

Predictors of Goiter among School Children in Southwest Ethiopia: Case-Control Study

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Abstract

Background: Goiter is the abnormal enlargement of the thyroid gland. It has been shown that prevalence of goiter was considerably highest in South Ethiopia particularly in Gamogofa zone. The study was aimed to identify factors that determine goiter among Botre Elementary and Junior Secondary school students, Gamogofa zone, Southern Ethiopia.

Methods: Case control study was conducted among Botre Elementary and Junior Secondary School students from February to March, 2014. A total of 298 students; 99 cases and 199 controls, were enrolled in the study. Examination of goiter was performed by Inspection and Palpation techniques. Structured interview guided questionnaire was used to collect data on independent variables. Data were entered using EPI info version 3.5.3 statistical software and analyzed using SPSS version 20 statistical package. Descriptive statistics was used to describe the study population in relation to relevant variables. Bivariate and multivariate logistic regression was also carried out to identify factors that determine the dependent variable.

Result: A total of 99 cases and 199 controls participated in the study. Being female [AOR: 2.48, 95% CI: 1.38, 4.44], rural residence [AOR: 2.07, 95% CI: 1.11, 3.86], cassava consumption [AOR: 2.92, 95% CI: 1.52, 5.62], cabbage consumption [AOR: 2.46, 95% CI: 1.17, 5.13], use of other than tap water source for drinking [AOR: 3.76, 95% CI: 2.07, 6.85], and lack of knowledge by parents about prevention of iodine deficiency disorders [AOR: 2.10, 95% CI: 1.03, 4.27] were independent predictors of goiter.

Conclusion: More than half of cases use other than tap water source(s) for drinking; either spring, well, river or some form of combination; alone or in addition to tap; which was the strongest independent predictor of goiter. So, access to safe drinking water should be improved for rural residents to reduce the level of goiter and its consequences.

Keywords: Goiter; Determinant factor; Ethiopia

Introduction

The thyroid gland is a small, butterfly shaped organ situated in the lower region of the neck in front of the windpipe [1]. The primary function of the gland is production of the two important thyroid hormones essential for metabolic processes, growth and development [2]. Thyroid hormones play a major role in the growth and development of brain and central nervous systems from the 15th week of gestation to age 3 years. If iodine deficiency exists during this period and results in thyroid hormone deficiency, the consequence is derangement in brain and central nervous system development. These derangements are irreversible, the most serious form being cretinism, with impairments of cognitive ability, physical and neurophysiologic defects [3]. The other physiologic role of thyroid hormone is to control several metabolic processes like, protein synthesis which increases energy production and thermogenesis [4].

Iodine deficiency occurs when iodine intake falls below recommended level. When iodine requirements are not met, the thyroid may no longer be able to synthesize sufficient amounts of thyroid hormone, resulting in low level of thyroid hormones in the blood and a series of functional and developmental abnormalities grouped under the heading of "Iodine Deficiency Disorders (IDD)" [5]. The spectrum of these disorders includes goiter, mental defects, deaf mutism, stillbirth and miscarriages, weakness and paralysis of muscles as well as physical dysfunction and mental retardation [6].

With chronic iodine deficiency, there will be shortage in hormone production. The pituitary gland senses that the thyroid hormone level is too low and releases a signal to the thyroid gland. This signal is

called thyroid stimulating hormone (TSH). As the name indicates, this hormone stimulates the thyroid to produce thyroid hormones and to grow in size as it tries to keep up with demand for thyroid hormone production. This abnormal growth in size of the gland produces what is termed as "goiter" [7].

The term "goiter" refers to the abnormal enlargement of the thyroid gland [8]. It is the most visible manifestation of IDD (5). Symptoms of goiter include a swollen, tender or tight feeling in the neck or throat, hoarseness and difficulty swallowing or breathing [9,10].

School-age children are considered an appropriate target group in determining iodine deficiency disorders in a population; because they fulfill the desired criteria of susceptibility to iodine deficiency, accessibility as a study group and representativeness of society as a whole [8,11]. Goiter in school children is the best indicator of IDDs in the community and it is recommended that a total goiter prevalence of 5% or more in schoolchildren should be used to signal the presence of a public health problem [3,8].

