**Imperial Journal of Interdisciplinary Research (IJIR)**
**Vol-2, Issue-11, 2016**
**ISSN: 2454-1362,** http://www.onlinejournal.in

# Investigation into the Iodine Nutritional Status of Pregnant and Lactating Women in Western Area of Sierra Leone.

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***Abstract:*** *The research used a non-probabilistic method to select samples of pregnant and lactating women attending both private and public Hospitals. Five hospitals were selected from each category i.e. Government/public hospitals and private hospitals, making a total of 10 hospitals. Urine samples were drawn from 25 pregnant and 25 lactating women in each of the selected hospitals for laboratory analysis in other to determine their urinary iodine concentrations. In addition to the urine samples, salt consumed by the individual participants were also collected and tested for their iodine concentrations. The median urinary iodine concentration was higher for pregnant women attending private hospitals (253µg/l) compared to those attending public hospitals (118µg/l). For lactating women on the other hand, the difference is minimal for the attendance of the two classes of hospitals i.e. 218µg/l and 212µg/l, for public and private hospitals respectively. The outcome of the plot of urinary iodine concentration versus the salt iodate content for both private and public hospitals shows a weak correlation. The currently recommended iodine consumption through iodization of salt universally proves to be appropriate.*

***Keywords:*** *Iodine; Deficiency, Pregnancy; Lactation, Nutritional Status, Sierra Leone*

## 1. INTRODUCTION

Iodine is a trace element necessary for thyroid hormones biosynthesis in human and is acquired exclusively from external sources (1). Its deficiency is a serious problem in many parts of the world especially in places where the daily diet has little or no iodine at all such as in typical remote inland regions and semi-arid equatorial environments which are void of marine foods. Thyroid hormones regulate several cellular metabolic processes, influencing the cells activities throughout life. The most significant role of thyroid hormones is its contribution in the development of normal brain and intellect (2-4). It has been revealed that inadequate iodine consumption during pregnancy, lactation and in newborns may result to permanent brain damage (5-7). The effect of this deficiency varies from cretinism in severe iodine deficiency (ID) areas to children inability of achieving their potential intelligence quotient in mild to moderate iodine deficiency regions (5). Additionally, ID can result to miscarriage, premature birth, increased rate of perinatal and infant mortality, low birth weight, goiter etc. (3, 4, 8). Thus a diet poor in iodine is linked with a wide range of adverse health effects collectively referred to as iodine deficiency disorder (IDDs) (5, 6). The effect of IDDs can be experienced by people of all ages; however the fetus is the most vulnerable to the deficiency of iodine as inadequate consumption of iodine during pregnancy decreases the neural interconnections network density in the brain of the fetus which can result to a permanent impairment of an individual intellectual ability (6). Research shows that low iodine intake can reduced intelligent quotient (IQ) with 10-15 points (9). Thus one can say sufficient iodine consumption during pregnancy and lactation can be a good aid to child's brain development.

As the concern of the effect of iodine deficiency in children keep growing, it has been recognized as a basic human right for every child to have a sufficient quantity of iodine nutrition for their normal development and same way so, all mothers has the right to sufficient iodine nutrition to enable their unborn babies reach their potential intellectual development (10). Additionally it is assumed that iodine-related neuro-developing deficits of generation yet unborn can be stopped or minimized by promoting salt iodination universally and the use of iodine supplement from the start of pregnancy or during preparation for pregnancy (11) . The thyroid gland is incapable of storing the amount of iodine needed in the human system, as a result , small quantity of iodine should be consumed in our everyday diet (12-13). Thus the World Health Organization (WHO) recommended the following daily consumption in micrograms for optimum iodine nutrition: adults = 150µg/day, pregnancy and lactation = 200µg/day, Children =

(6-12 years) = 120µg/day and infants (0-5 years) = 90µg/day (14).

