Advances in Life Science and Technology
ISSN 2224-7181 (Paper) ISSN 2225-062X (Online)
Vol.50, 2016

Analysis of Iodine Deficiency Disorders and Iodized Salt Consumption Levels among School Children in Amuma and Minjo Districts in Beneshangul Gumuz, Ethiopia

Fekadu Muleta[1*] Girma Kibatu[2]
1.Collage of Natural and Computational Science, Department of chemistry, Wolaita Sodo University, PO. Box 138, Ethiopia
2.Collage of Natural and Computational Science, Department of chemistry, Bahir Dar University, Ethiopia

The research is supported by Wolaita Sodo University, PO. box 138, Sodo, Ethiopia and financed by Bahir Dar University, PO.box.380, Bahir Dar, Ethiopia & Wombera woreda capacity building office.

Abstract
Iodine deficiency disorders (IDD) are currently a significant health problem in Ethiopia. Amuma and Minjo districts in Beneshangul Gumuz region are known for visible goiter prevalence. A study was conducted between February 2004 to May 2005 reported the total goiter prevalence (weighed) was 37.3% more than 30% an indication of sever iodine deficiency in the region. Despite some efforts by the government to eliminate IDD through universal salt iodination in public health education, no survey has been conducted on the status of iodine deficiency disorders in the Amuma and Minjo districts. Hence, the present mini pocket study was conducted in order to assess the prevalence of IDD in school children aged 6-18 years and to estimate the iodine content of salt consumed in the households of Amuma and Minjo districts. The proportional to population size (PPS) sampling methodology and indicators for the assessment of IDD as recommended by the WHO/UNICEF/ICCIDD consultation was utilized for the survey. A total of 200 school children in the 6-18 years age group were selected using PPS sampling methodology in the schools. Goiter prevalence in these children were tested using palpation method and 50 salt samples consumed in the household of the respective children were measured for their iodine content using UNICEF/WHO/ICCIDD recommended test kit and titration methods. A causal urine sample (5ml) was taken from 30 children to measure urinary iodine using spectrophometry. The total goiter prevalence was 39.5% (grade 1 = 31.5% and grade 2 = 7.9%). from 50 salt samples analyzed by salt test kit and iodometric titration 60% of the salt samples iodine level was 0-ppm, 30% had iodine content of less than 15ppm and only 10% was completely iodized (≥ 15ppm) and the median urinary iodine concentration range from 20.54-62.2(39.9ng/L). The study showed that the current and up-to-date data on the IDD prevalence in the study population remains iodine deficient. There is a need to further strengthen the existing controlling and monitoring system for the quality of iodized salt distribution public health education in the area in order to achieve the elimination of IDD in the society.
Keywords: Iodine, IDD, School-Children, urinary iodine, iodized salt North Western Ethiopia

1. Introduction

According to the WHO, iodine deficiency disorders are among the major public health problems of the world, particularly of women in developing countries [1]. Low level of thyroid hormones in the body due to lack of adequate iodine in foods and drinks is responsible for iodine deficiency disorders. Iodine deficiency causes a wide range of health related problems collectively known as iodine deficiency disorders (IDD) [2]. Long – term deficiency in iodine intake is associated with the development of goiter. When the prevalence of goiter in a population rises above 5-10%, the problem is considered as endemic. Iodine deficiency continues to be a significant public health problem in many countries, its deficiency not only causes goiter, it may also result in abortion, still birth, mental retardation, growth retardation, irreversible brain damage and retarded psychomotor development in the fetus, infant and in the child. It also affects reproductive function and impedes children learning ability [3].

In Ethiopia IDD has been recognized as a public health problem for many decades. A recent study [4] that did both clinical and biochemical assessment has confirmed that the situation of IDD deteriorated. In high goiter endemic regions the prevalence of goiter in children was greater than 30% while in less endemic regions it was less than 15%. In order to ensure adequate availability and use of iodized salt, the government of Ethiopia designs a five year strategic plan to eliminate IDD throughout the country through universal availability of iodized salt to the entire population.

