfall, which could lead to iodine deficiency in cereals and other plants having root in the affected area of the soil [2]. According to WHO, UNICEF, and ICCIDD, the

recommended daily intake of iodine is 90µg for pre-school children (0-59 months), 120µg for children (6-12 years), and $150\mu g$ for adults (above 12 years), [3]. There would be iodine deficiency when there is reduction of iodine intake, and the thyroid gland no longer synthesize sufficient amount of thyroid hormone in the blood circulatory system. This resultant reduction of thyroid hormones levels in the blood, also known as hyperthyroidism, is the primary cause of developing brain damage and other injurious effects collectively known as iodine deficiency disorders or syndrome in children [4], [5]. Previous studies showed that about 1600 million people mostly in developing countries are at risk of iodine deficiency disorder. The effect of iodine deficiency on growth and development can be monitored at various stages of the life cycle [6], [7]. Another group reported that, deficiency of iodine can actually effects the fetus and could result in stillbirths [8], while endemic cretinism as well as increased perinatal anomalies, associated with iodine deficiency leads to neonatal goiter, neonatal hyperthyroidism and exposes the thyroid and related glands to nuclear radiation [9], [10]. In children, iodine deficiency impairs mental function and retarded physical development, while in adults, it results in iodine-induced hyperthyroidism [11], [12].

Iodine is an integral part of the thyroid hormones, thyroxin, abbreviated as T₄, and tri-iodothyronine, T₃, respectively, which are very necessary for the normal growth and development body organs. 50% increase in iodine intake is required in order for pregnant women to produce enough thyroid hormones for both mother and the baby's utilization. Severe iodine deficiency is said to exist when more than 30% of children have goiter and such, the population has a MUIC < 20 μg/L. Pregnant women living in such an area give birth to cretins. Cretinism is associated with a significant impairment in mental function such as loss of hearing, disorder in speech, posture, hypothyroidism, and normal growth [13]. Normal Intelligent Quotient (IQ) in a population is 100%, while the IQ of cretins has been reported to be around 30% [14]. In areas with endemic cretinism, around 5-15% of non-cretineous children are likely to develop impaired mental function with an IQ of 50-69%; these children are sometimes referred to as subcretins. Although factors such as goitrogens in diet, thyroid autoimmunity, and interactions with other trace elements like selenium have been postulated to have a role in the progression and the particular type of cretinism. The predominant reason for cretinism is severe iodine deficiency in the expectant mothers [15]. Reports showed that, mothers whose children were given iodine earlier during the first or second trimester of pregnancy had improved cognitive outcomes compared those given later in pregnancy at both two years and when children were school-aged [16]. Some iodophors, used for the cleaning of milk cans and teats in the dairy industry, increases native iodine content of these dairy products through iodine-residues contamination [17].

A cross-sectional study reported evidence of thyroid function impairment in women of child bearing age as well as in neonates where some levels iodine deficiency affects the intellectual development of children [18]. It also was reported in Southern Spain that mild iodine deficiency (urinary iodine level of 90µg/L), the IQ was significantly more advanced in children with iodine urine levels above 100 μg/L [19]. Specific Iodine deficiency disorders include endemic goiter, [4], [20], caused by naturally occurring goitrogenic agents such as thiocyanate, isothiocyanate, disulfide, polyphenols, Polyhydroxyphenols, pyridines, phthalate esters, polyhalogenated biphenyls, polycyclic aromatic hydrocarbons, excess inorganic iodine [21]. Others include endemic cretinism, neurological cretinism, [22], myxedematous cretinism [23]. Iodine can be replenish by iodized salt [9, 24], iodine supplements in form of potassium iodide [25], iodized oil [26], iodized bread iodized water [27].

Two most frequently methods used in the assessment of iodine nutritional value or concentration in a given population are an estimation of the household use of adequately iodized salt and the measurement of urine iodine concentrations titrimetrically [28]. Urine iodine

concentrations quantification surveys are usually done in school-aged children because they are a convenient population, easy to access, and are usually a representative of the general population. Therefore, we aimed to determine and evaluate the concentration of iodine in the urine of school-age children, and its correlation to their intelligence quotient (IQ).