In sierra Leone, sub-clinical iodine deficiency is considered to be prevalent, a study by Aguayo et al (2003) reported an estimated 25% of child bearing age suffer from goiter, and only 23% of households have accessed to adequately iodized salt (15). Another study conducted to evaluate the extent of IDD among school going children in designated districts in Sierra Leone revealed: 12% mild, 32% moderate and 53% severe disorders respectively (10). As a result of these outcomes, the Government of Sierra Leone established a policy of iodized salt. This legislation requires that any salt imported into the country should contain a minimum of 35ppm of iodine. Salt is imported mainly from Senegal and Europe and the imported salt accounted for about 65% of the total consumable salt in the country with the locally produced salt which is void of iodine making up of about 35% respectively (1). Despite the fact that the percentage of iodized salt is high compared to the non-iodized salt, its cost is higher than that of the locally produced salt, thus some low income earners prefer the locally produced salt. Moreover, even those that can afford the iodized salt do not normally store the product properly, thus most of it's iodine content is lost by evaporation before been completely used ((1).A survey conducted in 2003 on available salts in the market and households showed that locally produced salt was highly consumed in producing areas in the country such as Port Loko District, which is the highest producer of local salt(10,16). This is so because locally produced salt being wet and heavy was not transported to far off markets. The study established that the local salt (non-iodized salt) has a greater market share in districts connecting the salt production areas and that the consumption of non-iodized salt in areas such as Port Loko is high(16)

Thus the study therefore aims at evaluating the iodine nutritional status of pregnant and lactating women in the western area of Sierra Leone, with the listed objectives:

- To reveal the status of iodine nutrition in pregnant and lactating women in the Western Area of Freetown
- To compare the iodine nutritional status of pregnant and lactating women attending private hospitals to those attending public/government hospitals
- To investigate the influence of iodized salt on the iodine statue of pregnant and lactating women and
- To evaluate the relationship between salt iodate content and urinary iodine concentration of pregnant and lactating women.

## 2. MATERIALS AND METHODS

### 2.1. Sample collection

There are two main categories of hospital in Sierra Leone; these are private and government hospitals. The private hospitals are far more expensive in terms of medication and treatment cost compared with government hospitals. Other things being equal, it is expected that patients in the private hospitals belong to the upper class in the society. Thus patients in the former category are expected to come from homes that feed on adequately iodized salt (more expensive) while those in the other category are more likely to come from homes that feed on less iodized or non-iodized salt. This serves as the premises for the selection of hospitals from which samples are drawn for analysis. Also it is expected that the analysis of salt samples from the homes of the patient will help correlate the relationship between urinary iodine concentration and salt iodate content. Five hospitals from each category were selected and samples (early morning urine) were taken from 25 pregnant and 25 lactating women in each hospital making up a total of 250 pregnant and 250 lactating women. Table 1 shows the selected hospitals.

Table 1: Selected Hospitals from where Samples were collected.

| Number | Public Hospitals | Private Hospitals |
|---|---|---|
| 1 | Jenner Wright Clinic | Rina Clinic |
| 2 | King Harman Road Hospital | St. john Clinic |
| 3 | Lumley Hospital | NacTIB New Life Hospital |
| 4 | Macauley Satellite hospital | Curney Barenes |
| 5 | P.C.M. hospital | West End Clinic |

### 2.2. Analysis of Urinary Iodine

The urinary iodine analysis was carried out using the Sandell-Kolthoff reaction (17).

- Standard solution of iodine was prepared by dissolving 1.68mg of $KIO_3$ in deionized water to a final volume of 100ml. The concentrated solution obtained was then diluted to obtain standards of 50,100,150,200 and 250µg/l respectively.

- Each urine sample was thoroughly shaken by hand to ensure solution uniformity.
- 0.25ml of each sample was pipetted into a labeled test tubes, samples of each standard (0.25ml) was also pipetted into similar test tubes followed by the addition of water to make up to a final volume of 250µg/l
- 1ml of 1.0M ammonium persulphate was added to each tube
- All the tubes including the samples, standards and blanks where heated in a boiling water bath at 100°C for about 60min.
- The tubes where cooled to room temperature
- 2.5ml of aresnious acid solution was added and mixed by inversion. They were then allowed to stand for 15min.
- 3.0ml of ceric ammonium sulphate solution was added to each tube and quickly mix.
- The test tubes where allowed to stand at room temperature for exactly 30min after the addition ceric ammonium sulphate to the first tube. After this time interval, the absorbance was read at 420mm. Successive tubes where also read at the same interval after the addition of the ceric ammonium sulphate and then recorded for each tube against their serial numbers.
- A standard curve was constructed by plotting the iodine concentration of each standard on the abscissa against its absorbance on the ordinate. Concentrations of the unknown samples were read on the standard curve obtained.