Amuma and Minjo districts are known iodine deficiency disorders endemic area in Wombera wereda in which two – third of the populations have visible goiter. A study conducted in 2007 in the region reported a goiter prevalence of 37.3% in the region. Despite the recognition of the problem in the region, an iodine deficiency controlling program was never officially implemented and no survey has been conducted on the status of iodine deficiency in Amuma and Minjo districts. Hence the present study was conducted in order to assess the prevalence of IDD and to estimate the iodine content of salt consumed in the households in the districts.

1.1. Significance of the study
This study was enabling in assessing the prevalence of iodine deficiency disorders and indigenous knowledge about methods of monitoring among the community in the study sites.

1.2. Objectives
1.2.1. General objectives
- To quantify and evaluate, the prevalence and frequency of iodine deficiency and monitoring methods in endemic goiter areas in Metekel zone of wombera wereda at Amuma and Minjo districts.

1.2.2. Specific objectives
- To assess the state of iodine deficiency in school children in Amuma and Minjo districts aged between 6-18 by using WHO/UNICEF/ICCIDD recommended method of goiter classification by palpation.
- To assess the use of iodized salt by school children in Amuma and Minjo districts aged between 6 - 18 by determining the level of iodine in salt used in their households using a UNICEF measuring kit for iodine in a salt and iodometric titration.
- To assess the state of iodine deficiency in school children in the districts aged between 6 and 18 by studying the availability, price, use and storage of iodated salts in the districts.
- To identify strategies to create awareness about IDD and use of iodized salt among the general population.

2. Methodology of the study
2.1. Study area
Across sectional study, which focuses on goiter and related variables, are conducted among school-children in Ammuma and Minjo districts, Wombera, Benishangul Gumuz, Ethiopia during September 2014 to Jun 2015 in 200 school children aged between 6 to 18 years. School children of this age group are recommended for the assessment of the severity of iodine deficiency and the prevalence of goiter and the outcome, because of their dramatic response to the inadequate intake of iodine.

Amuma and Minjo districts are the most thickly populated districts in northern part of the wombera woreda, found approximately 20 km to north of the wereda`s town. Most of the populations in the districts are farmers living in rural areas. Based on the figures from the (WSE) in 1999 this woreda has an estimated total population of 50,225 whom 24,470 are men and 25,755 are women , 4179 or 7.43% of population are urban dwellers. Among all the kebeles in this woreda, Amuma and minjo are thickly populated area in which population size is estimated to be 6,785. These populations are mostly farmers. Farming and cattle breeding are predominant occupation in the districts. Sorghum, teff, coffee, wheat and mango are among the majors' agricultural products. The woreda has three types of agro climatic zones Dega(10%), winadega(15%) and kolla (75%). from these climatic conditions, Ammuma and Minjo districts are found in winadega part.

2.2. Sampling method
A multistage "Proportional to population Size" (PPS) sampling method was used to determine the number of school aged children to be included in the study. The school-based PPS cluster sampling method is recommended as the most efficient and practical approach for performing an iodine status or an IDD prevalence survey [7, 8]. This method has been in use for many years for the evaluation of immunization coverage, and can be applied to many other health indicators. The principal requirement for applying the PPS method is that a listing (sampling frame) is available populations. For this survey, the sampling units are the schoolchildren. To determine the sample size of this study 95% confidence interval was used. A systematic random sampling technique using roster as a sampling frame was used to select school children. Sample size was determined by the following formula developed by Bland (1989) [7].
Calculating the sample size (n) using the formula:-

$$Sample\ size = \frac{4xpx(1-p)xD}{M^2}$$

Where: - P= proportion of population to be measured
D= confidence level (95%).
M= margin error (standard value of 0.1)

Accordingly, 200 school children age 6-18 years (male= 111 and female= 89) from a total of 750 school children were selected using systematic random sampling. After numbers were allocated to every child in the school the first individual was picked using a random table, and subsequent subjects were selected using a fixed interval, i.e.

every n^{th} person. Randomly 50 salt sub samples brought to school from households of the sampled children and randomly selected 30 causal urine sub samples from children were collected and measured.

