Assessing the status of iodine deficiency disorder (IDD) and associated factors in Wolaita and Dawro Zones School Adolescents, southern Ethiopia

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Abstract

Background: Iodine deficiency is the major preventable cause of irreversible mental retardation in the world. Ethiopia is a country with high prevalence of iodine deficiency disorders which continue to affect a large number of the country’s population. The aim of the study was to assess the prevalence of iodine deficiency disorder in Wolaita and Dawuro zones.

Methods: A descriptive, cross-sectional study was conducted in high school and preparatory students in Wolaita and Dawuro zones between April and May 2012. Data were collected from 718 school adolescents using pre-tested questionnaire through systematic random sampling technique. Data were entered and cleaned using Epi-info version 3.5.3 and then transported to SPSS version 20 for analysis. Bivariate and Multivariable logistic regression were done and the cut off value set was P < 0.05 as this is considered as statistically significant.

Result: The overall prevalence (total goiter rate) of goiter in study area was 351 (48.9%). Students with Grade-1 goiter were 265 (36.9%) while with Grade-2 goiter was 86 (11.9%). Females were by a long way vulnerable for goiter and accounts 60.9% with Pearson correlation coefficient 0.300, P value 0.0001. Generally, the occurrence of goiter in the study area was found to have statistical significant association with sex of respondents (being female) [AOR = 3.526; 95% CI (2.55–4.87)], climatic condition of resident (temperate climate) [AOR = 0.617; 95% CI (0.404–0.943)], frequency of iodized salt use [AOR = 0.484; 95% CI (0.317–0.739)] and consumption of cassava [AOR = 4.184; 95% CI (2.6–6.707)].

Conclusion and recommendation: In general, the study revealed that iodine deficiency disorder was a serious public health concern. Nearly half of adolescent students in Wolaita and Dawuro zones were affected by goiter. Therefore, emphasis on a sustainable iodine intervention program targeted at population level, particularly at females is mandatory. Nutrition education along with adequate Universal Salt Iodization program is urgently required.

Keywords: Iodine deficiency, Adolescent students, Wolaita and Dawuro zone, Ethiopia

Background

Iodine deficiency disorder, one of the most prevalent micronutrient deficiencies globally, is the main cause of potentially preventable mental retardation in childhood, as well as a spectrum of morbidities referred to as iodine deficiency disorders (IDD). The World Health Organization estimates that approximately 37% of school-age children, 285 million, and 1.88 billion people worldwide remain at risk of insufficient iodine intake and approximately a third of the world’s population lives in areas with some iodine deficiency [1]. Iodine deficiency is not only a common problem of developing countries but also developed countries including Australia, New Zealand and the United Kingdom are confronted with re-emergence of mild iodine deficiency and taken as public health problem in more than 50 countries [2, 3].
The estimated annual potential cost attributable to IDD in the developing world prior to widespread salt iodization was $35.7 billion per year versus $0.5 billion per year after salt iodization, giving a benefit–cost ratio of 70:1 [4].

Iodine deficiency poses a threat throughout the life-cycle and has been associated with mental impairment and goitre in older children and adults and complications with pregnancy, including stillbirth and congenital anomalies [5]. Inadequate iodine intake during pregnancy may lead to irreversible foetal brain damage. Ethiopia is a country with a high prevalence of iodine deficiency disorders which continue to affect a large number of the country’s population. Goiter prevalence rates vary significantly from region to region in Ethiopia and in certain areas the prevalence rate may be as high as 71% [6].

Total goiter prevalence (weighted) in Ethiopia was 35.8% in which 24.3 and 11.5% were palpable and visible goiter respectively. Goiter prevalence in four regional states namely Southern Nation Nationals and People Region (SNNPR), Oromia, Benshangul-Gumuz and Tigray was greater than 30%, with the maximum of about 60% in SNNPR, an indication of severe iodine deficiency [7].

