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Research Article

Goiter and Its Associated Factors among Adolescent High School Girls at Tach Armachiho District, Northwest Ethiopia: An Institution-Based Cross-Sectional Study

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Introduction. In Ethiopia, iodine deficiency disorder (IDD) is a major public health problem. The most visible effect of IDD is the appearance of goiters, and 28 million people are affected by goiter. Therefore, this study aimed to assess the prevalence and associated factors of goiter among high school adolescent girls at Tach Armachiho district, Northwest Ethiopia. *Methods*. An institution-based cross-sectional study was conducted from October to November 2018. A total of 620 high school adolescent girls were selected using the simple random sampling technique, and structured questionnaires having observational check-list were used for data collection. The presence of goiter was estimated using criteria set by World Health Organization. Iodine content of the salt was estimated by using spot testing kits. Both bivariable and multivariable logistic regressions were used to identify associated factors. The degree of association between independent and dependent variables was assessed by using odds ratio with 95% confidence interval. Those variables having p value of less than 0.05 in the multivariable analysis were considered as significant factors for goiter. *Results*. A total of 614 adolescent girls gave a complete response. The prevalence of goiter among adolescent girls was 24.1%. In the multivariable logistic regression analysis, age of adolescent girls (adjusted odds ratio (AOR) = 1.57, 95% CI: 1.01–2.46), residence (AOR = 1.91, 95% CI: 1.04–3.51), family history (AOR = 4.96, 95% CI: 3.19, 7.72), low dietary diversity (AOR = 8.39, 95% CI: 4.36–16.14), and medium dietary diversity (AOR = 2.26, 95% CI: 1.36–3.77) were significantly associated with adolescent girls goiter. *Conclusions*. Goiter among high school adolescent girls in this study was high. Age of adolescent, residence, family history of goiter, and dietary diversity were statistically significant factors for goiter. Therefore, more emphasis will be given for late adolescent age, having family history of goiter, low dietary diversity, and rural residence to improve the burden of adolescent goiter.

1. Introduction

Goiter, which refers to an abnormal enlargement of the thyroid gland, is one of the most common endocrine problems for children and adolescents [1]. Each of the lateral lobes of the thyroid gland is larger than the terminal phalanges of the thumb of a person examined for goiter [2], reflecting a chronic iodine deficiency as a sensitive long-term indicator of the successes of iodine intervention programs [3]. Adolescents are young people aged between 10–19 years [4] who are known to have serious nutritional challenges because of intense physical, psychosocial, and cognitive developments and transition from childhood to adulthood [5]. Interventions during adolescence are used to break the vicious cycle of malnutrition.

The consequences of iodine deficiency are goiter, hypothyroidism, physical and neurophysiologic defects, mental retardation, and brain damage [6]. The educational potential of a nation can be unattainable as iodine deficiency reduces the intelligence quotient (IQ) by 13.5 points due to

an inadequate production of the thyroid hormone [7]. The problem is a threat to the productivity of the workforce and a cause of cretinism and mental retardation [8]. To prevent these problems, the Ethiopia government launched the iodized salt fortification, a monitoring and regulatory system in May 2011 [9]. Iodine deficiency is associated with a wide range of physical and mental disorders during the most critical period of development, like adolescent girls and the first trimester of gestation. Furthermore, 30% of all school-age children are mild to severely iodine-deficient, and the deficiency is more prevalent among adolescent girls [10, 11].

Different studies show that the prevalence and associated factors of goiter among adolescent girls varies from country to country. For instance, in Africa, the burden of goiter ranges from 34.5% to 37% on an average; in Ethiopia, about 30% of the adolescent girls develop goiter [12]. The magnitude of goiter also varies from region to region in Ethiopia: in Southern Nations, Nationalities and Peoples region (SNNP) (56.2%), Oromia (42%), Benishangul Gummuz (40%), Amhara (29.1%), and Tigray (21.9%) [7]. The prevalence of goiter is also influenced by factors, such as sex [13], educational status and age [14–16], place of birth and family income [17], residence [18], consumption of iodized salt [17], knowledge, dietary intake, drinking unprotected water, eating goitrogenic foods, and family history [18].