2.3. Methods and materials

Goiter prevalence: goiter prevalence was tested using palpation of the neck in 200 selected school aged children in Amuma and Minjo primary school. It can be determined by using WHO/UNICEF/ICCIDD classification scheme using the physical examination of the thyroid gland. The person performing the palpation is health personnel who has 10 years of working experience and had an experience of doing palpation in another area in the region.

WHO/UNICEF/ICCIDD classification scheme is as follow:

Grade 0: None or no goiter (not palpable or visible)

Grade 1 or Palpable:A goiter that is palpable but not visible when the neck is in the normal Position.

Grade 2 or Palpable and Visible: Goiter is palpable and visible in the normal position of the neck Grade 2 or perceptible from distance. A swelling in the neck that is clearly visible when the neck is in normal position and is Consistent with an enlarged thyroid when the neck is palpated.

Total Goiter Rate: Sum of goiter grades 1 and 2

Technique: - The examiner faces the subject and looks for visible thyroid enlargement. The subject then looks up, extending the neck and making any thyroid enlargement more visible. The examiner palpates the thyroid by sliding his thumb along each side of trachea between the thyroid cartilage and the top of sternum and the size and consistency of the thyroid is carefully noted. The thyroid moves upwards when the subject swallows (Report from WHO November, 1992).

Coverage of iodized salt sample at household level:- For the analysis of salt samples, there are a no/ of methods for testing the iodine content of salt, ranging from qualitative spot test by rapid salt testing kit to the more quantitative methods such as iodometric titration performed in laboratories for validation purpose. To monitor the iodine content of salt samples available in the area 50 tight plastic containers were distributed at random to the students and they were asked to bring samples of edible salt from their homes in the next day. The salt samples were kept at room temperature in the laboratory and iodine content was measured using internationally used rapid salt testing kits supplied by UNICEF and the iodine content of salt sample is measured using the iodometric titration method [10, 11].

The method uses sulfuric acid and potassium iodate as principal reagent standardized sodium thiosulphtes as titrant and starch solution as indicator. After analysis, the salt samples were classified according to their iodate level [14, 15].

Measurement of iodine content in salt intake

A. Rapid salt test kit supplied by UNICEF

- Measures qualitatively the iodine content of salt.
- The test kit contains the following reagents:-
  - Two test solution ampoules of 10 ml.
  - One recheck solution ampoule of 10 ml.
  - One chart and one white cup.
  - A detailed instruction sheet in the local language
  - All the contents are packed in a small kit box that can fit into a shirt pocket.

Description of Reaction:-

- Liberation of free Iodine from salt and Titration of free Iodine with thiosulfate.

Reaction steps:-

1. $\underset{\text{(From salt)}}{IO_3^-} + \underset{\text{(From KI)}}{5I^-} + \underset{\text{(From } H_2SO_4\text{)}}{6H^+} \longrightarrow 3I_2 + 3H_2O$

2. $\underset{\text{(Sodium thiosulfate)}}{2Na_2S_2O_3} + I_2 \longrightarrow 2NaI + \underset{\text{(Sodium tetrathionate)}}{Na_2S_4O_6}$

Urinary iodine concentration: thirty school children were randomly selected from the main sample of 200 students for urinary iodine excretion test. These children were provided with screw cup plastic bottles and causal urine sample (morning 5ml) was collected from each child under the supervision of the researchers. Samples were put in an ice-packed cool box and transported to the Ethiopian nutrition and health research institute laboratory for measurement. Iodine concentration in urine samples was determined using Sandell-Kolthoff reaction in which urine was digested first with ammonium persulphate [16].The concentration of iodine was determined from its catalytic reduction of ceric ammonium sulphate in the presence of arsenious acid. A spectrophotometer (Uv-vis) was used to examine reduction of ceric ammonium sulphate (yellow). The disappearance of the yellow color is proportional to the amount of iodine present in the sample. A standard iodine solution was used in order to extrapolate the concentrations of iodine. After determination, the concentration of iodine was recorded in micrograms of iodine per liter of urine and classified according to IDD status.

