Original article

Iodine deficiency disorder and its correlates among antenatal care service users from Northwest Ethiopia: Evidence from Lai-Gayint District

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Abstract

Background: Iodine deficiency in pregnant and lactating women results in serious damage to their fetuses, newborns, and infants. The effect of dietary iodine intake on maternal and infantile thyroid function has not been well studied, and there are few data on appropriate gestational age-specific reference ranges for urinary iodine excretion during pregnancy and lactation.

Objective: The objective of the present study was to assess the magnitude of iodine deficiency disorder (IDD) and its associated factors among antenatal care users.

Methods: A facility based cross-sectional study was conducted among 350 pregnant women attending antenatal care from six randomly selected public health centers in Lai-Gayint *Woreda*, Northwest Ethiopia in 2013. A structured questionnaire was used to collect the important information and Physical examination for thyroid enlargement was done and urine samples were taken for urinary iodine excretion (UIE) from all study subjects. Data were entered and analyzed using SPSS version 20.

Result: Both Bivariate and Multivariate analysis were done to identify the factors associated with IDD. The overall prevalence of iodine deficiency disorder based on total goiter rate and UIE less than 150µg/L was 36.6% and 61.4%, respectively with a median UIE of 110µg/L. Among the various factors identified, place of urban residency (AOR=0.53; 95%CI=0.29-0.99), being employed (AOR=0.39; 95%CI: 0.24-0.67), having miscarriage at least once in the previous history of pregnancy (AOR=3.34; 95%CI: 1.44-7.76), consumption of iodized salt (AOR=0.27; 95%CI: 0.09-0.86), having knowledge on IDD prevention (AOR=0.39; 95%CI: 0.16-0.81), having family history of goiter (AOR=4.7; 95%CI: 2.3-9.7) and gestational period of first trimester (AOR=0.7; 95%CI=0.5-0.98) were found significantly and independently associated with iodine deficiency disorder.

Conclusion: The magnitude of IDD and its associated factors in the district which could provide helpful insights for policy makers and program implementers are highlighted. Thus, an immediate effective intervention that includes nutrition education and regular administration of iodine are recommended. [*Ethiop. J. Health Dev.* 2013;27(3):208-215]

Introduction

Iodine is essential micronutrient with an average daily requirement of 100-150 micrograms for normal human growth and mental development. Inadequate or poor intake of iodine can cause a spectrum of disorder collectively referred as iodine deficiency disorder (IDD). It affects people of all ages, both sexes and of different socio economic backgrounds. Iodine deficiency in pregnant women defined as a median of urinary iodine excretion of less than 150µg/L in pregnant and lactating women and goiter is often the only visible manifestation of all the damage brought by lack of iodine (1-3).

According to the 2005 estimates, about 2.2 billion people or 30.6% of the global population had insufficient iodine intake (4); of these 285 million children were in Africa and 21.9 million were in Eastern and Southern Africa region (5). However, as research continues, more areas were found to have IDD though the total global goiter prevalence dropped to 15.8% (6, 7). When pregnant women are deficient of iodine, the fetus will not produce enough thyroxin, causing intrauterine growth retardation, which could lead to fetal loss that includes miscarriages, stillbirths, and premature deliveries. The survived infants born from such mothers may also have severe mental problems such as congenital anomalies, speech and hearing impairment and cretinism, which essentially is the severe form of mental retardation, and is by far the most serious health consequences of iodine deficiency in pregnant women (11). Severity of IDD follows the geographical land escape patterns of the country and ID is more severe in high land areas and in densely populated plains and river basins blighted by periodic flood (10). The problem is even more severe and widely seen in countries where universal salt iodization coverage is low and consumption of goitrogenic substances are common and iodine fortified food is limited.

In Ethiopia, iodine deficiency problem is among the leading public health problems based on various studies (8-9). The first national survey conducted in 1980/81 reported goiter prevalence of 30% and 18.7% among school children and household members, respectively (8). The recent national survey conducted in school children aged 6-12 years and women of child bearing aged 15-49 years, goiter prevalence, was 39.9% and 35.8%

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respectively, with an overall median urinary iodine excretion(UIE) of 24.5μg/(9) which is very far from the recommended optimal iodine intake for the general population (100-200μg/L) (10). Based on these data, presumably there are big numbers of children dying before they are born or born mentally disabled due to iodine deficiency in high land area necessitating growing concern by the authors that programs and interventions fail to reach those who need them at most. Therefore, assessing the IDD status among the pregnant women was the intention of this study which we believed essential for scaling up of effort to improving maternal, newborn and child health and achieves the fourth and fifth Millennium Development Goals (MDGs).