Although the Government of Ethiopia has increased its efforts to prevent goiter, its magnitude among adolescent girls is still high, and factors vary from place to place. Therefore, this study aimed to assess the magnitude of goiter and associated factors among adolescent girls in Tach Armachiho district.

2. Methods and Materials

2.1. Study Setting and Sample Size. An institution-based cross-sectional study was conducted from October to November 2018 among adolescent high school girls at Tach Armachiho district, Northwest Ethiopia, located 854 km from Addis Ababa, the capital of Ethiopia. The district has 38 kebeles (the smallest administrative units). Its altitude is 1050 to 1800 ms above sea level; 42% of its area is mountainous, with a temperature of 25–42 degree Celsius. According to the 2018 report, the district had four high schools with 1,972 adolescents. One district hospital and nine health centers provide health services.

The single population proportion formula was used to determine the sample size by considering 37.6% previous prevalence of goiter [14], 95% confidence interval, 4% margin of error, and 10% none response rate, which yielded 620. The sample size was distributed proportionally to four high schools based on the number of students in each school. The simple random sampling technique was used to select study participants.

2.2. Inclusion and Exclusion Criteria. Adolescent girls who were learning in high school during data collection were included in the study, and adolescent girls who suffered from serious illness during the period of data collection were excluded from the study.

2.3. Assessment of Goiter and Salt Iodine Content. For the general data collection, eight nurses, two general practitioners, and two public health experts participated as supervisors, after they were given two-day training by the principal investigator. In order to maintain data quality, a pretest was administered on 5% of the sample in Tsegede district out of the study area. Onsite supervision was performed, and each copy of the questionnaire was checked for completeness and accuracy before data entry.

Physical examination of a thyroid gland was performed by two skilled general practitioners (GPs), using WHO/ICCIDD/UNICEF clinical criteria. Accordingly, goiter was defined as grade 0 if no palpable mass in the neck was detected, grade 1 if there was a mass in the neck consistent with palpable enlarged thyroid, but not visible when the neck was in the normal position, whereas grade 2 if there was a swelling in the neck that was visible when the neck was in a normal position and is consistent with an enlarged thyroid when the neck is palpated (palpable and visible). Lastly, the child was deemed as having goiter when he/she had goiter of grade 1 or 2 [19].

Iodine level of salt was determined by a rapid test kit (ARCHIV MANNAR no. 107397). The kit was used in houses of all participants; the interviewer asked households to provide a teaspoon of salt used for cooking and added two drops of test solution to determine the iodine content in the salt. It was filled in a small cup and spreaded flat, two drops of test solution were added on the surface of salt by piercing the white ampule, the color of salt was compared with a color chart within one minute, and the iodine concentration was determined (intense color). If no color change appeared on the salt after one minute, up to five drops of recheck solution were added in red ampule on a fresh sample, two drops of test solution were added on the same spot, and the color was compared with the color chart. The iodine content was determined, if it is 0 parts per million (no iodine), <15 ppm (light blue), ≥15 ppm (deep blue) [16, 20].

2.4. Assessment of Household Wealth Status. Household's wealth index, adopted from EDHS 2011, was determined using principal component analysis (PCA) by considering the household assets, such as quantity of cereal products, type of house, livestock, and agricultural land ownership. First, variables were coded between 0 and 1 and then entered and analyzed using PCA. Those variables having a communality value of greater than 0.5 were used to produce factor scores. Finally, the factor scores were summed and ranked into tertiles as poor, medium, and rich [21].

2.5. Data Processing and Analysis. The collected data were entered by using Epi Info 7 and transferred to SPSS version 20 for further analysis. Data cleaning was performed to check for accuracy, consistency, and missed values. Frequencies, proportions, and summary statistics were used to describe the variables.

The result was presented using tables, and statistical associations were assessed by using bivariable and multivariable logistic regressions to obtain crude and adjusted

Table 1: Sociodemographic and environmental-related characteristics of adolescent girls in Tach Armachiho district, 2018 ($N = 614$).