Scheme-2:- Sandell-Kothoff reactions

$$As^{3+} + I_2 \longrightarrow As^{5+} + 2I^-$$
$$2Ce^{4+} + 2I^- \longrightarrow 2Ce^{3+} + I_2$$

(Yellow) (Colorless)

Data processing and analysis: statistical package for social science (SPSS) software version 17 was used to summarized and analyze the data. Descriptive statistics for all variables were computed and associate between variables were tested using chi-square test. A value of $p<0.05$ was considered statistically significant.

Ethical approval: the study was approved by the review committee of Bair Dar University and written consent was obtained from local health and education authorities. Children who declined participation were substituted with other students selected randomly from the sample frame.

3. Results and discussion

Evaluation of Goiter Grading

A total of 200 school children in age 6-18 years were enrolled in the study, which were clinically examined for goiter. The total goiter prevalence rate was found to be 39.5% as shown in table 1 bellow.

Table 1.Age specific goiter prevalence in the school children of Ammuma and Minjo districts and total number of students with their respective age group.

Age (year)	**Total no/ of students exam.**	**Number of children with goiter**					
		Grade 1		**Grade 2**		**Total (1+2)**	
		No/	%	No/	%	No/	%
6	16	5	31.5	1	6.3	6	37.5
7	13	3	23	1	7.7	4	30.5
8	24	7	29.2	2	8.3	9	37.5
9	20	7	35	2	10	9	45
10	19	6	31.5	1	5.3	7	36.8
11	11	4	36.4	--	--	4	36.4
12	14	5	35.7	1	7.2	6	42.9
13	20	7	35	2	10	9	45
14	14	4	28.6	2	7.1	6	42.9
15	18	6	33.5	2	11	8	44.5
16	18	5	27.8	--	--	5	27.8
17	9	3	33.3	1	5.5	4	44.4
18	5	1	20	1	11.1	2	40
Total	200	63	31.5	16	7.9	79	39.5

In all 200 students were screened out of which 16 were found to have goiter of grade 2, that means visible goiter and 63 were found to have goiter grade 1 which makes 79 of them have total goiter rate of 39.5% .

Table 2. Age and sex-wise prevalence of goiter among school children

Sex	samples	Grade 1		Grade 2		Total (1+2)	
		No/	%	No/	%	No/	%
Boys	112	28	14	7	3.4	36	18
Girls	88	34	17	9	4.5	43	21.5
Total	200	63	31.5	16	7.9	79	39.5

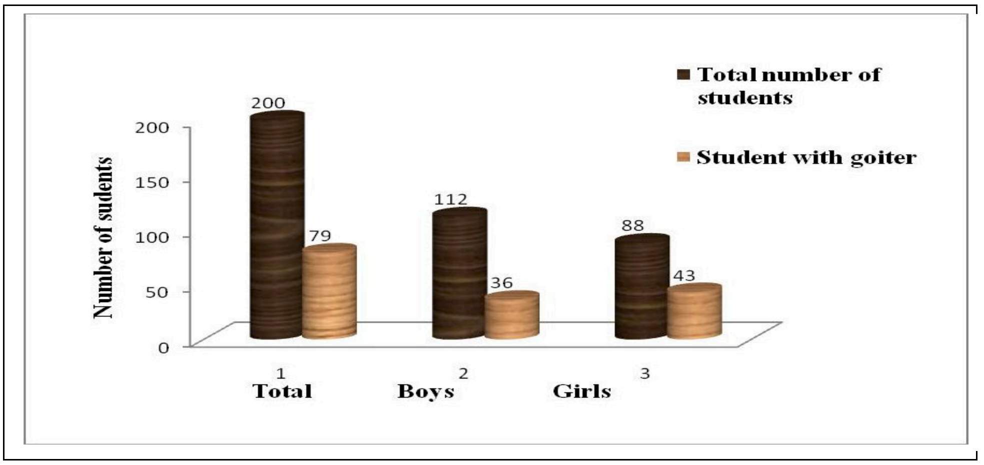

Figure 1. Sex wise prevalence of goiter

Evaluation of concentration of urinary iodine excretion

A sample of 30 school children (11 female and 19 male) was randomly selected from the main sample of 200 for urinary iodine excretion test. Median urinary iodine concentration of the school children was 39.9µg/L with minimum and maximum values of 20.54µg/L and 62.2µg/L respectively. One fifth (20%) of the school children had mild iodine deficiency, while 80% had moderate iodine deficiency.

