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Research Article

Assessment of Iodine Levels of Secondary Schools Girls in Sokoto State, Nigeria

[*1]Umar AI, [2]Umar RA, [3]Wasagu RSU and [4]Oche MO

[1]Department of Biochemistry, Sokoto State University, P.M.B. 2134, Sokoto, Nigeria
[2,3]Department of Biochemistry, Usmanu Danfodiyo University, P.M.B. 2346, Sokoto, Nigeria
[4]Department of Community Health, Usmanu Danfodiyo University Teaching Hospital, Sokoto, Nigeria

Urinary iodine excretion is a good marker of dietary iodine intake and is the index for evaluating the degree of iodine deficiency, correction and toxicity. Studies on urinary iodine excretion level in school girls of Sokoto State are scanty. Multi-stage sampling procedure was adopted to determine current iodine status in 246 school girls in three zones of Sokoto State, Nigeria aged 14 - 17 years. Urinary iodine level was measured using the standard method of ammonium persulphate reaction. Thyroid Stimulating Hormones (TSH), Triiodothyronine (T3) and thyroxine (T4) were measured using Competitive Enzyme linked Immunoassay. Validated questionnaires were used to test the knowledge of iodine nutrition among the respondents. World Health Organization and International Council for the Control of Iodine Deficiency Disorders recommendations were used to classify the urinary iodine levels. The results show that of the 246 school girls studied, 49 (20%) had mild iodine deficiency 37 (15%) had moderate iodine deficiency, 156 (63%) had adequate status and 5 (2%) had above normal urinary iodine excretion level. These findings suggest that 86 (35%) of the study subjects were iodine deficient. Measures should therefore, be taken to improve iodine nutrition in the study area to avoid functional and developmental abnormalities.

Key words: Iodine, Iodine deficiency, Thyroid Stimulating Hormones, Triiodothyronine and thyroxine

INTRODUCTION

Iodine is an indispensable micronutrient for all mammalian life, including humans. It is necessary for thyroid hormone synthesis. These hormones are required for normal growth, development and metabolism throughout life, beginning with the fetal stadium (Delange, 1994; Yen, 2001; Zimmermann, 2009). When dietary iodine intake is insufficient, thyroid hormone synthesis is impaired. This results in a series of functional and developmental abnormalities termed "iodine deficiency disorders" (Delange, 1994; Zimmermann *et al.,* 2008). ID during pregnancy or infancy increases the risk of stunted growth as well as neuromotor and neurocognitive impairment of the child. In extremis, this results in cretinism (Glinoer, 2007; Zimmermann, 2007a). Worldwide, ID is the most common cause of preventable brain damage (World Health Organization, 2007; Zimmermann *et al.,* 2008). The reason for the high prevalence of IDD is that soils in many regions in the world (especially inland and mountainous regions) are poor in iodine. Hence, crops that are grown on these soils are also poor in iodine and do not provide adequate amounts of iodine to the population (Haldimann *et al.,* 2005; Zimmermann *et al.,* 2008). In order to eliminate iodine deficiency disorders, universal salt iodization is the recommended and best long-term strategy that supplies iodine to a population (WHO, 2007). Urinary Iodine Level (UIL) reflects recent iodine intake as most of Ingested iodine is finally excreted in urine (Vought and London, 1967; WHO, 2007).

***Corresponding author**: Umar Aminu, Department of Biochemistry, Sokoto State University, P.M.B. 2134, Sokoto, Nigeria. E-mail mamunetdaji@gmail.com Phone: +2348065310438

Therefore, the most commonly used indicator to assess the iodine status of a population is the median UIL of spot urine specimens from a representative sample of the target group (Zimmermann, 2008b).

In Nigeria, Methodology developed by the Micronutrient Initiative (MI) and UNICEF in Vitamin and Mineral Deficiency: A Damage Assessment Report; in 2004. National benefits derived from a decrease in Total Goiter Rate (from 20% estimated for 1993 to 7.7% estimated for 2004) reaching 590,000 fewer babies born with intellectual impairments annually and the future productivity gains of $220 million per year to the Nigerian economy. Iodine deficiency was a singular cause of most cases of mental retardation in children in Nigeria (USIN, 2005). To attain optimal nutritional status for all Nigerians, with particular emphasis on the most vulnerable groups such as children, adolescents, women, elderly, and groups with special nutritional needs, Nigerian Government reviewed its National Food and Nutrition Policy (2016), underscoring its determination to improve the well-being of its populace. That policy set definite goals in micronutrients deficiency, which included, Reduction in anemia among pregnant women from 67% in 2013 to 40% in 2025, Increase coverage of Vitamin A supplementation from 41% in 2013 to 65% by 2025 and to achieve and sustain universal household access to iodized salt by 2025.

