Iodine Replete among Populations in Nigeria: Is the Population Tending Towards the Development of Iodine Induced Hyperthyroidism (IIH)?

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Abstract: Iodine is a micronutrient which is required for normal thyroid function. The recommended daily intake for iodine is 150 µg, however in pregnant women; higher levels up to 250 µg could be required. Deficiency of iodine in any given population results in iodine deficiency disorder (IDD). Researchers in Nigeria as far back as 1967 had reported the existence of IDD. To combat this public health problem with its associated medical consequences, a policy to ensure salt iodization was enacted. The Nation’s consistent approach to combat IDD was globally recognized and it was adjudged as the only country in Africa that had achieved the goals of sustained elimination of IDD. Although the health benefits derivable from salt iodization seem to outweigh its risk, yet recent epidemiological data are pointing that populations within the country could be tending toward the development of Iodine Induced Hyperthyroidism (IIH), a common disorder associated with salt iodization following chronic iodine deficiency. The need therefore to use evidence based approach to re-examine the County’s iodization policy as well as investigate the impact of salt iodization on thyroid hormone formation, metabolism and associated pathologies becomes very imperative. This could be very helpful in order to prevent the burden of non- communicable disease in a nation already battling with epidemics of various infectious diseases.

Key Words: Iodine Induced Hyperthyroidism, iodine, goiter.

Introduction:
The Trace Element, Iodine
Iodine is an essential micronutrient for all animals including humans. It is a chemical element like oxygen, hydrogen and iron. It occurs in a variety of chemical forms, the most important being iodide (I-), Iodate (IO3) and elemental iodine (I2). Iodine is generally distributed in major food items including dietary products. Large quantities of iodide are present in drugs, antiseptics, bread, food preservatives and fast food products, and these however form the major sources for iodine intake. Iodized table salt or oil usually make up for any lack of it in the food that we consume.[1,2]

Iodine Requirement and Functions:
The daily recommended intake of iodine is: 150 microgram (µg) for adults, 200 µg during pregnancy, 50 µg for the first year of life, 90 µg for ages 1 to 6, and 120 µg for ages 7 to 12.[3,4] Normal thyroid status is dependent upon iodine for production of thyroid hormone. Iodine is a component of thyroid hormones: thyroxine (T4) and tri-iodothyronine (T3). Iodine deficiency may affect approximately one billion people throughout the world. One of the major physiological functions of thyroid hormone is the promotion of general body growth and development. It helps in normal foetal development and in the myelination of the brain, thus enhancing brain development.

The Thyroid and Iodine Metabolism:
Iodine is an essential element for thyroid hormone synthesis. The thyroid gland has the capacity to handle iodine efficiently both when the availability of iodine becomes scarce and when iodine is in excess. In the latter, the conversion of iodide to iodine (oxidation), iodination of tyrosine (an amino acid which is required for the synthesis of thyroid hormone) and the enzyme that catalyses the reaction, thyroid peroxidase (TPO) are inhibited. This is known as the Wolf-Chaikoff effect. This process prevents the formation of monoiodothyroxine (MIT) and diiodothyroxine (DIT) thus limiting the production of thyroid hormone. This effect is an effective means by which the thyroid rejects large quantities of iodine thus preventing the thyroid from synthesizing large quantities of thyroid hormones.

Iodine Deficiency Disorders:
The term Iodine Deficiency Disorders (IDD) refers to all the ill-effects of iodine deficiency in a population. This disorder can be prevented by ensuring that the population has an
adequate intake of iodine.[1] These disorders include: endemic goiter, hypothyroidism, cretinism and congenital abnormalities. While endemic goiter is the most visible consequence of iodine deficiency, the most significant and profound effects are on the developing brain. The potential impact of iodine deficiency on the intellectual development of large segments of populations in underdeveloped countries and in most parts of developed world is of particular concern, especially when all of the adverse effects of iodine deficiency can be prevented by long-term, sustainable iodine prophylaxis.[1] In most countries of the world, universal salt iodization has been employed as a means of eliminating disorders secondary to iodine deficiency. WHO, UNICEF and ICCIDD has brought iodine sufficiency within reach of about 1.5 billion people of the world who were deficient decades ago; and now rely on the urinary iodine concentration as the primary indicator of effectiveness.[4] In Africa and indeed Nigeria, great progress has been made towards the elimination of iodine deficiency, saving millions of children from its adverse effects, largely due to the increased household availability of iodized salt.[5]