Evaluation of iodine content in salt intake

A. Results of determining iodine content of salt samples using international rapid salt testing kits supplied by UNICEF

According to the recommendation of ICCIDD,(1999) for salt analysis for iodine quality monitoring, 50 samples were collected by the children from their house hold and the iodine content were checked on the spot using the internationally used rapid salt test kit and iodometric titration method. The iodine content of salt samples collected and analyzed is depicted in table 3.

Table 3**.** Results of salt sample analysis for iodine content using UNICEF test kit for salt consumed in the households of school children in Amuma and Ammuma districts.

Type	No/ of samples	0-ppm	Less than 15ppm	≥15ppm
crystal	36 (72%)	23 (46%)	10 (20%)	3 (6%)
Powdered	14 (28%)	7 (14%)	5 (10%)	2 (4%)
Total	50	30 (60%)	15 (30%)	5 (10%)

Most of the samples of crystal salt contain no any quantity of detectable iodine. Though it may be the quantity of iodine is negligible and cannot be detected. The iodine content of the edible salts were measured and it was found that most of the salt samples tested had iodine level of 0-ppm (60%), and 30% of salt samples had iodine level less than 15ppm and only 10% had adequate iodine level which is ≥ 15 ppm.WHO/UNICEF/ICCIDD/ further recommends that 90% of the household salts should get iodized at the recommended level of 15ppm [15]. However, the study shows that about 90% of the households in Amuma and Minjo are consuming salt which is at inadequate level. i.e. 60 % of the salt samples had iodine level of 0-ppm, 30% had less than 15ppm and only 10% had adequate iodine level ≥ 15ppm as shown in table 3.

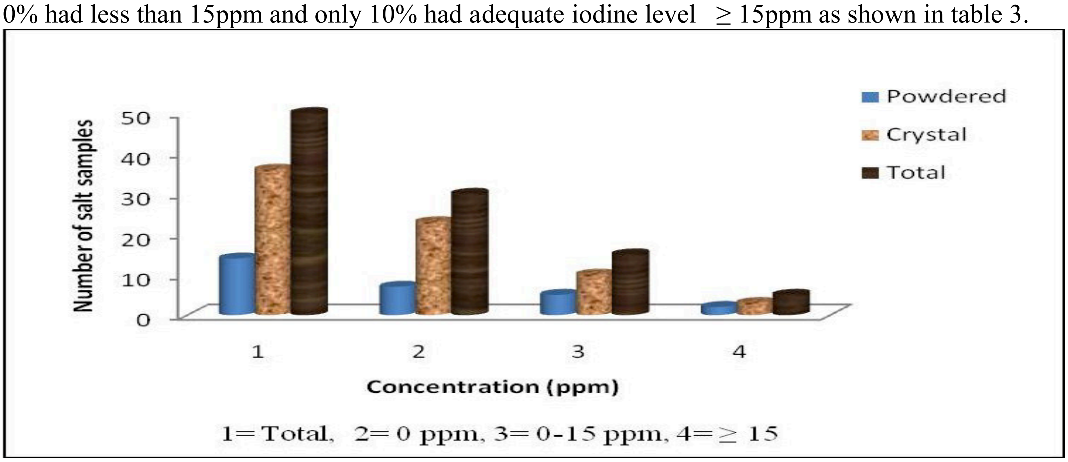

Figure 2. Number of salt samples verses concentration of Iodine in salt in ppm

B. Titration methods for salt iodine analysis results

The results of iodine content of the salt samples using the titration method varied from 0-ppm to 31.73- ppm of iodine (Table 4). The 15 salt samples showed iodine content which varied between 5.29 to 10.57 ppm and only 5 salt samples had iodine content of more than 15-ppm. While the rest of the samples did not show any iodine content (Table 4).