### 2.3. Analysis of Salt Samples

- 50g of each salt sample was accurately weighed in a clean dry beaker, dissolved with distilled water and then transferred quantitatively to a 250ml volumetric flask and then made up to the mark.
- 50ml of this solution was then pipetted into a 250ml conical flask, 1.0ml of 2.0M $H_2SO_4$ was added followed by 5.0ml of 10% KI solution (the solution turns yellow). The flask was closed and put in a dark fume cupboard for 10minutes
- The solution from each flask was titrated with thiosulphate solution until the solution turned pale yellow. 2ml of starch indicator was added to the solution (the solution turns dark purple) and then the titration was continued until the solution turns pink and finally colorless.
- The level of the thiosulphate in the burette was recorded and the titer value noted.
- The titration was done in triplicate and average titter values were then calculated.
- The average titter values were converted to ppm using a standard conversion table.

## 3. Results

Since values of urinary iodine tend not to be normally distributed, the median values are the preferred measure to report a population urinary iodine concentration data (5). The results of this study were analyzed in accordance with Table 2 (5).

Table 2: Measure to report population urinary iodine concentrations for pregnant and lactating women.

| **Median Urinary Iodine Concentration (µg/l)** | **Iodine intake** |
|---|---|
| **Pregnant women** | |
| **<150** | Insufficient |
| **150-249** | Adequate |
| **250-499** | Above requirement |
| **≥500** | Excessive |
| **Lactating women** | |
| **<100** | Insufficient |
| **≥100** | Adequate |

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Table 3: Urinary iodine concentrations and Salt iodate concentrations of pregnant and lactating women for both private and public hospitals.

| Urinary iodine concentration for pregnant and lactating women (µg/l) | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Pregnant women | | | | | | | | | Lactating Mothers | | | | | | | | |
| | | | Percentage in ranges(µg/l) | | | | | | | | | Percentage in ranges (µg/l) | | | | | |
| Categories | Mean(µg/l) | Median(µg/l) | <50 | 50-99 | 100-149 | 150-199 | ≥200 | | Categories | Mean(µg/l) | Median(µg/l) | <50 | 50-99 | 100-149 | 150-199 | ≥200 | |
| Public hospitals | 153 | 118 | 20 | 20 | 16 | 12 | 32 | | Public hospitals | 207 | 212 | 8 | 16 | 4 | 12 | 60 | |
| Private hospitals | 218 | 253 | 4 | 12 | 12 | 4 | 68 | | Private hospitals | 216 | 218 | 4 | 4 | 12 | 16 | 64 | |
| Salt iodate concentration for pregnant and lactating women (ppm) | | | | | | | | | | | | | | | | | |
| Pregnant women | | | | | | | | | Lactating mothers | | | | | | | | |
| | | | Percentage in ranges (ppm) | | | | | | | | | Percentage in ranges (ppm) | | | | | |
| Categories | Mean (ppm) | Median(ppm) | <15 | 15-25 | 25-35 | ≥35 | | | Categories | Mean(ppm) | Median(ppm) | <15 | 15-25 | 25-35 | ≥35 | | |
| Public hospitals | 17.43 | 17 | 28 | 56 | 16 | 0 | | | Public hospitals | 21.15 | 21 | 16 | 44 | 40 | 0 | | |
| Private hospitals | 21.12 | 23 | 12 | 56 | 28 | 4 | | | Private hospitals | 22.52 | 22 | 8 | 60 | 24 | 8 | | |

Out of a total of 250 pregnant women in private hospitals, 180 showed adequate urinary iodine concentration which constitute 72% of the total and the remaining 28% accounted for insufficient iodine intake. The mean and median urinary iodine concentration for pregnant women in private hospital is 218 µg/l and 253µg/l respectively. For lactating mothers on the other hand, 92% showed adequate urinary iodine concentrations. The remaining 8% that showed low urinary iodine concentration was considered iodine deficiency. The mean and the median urinary iodine concentrations for lactating mothers in private hospital are 216µg/l and 218µg/l respectively. This results shows that there is little or no risk of iodine deficiency for pregnant and lactating women in this category of hospitals.