Variable	Category	Frequency	Percentage
Age	10–15	234	38.01
	16–19	380	61.90
Religion	Orthodox	588	95.8
	Catholic	3	0.5
	Muslim	23	3.7
Grade level	Grade 9	290	47.2
	Grade 10	143	23.3
	Grade 11	101	16.4
	Grade 12	80	13.0
Residence	Urban	179	29.2
	Rural	435	70.8
Fathers occupation	Government employee	47	7.7
	Farmer	510	83.1
	Daily labor	12	2.0
	Merchant	45	7.3
Mothers occupation	Government employee	10	1.6
	Farmer	517	84.2
	Daily labor	5	0.8
	Merchants	35	5.7
	Nongovernment employee	47	7.7
Maternal education	Illiterate	466	75.9
	Informal education	95	15.5
	Primary school (1–8) grade	34	5.5
	Secondary school and above	19	3.1
Family size	<5	367	59.8
	>5	247	40.2
Wealth status	Poor	214	34.9
	Medium	211	34.4
	Rich	189	30.8
Source of drinking water	Tap water	252	41.0
	Public tap	153	24.9
	Protected well	177	28.8
	Unprotected well	32	5.2
Practice water safe to drink	Boiled	78	12.7
	Wuhagar/chlorine added	457	74.4
	Strained through cloth	7	1.1
	Sunlight with bottle	38	6.2
	Others**	34	5.5
Community gardening	Yes	277	45.1
	No	337	54.9
Community gardening ($n = 277$)	Selling all	39	14.1
	Selling some of	132	47.7
	All used by the family	92	33.2
	Others	14	5.1

**Add sand and settle and sediment the dirty pieces.

odds ratios with a 95% confidence interval. Variables with less than or equal to 0.2 p values in the bivariable analysis were entered into the multivariable analysis to control the possible effects of confounders. Variables with p value <0.05 in the multivariable analysis were considered as statistically significant for adolescent goiter.

3. Results

3.1. Sociodemographic and Environment-Related Characteristics. A total of 614 adolescent girls participated with a response rate of 99.03%. The mean age of the participants was 16.78 years with SD ± 1.66. A majority of the

Table 2: Utilization of iodized salt and dietary practice-related characteristics of adolescent girls in Tach Armachiho district, Northwest Ethiopia, 2018 ($N = 614$).

Variable	Category	Frequency	Percentage
Use iodized salt during cooking "wott"	Yes	518	84.4
	No	96	15.6
Salt added during cooking ($n = 518$)	Early	106	20.5
	Middle of cooking	88	17
	End of cooking	259	50
	After cooking	65	12.5
Salt storage in the house	By opened parcel	77	12.5
	By closed parcel	537	87.5
Salt exposure to sunlight	Yes	192	31.3
	No	422	68.7
Storage of salt relation to fire	Near to fire	224	36.5
	Away from fire	390	63.5
Current salt iodine level	"0" PPM	36	5.9
	1–15 PPM	96	15.6
	>15 PPM	448	73
	No salt got in house	34	5.5
Family history of goiter	Yes	161	26.2
	No	453	73.8
Get treatment ($n = 90$)	Traditional healthier	37	41.1
	Health institution	53	58.9
Dietary diversity score (DDS)	Poor	56	9.1
	Moderate	120	19.5
	Good	438	71.3

participants, 380 (61.9%), were in the age group of 16–19 years; 588 (95.8%) were Orthodox Christian; 290 (47.2%) were grade nine completed; 435 (70.8%) were rural dwellers, and 214 (34.9%) had low economic status; 510 (83.1%) of the fathers were farmers; 517 (84.2%) of the mothers/care givers were housewives, and 466 (75.9%) were unable to read and write (Table 1).

3.2. Utilization of Iodized Salt and Dietary Practice-Related Characteristics. In this study, 448 (73%) households used adequate iodized salt (≥15 ppm). Of the participants, 580 (84.4%) used iodized salt during food preparation, 259 (50%) added it at the end of cooking, and 422 (68.7%) households stored salt without exposing it to direct sunlight. One hundred and sixty (26%) of the participants had a family history of goiter, and 448 (71.3%) had adequate dietary diversity score in the last 24 hours (Table 2).