Methods

A facility based descriptive cross-sectional study design was employed in May, 2013 to determine the magnitude, the health consequence, contributing factors of IDD among pregnant women from the rural Lai-Gayint *Woreda*. The *Woreda* is found in South Gondar Zone, Amhara National Regional State, Northwest Ethiopia. It is 754 kms north from the capital city, 280 kms away from the Regional Capital Bahir Dar and 75 kms from the Zonal Capital Debre Tabor. The district is divided into 33 *kebele*s, of which 5 are and the 29 are rural, with an elevation of >2500 meter above sea level. The total population was estimated at 230,338, of whom 49.5% were males and the rest were females. The living standard of the community is low and their livelihood is based on farming. Potato, apple and sorghum are the main crops grown in the *Woreda* (12). There were eight public health centers available in the *Woreda*, of which six of them were randomly selected and the number of pregnant women registered in each facility at the time of the study was 115, 47, 55, 36, 44 and 90 in *Hageregenet, Checheho, Welela bahir, Gobgob, Sehale* and *Nifas mewucha* health centers, respectively.

The source populations for the study were all pregnant women in the *Woreda* and the study populations were registered antenatal attendees in the selected facilities who consented to participate in the study and had no gross abnormality.

The Sample size was estimated based on a previous study report which documented 28.8 % of IDD for child bearing women for the region (9) with 5% degree of precision and 95% confidence level of certainty and 10.0% non response rate. A total of 350 subjects were required and allocated proportionately across the six facilities namely *Hageregenet* (n=105); *Checheho* (n=42); *Welela bahir* (n=53); *Gobgob* (n=33); *Sehale*(n=40); and *Nifas mewucha* (n=77). The subjects in each facility were enrolled consecutively until the required sample size was reached.

A structured questionnaire adapted from the WHO multi-country questionnaire on IDD and other relevant studies was used. The questionnaire also was made to measure socio-demographic, socio-economic characteristics and other relevant areas to assess possible determinants of IDD. The questionnaire was developed in English and translated to Amharic (local) language and back to English to see for its consistency. The final questionnaire administered in the data collection process was the Amharic version (local language of the study site). To ensure the quality of data, the questionnaire was undergoing two stages of pre-testing in the same setup having similar age group as the target group, but in non-selected facility. Vague questions, difficult to be answered by most of the subjects gave high emphasis and were corrected accordingly.

Six data collectors (three health officers and three clinical nurses) were recruited and trained on ethical issue, confidentiality, thyroid examination, urine specimen handling and facilitation of the study by the principal author (PA). Each completed questionnaire was checked immediately by the PA to ascertain all the questions have been answered consistently. The information entered was rechecked in 5% of randomly selected respondents.

The dietary data were collected from all women by the nurses using WHO standardized questionnaire based on the 24 hours and the last one week recall method. All subjects were examined for thyroid enlargement by trained Health officers through physical observation and palpation and goiter grading was done as recommended by the Joint WHO/UNICEF/ICCIDD Technical Consultation Group (16). Urine sample were collected from all subjects with clean plastic bottles and stored at 4°C for four weeks and then transported to Addis Ababa Ethiopian Health and Nutrition Research Institute (EHNRI) for analysis. The iodine determination was done by ammonium per sulfate (Sandell-Kolthoff reaction) method, where urine was digested with ammonium per sulfate solution. The results were calculated through construct a standard curve on graph paper by plotting iodine concentration of each standard on the abscissa against its optical density at 405 mg/l (OD405) on the ordinate.