For public hospitals, 44% and 76% of the sample studied showed adequate urinary iodine concentration for pregnant and lactating women respectively. The mean and the median urinary iodine concentration for pregnant women in this category of hospital are 153µg/l and 118 µg/l and that for lactating mother is 207µg/l and 212µg/l respectively. Thus, there is a risk of iodine deficiency for pregnant women while there is little or no risk of iodine deficiency for lactating mothers.

The mean and median salt iodate content for pregnant women attending private hospitals is 21.12ppm and 23.00ppm respectively. From this a total of about 12% of the test samples do not contain adequate iodine and 88% contain adequate iodine (≥15ppm). For the lactating mothers, the mean and the median salt iodate concentrations are 22.52ppm and 22.00ppm respectively. 92% of the sample under study showed adequate iodine concentration (≥15ppm) with only 8% of the sample with insufficient iodine.

Pregnant women in public hospital shows mean and median salt iodate concentrations of 17.43ppm and 17.00ppm respectively. A total of 72% of pregnant women do consume salt that is adequately iodized (≥15ppm). For lactating mothers, the mean and median salt iodate concentration was 21.15µg/l and 21.00µg/l respectively. 84% of lactating mothers in this category of hospital do consume salt that is adequately iodized (≥15ppm).

Figure 1 and 2 compared the results obtain form both category of hospitals i.e. urinary iodine concentration and salt iodate content for both private and public attendance.

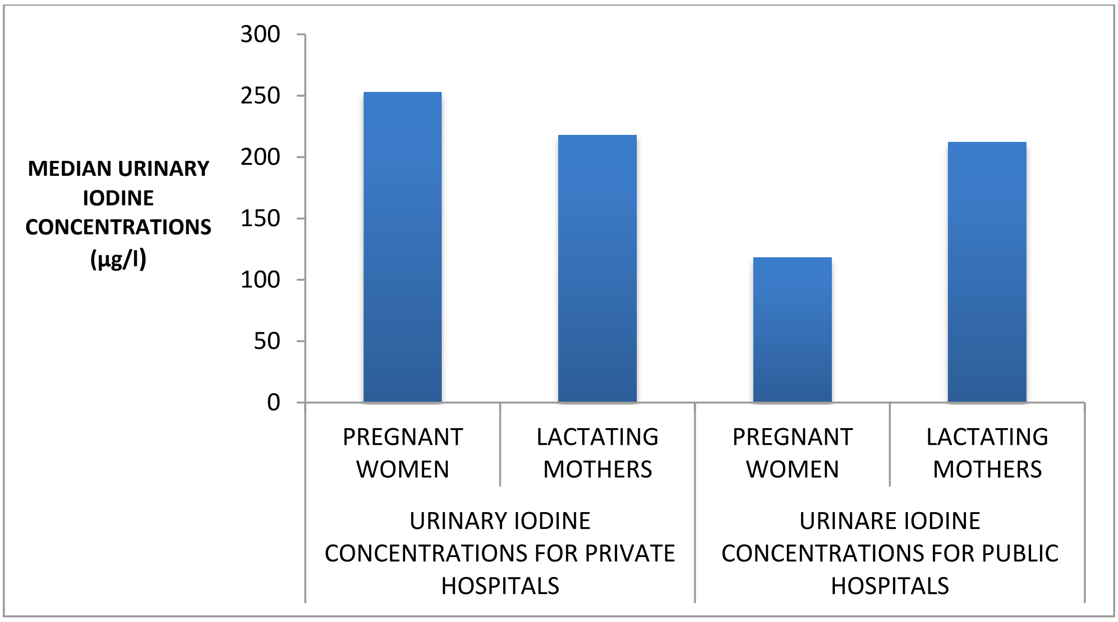


Figure 1: Comparison between urinary iodine concentration of pregnant and lactating women in private and public hospitals.