II. MATERIALS AND METHODS

A. Study subjects

The iodine concentration of school-age children (ages 6-12 years) was evaluated by randomly collecting a representative number of 40 urine samples from the population in Ogboin central school Amassoma, Bayelsa State. The urinary iodine concentration was evaluated following the method proposed by Kendal 1912, [5]; a titrimetric method to determine the level of iodine in urine samples that is suitable for micro and macro scale analysis. The method indicates that 0.1M Sodium thiosulphate is equivalent to 2.115 mg of iodine. 0.001M of Sodium thiosulphate would be equivalent to 21.15µg and was used because of the high concentration of 0.1M NaS₂O₃.

B. Chemicals Reagents

Phosphoric acid, Sodium thiosulphate, Potassium iodide, Bromine water, Phenol, Starch indicator, and Distilled water. All reagents were of analytical grade and used without further purification.

C. Experimental Procedure

Urine (5 ml) was measured from a universal bottle and transferred to a 50 ml beaker and water (20 ml) was added. An aliquot of the diluted urine (5 ml) was measured into three (3) test tubes and saturated bromine water (0.2 ml) was added to each and was heated for a few minutes to remove unfavorable matter. At this point, the orange color of the bromine had started to fade. The test tube containing the solution was removed from the hot water bath before it finally lost its orange color after cooling it at room temperature and was transferred to a conical flask. Saturated phenol (3drops) was added to it and shaken with a rotary motion to give a slightly perceptible white turbidity. The solution was aerated to ensure complete removal of bromine vapors, then 50% phosphoric acid solution (0.5 ml) was added with potassium iodide (0.5 g) which made the solution a fresh yellow color. Starch indicator (3 drops) was added changing the color of the solution to blue-black. The mixture was titrated with 0.001M sodium thiosulphate using a burette, and at the endpoint colorless solution was obtained the steps were repeated for all urine samples.

III. RESULTS AND DISCUSSION

Results obtained from the qualitative analysis are presented in tables and charts: as shown in table I, II, III and fig 1, respectively.

TABLE I: CONCENTRATION ($\mu g/L$) OF IODINE OBTAINED FROM SUBJECT URINE

| Sample | Mean titre value (ml) | Concentration of Iodine $(\mu g/L)$ |
|--------|-----------------------|-------------------------------------|
| 1 | 7.30 | 154.40 |
| 2 | 7.53 | 159.26 |
| 3 | 7.10 | 150.17 |
| 4 | 8.20 | 173.43 |
| 5 | 6.93 | 146.57 |
| 6 | 10.73 | 226.94 |
| 7 | 7.10 | 150.17 |
| 8 | 8.37 | 177.03 |
| 9 | 7.03 | 148.68 |
| 10 | 8.00 | 169.20 |
| 11 | 11.07 | 234.13 |
| 12 | 6.97 | 147.42 |
| 13 | 5.07 | 107.23 |
| 14 | 8.70 | 184.01 |
| 15 | 7.67 | 162.22 |
| 16 | 6.07 | 128.38 |
| 17 | 5.30 | 112.10 |
| 18 | 6.67 | 141.07 |
| 19 | 6.00 | 126.90 |
| 20 | 7.07 | 149.53 |
| 21 | 5.80 | 122.67 |
| 22 | 7.23 | 152.91 |
| 23 | 7.97 | 168.57 |
| 24 | 4.97 | 105.12 |
| 25 | 8.60 | 181.89 |
| 26 | 11.87 | 251.05 |
| 27 | 4.27 | 90.31 |
| 28 | 7.97 | 168.57 |
| 29 | 6.00 | 126.90 |
| 30 | 6.40 | 135.36 |
| 31 | 8.97 | 189.72 |
| 32 | 8.37 | 177.03 |
| 33 | 5.03 | 106.38 |
| 34 | 8.70 | 184.01 |
| 35 | 8.75 | 185.06 |
| 36 | 10.40 | 219.96 |
| 37 | 9.20 | 194.58 |
| 38 | 10.67 | 225.67 |
| 39 | 7.23 | 152.91 |
| 40 | 7.03 | 148.68 |

Iodine concentration (x μ g) = Titre value (ml) × 21.15. Where X= value of iodine concentration in 10ml of urine. (μ g - microgram, L - Litre, ml - millitre)