After sorting data and performing quality control for completeness and consistency, data were coded and entered into computers and validated for consistency using EPI-Info version 6 statistical packages and analysis was done using SPSS version 20 for windows. After completion of data entry, it was cleaned using tabulation, frequency and sorting for outliers and accidentally entered data. Analysis of data was made by tabulation of the dependent variable (goiter and UIE) against the independent variables (socio-demographic characteristics, dietary consumption factors, health related factors and other important factors). Statistical test using odds ratio and 95% confidence interval was computed, and for independent variables that have borderline association with the dependent variable

entered to a model to look for confounding effect in a binary logistic regression.

Ethical approval of the study was obtained from School of Public Health ethical committee of Addis Ababa University. Officials at different levels were contacted, and permission was secured. Informed consent was obtained from participants in the study. The right to withdraw from the study at any time was also communicated to the participants and respected.

Results

All the eligible women responded to the questionnaire and had complete urinary iodine excretion (UIE) data making the response rate 100 percents.

The prevalence of IDD as determined by total goiter rate (TGR) and UIE is shown in Table 1. The prevalence of TGR was 36.6% (128/350); of these, 108 (30.9%) had palpable goiter and 20 (5.7%) had visible goiter. The prevalence of severe IDD determined by UIE was 61.4% (216/350) while 12.3% (43/350) had excess level of iodine concentration. The UIE level ranged from 0 to 552µg/L with mean and median of 138.7µg/L and 110µg/L, respectively.

Table 1: **Magnitude of IDD among antenatal care users in Lai-Gayint, April, 2013**

Characteristics	Frequency	Percent
No goiter	222	63.4
Palpable goiter	108	30.9
Visible goiter	20	5.7
Total Goiter Rate	128	36.6
Urinary Iodine excretion Level (in µg/L)		
Insufficient (<150)	215	61.4
Adequate (150-249)	92	26.3
High (250-499)	40	11.4
Excessive (>500)	3	-/0
Mean=138.7; Median 110		

The major factors associated with the magnitude of TGR are displayed in Table 2. Pregnant women who were living in urban areas were about 0.61times (COR=0.39; 95%CI=0.25 to 0.63); literate were about 0.49 times (COR=0.51; 95%CI=0.33 to 0.89); employed were 0.10 times (COR=0.9; 95%CI=0.24 to 0.63); and consumed energy and oil at list once a day were 0.47 times (COR=0.53; 95%CI= 0.32 to 0.89); had used iodized salt were about 0.80 times (COR=0.2; 95%CI= 0.07 to 0.6) and had awareness about IDD were 0.73 times (COR=0.27; (95%CI: 0.14 to 0.54) less likely to develop goiter than their counter parts.

While Pregnant who had experienced stillbirth in the previous pregnancy were 2.7 times (COR=2.7; 95%CI=1.1 to 6.9); miscarriage in previous pregnancy were 2.4 time (COR=2.4; 95%CI=1.16 to 5.07); had family history of goiter were 2.6 times (COR=2.6; 95%CI=1.46 to 4.8) and had not used salt at the beginning while they are cooking were 3 times (COR=3.0; 95%CI=1.6 to 5.6) more likely to develop goiter than their counter parts. Variables which were identified to have significant association in the bivariate analysis were further analyzed using stepwise forward multivariate regression. In the multivariate logistic regression model, residency of women (AOR=0.53; 95%CI=0.29 to 0.98), miscarriage in previous pregnancy (AOR=3.3; 95%CI=1.44 to 7.75), occupation of women (AOR=0.39; 95%CI=0.24 to 0.67) and awareness about IDD (AOR=0.39; 95%CI=0.16 to 0.89), goiter case in family (AOR=4.7; 95%CI= 2.0 to 9.7) had independent association with goiter. Nevertheless, age, consumption of cabbage, potato, millet and protein, had heart disease, hearing problem, and breathing problem, easily get tired, restless and easily get irritated in pregnancy, unusual sweating, third trimester, type of salt used in household and source of drinking water had no significant association with goiter.