3.3. Prevalence of Goiter. The overall prevalence of goiter among adolescent girls was 24.1% (CI: 95%, 20.6–27.5); 13.2% and 10.9% of the goiters were grade 1 and grade 2, respectively.

3.4. Factors Associated with Goiter. The result of the multivariable analysis revealed that age, residence, family history of goiter, and DDS were significantly associated with goiter. Accordingly, the odds of goiter were 1.57 times more likely among late than early adolescent girls (AOR: 1.57; 95% CI: 1.01, 2.46). Likewise, the odds of getting goiter were 2 times higher among participants who lived in rural areas than in urban settings (AOR: 1.91; 95% CI: 1.04, 3.51). Adolescent girls who had a family history of goiter were more likely to develop the problem than their counterparts (AOR: 4.96; 95% CI: 3.19, 7.72). Similarly, higher odds of goiter were noted among adolescent girls who consumed inadequately diversified diets than their counterparts (AOR: 8.39; 95% CI: 4.36, 16.14) (Table 3).

4. Discussion

The prevalence of goiter among adolescent girls school at 24.1% (20.0–29.9%) posed a moderate public health challenge to the study area [22]. This finding was lower than those of studies done in two zones of Ethiopia, such as Metekel (39.4%) [23] and Wolaita (60.9%) [18], Bangladesh (44%) [13] and Rawalpindi, and Pakistan (57.1%) [24]. The possible justification for this disparity might be variations in topography and dietary habits; for instance, in Wolaita, Ethiopia, the community had a dietary history of frequent and high (81.3%) consumption of cassava and poor utilization of iodized salt. In addition, the variations might be due to differences in study settings and periods. However, the result of our study was higher than those studies done in Charsadda, Pakistan (11.5%) [25], and Uttarakhand, India (15.9%) [26]. This difference might be due to variations in the topographies of the study areas. This study was done in a mountainous (high altitude) area that resulted in poor soil conservation over a long period

Table 3: Factors associated with goiter among adolescent girls in Tach Armachiho district, Northwest Ethiopia, 2018.

Variable	Category	Goiter		COR (95% CI)	AOR (95% CI)
		Yes	No		
Age	10–15	45	189	1	1
	16–19	103	277	1.56 (1.05, 2.32)	**1.57 (1.01, 2.46)***
Maternal education	Illiterate	108	358	0.42 (0.16, 1.06)	0.31 (0.10, 0.96)
	Informal education	22	73	0.41 (0.15, 1.16)	0.37 (0.11, 1.26)
	Primary school	10	24	0.57 (0.18, 1.9)	0.51 (0.13, 1.98)
	Secondary and above	8	11	1	1
Source of drinking water	Tap water	54	198	1	1
	Public tap	40	113	1.29 (0.81, 2.08)	0.99 (0.53, 1.85)
	Protected wall	42	135	1.14 (0.72, 1.80)	0.69 (0.38, 1.28)
	Unprotected wall	12	20	2.20 (1.01, 4.78)	1.18 (0.45, 3.12)
Family size	<5	79	288	1	1
	>5	69	178	1.41 (0.97, 2.05)	1.11 (0.72, 1.70)
Residence	Rural	117	318	1.76 (1.13, 2.73)	**1.91 (1.04, 3.51)***
	Urban	31	148	1	1
Family history	No family history	71	382	1	1
	Had family history	77	84	4.93 (3.31, 7.36)	**4.96 (3.19, 7.72)***
Salt storage	Open parcel	24	53	1.5 (0.89, 2.54)	1.19 (0.65, 2.16)
	Close parcel	124	413	1	1
Salt exposure to sun light	Yes	56	136	1.48 (1.0, 2.2)	1.33 (0.83, 2.14)
	No	92	330	1	1
Salt storage site	Near to fire	65	159	1.51 (1.04, 2.20)	1.52 (0.97, 2.38)
	Away from fire	83	307	1	1
Dietary diversity (DDS)	Poor	33	23	6.73 (3.74, 12.09)	**8.39 (4.36, 16.14)***
	Medium	38	82	2.17 (1.38, 3.43)	**2.26 (1.36, 3.77)***
	Good	77	361	1	1

*Significant at p value less than 0.05.

of time and contributed to leaching away of the iodine-rich soil layer, exposing the iodine-poor layer beneath.