**History of Iodine Deficiency Disorder (IDD) in Nigeria:**
The entire landscape of Nigeria predisposes the country to IDD because of its proximity to the long months of rainfall ranging from April to November.[6] As early as 1967, Ekpechi [7] alerted the Federal Government of Nigeria of the existence of IDD in the country. To address this, a ministerial committee on salt iodization was set up in 1974. This committee was not able to achieve much due to lack of funds. Furthermore, early studies of Ekpechi [7,8], Olunin [9] and Nwokoko and Ekpechi [10] showed that IDD was a public health problem in Nigeria. Isichei in 1987 [11] made more revelations on the existence of IDD in the country and subsequently conducted a study which led to the production of the goiter belt map for Nigeria.

**Universal Salt Iodization in Nigeria and Control of IDD**
As stated earlier, the geographical location of Nigeria coupled with the long period of rain fall witnessed in the country predisposes the citizens of Nigeria to IDDs.[6] To combat this public health problem which has severe health consequences on humans and animals, the government of Nigeria in 1994, enacted a law stipulating that all salt for human and animal use should be iodized. Iodine concentration of 50ppm was enacted a law stipulating that all salt for human and animal use should be iodized. Iodine concentration of 50ppm was the goiter be

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**Recent Scientific Data Pointing to Iodine Induced Hyperthyroidism in Nigerian Population:**
Campaign for universal salt iodization in Nigeria has been on for a very long time. This is following a long period of advocacy with medium and high policy makers, regulatory agencies and the salt industry. Universal Salt Iodization has been adopted by almost all the households in the country. At present, about 98.7% of Nigerians have access to iodized salt.[13]

As far back in 1996, Latum [16] had reported that iodine consumption was high in two major towns in Nigeria. These towns were: Uzo-Uwani and Akoko-Edo. These towns have been known for iodine deficiency. In the study, it was
discovered that urinary iodine excretion ranged from 55-3250µg/L and 55-1200µg/L in Uzo-Uwani and Akoko-Edo respectively.[16]

In 2009, study was conducted to assess the Urinary Iodine excretion (UIE) among Primary School Children in Ibadan, Nigeria. Classifying the urinary iodine level obtained based on World Health Organization (WHO), United Nation’s International Children Emergency Fund (UNICEF) and International Council for the Control of Iodine Deficiency Disorders (ICCIDD) recommendation, it was found that more than 67% of the studied populations had excess urinary iodine concentration with levels greater than 300µg/L (Table 1).[20]

In a similar study conducted to investigate the nutritional status of Iodine among selected population in Saki, South West, Nigeria. a region well known for iodine deficiency and endemic goiter, the finding revealed that 50% of the studied population had excess urinary iodine concentration, with UI concentrations greater than 300µg/L. (Table 2).[21] The findings from these studies are good pointers that the population might be consuming high amounts of iodized salts. These reports are in consistent with the observations made by previous studies.[16,17]

Laboratory data showing the pattern of thyroid function test and results obtained, collected from the endocrinology laboratory, Clinical Chemistry unit of the University College Hospital Ibadan, a major referral center for many patients in south-western Nigeria and other nearby states have shown that there has been a consistent increase in the number of patients investigated for endocrine thyroid disorder as well as in the diagnosis made for classical hyperthyroidism and sub-clinical hyperthyroidism (SCH) Figure 2. There is no doubt that the increase in the number of thyroid request and the high rate of diagnosis of both clinical hyperthyroidism (high T3, T4 and low TSH) and sub –clinical hyperthyroidism (Normal T3, T4 and Low TSH) could be a pointer to long exposure to iodine prophylaxis from various sources. In Nigeria, the iodine legislation for the country allowing iodized salt at 50ppm per kg of salt contrary to the WHO recommended level of 20-40ppm/kg of salt might not have been based on available evidence. Recognizing this fact, experts in 2009 called on researchers to study the likelihood of the presence of iodine induced hyperthyroidism in the country.[13,22]

Table 1: Classification of Iodine Nutrition of children (N=300) from selected primarily schools in Ibadan, Nigeria based on the epidemiological criteria for Assessing Iodine nutrition using Joint criteria of WHO, UNICEF and ICCIDD (2001)

<table>
<thead>
<tr>
<th>Range (µg/L)</th>
<th>Distribution (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Severe (&lt; 20)</td>
<td>0</td>
</tr>
<tr>
<td>Moderate (20-49)</td>
<td>15 (5)</td>
</tr>
<tr>
<td>Mild (50-99)</td>
<td>15 (5)</td>
</tr>
<tr>
<td>Sufficient (100-199)</td>
<td>69 (23)</td>
</tr>
<tr>
<td>Excess (&gt;300)</td>
<td>201 (67)</td>
</tr>
</tbody>
</table>

Source: Onyeaghalu et al., [20].