Due to the severity of IDD in the nation, Ethiopia mandated that all salt for human consumption should be iodized since February 2011. A national survey conducted in 2014 by Ethiopia’s Public Health Institute (EPHI) found that an impressive 95% of households were using iodized salt. However, only 43% of the salt contained more than 15 ppm of iodine [8].

In the past 5 or more years, different small-scale studies or pocket studies and two nationwide studies conclude that Ethiopia is suffering from severe iodine deficiency as using total goitre rate as indicator and in all studies the prevalence was more than 30% [9–11]. This indicates that the presence of severe iodine deficiency accomplished with cretinism, poor scholastic performance and reduced economic productivity in general.

The problem of iodine insufficiency had got major public concern in the country and legislation as well as specific intervention strategies has been developed and implemented throughout the nation. But currently there are no scientific evidences that whether the implemented interventions are effectively reduce total goitre rate. In addition, from nationwide survey report the highest goitre rate (56%) was observed in southern Ethiopia, the area where consumption of cassava and other iodine intake inhibitor diets are very common [6]. The goiter prevalence in Ethiopia especially in SNNPR is a big problem. The magnitude of goiter among adolescent students in Ethiopia, have not been well assessed. It was necessary and timely to study this important issue in the adolescent age group. This study was therefore aimed at investigating the magnitude of goiter and associated risk factors in Wolaita and Dawuro zones, Southern Ethiopia that would serve as a baseline data.

Methods

Study area and period
The study was conducted from April to May, 2012, in Wolaita and Dawuro Zones. Wolaita zone is one of the thirteen zones of the SNNPR region covering an area of 4471.3 km². For administrative purpose, it is divided into twelve Woredas and three administrative cities. Topographically the zone lies on an elevation ranging from 1200 to 2950 m above sea level. The zone has three agro-ecological zones. Dega (cold climate) (3%) Woina dega (temperate climate) (57%) and Kolla (hot climate) (40%). The annual average temperature of the zone is 15.1 °C and the mean annual rainfall ranges from 1200 to 1300 mm. Sodo town is the administrative center of the zone. It is located at a distance of 380 km. South of Addis Ababa and 157 km away from Hawassa town.

Dawuro zone is also another zone in SNNPR region and administratively divided into five Districts and one administrative city. Topographically the zone lies on an elevation ranging from 500 to 2800 m above sea level. The zone has three agro-ecological zones. It is located at a distance of 497 km south of Addis Ababa and 274 km away from Hawassa town.

Study design
An institutional based cross-sectional study design was employed.

Source population
All high school and preparatory adolescents were involved in two zones.

Study population
Participants (high school and preparatory students) or study subjects were selected from the selected city administration of the two zones using a purposive sampling technique.

Sample size determination
The required sample size of the study was determined by single population proportion formula as 59.1% prevalence of goiter in school of Shebe Senbo District [11] is used to estimate the sample size, with a margin of error 4%, confidence interval of 95%. Final sample was multiplied by design effect of 2 and the total sample size was 740.

Sampling procedure
The sampling procedure was multi stage sampling method. First four city administrations from the two
zones were purposely selected. All high schools and preparatory schools were selected which is found in all city administrations. Then sample size was allocated to each school based on the number of students found in each school and grade. Students list was found from the school registrar. Finally, systematic random sampling technique was employed to select each student.

Data collection instrument and procedure
Data was collected using structured self-administered questionnaires. Clinical assessment of goiter was made by five health officers. The stage of the thyroid gland enlargement examination was graded on standard survey forms. Physical examination of the thyroid gland was done to assess goiter rate using the WHO/UNICEF/ICCIDD classification scheme [5, 12]. The gland classified as grade 0: Normal (No palpable or no visible), Grade 1: goiter palpable, in normal position and Grade 2: goiter visible in normal position; and total goiter prevalence (TGP) was measured by the sum of Grade 1 and Grade 2.

The principal investigators trained five health officers for clinical diagnosis of goiter and ten nurses for data collection activity from Wolaita Sodo University for one day on instruction and how to supervise the whole activity.