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IDDs are greatest cause of brain damage and the world's preventable cause of irreversible mental retardation in childhood [12], which is the primary motivation behind the current world-wide drive to eliminate it [8]. Yet, IDD's are major nutritional public health problems all over the world affecting millions of people, the largest share occurring in less developed countries [3]. As studies indicated, goiter has been found to be a public health problem in Ethiopia [13,14]. It has been shown that prevalence of goiter was considerably high in South part of the country [12]. Therefore this study was aimed to identify factors that determine goiter among Botre Elementary and Junior Secondary school students, Gamogofa zone, Southern Ethiopia.

Methods

Study design and setting

Unmatched case-control study design was employed in Sawla town, Gamogofa zone from February to March, 2014. The town is found about 510 Km South of the capital Addis Ababa. The town has an estimated total population of about 34,192. The common food crops cultivated in the woreda and the surrounding rural areas of the town include maize and teff from cereals; potatoes and cassava from root crops, pumpkins, and cabbage from vegetables. Cassava is consumed in the great majority of households being processed, either alone or mixed with other cereal foods. Cabbage is more commonly consumed during summer season. There is one public hospital, one public health center, and five private clinics in the town. Botre Elementary and Junior Secondary school, which was established in 1961, is the oldest and popular school in the town enrolling great majority of students that are perceived to better represent the local community. The school currently enrolled a total of 3,364 students in 2014 academic year, with 52.5% females.

The study populations for cases were all Botre Elementary and Junior Secondary School students of 2014 academic year who were between age of 6 to 15 years and who have goiter; and for controls, all Botre Elementary and Junior Secondary School students of 2014 academic year between 6 to 15 years of age who don't have goiter.

The assumptions used to determine the sample size were; 95% level of confidence, 80% power of the test, 1:2 ratio of cases to controls and ($p_1=31.97\%$) proportion of cassava consumption among cases and ($p_2=16.24\%$) proportion of cassava consumption among controls [15]. With these assumptions, sample size was calculated using two population proportion formula. Accordingly, sample size was calculated by STATCALC program of Epi Info 3.5.3 and resulted to 279 samples (93 cases and 186 controls). By considering 10% of possible non-response, the final sample size was calculated to be 307 students, 102 cases and 205 controls.

Sampling technique and procedure

Presence or absence of goiter was identified by conducting preliminary school survey among 2,673 students who were between 6 to 15 years of age. During physical examination, every student examinee was registered on the registration form with a specific identification code. A total of 1,039 potential cases were identified in the examination and lists of students who have goiter and those who don't have were separately established from the registration form on the basis of the specific identification codes. Simple random sampling technique was used for selection of both cases and controls.

Operational definitions

Case: A student of the school who had palpable but not visible

enlargement in the neck when the neck was in the normal position, or had a swelling in the neck that was clearly visible when the neck was in the normal position and was consistent with an enlarged thyroid when the neck was palpated.

Control: A student of the school who had neither visible nor palpable enlargement in the neck Goiter: palpable but not visible enlargement in the neck when the neck is in the normal position, or a swelling in the neck that is clearly visible when the neck is in a normal position and is consistent with an enlarged thyroid when the neck is palpated [8].

Grade 0: No palpable or visible enlargement in the neck indicating absence of goiter.

Grade 1: Palpable but not visible enlargement in the neck when the neck is in the normal position Grade 2: a swelling in the neck that is clearly visible when the neck is in a normal position and is consistent with an enlarged thyroid when the neck is palpated [8].

Parent knows cause of goiter: If mentioned 50% or above of four items perceived to be correct response for the question on cause of goiter.

Parent knows prevention of iodine deficiency disorders: If the student's parent mentioned use of iodized table salt for the question on prevention of goiter.

Total Goiter Prevalence (TGP): Sum of goiter grades 1 and 2 [8].

Data collection tools and procedures

Pretested interviewer administered questionnaire was used to collect household survey data. The questionnaire was translated to the local language Amharic and then back translated to English to maintain conceptual consistency.

Preliminary school survey was conducted to identify cases. In the survey, diagnosis of goiter was performed by seven professional nurses working in hospital and health center. Presence or absence of goiter was determined by physical examination using Inspection and Palpation techniques. Physical examination of the students was conducted in the school compound by making appropriate adjustments with the school administration. Goiter was graded as per the recommendation by WHO/UNICEF/ICCIDD in to Grade 0, Grade 1, and Grade 2. Except age and gender of the students other data on independent variables were obtained by visiting households. Households and parents were traced by the students and data were obtained from the student's mother, father or any other head of the household that was considered student's parent in the study. The household survey was also conducted by the nurses.