Calculation

Mg/kg (ppm) iodine = titration volume in ml x 21.15 x Normality of sodium thiosulfate x 1000 / salt sample weight in g.

Table 4. Results of iodine content of salt samples by iodometric titration

S.no/	Burret reading	Iodine content in ppm	S.no/	Burret reading	Iodine content in ppm
1.	0.0	Nil	26.	0.0	Nil
2.	0.0	Nil	27.	0.0	Nil
3.	2.0	21.15	28.	0.0	Nil
4.	0.0	Nil	29.	0.0	Nil
5.	0.0	Nil	30.	1.0	10.57
6.	1.0	10.57	31.	0.0	Nil
7.	0.0	Nil	32.	0.0	Nil
8.	0.0	Nil	33.	0.0	Nil
9.	1.0	10.57	34.	0.5	5.29
10.	1.0	10.57	35.	1.5	31.73
11.	0.0	Nil	36.	0.0	Nil
12.	0.0	Nil	37.	0.5	5.29
13.	1.0	10.57	38.	0.0	Nil
14.	0.0	Nil	39.	0.0	Nil
15.	3.0	31.73	40.	1.0	10.57
16.	0.0	Nil	41.	0.0	Nil
17.	0.0	Nil	42.	0.5	5.29
18.	1.8	19.04	43.	1.8	19.04
19.	0.8	8.46	44.	0.0	Nil
20.	0.0	Nil	45.	0.0	Nil
21.	0.5	5.29	46.	0.0	Nil
22.	1.0	10. 57	47.	0.0	Nil
23.	0.8	8.46	48.	0.0	Nil
24	0.6	6.35	49.	0.0	Nil
25	0.5	5.29	50	0.0	Nil

Discussion

The most widely accepted marker to evaluate the severity of IDD in a region is the prevalence of endemic goiter in school children. It has been recommended that if more than 5 percent of school aged children (6-18 years) are suffering from goiter, the area should be classified as endemic for iodine deficiency. On the basis of its prevalence, WHO/UNICEF/ICCIDD recommended the criteria to understand the severity of IDD as a public health problem in a region.

The majority of the children with goiter belong to the age group 12—15 and 70% percent of the goiter cases are seen among them.

The goiter prevalence is increasing as the age increases except in 16 year age group. This finding is in conformity with the statement that goiter increases with age and reaches the maximum with adolescence [Hetzel, B. 1997]. Goiter is prevalent at endemic level in the study area among school children and this was evidenced by total goiter rate of 39.5% (grade 1 = 31.5%, grade 2 = 7.9%), indicating that IDD is a sever public health problem in the district so that they are found at the red traffic light. In the present study 60 percent of the beneficiaries consumed salt with an iodine content of 0-ppm (nil) and 30 percent were consume salt with an iodine content of less than 15ppm . So a total of 90 percent consumed salt with an iodine content which was bellow the stipulated level. Urinary iodine concentration in community members is a good index of iodine intake and school children have been widely recommended as representative group to assess the iodine deficiency in an area. Medians of urinary iodine concentration have been classified by WHO/UNICEF/ICCIDD as follows: (1) less than

From the iodometric titration result (Table 4) shows that in the crystalline salt samples, 63.8% had iodine level of 0ppm, 27.8 % of the samples had iodine level between less than 15ppm and only 8.3% had adequate iodine level, which is ≥ 15ppm. While in the powdered salt samples 50% had iodine level of 0ppm, 35.7% had less than 15ppm and only 14.3% had that recommended value. All these results suggest that most of the salt samples that the society uses were not adequately iodized. So there is need to strengthen the awareness on the community to use only the packed iodized salt for monitoring iodine deficiency disorder. This finding also revealed that salt was treated as either inadequate quantity of iodine was added to it at the production level or there were losses of iodine at the different points of distribution. Loss of iodine might be lost by the following ways [16, 17]:-

Storage of salt: - Depending upon packing, transportation and storage, 20 to 40 percent iodine may be lost from the salt [16]. Salt should not be stored in open space or in damp places. It must be shielded from moisture, sunlight and high temperature. It should be stored in airtight containers made of plastic, wood, glass or clay with well-fitting lid. The moisture content in the salt, humidity in the air, acidity of the salt and chemical form of iodine are important factors limiting the stability of iodine (bulletin, June 1996).In the study area the societies do not understand these limitations. Even in wet seasons, people put their salt with its open containers on ceiling just above the fire place to protect it from losing their salt by moisture or dissolution. This process could cause iodated salt to lose its iodine due to exposure to high temperature [18, 19, 21].