The English version of the questionnaire was translated to local (Amharic) language.

The supervisors clarified any doubts and collected the questionnaire after filled by the respondents.

General safety procedures during diagnosis were applied and special or separate class room for diagnosing students used in school, this helped students felt free to show their neck.

Data quality control
To assure the quality of the data in the study, data collectors and supervisors were trained and a regular supervision and follow-up was made by supervisors and the principal investigator. In addition, regular check-up for completeness and consistency of the data were made on daily basis. English version questionnaire was translated to Amharic and back translated to English by translators who are blind to the original questionnaire. To assure the quality of the data high emphasis was given in designing data collection instrument for its simplicity and pre-test followed by modification was made. Prior to the data collection, pre-test was conducted on 5% of the total sample size of the respondent’s from Humbo Woreda of the two zones.

Data analysis procedures
After thorough check up for completeness, free from any error on daily, the data were coded, cleaned and entered into Epi-info version 3.5.3 and exported to SPSS version 20 for analysis. Then descriptive frequencies were used for checking of outliers and to clean the data. The frequency distribution of dependent and independent variables was worked out. Correlation, Bivariate and Multivariable logistic regression were done. For all statistical significance test, the cut off value set was P < 0.05 as this is considered statistically reliable for the analysis of this study.

Results
Socio-demographic characteristics
Of the total 740 sample size, a complete response was obtained from 718, which makes 97.0% response rate. From the total study participants, 390 (54.3%) were males and 328 (45.7%) were females resulting in an overall male to female ratio of 1.18:1. Majority of the students, 607 (84.5%) were between the ages of 15 and 19 years and 654 (91.1%) were never married.

Out of the total 718 students, 64.5% were lived in plain land topography type while the rest were in mountainous type. Four hundred twenty-one (58.6%) of the study participants came from urban places (Table 1).

Dietary habit of respondents
Salt utilization, half of the study participants were used non-iodized type (commonly known as rock salt) 361 (50.3%) and one quarter of the respondents were consumed iodized salt commonly known as table salt) 173 (24.1%). Among iodized salt users in their home, 160 (43.8%) of them used it always, while the rest has been used it sometimes and not at all.

There were different types of food items commonly eaten in the area. Among these fruits were predominantly consumed 409 (58.8%) and followed by others such as cereal, legume and tubers, but fish were rarely consumed in the area 69 (9.8%) only.

Among the students 584 (81.3%) of them ate Cassava and 326 (56%) of the students ate once in a week while 111 (19.1%) ate twice in a week. Similarly, 684 (95.26%) and 670 (93.3%) of them ate Cabbage and spinach (Habesha Gommen) respectively (Table 2).

Knowledge about goiter among students
Six hundred twenty-two, (90.5%) of the study participants had ever heard about goiter. Among these 29.3, 22, 20.1, 16.4% of the participant reported that the causes of goiter were inadequate dietary intake, drinking unprotected water, eating goiter causing foods and family pre-disposition respectively.

Concerning the health risks of goiter other than goiter, 500 (79.7%) of the respondent believed that goiter can cause other health risk, while the rest 86 (13.7%) and 41 (6.1%) they didn’t know about other risks and believed no other causes respectively. Among the potential risks of goiter, 252 (49.3%) of the respondent believed that goiter
Table 1 Socio demographic characteristics of high school and preparatory students in Wolaita and Dawuro zones, Southern Ethiopia, April, 2012