Data processing and analysis

The filled questionnaires were checked for completeness and entered into Epi Info version 3.5.3 statistical software and then exported to SPSS version 20 for further analysis. Descriptive statistics was used to describe the study population in relation to relevant variables. Both bivariate and multivariate logistic regression models were used to identify associated factors. Only variables that showed p-value ≤ 0.25 on the bivariate analysis were entered in to the multiple binary logistic regression models. Odds Ratios and their 95% Confidence Intervals were computed and variables with p - value less than 0.05 were considered as statistically significant.

Data quality control

Diagnosis of goiter was performed only by professional nurses who

have clinical experiences; after they get one day training by a medical doctor. Field supervision was maintained by the medical doctor and the principal investigator; for the household survey data collection, training and supervision was given by the principal investigator. A pre-test was conducted using 10% of the sample on students randomly selected from school which was not included in the study. Appropriate modifications were made after analyzing the pretest result before the actual data collection.

Ethical consideration

Ethical clearance was obtained from the sawla town administration health unit. Communication with the school administrators were made through formal letter obtained from the health unit. Goiter examination was performed after written consent was obtained jointly from the school and parents of study participants. Household survey data was collected after informed consent was assured from the respondents. Students who diagnosed to have goiter was counseled on benefits of iodized salt consumption and linked to Sawla town health unit. Confidentiality was maintained by making the data collection procedure anonymous.

Results

Socio-demographic characteristics of the study participants

Out of the expected 307 participants, 298 were enrolled (99 cases and 199 controls) making the response rate 97.07%. The median age was 11 years for cases and 12 years for controls. Females accounted for 64.6% of cases and 48.2% of controls. One third (36.4%) of cases born to illiterate mothers, while 28.6% of controls born to mothers with educational level of 5-8 grades followed by 24.1% born to illiterate mothers. As to parent's occupational status, 42.4% of cases and 38.2% of controls born to housewives; whereas 27.3% of cases and 30.7% of controls born to businessmen with regard to father's occupational status (Table 1).

Description of dietary characteristics

Majority (96.3%) of the respondents use rock salt, while only 9.7% of the study participants' use iodized table salt; 9.1% of cases and 10.1% of controls. Two third (66.7%) of iodized table salt users among cases and 40.0% among controls stored it in glass bottle followed by 33.3% among cases and 40.0% among controls who stored in plastic bag. Most (81.8%) of cases and 59.8% of controls consume cassava. Among consumers, 37.0% of cases and 36.1% of controls consumed it only once, while 54.3% of cases and 47.1% of controls consumed it twice or above in the last week prior to data collection. Three fourth (84.8%) of cases and 72.9% of controls consume cabbage. From these, 64.3% of cases and 60.0% of controls consumed it twice or above in the last one week. More than half (55.6%) of cases use other than tap water source (s) for drinking, either spring, well, river or some form of combination; alone or in addition to tap; while the larger proportion (79.9%) of controls use only tap water for drinking (Figure 1).

Parent's knowledge and familial predisposition

Most (90.9%) of cases and 82.9% of controls were from parents that do not know cause of goiter. Also great majority (83.8%) of cases and (72.4%) of controls were from parents that do not know about the importance of Universal Salt Iodization for prevention of iodine deficiency disorders. One third (37.4%) of cases and 21.1% of controls reported family history of goiter (Table 2)

Variable	Cases (n=99)		Controls (n=199)	
	Number	Percent	Number	Percent
Categorized age of students				
6 to 11 years	44	44.40%	103	51.80%
12 to 15 years	55	55.60%	96	48.20%
Gender of students				
Male	35	35.40%	103	51.80%
Female	64	64.60%	96	48.20%
Current residence				
Sawla town	58	58.60%	162	81.40%
Rural area / village out of Sawla town	41	41.40%	37	18.60%
Categorized household monthly income (in ETB)				
≤500	35	35.40%	61	30.70%
501 to 999	34	34.30%	54	27.10%
≥1000	30	30.30%	84	42.20%
Mother's educational level				
Illiterate	36	36.40%	48	24.10%
1 to 4	19	19.20%	43	21.60%
5 to 8	19	19.20%	57	28.60%
9 to 12	21	21.20%	33	16.60%
12+	4	4.00%	18	9.10%
Father's educational level				
Illiterate	20	20.20%	33	16.60%
1 to 4	9	9.10%	24	12.10%
5 to 8	29	29.30%	45	22.60%
9 to 12	30	30.30%	61	30.70%
12+	11	11.10%	36	18.10%
Mother's occupational status				
Government employee	6	6.10%	28	14.10%
Businesswoman	31	31.30%	67	33.70%
Housewife	42	42.40%	76	38.20%
Daily laborer	10	10.10%	12	6.00%
Other *	10	10.10%	16	8.00%
Father's occupational status				
Government employee	26	26.30%	58	29.10%
Businessman	27	27.30%	61	30.70%
Farmer	21	21.20%	38	19.10%
Daily laborer	14	14.10%	22	11.10%
Other **	11	11.10%	20	10.10%