Adding salt while cooking: - Iodized salt should be added to the food substances after cooking to reduce the loose of iodine. Addition of salt before cooking results in loss of iodine and hastens the loss of the other nutrients. Losses in cooking and extent of absorption are other factors which determine the ultimate availability of iodine to the body. Washing salt before use in order to remove impurities would remove all the iodine. It is seen that the majority of households in the study area follow the practice of adding salt before cooking. In the study areas crystal salt was available in unpacked form with some impurities and attempts to remove the impurities by washing salt before use could remove the iodine content of the salt. Powdered iodized salt are sold currently in very little in packets [20, 23].

4. Conclusion and recommendations

The present study showed sever goiter prevalence in primary school children in Amuma and Minjo district of Wombera woreda due to inadequate iodine intake or content from salt at household level. It was evident from the findings of this study that biochemical indicators as measurement by goiter grading, determination of salt iodine content and analysis of urinary iodine concentration are more reliable in measuring the actual situation of iodine intake [22, 24]. The study demonstrate that the population are in the endemic goiter prevalent range and the society do not use adequately iodized salt, so there is need to improve awareness among society to use iodized salt. This will have prevented thousands of children from mental retardation.

This study show current and up-to-date information on the IDD prevalence in the study area and recommended strategies in controlling and eliminating the deficiency of iodine in the study area in particular and in Ethiopia in general. Universal salt iodization, with time supplements and fortification of food and water using iodine are some strategies recommended by WHO/UNICEF/ICCIDD joint consultation.

The government of Ethiopia, however still need to strengthen its efforts to control and eliminate IDD in populations. The existing provision, controlling and monitoring systems for quality iodized salt distribution is not enough to guarantee adequate iodine to healthy population.

This study showed that a good proportion of the study population are consuming salt without iodine fortification (90 percent), due to the fact that the communities have no awareness about the importance of iodized salt and the edible salts available in the area are still not iodized.

The suppliers are not complying with the standards and specifications which make the addition of iodine to the salt as mandatory. The successful application of universal salt iodization in combating IDD in a country requires adequate supplies and regular monitoring at the production and consumption level. Universal iodization of Salt has to go on hand in hand with laboratory development and research, capacity building, advocacy and public education on IDD. Commitment by health professionals and scientists to the assessment and reassessment of the progress in iodine nutrition status by measuring iodine in salt and urine in school aged children, women and infants, and periodic surveys and analysis of their data are very important.

Surveillance of the iodine nutrition status including urine iodine determination and monitoring the quality of salt is needed to provide the basis for continuing iodine deficiency disorder elimination work. Results from such efforts are vital for policy and program management decision and continuing and renewing commitment [25]. With the problem clear, the impact understood, and the solution affordable and sustainable we should not allow even a single child entering our world and growing up without the iodine protection against brain damage. If we should fail to attain the goal of sustained IDD elimination, what prospects does we have in tackling the more development tasks?

Iodized salt utilization need to be universal throughout the country. Efforts to educate the society to use iodized salt and monitoring the sales of iodated salt needs to be stepped up so that every citizen can benefit from this cost-effective and smarter health intervention.

Based on the above facts the following recommendations can be drowning:-

1. More attention should be given in the future to use iodized salt in monitoring IDD.
2. A comprehensive monitoring plan should be implemented to aware all communities to use only the packed iodized salt.
3. Development of program to improve knowledge, attitude and practice in using iodated salt.
4. The fortification of iodine to the other food products which used salt as main ingredient in processing or for preservation.
5. To ensure availability of a minimum of 150µg of iodine (15ppm) at consumption level, a network of Iodine Monitoring Laboratories should be established which would carry analysis of salt samples at regular intervals.