Research to date, on iodine status, has been predominantly conducted on people living in neighbouring states of Sokoto. This study will therefore assist in mapping out the state to plan for intervention. The present study will provide a baseline data for secondary schools girls. This study is therefore timely, relevant and important. The study primarily aimed to evaluate the current status of urinary iodine excretion level of girl's secondary schools in the three zones of Sokoto state, Nigeria.

MATERIALS AND METHODS

Selection of study subjects and sample collection

Multi-stage sampling procedure was applied at all Steps. Three zones were all selected in first stage followed by selection of two local governments from each zone using simple random sampling. Random selection of girls school after line listing (Total number of schools in LGA) as the third stage followed by Proportionate allocation of students in each school and fifth stage was convenient sampling of students as recommended by World Health Organization (WHO 2007). A total of 246 female secondary schools students as sample size using Ejeliogu *et al*., 2014 method of which 83 subjects were from Sokoto central zone (SCZ), 79 subjects from Sokoto western zone (SWZ) and 84 subjects from Sokoto eastern zone (SEZ) aged between 14 - 17 years. Furthermore, measurement of urinary Iodine level in school girls is important for public health considerations, as this group effectively reflects the current status of IDD in the general population, as well as the extent to which IDD control measures have had an impact on the population.

Ethical clearance

Approval was obtained from Research and Ethics Committee of Sokoto State Ministry of Health, Consent was provided by subjects parents and schools' authority, Questionnaires were administered to all the study subjects.

Well-structured questionnaires consisting of a mixture of closed and open ended questions were used to extract demographic data, dietary lifestyle and Knowledge of iodine nutrition among study population. Simple Spread Sheet was used to collect data and the information from the study subjects.

Determination of urinary iodine excretion

Two hundred and fifty microlitres (250µL) of spot urine sample were collected into clean and sterile universal bottle from all the study subjects using systematic sampling method. Since the samples were not analyzed immediately, they were stored frozen at -20^{0}C until ready for analysis in the research biochemistry laboratory. The standard method of ammonium persulphate technique was used for estimating the level of iodine in the urine by two trained competent laboratory technologist. Urine was digested with ammonium persulphate. Iodine present in the urine acts like a catalyst in the reduction of ceric ammonium sulphate (yellow) to cerous ammonium sulphate (colourless). The degree of disappearance of the yellow colour is a measure of iodine content in the urine. A standard curve plotted during the analysis was used to extrapolate the concentration of iodine in the urine samples.

Measurement of serum Thyroid Stimulating Hormones, (TSH), Triiodothyronine (T3) and thyroxine (T4) levels

Serum TSH, T3 and T4 levels were measured by Competitive Enzyme Immunoassay using commercial kits (Accu-Bind by Mono bind Inc., United State of America). The normal range of TSH, T3 and T4 level determined with this kit were 0.39 – 6.16IU/ml, 0.52 – 1.85ng/ml and 4.8 – 11.6 µg/dl. Upon mixing immobilized antibody, enzyme-Antigen conjugate and a serum containing the native antigen, a competition reaction results between the native antigen and the enzyme-antigen conjugate for a limited number of insolubilized binding sites. After equilibrium was attained, the antibody-bound fraction was separated from unbound antigen by decantation and wash to remove excess unreacted Ag. Enzyme substrate was added and