| Variable                        | Number (n = 718) | Percent |
|---------------------------------|------------------|---------|
| Sex of the student              |                  |         |
| Male                            | 390              | 54.3    |
| Female                          | 328              | 45.7    |
| Age of the students (years)     |                  |         |
| 10–14                           | 52               | 7.3     |
| 15–19                           | 607              | 84.5    |
| ≥20                             | 59               | 8.2     |
| Marital status                  |                  |         |
| Single                          | 654              | 91.1    |
| Married                         | 47               | 6.5     |
| Divorce and widowed             | 17               | 2.4     |
| Religion                        |                  |         |
| Orthodox                        | 230              | 32      |
| Protestant                      | 452              | 63.0    |
| Other                           | 36               | 5       |
| Ethnics of the student          |                  |         |
| Wolaita                         | 517              | 72.0    |
| Dawuro                          | 159              | 22.1    |
| Other (Amhara, Oromo …)         | 42               | 5.9     |
| Permanent address of the student|                  |         |
| Urban                           | 421              | 58.6    |
| Rural                           | 297              | 41.4    |
| Climate condition               |                  |         |
| Dega                            | 273              | 38.0    |
| Woina dega                      | 283              | 39.4    |
| Kola                            | 162              | 22.6    |
| Topography of the area          |                  |         |
| Plain land                      | 463              | 64.5    |
| Mountainous                     | 255              | 35.5    |
| Family size (n = 574)           |                  |         |
| <5 family                       | 378              | 65.9    |
| ≥5 family                       | 196              | 34.1    |

is a risk to physical deficit and followed by reduce school performance 123 (24.1%).

Among the study participants, two hundred twelve (31.8%) of them had a goiter victim family member. Among these family only 131 (65.2%) did get treatment for the goiter. Regarding to preference for treatment of goiter, 117 (68%) of them were got treatment from health institution and followed by traditional healer 24 (14%) (Table 3).

Prevalence of goiter
Overall prevalence of goiter in study area was 48.9%. Status of goiter in the study area varied with its stage, goiter stage of Grade-1, 265 (36.9%) was higher than Grade-2 which was 86 (11.9%). Out of these female accounts 214 (60.9%) with Pearson correlation coefficient 0.30 P value 0.00001.

Factors associated with goitre (thyroid gland enlargement)
In bivariate analysis of socio-demographic determinants being female is the risk for goiter compared with male with COR = 3.46 (95% CI 2.54–4.72) but age has no association with occurrence of goiter. Meanwhile, respondents who lived in the temperate (Woina Dega) climatic areas are a protective factor against the occurrence of goiter [COR = 0.62, (95% CI 0.42–0.91)]. The remaining socio-demographic variables had no association with occurrence of goiter.

From dietary pattern in bivariate analysis type of salt had no statistically association with goiter rather the frequency of iodized salt usage had an association with the occurrence of goitre. Iodized salt always user had preventive effect on the occurrence of goiter i.e. (COR 0.65, 95% CI 0.44–0.96). Those who ate cassava also had an effect on the occurrence of goiter with COR = 3.49 (95% CI 2.29–5.32) but frequency of eating cassava had no association with the occurrence of goiter. Prevalence of goiter has an association with eating of cabbage as compared to their counterparts. Similar to that of cassava frequency of cabbage eating had no association with occurrence of goiter.

During multivariable logistic regression analysis, only sex of the respondent, climatic condition of the living area, frequency of iodized salt usage and eating of cassava had an association with the occurrence of goiter (Table 4).

Discussion
Overall prevalence of goiter among school adolescents was 48.9% in this area. The status of goiter in the study area varied with its stage, Grade-one goiter (36.9%) was higher than Grade-two which was (11.9%). Females were significantly affected (60.9%) as compared to males. The rate of goiter among adolescent students of Wolaita and Dawuro zones was found to be higher than report on global burden of Iodine deficiency accounted 16% of world population and 27% of African population [13] and finding from Western part of Germany (23.9%) [14]. Likewise, it is also higher than finding from Tanzania which is 25% of TGP in 6–18 years of school children [15]. However, it was less than findings from northwest (54%) [10] and southwest (59%) [11] Ethiopia; and in Enda-Mehoni district in Tigray, Ethiopia, 71.4% [16] and school children in Islamabad which is 71.6% [17]. The presence of high prevalence of goiter in this area may be due to low or inhibited thyroidal uptake of iodine because of frequent and high consumption of cassava and low coverage...
The study also revealed that sex of the students was significantly associated with goiter prevalence. This finding is supported by studies in Sub-Saharan Africa and northern Ethiopia which states that females were drastically affected [16, 18], and on the other hand, it is contradicted with findings from western part of Germany and Islamabad reported that males were more likely affected than females [14, 17]. In our finding the reason may be female adolescents have greater physiological demand of nutrients particularly iron and iodine due to the burden of menstruation and development of secondary sexual characteristics in addition with stigmatization or deprivation due to sex preferences.