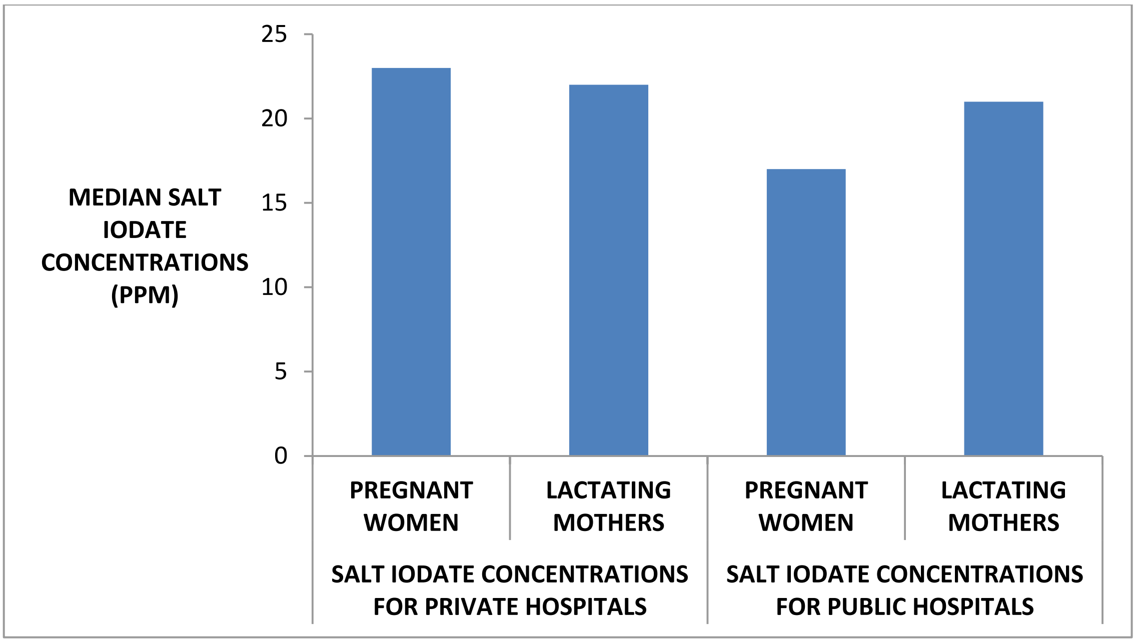


Figure 2: Salt iodate content of pregnant and lactating women in private and public hospitals

From these results, it can be seen that patients attending private hospitals seem to have a higher median urinary iodine concentration and salt iodate content when compared to those attending public hospital.

Figures 3, 4, 5 and 6 represent the relationship between urinary iodine concentration and salt iodate content for both private and public attendance. For this correlation, results from one of the hospitals in each of the categories under study was used i.e. Curney Barns for private hospital and PCMH for public hospital.