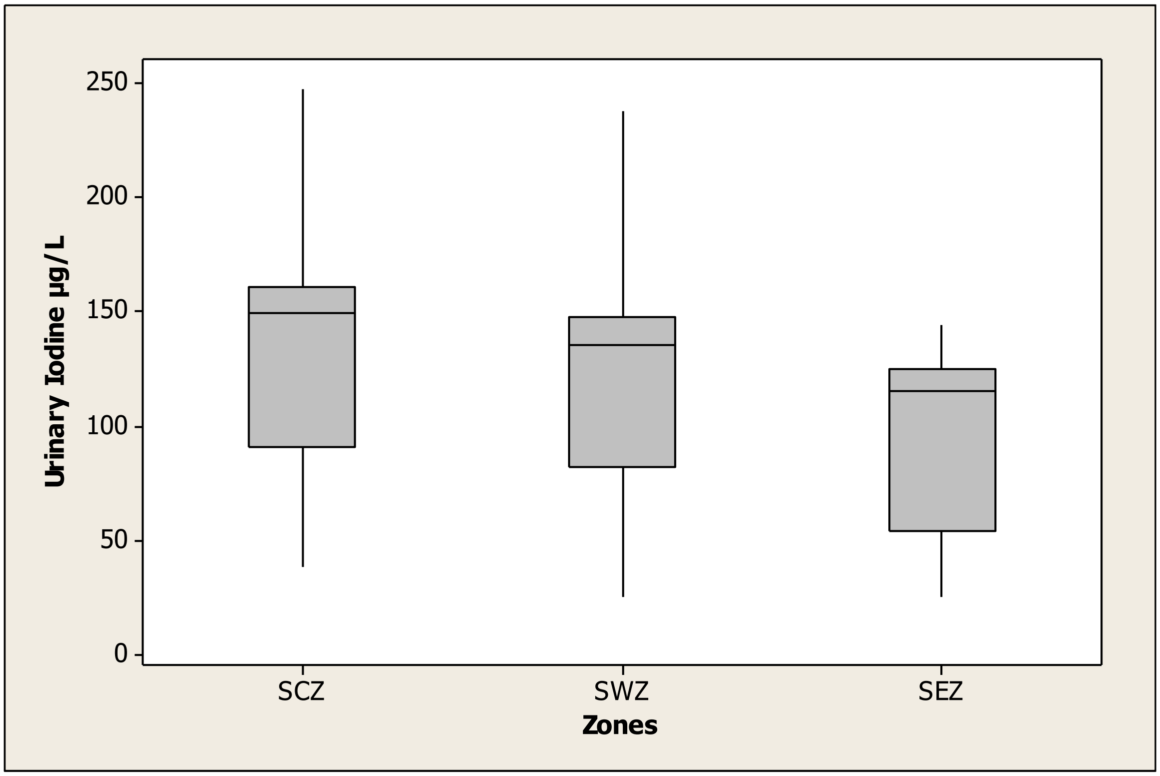

Figure 1: Median urinary iodine level of Study Subjects according to Three Zones.
SCZ = Sokoto Central Zone SWZ = Sokoto Western Zone SEZ = Sokoto Eastern Zone

Table 1: TSH, T3 and T4 level of Study Subjects in Zones

PARAMETERS	SCZ	SWZ	SEZ
TSH IU/ml	2.50 ± 0. 57	2.69 ± 0. 73	3.04 ± 0.92
T3 ng/ml	1.51 ± 0.32*	1.39 ± 0.35*	0.97 ± 0.31*
T4 µg/dl	8.2 ± 1.59 *	7.4 ± 1.27 *	6.6 ± 1.28*

Values are mean ± SD
Values with same superscript in the same row are statistically significant at p < 0.05
SCZ = Sokoto Central Zone SWZ = Sokoto Western Zone SEZ = Sokoto Eastern Zone
TSH = Thyroid Stimulating Hormones T3 = Triiodothyronine T4 = Thyroxine

labeled enzyme act on it to produce a colour end product which is measure spectrophotometrically at 450nm. The enzyme activity in the antibody-bound fraction is inversely proportional to the native antigen concentration.

Statistical Analysis

Data obtained from spread sheet and questionnaires were coded and analysed into frequencies and percentage, using Excel (Microsoft, Seattle, 2003), Minitab software (version 1.6) and Statistical Package for Social Sciences (SPSS) Version 2.2. Kolmogorov-Smirnov (K-S) test was used to check for the normality of the data. Normally distributed data were presented as mean ± SD, non-normally distributed data were presented as median (95% CI or range). UIL iodine levels were not normally distributed. Mann-Whitney U (MWU) test was used to calculate the difference between three groups of continuous, non-normally distributed data. Kruskal-Wallis (K-W) test was used for group comparisons of continuous, non-normally distributed variables (with Bonferroni corrected post-hoc tests). Results were expressed as means ± SD and Significant level was set at P< 0.05

Box plots: the line in the middle of the box represents the median, the lower end of the box the 25th percentile and the upper end the 75th percentile. The whiskers represent the lowest/highest value that is not yet an outlier. The maximum length of the whiskers is 1.5-fold the height of the box, values outside this range are shown as outliers.