Regarding with climatic condition of the residents, participants from Woina Dega (temperate or medium climatic condition) were less likely to develop goiter as contrast to who lived in Dega (cold temperature) and kola (hot temperature). The result is consistent with findings from Veneto Region, Italy and in different geographical landscape of Ethiopia [12, 19]. Probably individual reside in hot temperature will suffer from inadequate intake of iodine due to its nature of volatility apart from the presence of other iodine inhibitors.

Despite of the availability or the presences of iodized salt, respondents who were always or frequently used iodized salt were protected from the occurrences of goiter as compared to those who used sometimes or

Table 2 continued

| Variables                                      | Frequency (718) | Percent |
|------------------------------------------------|----------------|---------|
| How frequently did you consume cabbage?        |                |         |
| Not eat                                        | 34             | 4.74    |
| Only 1 day                                     | 180            | 26.7    |
| 2 days                                         | 202            | 29.5    |
| 3 days                                         | 93             | 13.8    |
| 4 or more days                                 | 199            | 29.5    |
| Did you consume Habesha Gommen?                |                |         |
| Yes                                            | 670            | 93.3    |
| No                                             | 48             | 6.7     |
| When did you consume Habesha Gommen? (670)     |                |         |
| Only during summer                             | 173            | 25.8    |
| Every time during food shortage                | 307            | 45.8    |
| When we want to eat it                         | 149            | 22.2    |
| Other                                          | 60             | 8.95    |
| How frequently did you consume Habesha Gommen? |                |         |
| (n = 668)                                      |                |         |
| Only 1 day                                     | 155            | 23.2    |
| 2 days                                         | 150            | 22.5    |
| 3 days                                         | 125            | 18.7    |
| 4 and more days                                | 238            | 35.6    |

Table 2 Iodized salt utilization and dietary intake characteristics of high school and preparatory students in Wolaita and Dawuro zones, Southern Ethiopian, April, 2012

| Variables                                      | Frequency (718) | Percent |
|------------------------------------------------|----------------|---------|
| Variables                                      |                |         |
| Type of salt frequently used                   |                |         |
| Rock salt (non iodized)                        | 361            | 50.7    |
| Iodized (table salt)                           | 173            | 24.1    |
| Both                                           | 181            | 25.2    |
| How often you use iodized table salt in your home? |            |         |
| Not use                                        | 337            | 46.9    |
| Always                                         | 153            | 21.3    |
| Sometimes                                      | 228            | 31.8    |
| Source of iodized salt (n = 365)               |                |         |
| Shop/market                                    | 314            | 86      |
| Donation                                       | 51             | 14      |
| Is iodized salt available at the source? (n = 363) |            |         |
| Yes                                            | 194            | 53.4    |
| No                                             | 169            | 46.6    |
| Type of food frequently eaten                  |                |         |
| Cereal (n = 703)                               | 345            | 49.1    |
| Legume (n = 703)                               | 348            | 49.5    |
| Tuber (n = 703)                                | 328            | 46.7    |
| Fruit (n = 701)                                | 409            | 58.3    |
| Fish (n = 703)                                 | 69             | 9.8     |
| Others (n = 703)                               | 224            | 31.9    |
| Did you eat cassava?                           |                |         |
| Yes                                            | 584            | 81.3    |
| No                                             | 134            | 18.7    |
| When did you consume cassava? (584)            |                |         |
| Only during summer                             | 229            | 39.3    |
| Every time during food shortage                | 144            | 24.8    |
| When we want to eat it                         | 176            | 30.4    |
| Other                                          | 53             | 9.2     |
| How frequently consume cassava per week?       |                |         |
| Not eat                                        | 134            | 18.7    |
| Only 1 day                                     | 290            | 40.4    |
| 2 days                                         | 108            | 15.4    |
| 3 days                                         | 76             | 10.6    |
| 4 or more days                                 | 110            | 15.3    |
| In what form did you consume cassava? (n = 584) |                |         |
| Only boiled                                    | 233            | 39.8    |
| In injera/porridge/bread/possessed             | 156            | 26.8    |
| Both                                           | 195            | 33.4    |
| Did you consume cabbage?                       |                |         |
| Yes                                            | 684            | 95.26   |
| No                                             | 34             | 4.74    |
| When did you consume cabbage? (684)            |                |         |
| Only during summer                             | 165            | 24.4    |
| Every time during food shortage                | 107            | 15.9    |
| When we want to eat it                         | 342            | 50.5    |
| Other                                          | 85             | 12.6    |
never users. This is similar with report from Germany and Italy [14, 19]. This may be in the study setting daily intake of iodized salt may overcome the competitive inhibition of thyroidal uptake of iodine.

