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IODINE DEFICIENCY DISORDERS (IDD) IN BURIE AND WOMBERMA DISTRICTS, WEST GOJJAM, ETHIOPIA

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ABSTRACT

Iodine deficiency disorders (IDD) affect millions of people in developing countries mainly due to dietary iodine deficiency and aggravating factors that affect the bioavailability of iodine in the body. Iodine deficiency disorder is one of the public health problems of Ethiopia. Recent findings show that both endemic and non-endemic areas have high goiter rates. Burie and Womberma districts are two of the endemic goiter areas in the country. The etiology of goiter in these areas is not fully studied so far. The objective of this cross-sectional community based study was to assess the magnitude and causes of goiter. The study was conducted in July 2010. The sample size was determined by assuming 50% prevalence of total goiter rate, 5% error, 95% confidence interval, design effect of 1(random) and 5% of non-response rate. A two-stagerandom sampling (sub-district and village) was used to select children aged 6-12 years and their biological mothers from10 randomly selected villages in each of the districts. Overall, 403 households participated in the study. The assessment was conducted using palpation of thyroid size, urinary iodine level determination, household level interview and Focus Group Discussion (FGD). The study revealed a total goiter prevalence rate of 54% and 30.1% in children and their biological mothers, respectively. More than 64% of the children were severely iodine deficient. The major cause for goiter as revealed by urinary iodine level and concentration of iodized salt is dietary iodine deficiency. There are no goitrogenic foods such as cassava; however, goitrogenic chemicals such as Dichlorodiphenyltrichloroethane (DDT) and 2,4-Dichlorophenoxyacetic acid (2,4-D) were widely used. The study areas are known for surplus produce of cereals, legumes and chilli. In order to reverse the problem, immediate and sustainable distribution of iodated salt/oil capsule, prohibition of direct application of pesticides on foods and awareness creation on adverse effects of IDD and benefits of iodine nutrition is highly recommended.

Key words: Goiter, Goitrogenic factors, Pesticides, Gojjam

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INTRODUCTION

Healthy humans require iodine, an essential component of the thyroid hormones. Insufficient intake or/and inefficient absorption of iodine from the diet leads to insufficient and inadequate production of thyroid hormones, which affects many different parts of the body, particularly the developing brain [1-3]. Iodine deficiency causes a wide range of health related problems that are collectively called iodine deficiency disorders [4]. Iodine deficiency in childhood and adolescence is characteristically associated with endemic goiter [5]. The global database of the World Health Organization shows that iodine deficiency remains a public health problem in about 54 countries, and an estimated two billion individuals have an insufficient dietary iodine intake [6]. Globally about 740 million people are affected by goiter [7]. In Ethiopia, around 28 million people suffer from goiter, and more than 35 million people are at risk of iodine deficiency. More importantly, 50,000 prenatal deaths are related to iodine deficiency each year in Ethiopia [8]. The education potential of the nation is unattained as iodine deficiency may cause an intelligence quotient reduction of 13.5 points. The problem is both a threat to the productivity of the workforce and a cause of cretinism and mental retardation [4, 9].

Iodine deficiency disorder is one of the most common micronutrient deficiencies worldwide and is a major cause of preventable mental retardation. When goiter prevalence is severe or exceeds 30% in a given area, cretinism may affect up to 5 to 15% of the population. It has been known that as severity of iodine deficiency increases, the occurrence of poor pregnancy outcomes such as miscarriage, stillbirth, and increased infant mortality is more likely. Several experimental studies have revealed that, reproductive failure could be corrected by iodine supplementation in goiter endemic areas [4]. Iodine deficiency disorder is one of the major public health problems of pregnant and young women in many developing countries [6]. It affects millions of people in developing countries mainly due to inadequate iodine in foods and drinks and aggravating factors that affect the bioavailability of iodine in the body. Multiple nutritional and environmental factors influence the prevalence and severity of iodine deficiency disorders in iodine deficient areas**.** Protein energy malnutrition and vitamin A, iron, and selenium deficiency and, variety of goitrogenic factors from food sources such as cassava and millet can aggravate iodine deficiency [9-10].

Studies have shown a wide occurrence of goiter of different magnitudes in different parts of the country and that iodine deficiency is one of the nutritional problems of public health importance in Ethiopia [8, 11-12]. A goiter study conducted in Ethiopia about 30 years ago on 36,635 school children and 19,128 household members revealed that prevalences of 30.6% and 18.7%, respectively [13]. The prevalence was higher in high altitudes for both school children and household members. A survey of goiter prevalence conducted by former Ethiopian Nutrition Institute from 1988 to 1991 revealed that both the endemic and non-endemic regions had higher goiter prevalence rates than previously reported [11, 14]. Another study conducted in four administrative zones indicated that the gross prevalence rate among school children was 53.3% [15]. This prevalence rate was regarded as severe according to the

classification of WHO [6]. The same study revealed that prevalence rate of goiter was higher in females (56.1%) than in males (50.1%).