Late adolescent (16–19 years) girls were more likely to be affected by goiter than early age groups. This finding was consistent with the results of studies done in Hawassa, Goba, and Robe, Ethiopia [14, 15, 17], respectively. This might be due to the fact that iodine requirement increases with age, and older children had prolonged exposure to iodine-deficient environment. Besides, thyroid size correlates with body surface area and increases with age, making an enlarged thyroid more visible and palpable in the age of adolescents [18, 23].

In our study, rural dweller adolescent girls were more likely to have goiter compared with urban residents. The result was consistent with the findings of Gamogofa [27] and Lay Armachiho zones, Ethiopia [28]. The possible reason might be difference in knowledge about the causes and preventions of goiter and inadequate diversified food. It could also be due to variations in iodized salt storage area that affects the content of iodine because of its volatile nature, and the commonly stable maize and millet diet of the rural community has poor iodine content.

Adolescent girls who had a family history of goiter were more likely to develop goiter than their counterparts. This finding was supported by the result obtained in Lay Armachiho and Gamogofa, Ethiopia [28, 29], Brazil [30], and Germany [31]. The possible reason might be that family clustering of goiter has been common historically, and a complex "multifactorial" interactions of genetic and shared environmental factors lead to higher rates of goiter among people [32].

Dietary diversity of adolescent girls was significantly associated with goiter. Poor DDS among adolescent girls was almost 8 times more likely to develop goiter compared to adolescent girls without the problem. The result was supported by studies done in the Amhara regional state, Adama city and Bale, Ethiopia [33–35], respectively. The possible justification for this could be that when adolescent girls have no access to diversified foods, the probability of getting iodine is low. One of the iodine deficiency disorder strategies is adequate dietary intake. Communities with cereal-based monotonous dietary habits suffer from iodine and other micronutrient deficiencies, such as vitamin A and iron [21].

5. Conclusion

The overall prevalence of goiter among adolescent girls was a moderate public health problem. Age, residence, family history, and DDS were significantly associated with goiter. Therefore, due emphases should be given to late adolescents by counseling about diversified diets and the causes and prevention of goiter.

Abbreviations

AOR: Adjusted odds ratio
BCC: Behavioral change and communication
CI: Confidence interval
COR: Crude odds ratio
DDS: Dietary diversity score
GP: General practitioner
HH: Household
ICCIDD: International Council for the Control of Iodine Deficiency Disorders
IDD: Iodine deficiency disorder
IQ: Intelligence quotient
PPM: Parts per million
SPSS: Statistical Package for the Social Sciences
SNNP: Southern Nations, Nationalities and Peoples
TGR: Total goiter rate
TSH: Thyroid stimulating hormone
UNICEF: United Nations International Cultural and Educational Foundation
WHO: World Health Organization.

Data Availability

Full data set and materials pertaining to this study can be obtained from the corresponding author upon reasonable request.

Additional Points

The limitation of this study might be observer bias in grading goiter and inability to get the appropriate of ultrasound findings.

Ethical Approval

Ethical clearance was first obtained from the Institutional Ethical Review Board of Institute of Public Health, College of Medicine and Health Sciences, University of Gondar. Supportive letter was obtained from central Gondar Zonal Health Department and Tach Armachiho Educational office, and permission was obtained from the school leaders.

Consent

Written informed consent was obtained from adolescent girls who are above 16 years old, and written informed consent for participation in the study was obtained where participants are under 16 years from their parent or guardian. Adolescents who had identified goiter were referred to health institutions to get appropriate treatment and support.

Conflicts of Interest

The authors declare that they have no conflicts of interest.

Authors' Contributions

BM has designed the study and involved in data collection, supervision, and data processing. MTH, BM, EAM, and MTH have cleaned, analyzed, and interpreted the data as well as drafted the manuscript. All the authors have critically reviewed the manuscript read and approved the final manuscript.

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