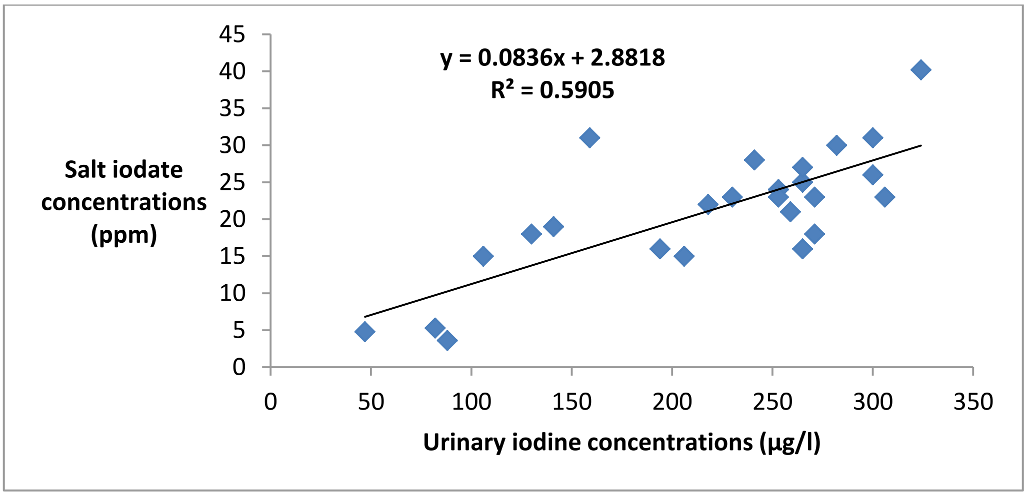


Figure 3: Urinary iodine concentration versus the salt iodate content for pregnant women attending private hospital

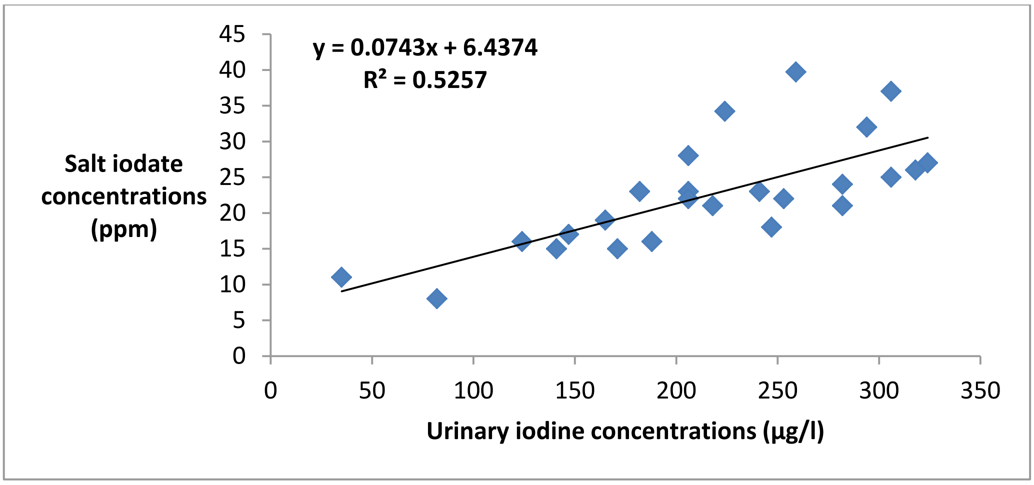


Figure 4: Urinary iodine concentration versus the salt iodate content for lactating women attending private hospital.

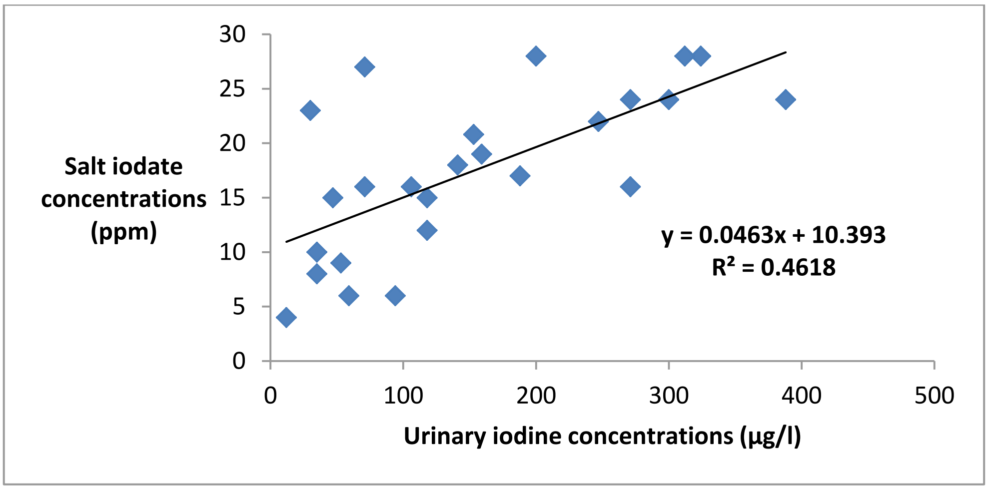


Figure 5: urinary iodine concentration versus the salt iodate content for pregnant women attending public hospital