*Other ** consists of self-employee, farmers and students

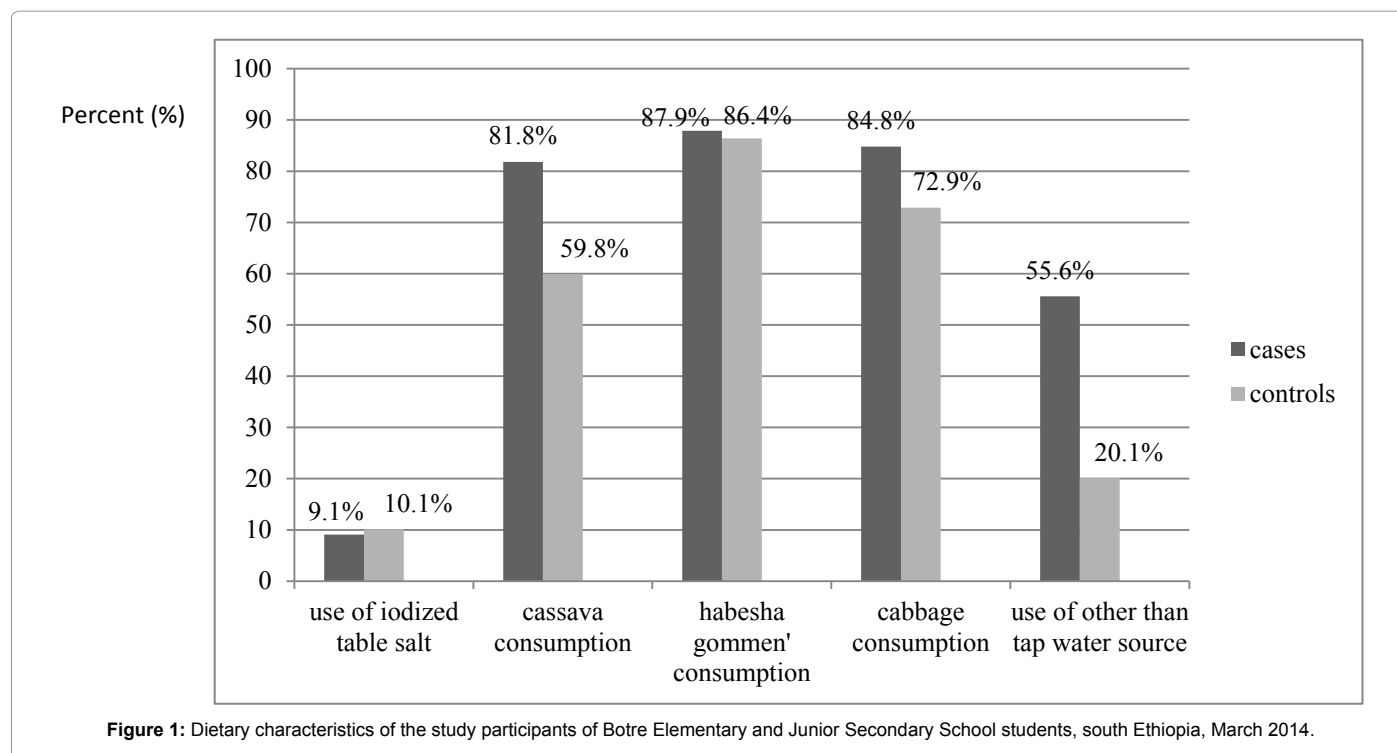
*Other *** consists of self-employee, unemployed and students

Table 1: Socio-demographic characteristics of Botre Elementary and Junior Secondary School students, south Ethiopia, March 2014.