Figure 2: Review of Thyroid Function Test in University College Hospital Ibadan, (2004-2009)

Research should be designed to investigate the current impact of salt iodization on the population with a view to ascertaining its effects on the thyroid and associated pathologies. There is a need therefore to use evidence based approach to re-examine the County’s iodization policy as well as investigate the impact of salt iodization on thyroid hormone formation, metabolism and associated pathologies becomes very imperative.

Recommendation:
Following this review, we recommend that a well-structured research should be designed to investigate the current impact of salt iodization on the population with a view to assessing its effects on the thyroid and associated pathologies. There is a need therefore to use evidence based approach to re-examine the County’s iodization policy as well as investigate the impact of salt iodization on thyroid hormone formation, metabolism and associated pathologies becomes very imperative.

Table 2: Classification of Iodine Nutrition of children (N=280) from selected primarily schools in Saki, South West Nigeria based on the epidemiological criteria for Assessing Iodine nutrition using Joint criteria of WHO, UNICEF and ICCIDD (2001)

<table>
<thead>
<tr>
<th>Range (µg/L)</th>
<th>Distribution (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Severe (&lt; 20)</td>
<td>2 (0.7)</td>
</tr>
<tr>
<td>Moderate (20-49)</td>
<td>9 (3.2)</td>
</tr>
<tr>
<td>Mild (50-99)</td>
<td>14 (5)</td>
</tr>
<tr>
<td>Sufficient (100-199)</td>
<td>115 (41.1)</td>
</tr>
<tr>
<td>Excess (&gt;300)</td>
<td>140(50)</td>
</tr>
</tbody>
</table>

Source: Onyeaghalu et al., [21].

Thyroid Antibodies in Nigeria Population:
In iodine deficiency, there is the proliferation and mutation of thyrocytes, with increase in production of thyroid antibodies. Studies describing the presence of thyroid antibodies in Nigeria population are limited. However, in a study conducted by Okosie et al [23], they reported the presence of significant thyroid peroxidase antibody (TPOAb) and Thyroid Globulin antibody (TgAb) in selected patients with various thyroid diseases (Figure, 3). They concluded that thyroid antibody appears more common in Nigerian patients than in previous studies conducted in other African countries. It might be possible that the secretion of thyroid auto antibodies and TSH- sensitive cells could be precipitating the development of various hyperthyroid disorders in a population previously challenged with iodine deficient disorders.

Figure 3: Percentage of subjects with positive TPOAb and TgAb in the various clinical groups of patients. Asterisk indicate differences from control groups * P< 0.05; ** P< 0.001, X² test. (Notes: TPOAb : Thyroid Peroxidase Antibody, TgAb: Thyroid Globulin Antibody, GD; Grave’s Disease, SNTG: Simple non-toxic Goiter, TNG: Toxic Nodular goiter, HT: Hyperthyroidism) Source : Okosie et al [23].

Conclusion:
Nigeria is a country burdened with many communicable and non-communicable diseases. With inadequate healthcare facilities, inequalities in health distribution, limited access to adequate healthcare by citizens where available, the country may not be able to accommodate a new epidemic of non–communicable disorder. In all programs targeted towards improving the micronutrient nutritional status of any population including that of iodine, adequate monitoring of targeted population with a view to preventing either an over or under correction of the micronutrient is always an integral component of interventional programmes. The need therefore to use evidence based approach to re-examine the County’s iodization policy as well as investigate the impact of salt iodization on thyroid hormone formation, metabolism and associated pathologies becomes very imperative.
also the need to use evidence base approach to reassess the current level of salt iodization within the country.

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Conflict of Interest:
We declare that this publication is devoid from any form of conflict of interest

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