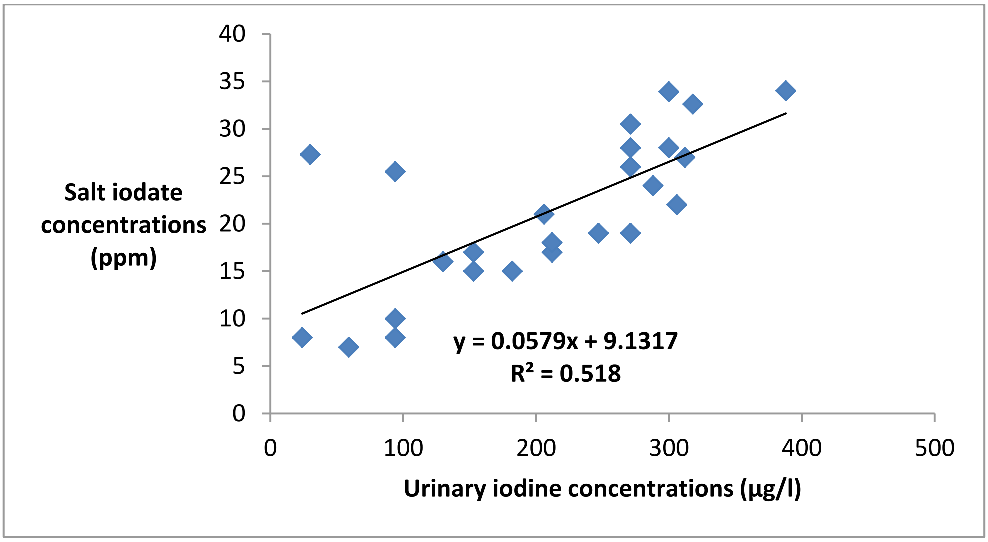


Figure 6: urinary iodine concentration versus the salt iodate content for lactating women attending public hospital

## 4. Discussions

Accessibility and consumption of sufficiently iodized salt must be established for sustainable eradication of IDD. According to WHO, IDD elimination will be visible if more than 90% of households consume salt that is adequately iodized. Sierra Leone, in its food and nutrition security policy plan 2012-2116, has set a goal to reduced ID in school children by 20% by 2016 through universal salt iodization and objective to increase availability of iodized salt among households (10).

This study showed little or no risk of ID for patient attending private hospitals (pregnant and lactating mothers), while pregnant women attending public hospital shows risk of ID and their counterpart lactating women showed little or no risk of ID. This may be attributed to the fact that most of the participant comes from households that do consume adequately iodized salt. This might be linked to availability of iodized salt in the market, legislation and policies enforcement on fortification of salt with iodine, and consistent follow up and monitoring concerning iodized salt utilization. Moreover locally produced salt (which is void of iodine) hardly reach the city now- a- days because the local salt producing areas are far from the city. These results are in accordance with a survey on consumption of iodised salt in Sierra Leone, the research showed a remarkable increase in the consumption of iodised salt from 45% in 2005 to 63% in 2010 (18).This is very good when compared to studies in other country such as that conducted in Tanzania and South Africa, which shows that the national coverage of iodized salt consumption at the household level was 58.4% and 62.4%, respectively (19). Similar results were obtained in South Sudan, Malawi, Ghana, Uganda and Benin, where sufficiently iodized salt intake at household level ranges from 72.9% to 96% (20).