TABLE II: URINE IODINE CONCENTRATION ($\mu g/L$) IN SCHOOLAGE CHILDREN (6-12)

| Class | Class interval | Frequency | Cumulative |
|-------|-----------------|-----------|------------|
| | $(x) - \mu g/L$ | | Frequency |
| M1 | 90 - 124 | 2 | 2 |
| M2 | 125 - 159 | 9 | 11 |
| M3 | 160 - 194 | 5 | 16 |
| M4 | 195-229 | 3 | 19 |
| M5 | 230 - 264 | 1 | 20 |
| F1 | 90 - 124 | 4 | 4 |
| F2 | 125-159 | 7 | 11 |
| F3 | 160 - 194 | 5 | 18 |
| F4 | 195-229 | 1 | 19 |
| F5 | 230 - 264 | 1 | 20 |

Key: M-Male, F-Female

TABLE III: SUMMARY OF URINARY IODINE CONCENTRATION $(\mu g/L)$ IN SCHOOL-AGE CHILDREN.

| Class | Class interval (x) | Frequency | Cumulative Frequency |
|-------|--------------------|-----------|-------------------------|
| 1 | 90-124 | 6 | 6 |
| 2 | 125 - 159 | 16 | 22 |
| 3 | 160 - 194 | 12 | 34 |
| 4 | 195-229 | 4 | 38 |
| 5 | 230 - 264 | 2 | 40 |

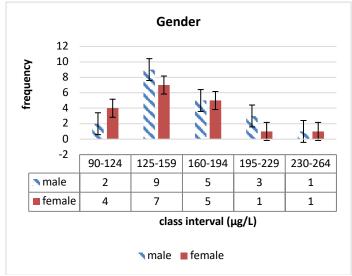


Fig 1. Gender comparison of urinary iodine concentration ($\mu g/L$) in schoolage children.

Iodine in the blood is in the iodide form, it is either taken up by the thyroid and converted into thyroid hormone or excreted in the urine. Almost 90% of the ingested iodine is excreted in the urine. Thus, urinary iodine excretion is a good biomarker of very recent dietary intake of iodine [29]. The epidemiological criteria for assessing iodine nutrition based on median urinary concentration in school-age children (6 years and above) is given by WHO, UNICEF, ICCIDD [3].

From this study, the median urinary iodine levels of the school-age children in Ogboin Central School Amassoma were 117.7 μ g/L which is within the adequate iodine intake range (100-199 μ g/L). This figure suggests there's no risk of iodine deficiency disorder in any form amongst the school

children in Amassoma. There may be no risk of mental impairment and goiter development in the children if high urinary iodine is a factor. According to Aghini, et al (1997) who reported that the intellectual quotient (IQ) is higher in children with urinary iodine levels above 100 µg/L than those with urinary iodine levels less than 100µg/L [18]. Thus this could be applied to the children of Ogboin Central School Amassoma, Bayelsa state, as their urinary iodine level fell within the required acceptable standard range.

Urinary iodine quantification is a well-accepted, costefficient, and easily obtainable indicator of iodine status. Since the majority of the iodine absorbed by the body is excreted in the urine. It is therefore considered, a sensitive marker of current iodine intake and can reflect recent changes in iodine status. The main biochemical indicator widely used for the assessment of iodine deficiency disorder is the urinary iodine concentration (UIC) and the quantity of iodine required (IDD) by an individual is between 150-200µg per day [30], which main role is in the synthesis of thyroid hormone, essential for the brain and physical development [31]. IDD affects all ages but pregnant women and children are at high-risk of developing IDD [32]. Furthermore, no form or symptom of malnutrition was observed among the students [33]. Thus, since the results indicates the optimal iodine level in the body (urine), the iodine nutritional intake should be maintained among this population.

IV. CONCLUSION

Monitoring the iodine nutrition of a population is a good marker in the assessment of iodine deficiency disorder. Insufficiency and excessive intake of iodine can result in thyroid dysfunctional diseases. If the thyroid diseases are due to iodine-induced phenomena, the main management is to either avoid or reduce intake of iodine, followed by the appropriate medications when there are symptoms or abnormality with the thyroid function test (TFT) results. This population showed an acceptable level of iodine concentration in their, which is a good indicator that the sources of their iodine consumption such commonly used home table salts, iodine fortified diets and other sources are very reliable. This was evident on the part of the school children, from their good academic performances and testimonies from the teachers. None of the students was seen with any symptom or syndrome (syndrome) associated with iodine deficiency or malnutrition. Hence, the method is efficient in the qualitative determination iodine from biological fluids.

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