RESULTS

Excretion of urinary iodine of 246 school girls across the three zones of Sokoto state is shown in the in Figure 1 which Represents Box plot of Median urinary iodine level of Study Subjects in the Zones. Subject in Sokoto Central Zone (SCZ) were shown to have median urinary iodine

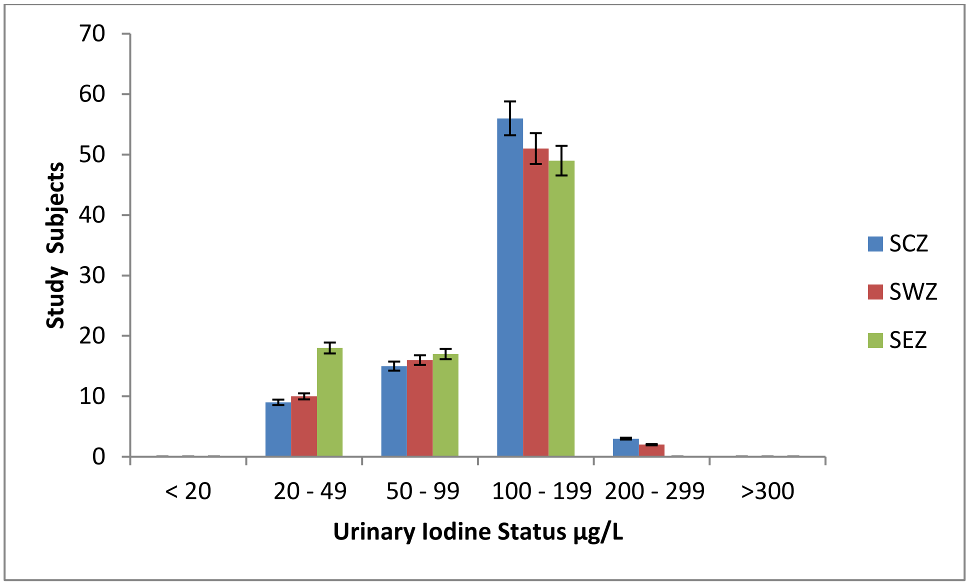

Figure 2: Urinary Iodine status of study subjects in three zones of Sokoto state

CZ = Sokoto Central Zone SWZ = Sokoto Western Zone SEZ = Sokoto Eastern Zone

Table 2: Some Characteristic of Study Subjects from Three Zones of Sokoto State

	Sokoto Central Zone (SCZ)	Sokoto West Zone (SWZ)	Sokoto East Zone (SEZ)
	NO OF SUBJECTS	PERCENTAGE (%)	
Knows basic knowledge on iodine nutrition	13 (15.7)	9 (11.4)	6 (7.1)
Knows not in basic knowledge of iodine nutrition	70 (84.3)	70 (88.6)	78 (92.9)

SCZ = Sokoto Central Zone SWZ = Sokoto Western Zone SEZ = Sokoto Eastern Zone

level 149 µg/L (IQR 91-161), for subjects in Sokoto Western Zone (SWZ) median urinary iodine level was 135 µg/L, (IQR 82-148) and Median urinary iodine level of subjects in SEZ was 115 µg/L, (IQR 54-125) Median urinary iodine level in subjects of all the three zones were statistically significant between zones ($p<0.005$). Whisker level in SCZ subjects were 38-247 µg/L and 25-238 µg/L in SWZ subjects while that of SEZ subjects were 25- 144 µg/L.

Results obtained from the three zones of the states on urinary iodine status shown in figure 2. Indicates some degrees of iodine deficiency, nine (10.8%) subjects in SCZ, 10 (12.7%) subjects in SWZ and 18(21.4%) subjects have moderate (20 - 49µg/L) iodine deficiency. Fifteen subjects (18.1%) in SCZ, 16 subjects (20.3%) in SWZ and 17 subjects (20.3%) in SEZ have mild (50 - 99 µg/L) iodine deficiency.

Fifty six subjects (67.5%) in SCZ, 51 subjects (64.5%) in SWZ and 49 subjects (58.3%) in SEZ have optimal (100 - 199µg/L). Three subjects (3.6%) in SCZ and 2 subjects (2.5%) in SWZ have above requirement (200 - 299 µg/L).