Table 2: **Factors associated with goiter among antenatal care users, Lai-Gayint, Northwest Ethiopia, 2013**

Characteristics	Pregnant Goiter Status		Crude OR (95% CI)	Adjusted or (95% CI)
	With	Without		
Age distribution (in years)	54(37.2%)	91(62.8%)	1.12(0.7-1.80	
15 – 24	58(16.6%)	113(32.3%)	0.67(0.3-1.42)	
25 – 34	16(34%)	18(66%)	1.0	
35 – 49				
Residency of women	103(43%)	137(57%)	0.4(0.2-0.65)*	0.53(0.29-0.9)*
Urban	25(22.7%)	85(77.3%)	1.0	1.0
Rural				
Literacy Status of women	82(43.6%)	106(56.4%)	0.5(0.3-0.8)*	
Literate	46(27.9%)	116(72.1%)	1.0	
Illiterate				
Occupation of women	33(24%)	104(76%)	0.9(0.25-0.6)*	0.39(0.2-0.67)*
Employed	95(44.6%)	118(55.4%)	1.0	1.0
House wife's				
Consumption of Cabbage potato	56(44.4%)	76(55.6%)	1.5(0.96-2.3)	
Yes	72(33%)	146(67%)	1.0	
No				
Still birth in previous pregnancy	11(57.9%)	8(42.1%)	2.8(1.1-6.9)*	
Yes	117(35.3%)	214(64.7%)	1.0	
No				
Miscarriage/abortion	18(56.2%)	14(43.8%)	2.4(1.2-5.1)*	3.34(1.4-7.76)*
Yes	110(34.6%)	208(65.4%)	1.0	1.0
No				
Easily get tired in pregnancy	69(85%)	12(15%)	1.0	
Yes	59(36.8%)	101(63.2%)	0.9(0.6-1.5)	
No				
Unusually sweating problem	12(75%)	47(25%)	1.0	
Yes	126(41.8%)	175(58.2%)	0.4(0.2-0.76)*	
No				
Gestational Period	11(22.9%)	37(77.1%)	1.0	
First trimester	47(47%)	53(53%)	0.34(0.2-0.7)*	
Second trimester	70(34.7%)	132(65.3%)	0.3(0.3-1.15)	
Third trimester				
Use iodized salt	4(11.7%)	30(88.3%)	0.2(0.07-0.6)*	0.27(0.1-0.86)*
Yes	124(39.2%)	192(60.8%)	1.0	1.0
No				
Hear about IDD	11(16%)	57(84%)	0.3(0.14-0.5)*	0.39(0.16-0.8)*
Yes	117(41.4%)	165(58.6%)	1.0	1.0
No				
Family history of Goiter	30(56.6%)	23(43.4%)	2.6(1.5-4.8)*	4.7(2.3-9.7)*
Yes	98(33%)	199(67%)	1.0	1.0
No				
Type of salt using in HH	89(34.7%)	167(65.3%)	0.8(0.5-1.2)*	
Fine	39(41.5%)	55(58.5%)	1.0	
Rock				
Salt while you are cooking	61(45.8%)	72(54.2%)	1.5(0.9-2.4)*	
At the beginning	49(36.2%)	86(63.8%)	3.0(1.6-5.6)*	
At the middle	18(21.9%)	64(78.1%)	1.0	
At the end				
Source of drinking water	61(31.9%)	130(68.1%)	0.7(0.4-1.0)	
Protected Source	67(42%)	92(58%)	1.0	
Unprotected source				

Table 3 illustrates factors associated with Urinary Iodine Excretion level. Pregnant women who had no breathing problem were about 0.51 times less likely to be iodine deficient compared to those who had breathing problem (COR=0.49; 95%CI=0.24 to 0.9); while women who had gestational period of first trimester were about 0.50times less likely to be iodine deficient than those whose gestational period was third trimester (COR=0.5; 95%CI=0.26 to 0.92).

Women who used iodized salt were about 0.77 times less likely to have severe IDD than those who had not used iodized salt (COR=0.3; 95%CI=0.2 to 0.7). Respondents who had used unprotected source of water were 1.5 times more likely to have inefficient iodine intake than their counter parts (COR=1.5; 95%CI=1 to 2.3). Variables that had significant association in the bivariate regression model were further analyzed using stepwise forward multivariate regression. In the multivariate logistic

regression model, use of iodized salt (AOR=0.7; 95%CI=0.5 to 0.98) and gestational period of women (AOR=0.3; 95%CI=0.2 to 0.7) retained their significant association with inefficient iodine intake. Nevertheless, age, consumption of cabbage, potato, millet and protein, women who had health problem like heart disease, hearing difficulty, easily get tired, restless, easily get irritated in pregnancy, who had knowledge about IDD, place of residency, education level, family history of goiter, still birth, miscarriage, unusual sweating problem were found to have no significant association with inefficient iodine intake.