Most common staple diet of the participants was cassava that accounts about 82% and in this study, Cassava consumption was identified as independent predictors of goiter and the result was similar with study conducted in sub-Saharan Africa [18]. Cassava contains cyanide compound that compete for uptake by the gland. Therefore, high concentrations of cyanide considerably reduce the absorption of iodine and the gland progressively enlarged (hyperplasia of the gland).

Eventually, the study failed to measure the recent iodine level in the participants which is the drawback of the use of total goiter prevalence that is not sensitive indicators of IDD. Moreover, the study had limitation to generalized the overabundance of goiter is purely the consequence of iodine deficiency. The subjects under study were not the preferable target population to study iodine deficiency and there could have been a room for recall bias which subsequently could have resulted in underestimation of the true prevalence of goiter among the students.

**Conclusion**

In general, goiter was a serious public health concern in both zones. Significant proportion of students in Wolaita and Dawuro zones, were affected by goiter and female students were getting serious impact than male students. Iodine salt utilization is not enough to prevent goiter unless it was used always. Generally, the occurrence of goiter was affected by sex, climatic condition, frequency of iodine salt utilization, and cassava consumption.

**Recommendation**

Emphasis should be given on a sustainable iodine intervention program targeted at population particularly female. Nutrition education along with Universal Salt Iodization program where iodine deficiency is severe is urgently required. Intensive iodized salt donation to the community is the option until awareness of the community is optimum. It is very imperative that health education should be given to increase community awareness on the importance of iodized salt to the general public.
Abbreviations
AOR: adjusted odds ratio; COR: crude odds ratio; IDD: iodine deficiency disorder; SNNPR: Southern Nations and Nationality Peoples’ Region; TGP: total goiter prevalence.

Authors’ contributions
YGA conceived the study. AAG and YGA equally participated in the design, data collection, statistical analysis and writing-up of the manuscript. SBW participated in study design, participated in data collection, and write-up. TCM involved in the analysis and write-up of the report. All authors read and approved the final manuscript.

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Competing interests
The authors declare that they have no competing interests.

Availability of data and materials
All the data in manuscript and related supporting materials will be shared without restriction up on request.

Ethical approval and consent to participants
Ethical clearance was obtained from Wolaita Sodo University, College of Health science and Medicine, Research and Ethics Review Committee. Informed verbal assent was obtained from parent/guardian for respondent whose age is less than 18 years and from the respondent above 18 years written consent was taken after explaining the aim of the research, assurance of confidentiality, securing privacy and the right to withdraw the participation at any time without any consequences.

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