Burie and Womberma districts are known for endemic goiter. To make matters worse, the rate of goiter in the districts is on the increase. So far, there is no specific data on iodine deficiency disorder concerning the two districts. The major objective of this study was to assess the prevalence and cause of IDD in Burie and Womberma districts by conducting clinical examinations for total goiter rates, urinary iodide level determination, assessment of goitrogenic factors and knowledge, attitude and practices of the communities towards the use of iodated salt.

MATERIALS AND METHODS

Description of study area

The study areas are suitable for cultivation; they are known for surplus production of various crops, mainly cereals, legumes, chilli and oil seeds. More than half of the topography of the area is middle land (>50%) with a range of 750-2,500 meters above sea level and heavy rainfall and run-off. Both districts are erosion prone. Malaria, parasitic diseases and pneumonia are among the ten top diseases. One health center serves approximately five sub-districts on average. The staple foods and drinks are mainly made of cereals and legumes. Both districts are similar in all geographic and demographic characteristics.

Sample size and data collection

The sample size was determined by using total goiter rate of 50%, 5% error, 95% confidence interval, design effect of 1 (random) and 5% non-response rate. Based on this assumption, 403 households with school age children (6-12 years old) were randomly selected. The districts were equally divided into 20 clusters. From each cluster, 20 eligible households were selected. In each household, all eligible children and their biological mothers were included in the assessment. Demographic information knowledge, attitude, and practices on goiter, use of iodized salt and iodine nutrition among women was collected using an interview.

Goiter rate and urinary iodine assessment

School age children and their biological mothers were included in the clinical examination for goiter and household interview. In each selected household biological mother and school age children (6-12 years) were assessed by experienced nutritionist for goiter rate and classified using palpation as recommended by WHO/UNICEF/ICCIDD [6]. Spot urine samples were randomly collected from 20% of children for determination of urinary iodine. Urinary iodine analysis was performed in duplicate in the iodine laboratory of the Ethiopian Health and Nutrition Research Institute (EHNRI) using the modified wet digestion method of Sandell-Kolthoff [16]. The result of urinary iodine examination (UIE) was expressed as micrograms of iodine per 100ml of urine (µg iodine per dl urine). Urinary Iodine status of the children was classified using WHO/UNICEF/ICCIDD recommended cut-off points for urinary iodine excretion (2,6).

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Demography, Knowledge, Attitude and Practices
In each selected household, demographic, dietary habit as well as Knowledge, Attitude and Practices (KAP) on iodized salt, and other related information were collected. Salt iodine level was tested using a kit as recommended by WHO [6].

Focus Group Discussion and Secondary data
Qualitative data were collected using focus group discussions, key informant interviews and secondary data from relevant offices. The focus group discussion was conducted in each selected sub-district. The group composed of 7-9 members from elders, kebeles (sub-district) cabinet, farmer, trader, religious leader, health extension worker and agriculture development agent. Assessment team and personnel from district health office facilitated the discussion. General information regarding health, agriculture and nutrition were collected in written document from relevant offices.

Ethics (Informed consent)
The study was conducted in accordance with the rules and guidelines of Research and Ethical Clearance committee of Ethiopian Health and Nutrition Research Institute and permission letter from Ministry of Health, Federal Democratic Republic of Ethiopia. In each household a woman was verbally informed about the aim and benefit of the study at the beginning and orally asked for permission to get interview, clinical examination of mother and child for goiter grading and child urine specimen collection. Both children and mothers who were found positive for iodine deficiency were referred to the health center and instructed to use iodized salt.

Data management
Data were cleaned, edited and analyzed using SPSS (Statistical Package for the Social Sciences) windows volume 15. Descriptive statistics were used for frequency distribution and Chi-square statistical tests were used where necessary to test the association between factors and IDD.

RESULTS

Age and sex distribution of participants
Over all 513 school age children (6-12 years age) from a total of 403 households were assessed for total goiter rate of which 95 urine specimen were collected randomly for urinary iodine analysis. Male to female ratio of the children was 0.69.

Goiter prevalence in children and biological mothers
The total goiter rate was found to be 54.5% (Table 1) in school age children and 30.1% in biological mothers of the children. The goiter rate was higher in girls (60.3%) than boys (45.7%) (p=0.001).

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Goiter prevalence in women by age

Goiter prevalence is high in younger age group than their older counterparts (Figure 1). Generally, as age increases goiter rate decreased in women. Among the women, the most affected age categories are those who are below 30 years (TGR=20.2%).