Table 3: **Factors associated with UIE among antenatal care users, Lai-Gayint, Northwest Ethiopia, 2013**

Characteristics	Urinary Iodine excretion		Crude OR (95% CI)	Adjusted or (95% CI)
	<150µg/L	≥150µg/L		
Age distribution (in years)				
15 – 24	91(63%)	54(37%)	1.06(0.6-0.7)*	
25 – 34	105(61.4%)	66(38.6%)	1.3(0.63-2.8)	
35 – 49	19(55.9%)	15(44.1%)	1.0	
Residency of women				
Urban	150(62.5%)	90(37.5%)	0.87(0.55-1.4)	
Rural	65(59%)	45(41%)	1.0	
Literacy Status of women				
Literate	94(58%)	68(42%)	0.76(0.49-1.2)	
Illiterate	121(43.4%)	67(56.6%)	1.0	
Consumption of Cabbage potato				
Yes	134(61.5%)	84(38.5%)	0.99(0.64-1,5)	
No	81(61.4%)	51(38.6%)	1.0	
Still birth in previous pregnancy				
Yes	12(60%)	8(40%)	1.0	
No	203(61.5%)	127(38.5%)	0.94(0.4-2.4)	
Miscarriage/abortion				
Yes	21(65.6%)	11(34.4%)	1.0	
No	194(61%)	124(39%)	0.8(0.38-1.75)	
Breathing Problem				
Yes	16(45.7%)	19(54.3%)	1.0	
No	199(63.2%)	116(36.8%)	0.5(0.24-0.9)*	
Easily get tired in pregnancy				
Yes	118(62.1%)	72(37.9%)	1.06(0.7-1.6)	
No	97(60.6%)	63(39.4%)	1.0	
Gestational Period				
First trimester	23(50%)	23(50%)	1.0	1.0
Second trimester	59 (60%)	40(40%)	0.6(0.31-1.24)	0.6(031-1.24)
Third trimester	133(65.5%)	70(34.5%)	0.5(0.26-0.9)*	0.7(0.5-0.98)*
Use iodized salt				
Yes	13(38%)	21(62%)	0.3(0.2-0.7)	0.3(0.2-0.7)*
No	202(63.9%)	114(36.1%)	1.0	1.0
Hear about IDD				
Yes	38(55.9%)	30(44.1%)	0.75(0.4-1.3)	
No	177(62.8%)	105(37.2%)	1.0	
Family history of Goiter				
Yes	32(60.4%)	21(39.6%)	1.0	
No	183(61.6%)	114(38.4%)	0.95(0.5-1.7)	
Type of salt using in HH				
Fine	165(64.4%)	91(35.6%)	0.63(0.4-1)*	
Rock	50(53.2%)	44(46.8%)	1.0	
Salt while you are cooking				
At the beginning	79(59.4%)	54(40.6%)	1.2(0.67-2)	
At the middle	84(62%)	51(38%)	1.1(0.6-1.9)	
At the end	52(63.4%)	30(36.6%)	1.0	
Source of drinking water				
Protected Source	109(57.4%)	81(42.6%)	0.68(0.4-1.1)*	
Unprotected source	106(66.2%)	54(33.8%)	1.0	

Discussion

The present study indicated that the prevalence rate of goiter was 36.6%, which is more than six times the cutoff point set for severe IDD based on total goiter rate (TGR> 5.0%) classification of severity of goiter (15, 17). The finding of UIE level also showed a wide individual scatter and ranged from 0 to 552µg/L in the study subjects with mean and median of 138.7µg/L and 110µg/L respectively. According to the WHO criteria (14), the iodine intake status of 61.0% pregnant women falls under severe category of public health significance. This high level of IDD observed in the district is failure to receive adequate iodine nutrition over a long period of time and needs the immediate attention of all concerned bodies.