Result on TSH, T3 and T4 are shown on Table 2 which observed Mean TSH IU/ml level in SCZ, SWZ and SEZ were (3.69 ±1.57, 3.60 ± 1.57 and 4.04 ± 1.57 IU/ml) with lowest mean TSH level of 3.60 ± 1.57 IU/ml in SWZ. For T3 mean level of zones were 0.97± 0.31, 0.99 ± 0.35 and 1.01± 0.32 ng/ml in SCZ, SWZ and SEZ, T4 mean level of subjects in SCZ, SWZ and SEZ were 6.6 ± 1.28, 6.9 ± 1.27 and 7.2 ± 1.59 mg/dl. The mean T4 was statistically significant between the zones $p < 0.05$

Table 2 Shows Age group, Ethnicity, Religion and Educational level of the study subjects.

More than half (141 subjects) of 247 study subjects were aged between 14 to 15 years (of which 53% are from SCZ, 60.7% from SWZ and 57.2% from SEZ). Less than half (106 subjects) of 247 study subjects fall within the aged bracket 16 to 17 years 47% in SCZ, 39.3% in SWZ and 42.8% in SEZ. Eighty one point nine percent of subjects in SCZ, 87.3% of subjects in SWZ and 85.7% of subjects in SEZ, were Muslims. While Christian’s subject in SCZ were 18.1%, SWZ 12.7% and SEZ 14.3%. Almost half of the study subjects in SCZ (45.8%), 53.2% in SWZ and more than half in SEZ (46.4%) subjects were found to be

Table 3: Distribution of Subjects on Knowledge of Iodine Nutrition in the Zones of Sokoto State

Characteristic		Sokoto Central Zone (SCZ)	Sokoto West Zone (SWZ)	Sokoto East Zone (SEZ)
		NO OF SUBJECT PERCENTAGE (%)		
Age				
14		20 (24.1)	25 (31.6)	25 (29.8)
15		24 (28.9)	23 (29.1)	23(27.4)
16		20 (24.1)	19 (24.1)	20 (23.8)
17		19 (22.9)	12 (15.2)	16 (19)
Religion				
	Islam	68 (81.9)	69 (87.3)	72 (85.7)
	Christianity	15 (18.1)	10 (12.7)	12 (14.3)
Tribe				
	Hausa	38 (45.8)	42 (53.2)	39 (46.4)
	Yoruba	4 (4.8)	3 (3.8)	1 (1.2)
	Igbo	3 (3.6)	2 (2.5)	1 (1.2)
	Fulani	18 (21.7)	19 (24.1)	8 (9.5)
	Gobirawa	16 (19.3)	8 (10.1)	29 (34.5)
	Others	4 (4.8)	5 (6.3)	6 (7.1)
Class				
S.S.I		46 (55.4)	49 (62)	50 (59.5)
S.S.II		37 (44.6)	30 (38)	34 (40.5)

SCZ = Sokoto Central Zone
SWZ = Sokoto Western Zone
SEZ = Sokoto Eastern Zone

Hausa. Thirty-four point five percent of the subjects were gobirawa found mainly in SEZ, 19.3% and 10.1% of gobirawa subjects stays between SCZ and SWZ. Fulani subjects were 21.7% from SCZ, 24.1% from SWZ and 9.5% found in SEZ. Yoruba and Igbo constitute 4.8% in SCZ, 3.8% in SWZ & 1.2% in SEZ of the study subjects respectively. Others make up 4.8% in SCZ, 6.3% in SWZ, and &.7.1% in SEZ of the remaining of the study subjects. All the study subjects were secondary school students 55.4%, 62% and 59.5% of the study subjects in SCZ, SWZ and SEZ were SSI students and 44.6%, 38% and 40.5% in SCZ, SWZ and SEZ were SSII student.

Table 3 presents the distribution of knowledge of iodine nutrition among study subjects in the three zones of Sokoto State Few number (28 out of 247) among study in the three zones knows some basic knowledge of iodine nutrition which include 15.7% in SCZ, 11.4% in SWZ and 7.4%) in SEZ. A good number of the study subjects 94.3%, 88.6% and 92.6% in SCZ, SWZ and SEZ Knew nothing about the basic knowledge of iodine nutrition

DISCUSSION

Urinary iodine excretion is a good marker of dietary iodine intake and is the index for evaluating the degree of iodine deficiency, correction and toxicity (WHO, 2007).