Attendance of private hospitals shows a higher median urinary iodine concentration and salt iodate content when compared to those attending public hospital (Table 3, Figures 1 and 2). This may be due to the fact that most low income earner (mostly attendance of public hospital) hardly buy salt in supermarkets or shops were the storage facility is good (all salt are enclosed in polymeric bags and are kept in cupboards and shelves). Thus high income earner (mostly attending private hospitals) who can afford the high prices in supermarkets and shops stand a great chance of consuming salt with sufficient iodine content as these salts are not normally exposed to direct sunlight and are properly stored. Exposure of salt to sunlight was one of the factors significantly associated with iodine lost in adequately iodized salt. The halogen iodide with time and exposure to excess oxygen and carbon dioxide slowly oxidizes to metal carbonate and elemental iodine which then evaporates (21). Also, as Knowledge on the important of iodized salt consumption has also been found as a key parameter in eliminating ID (21-22). In Sierra Leone the population has little or no idea on the important of iodine in the human system. As a result most people care less about the type of salt they consumed (especially low income earners). Addition, most low income earners hardly consume sea foods or diets that contain iodine as these foods are very expensive.

It was also observed that some of the salt sample under study showed low iodine concentration especially for patient in public hospitals (Table 3). This may be due to the fact that these salt samples are locally produced and are normally void of iodine or the iodine content in the salts has been reduced/lost through various means such as storage method, exposure to sunlight , moisture , heat, humidity and extremely aerated environments. (24, 25) . A research carried out in Canada revealed that the content of iodine in salt samples analyzed remains unchanged for several months when packaged and stored in dry environment and prevented from exposure to strong light (26). In addition, a study conducted in Iraq revealed that packaged salt shows adequate iodine content when related with unpackaged salt (27). Another study also show about 31% loss of iodine from salt unprotected from direct exposure to sunlight (28) . Duration of storage at home has also been revealed by scholars as another course of loss of iodine content in salt. It was revealed by a study in London that storage of salt for a long time has a negative effect on it iodine content. The study revealed that 24% of iodine in iodized salt will be lost when kept for 10 weeks (29). Similarly, another research in Colombia revealed that longer storage beyond two months accelerates loss of iodine from iodized salt (30) . With regards to these studies, one may say that most of these factors affecting salt iodate content may be responsible for salt iodate concentration of more than half of the sample under study not to contain up to 35ppm of iodine even though all salt brought into the country by regulation must contain at least 35ppm of iodine (less than 1% of samples tested shows salt having salt iodate content up to 35ppm). Thus one may purchase salt with sufficient iodine but because of improper storage the iodine content would have been lost from the sample, more especially for salt sample purchased in open containers and are exposed to sunlight throughout the marketing period.

Figures 3, 4, 5, and 6 showed positive correlation between the urinary iodine concentration and the salt iodate content though not too strong. The moderate correlations suggest that a person may be purchasing iodized salt for household used but may end up not consuming the daily recommended dose because of lack of knowledge on how to properly store it in order to prevent the vaporization of the iodine content. Moreover it is not certain whether the salts brought in by the participant are actually the salt they eat at regular bases. As participants were asked to bring in sample of salt been consumed at home but no strict monitoring was done to ascertain that the instruction was adhered to.

The median urinary iodine concentration for pregnant women in public hospital (118µg/l) was observed to be low when compared to lactating women (212µg/l). This is so because in Sierra Leone, most pregnant women are advised to cut down on the consumption of salt during pregnancy as it is believed to be one of the courses of swollen feet during pregnancy. Thus, iodized salt being the only source of iodine for low income earners, it has a great impact on their iodine intake during pregnancy. Women attending private hospital on the other hand are exposed to a variety of food, some of which may contain iodine as a result even with little or no consumption of salt during pregnancy, it may result to little or no impact on their iodine nutritional status.

## 5. Conclusion

Based on the findings of this study, the following conclusions could be drawn:

- There is a risk of ID for pregnant women attending public hospital
- Attendance of private hospital shows little or no risk of ID
- Salt samples from patient cannot reliably indicate the concentration of iodine of an individual (week correlation between salt iodate content and urinary iodine concentration).
- Availability of adequately iodized salt at household level was encouraging in western area of the country. However households should be further sensitized on the importance of iodized salt consumption and its proper storage.
- The currently recommended iodine consumption through iodization of salt universally proves to be appropriate.

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