When the present figure is compared with the 2005 EHNRI findings, which reported 28.8% of goiter rate (9) for the same age group in the same region, the current figure is higher and has increased by about 8.0%. Nonetheless, when compared with some previous studies done in the country, the figure is almost similar (19, 20).
In this study, several factors were identified as contributing to the observed higher figures of goiter in the district. The presence of goiter was inversely associated with living in urban settings and the odds of developing goiter among those who were living in urban was 47% times lesser than in rural. Similar results were reported in some previous studies in Ethiopia (19, 20) and India (21) and attributed to the better awareness level and availability of iodized salt in urban.

Pregnant women who were employed were 61.0% times less likely to develop goiter than those who were housewives and the finding was consistent with the study done in Romania (22) and was attributed to the fact that being employed generates income which in turn improves the access and affordability to buy and consume iodized salt and probably other iodine rich foods.

When pregnant women are deficient of iodine, the fetus will not produce enough thyroxin which ultimately leads to poor pregnancy outcome that includes miscarriages, stillbirths, and premature deliveries. Similarly, pregnant women who had miscarriage at least once in the previous history of pregnancy were 3.34 times more likely to develop goiter than compared to those who did not and was in conformity with Abuye et al (19). For the developing fetus or infant, untreated maternal hypothyroidism due to severe iodine deficiency is a catastrophe because thyroid hormone is essential for maturation of the central nervous system, particularly its myelination. For the first 12 weeks of gestation, the fetus is completely dependent on maternal thyroxin. During the 10^{th} to 12^{th} week of gestation, fetal TSH appears and the fetal thyroid is capable of concentrating iodine and synthesizing iodothyronines. However, little hormone synthesis occurs until the 18^{th} to 20^{th} week. Thereafter, fetal thyroid secretion increases gradually (13). The present study showed that the first 18^{th} to 20^{th} weeks of gestation was independently and inversely associated with iodine deficiency disorder compared to the first 12 weeks of gestation.

Despite the fact that, iodized salt consumption is the best and most cost effective method of prevention of iodine deficiency disorders, consumption coverage of iodized salt in most of the developing counties is low (28). The present study showed that utilization of iodized salt among pregnant women was independently associated with deficiency of iodine. Women who consumed iodized salt were 73.0% times less likely to develop goiter than those who did not and the finding is consistent with the study conducted in India in 2004 (17) and other studies (20,25-30) underling the importance of iodized salt as a means of controlling and preventing method of IDD.

In this study pregnant women who had knowledge of iodine and iodine deficiency disorder were about 61.0% times less likely to develop goiter than their counterparts and our finding is consistent with previous studies done in Southern Ethiopia (20), Japan (18) and Australia (23).
A family history of goiter is a known risk factor for iodine deficiency (17). This study showed those mothers whose family had goiter history were 4.7 times more likely to develop goiter than those whose family had not history of goiter and the finding is similar with other studies (22, 23). However, in Malaysia a family history of goiter was not significant and this variation was attributed to some genetic influence (23).

Other than the total goiter rate, the median urinary iodine level of 110µg/L found in the present study also suggests the existence of severe public health IDD problem in the study community based on the WHO threshold criteria (14). And the findings are concordant with some previous studies conducted in Ethiopia as well as elsewhere (20, 23-27).

In conclusion, the study has highlighted the magnitude of IDD and its associated factors in the district which could provide helpful insights for policy makers and program implementers to design feasible prevention and control measures in pregnant women and therefore, an immediate effective intervention that includes nutrition education and regular administration of iodine is recommended.

The strength of this study is that, in addition to questionnaire survey and physical examination, laboratory and dietary consumption data were included. Some of the limitations of the study however, was that it was difficult to examine any potential temporal relationships due to the design and entertain the seasonal variations (the study was conducted during the major orthodox fasting periods), and there might also be some

potential recall bias among respondents answering questions relating to events happening in the past and information on some important confounding variables might not be collected which could cause problems in interpreting the results. For example iodine content of household salts.

Acknowledgements
We thank all the pregnant women who participated in our study as well as Amhara Regional Health Bureau, supervisors, facilitators and participant of this study. The study was funded by AAU and Micronutrient Initiative, Ethiopia. Our appreciation goes to Ethiopian Health and Nutrition Research Institute (EHNRI) for the unreserved support and analyzing the urine samples for the iodine concentrations.

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