A good number of study subjects 63.6% across the three zones fall within the normal range of iodine level which is recommended by the international body of nutritional agencies and world health organization, (WHO 2013). This study is similar to findings of Madukwe *et al.,* 2013 who reported 49% and 54% with normal urinary iodine level in school children of two towns of Nsuka south eastern Nigeria. The study is also comparable to the findings of Augustine *et al,.* 2012 who reported 41.1% with normal urinary iodine level in school children of saki south western Nigeria. The result can also be related with the findings of Onyeaghala *et al.,* 2010 who reported 23% with normal urinary iodine level in school children of Ibadan south western Nigeria

This is a step forward in public health and nutritional biochemistry that could prove many families and communities across the zones of Sokoto state have tremendously embraced salt iodization. The connection in occupation of subjects' parents, condition of living, consumption of iodine rich foods and fair knowledge on nutrition could be a reason for this incidence. Data from federal ministry of Heath, Nigeria in 1998 confirms decreases goiter rate to 12.5% in four geopolitical zones of Nigeria among which is northwest zone to which Sokoto state belong was inclusive. Further evaluation in 2001 shows drop of Total Goiter Rate (TGR) to 2.9% and mean urinary iodine of 146.5µg/l in Zamfara North West Zone.

Nigerian was honored with award of certificate in universal salt iodization in recognition of nation programmatic approach in combating endemic IDD through aggressive salt iodization programmed in Turkey 2007.

Thirty five percent of subjects were observed with mild to moderate iodine deficiencies in the three zones of Sokoto State. This study is similar to the findings of Madukwe *et al.,* 2013 who reported 43% and 56% with mild to moderate urinary iodine level in school children of Nsuka south eastern Nigeria. The study can be related to the findings of Augustine *et al,.* 2012 who reported 9% with mild to moderate urinary iodine level in school children of saki south western Nigeria. This result can be compared with the findings of Onyeaghala *et al.,* 2010 who reported 10% with moderate to mild iodine deficiency in school aged children in Ibadan Nigeria. Iodine deficiency Disorder (IDD) is the most common cause of preventable mental impairment worldwide. (WHO, UNICEF and ICCIDD 2007) Soil leaching and floods in the river valleys had removed the iodine from vast areas of the inland soil making it to be iodine-deficient Sokoto State inclusive. Consumption of agricultural products grown in iodine-deficient soil could also be a reason for the low urinary iodine excretion. Animal feed produce in the iodine deficient soil can be prime to deficiency of iodine in milk, consumption of this milk can prone individual's to low urinary iodine excretion. However, that there were still moderate to mild iodine deficiency as shown from this study could imply that not all families and communities in the three zones of the state have adopted the Massive salt iodization process.

The low urinary Iodine excretion observed in this study could be probably due to consumption of goitrogenic substance (such as cassava, millet vegetables etc.) which interfere with the proper functioning of the thyroid hormones synthesis and their utilization (Vanderpas, 2006; Zimmermann *et al.,* 2008) Other contributing factors include: poor farming techniques, avoidance of salt due to fear of high blood pressure. In addition, past sources of iodine in food have been removed. For example: Iodide was used as a dough conditioner in baked goods for three decades, but has since been replaced with bromide (a toxic halogen), In addition to iodine's disappearance from our food supply, ingestion of toxic halogens (bromine, fluorine, chlorine and perchlorate) which competes with natural iodine has increased. Absorption of these halogens through the food, water, medications and environment, selectively occupy iodine receptors, further deepening iodine deficit.

The T3, T4 and T serum level in all subjects of the zones fall within the normal range, which implies that subjects were able to keep serum levels of T4 and T3 stable suggesting good thyroid function and adequate dietary iodine intake particularly as seen in SCZ and SWZ subjects.

CONCLUSION AND RECOMMENDATION

Thirty five percent of the study subjects were observed to have low urinary iodine excretion level and it has Public health consequence. T3, T4 and TSH level were normal in all the study subjects across the zones. It is recommended that Campaign on iodine nutrition should be intensified among the communities by the government, civil societies and development partners to improve iodine nutrition to forestall functional and developmental abnormalities.

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