Determinant factors

The final model was built using backward stepwise logistic regression method. Finally, being female, rural residence, consumption of cassava, consumption of cabbage, use of other than tap water source for drinking and lack of parent's knowledge about prevention of iodine deficiency disorders were found to be independent predictors of goiter. Whereas age, mothers' educational level, mothers' occupational status, household monthly income, parents' knowledge about cause of goiter and family history were not statistically significant.

Being female and in rural residence outside Sawla town were found to be risk factors of goiter among socio-demographic variables. Female students were 2.5 [AOR: 2.48, 95% CI: 1.38, 4.44] times more likely to have goiter as compared to males. Students from rural area or village were about two [AOR: 2.07, 95% CI: 1.11, 3.86] times more likely to



Variables		cases	controls	Crude OR [95%CI]
		n=99 (%)	n=199 (%)	
Parent's knowledge about cause of goiter	Have knowledge	9 (9.1%)	34 (17.1%)	0.485 (0.22, 1.05)
	Don't have knowledge	90 (90.9%)	165 (82.9%)	1
Parent's knowledge about prevention of IDD's	Have knowledge	16 (16.2%)	55 (27.6%)	1
	Don't have knowledge	83 (83.8%)	144 (72.4%)	1.981 (1.06, 3.67) *
Family history of goiter	have family history	37 (37.4%)	42 (21.1%)	2.231 (1.31, 3.79) *
	Don't have family history	62 (62.6%)	157 (78.9%)	1

*shows variables that are statistically significant with $p < 0.05$.

Table 2: Parents' knowledge, familial predisposition, and their association with goiter among Botre Elementary and Junior Secondary School students, south Ethiopia, March 2014.

have goiter as compared to their counterparts who were from Sawla town.

Both cassava and cabbage consumption were observed to be risk factors of goiter. The students who consume cassava were about three [AOR: 2.92, 95% CI: 1.52, 5.62] times more likely to have goiter as compared to those who do not consume it; while those students who consume cabbage were about 2.5 [AOR: 2.46, 95% CI: 1.17, 5.13] times more likely to have goiter as compared to their counterparts who do not at all. Drinking water source was observed to have independently significant association with goiter; use of other than tap water source (s) for drinking being risk factor. Those students who use other than tap water source(s), either well, spring, river, or combination of them, alone or in addition to tap, were about four [AOR: 3.76, 95% CI: 2.07, 6.85] times more likely to have goiter as compared to their counterparts who use only tap water for drinking. Parents' knowledge about prevention of iodine deficiency disorders was found to have significant association with goiter in their children. Students whose parents do not know prevention of iodine deficiency disorders were about two [AOR: 2.10, 95% CI: 1.03, 4.27] times more likely to have goiter as compared to those whose parents know the prevention (Table 3).

Discussion

Iodine Deficiency Diseases are major nutritional public health problems all over the world, especially in developing countries. It has been reported that 38% of the world's population live in areas with iodine deficiency and risk its complications [16]. Globally, an estimated 740 million people are affected by goiter, and more than 2 billion are estimated to be at risk [16,17]. In Ethiopia, around 28 million people suffer from goiter, and more than 35 million people are at risk of iodine deficiency [18]. National total goiter weighted prevalence rate among children aged 6 to 12 years was 39.9%, [19]. According to another national study, TGR was high in south of the country accounting about 60% [14]. Therefore, the aim of this study was to identify determinants of goiter among Botre Elementary and Junior Secondary School students in Sawla town, south Ethiopia.

This study identified that female sex, rural residence out of Sawla town, consumption of cassava, consumption of cabbage, use of other than tap water source for drinking, and lack of parent's knowledge about prevention of iodine deficiency disorders were the major determinants of goiter.

The finding of this study showed that female students are more

Variable	COR (95% C.I)	AOR (95% C.I)
Sex of the Student		
male	1	1
Female	1.96 (1.19,3.22)	2.47(1.38,4.43)*
Residence		
Sawala town	1	1
Rural area	3.09 (1.81,5.29)	2.07 (1.11,3.86)*
Cassava Consumption		
Don't Consume at all	1	1
Consume	3.02 (1.68,5.42)	2.92 (1.52,5.62)*
Cabbage consumption		
Don't consume at all	1	1
Consume	2.08 (1.10,3.92)	2.46 (1.17,5.13)*
Source of drinking water		
Use only tap water source	1	1
Use other than tap water source (s)	4.96 (2.93,8.41)	3.76 (2.07,6.85)*
Parent's knowledge about prevention of IDD's		
Don't have knowledge	1.98 (1.06,3.67)	2.10 (1.03,4.27)
Have knowledge	1	1

*shows variables that are statistically significant with $p < 0.05$.