Acknowledgement
I would like to express my deepest gratitude to my advisor Dr. Girma Kibatu Berihie for sharing his ideas and suggestions. I would grateful to the research & community service of Bahir Dar and Wolaita sodo universities for financial support. Special thanks are due to my brothers Birhanu Gudeta and Dibaba Amenu for the financial support for my work.

5. References

1. Gouriprasanna, R., Mugesh, G. 2006. *Bioinorganic chemistry & applications,* 1-9.
2. Rastinejad, F. 1994. *Treatment of hyperthyroid Disease*. Medical pharmacology, 281-288.
3. Manner, G. 2005. *International council for the control of iodine deficiency disorders. Salt* iodination for the elimination of iodine deficiency, 347-650.
4. Cherinet, A.; Yemane, B. 2007. *The goiter rate and the knowledge of IDD among women in Ethiopia*. BMC puplic health, 7:316.
5. Toteja, G.; Singh, P.; Dhilon, B.; Saxena, B. 2004. *Iodine deficiency disorders in 15 districts of India*. Indian J. Pediatr, 71: 25-28.
6. Karmarkar, M.; Pandave, D. 1985. *All Indian institute of medical science. New Delhi*; 26.
7. Lwanga, S.; Emeshow, S. 1991. *Sample Size Determination in Health Studies.* WHO-Geneva
8. UNICEF. 1991. *Indicators for tracking progress in IDD elimination*. In IDD News letter; 10:37-47.
9. Assey, D.;Mgoba, C. Mlingi, N.; Sanga, A.; Ndossi, G.; Greiner, T.; Peterson, S. 2007 *Remaining challenges in Tanzania's efforts to eliminate iodine deficiency*. Public Health Nutr; 10.
10. UNICEF. 1995. A grain of salt: *The way to free the world from iodine deficiency disorder*. New York: 2-3.
11. Kapil, U. Nayar, D. 1994. *Supply of iodized salt and its iodine content* in Himachal Pradesh, India. Health and Population Perspectives and Issues; 17: 137- 44.
12. WHO/UNICEF/ICCIDD. 1994. *Indicators for assessing iodine deficiency disorders and their control through salt iodization* Geneva, WHO.
13. Hetzel, B.; Pandav, C. 1996. *The conquest of iodine deficiency disorders*, 2nd ed. New Delhi, Oxford University Press.
14. Cherinet, A.; Kelbessa, U. 2004. *Determinants of iodine deficiency in school children in different regions of Ethiopia,17*
15. Kapil, U. Nayar, D. *1994. Supply of iodized salt and its iodine content* in Himachal Pradesh, *India.* Health and Population Perspectives and Issues; 17: 137- 44.
16. Semba, R. 1998. *Iodine-deficiency disorders.* Trace mineral in food. New York, 249-81.
17. Burton, B.; Foster WR. 1988. *Human nutrition.* McGraw-Hill; 4:155-158.
18. www.aace. 2006. Com/pubthyroidbrochures/pdf/ *hyperthyroidism PDF,* accessed on March 29, 2011.
19. Zimmermann, M.; Jooste, P.; Pandav, C. 2008. *Iodine-deficiency disorders.* The Lancet, 372:1251-62.
20. Ling, J.2007. *Ending iodine deficiency now and forever*: A communication guide. ICCIDD, the State of the

World's Children**.**
21. WHO/UNICEF/ ICCIDD. 1993**.** *Global prevalence of iodine deficiency disorders***;** 1-11.
22. Hofvander, y. 1970**.** *Endemic goiter children in the Ethiopian Highlands*.
23. Poplov, L. 2000. Medical survey of goiter in Ethiopia. Eth Med**;** 6: 5-13.
24. Cherinet, A.;Yemane, B.; Girma, A.; Zewditu, G.; Tessema, E. 2005. *Goiter prevalence in children age 6-12 years in Ethiopia*. Food and nutrition bulletin in press.
25. Federal ministry of health: 2004**.** *Health and health related indicators*. Addis Ababa Ethiopia.