Table 3: Bivariate and multivariate logistic regression analysis of factors independently associated with goiter among Botre Elementary and Junior Secondary School students, south Ethiopia, March 2014.

at risk of goiter than male students. This result is comparable with other studies. A study conducted among school children in Isfahan, Central Iran [20], pointed out greater prevalence of goiter among girls. According to a national study conducted in Ethiopia [12], prevalence of goiter among school children measured by palpation was higher among females (56.1%) than in males (50.8%) of all age groups; also a study conducted among school children in Kafa zone, southwest Ethiopia, observed feminine sex associated with goiter [13]. Physiological factors such as hormonal effects might have played roles to bring about the observed difference.

Rural residence was found to be risk factor for goiter in the current study; students from the surrounding rural areas were more likely to have goiter as compared to their counterparts who were from Sawla town. This provides figurative evidence over the finding of surveys conducted in Lebanon [20] that have demonstrated that endemic goiter preferentially affects the rural population. The possible reason for the observed difference could be attributed to the relatively low educational status, knowledge of cause and preventions of goiter, and limited access to health services of the rural communities.

Consumption of cassava was identified to be strongly associated with goiter; it was observed that students who consume cassava were more likely to have goiter as compared to those who do not consume at all. A national community-based study conducted in Ethiopia revealed that consumption of cassava might be an additional factor responsible for the important epidemiological variations of endemic goiter observed [12], and other similar study found that school children who consume cassava frequently were significantly affected by goiter than those consuming rarely or not, with likelihood of having goiter being two times more; particularly in south Ethiopia [15].

Consumption of cabbage was found to be risk factor of goiter in this study; those students who consume cabbage were more likely to have goiter as compared to their counterparts who do not consume cabbage at all. The risk of cabbage consumption was also observed by a study conducted in Pagar Aram city, *South Sumatera Province* [21], which identified cabbage consumption as a significant determinant of iodine

deficiency disorders on school children. The possible explanation could be, these food items might have interference with iodine uptake of the body.

Increased prevalence of goiter has also been related to bacterial pollution of drinking water as pointed out in a study conducted among Brazilian school children; and bacteriological studies of drinking water [22] exhibited significantly higher prevalence of goiter in villages using water polluted with coli forms and *E. coli* than those villages using non-polluted drinking water, which provides evidence that coli forms and *E. coli* isolated from drinking water contribute to the high incidence of endemic goiter other than iodine deficiency [12]. The current study identified that use of other than tap water source(s) for drinking has strong association with goiter; students who use other than tap water source(s), either well, spring, river, or combination of them, alone or in addition to tap, were more at risk to have goiter as compared to their counterparts who use only tap water for drinking. This could be explained by the fact that these water sources, commonly used by the rural part of the community, are usually prone to contamination with microorganisms and bacterial coli forms. Microorganisms and bacterial coli forms might interfere with iodine metabolism and upset its bioavailability.

As observed in a community-based study conducted in Mali [23], level of knowledge about salt iodization was low, and only 39% of the households were using salt with any iodine. According to the current study, parent's knowledge of prevention of iodine deficiency disorders was found to have independently significant association with goiter in their children. Students whose parents do not know how to prevent iodine deficiency disorders were prone to have goiter as compared to those whose parents know how to do so. Level of knowledge could determine utilization of iodized table salt.

Conclusion

Determinant factors of goiter in this study were consistent with similar studies. Female gender, rural residence, use of other than tap water source for drinking, lack of knowledge by parents about prevention of iodine deficiency disorders, consumption of cassava and cabbage were found to be risk factors of goiter. More than half of cases use other than tap water source(s) for drinking; which was the strongest independent predictor of goiter. So, access to safe drinking water should be improved for rural residents to reduce the level of goiter and its consequences.

Authors' Contributions

DL participated in proposal development, data collection and analysis. YM participated in data analysis and drafted the manuscript. Both authors read and approved the final manuscript

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