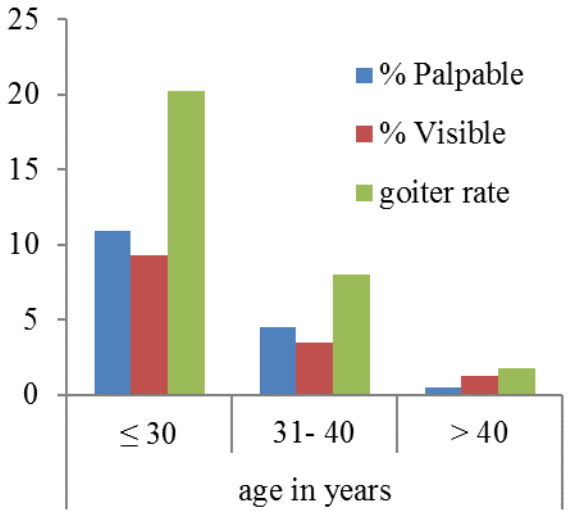

Figure1: Goiter rate of biological mothers of children by age category (N = 387)

Urinary iodine excretion level in children

Median urinary iodine is the main indicator used to assess iodine status of a population [6]. The median urinary iodine level found in this study was 0.5 µg /dl. It was observed that more than 65% of the children have UIE less than 2µg/dl (Table 2). Only 2.2 % of children in the study households have optimum urinary iodine level (10 µg/dl or above).

Salt iodine content of the study area

Iodized salt was found only in 1.1% of the households. In nearly all countries where iodine deficiency occurs, it is now well recognized that Universal Salt Iodization (USI) is the most effective way to achieve the virtual elimination of IDD. Iodized salt is scarce in Ethiopia and almost the entire population use bare salt. Although the government has set a Universal Salt Iodization program, until this assessment was conducted the program was not effective.

Knowledge, Attitude and Practices (KAP) of the community toward iodized salt

The assessment revealed that knowledge on the source, how to use and benefit of iodized salt in the communities is scarce (Table 3). During cooking of sauce, 95.1% of the households add salt in the process while 2.9% add at the beginning. Most of the households used salt as an ingredient during chilli powder preparation. Only 12% of the women were reported to have knowledge on the cause of goiter. Almost all the

households (98.7%) have no knowledge on the benefits of iodated salt. The community had a practice of treating salt before using it for household consumption. As observed from Table 3, the community used to roast (23.9 %), sun-dry (2.6%) and even wash (2.1%) to clean from impurity. Roasting is common in the area during rainy season and when humidity is high.

Use of Contraceptives and goitrogenic foods

The result from household questionnaire shows that 51.8% of the women of reproductive age use contraceptives of different kinds (Injection-44.2%; Pills-0.8%; IUCD-0.5% and other 6.2%).Among those who have goiter, 58.2% are women who use contraceptives (p=0.05). Wild foods especially fruits are commonly consumed by children. Unfortunately, the fruits are seasonal and were not present during our assessment. The leaves were analyzed for cyanide and did not contain significant amounts. Goitrogenic foods like cassava are not cultivated in the areas, but staples such as millet are common.

Summary of Focus Group Discussion

It was learned from the focus group discussion that goiter has been endemic in the area for several decades but the prevalence in children below 15 years of age is unusual, especially in the last 2-5years. According to the discussants, earlier, people believe that goiter is transmitted genetically; if mother had goiter so did her children. Each household had a person with goiter. As guessed by the group, the cause for goiter include shift of diet from “Teff”, barley and oats based food to maize, millet and wheat; use of variety of pesticides and herbicides and increasing use of contraceptives were also among the factors reported by the focus group discussants. From the group discussion, it was also learned that having goiter has an effect on marriage and other social activities. Goiter is treated traditionally by making tattoo (piercing under skin with a needle soaked in a hot salty charcoal solution). This local medical practice is believed to stop the progress of bulging goiter. The discussants and key informants further added that based on the response of the disease to tattoo, goiter is classified as “Wondie” meaning male or “Setie” meaning female. According to the belief of the discussants, the “female goiter” stops increasing in size upon making tattoo while the “male goiter” does not stop.

DISCUSSION

The prevalence of goiter in school age children observed in this study exceeded both national and regional results of 2005 national survey [11] by more than 15%. The prevalence (31.7%) among reproductive age group women is similar with the 2010 national nutrition report that is 36% [17]. According to joint WHO/UNICEF/ICCIDD [6] guidelines, the magnitude of goiter in school-age children is far above the cutoff point of 30%. The goiter rate is higher in girls (60.3%) than boys (45.7%) ($p = 0.001$). Similar result was reported by Abuye and Urga in their study conducted in four administrative regions of Ethiopia [15]. A study from Kidane and Woldegebriel [10] also showed a similar trend.

Urinary iodide level is also similar with other studies [11, 18] conducted earlier indicating that the observed level of goiter rate is surprisingly high. In terms of severity, the result of UIE is in line with the total goiter rate found for the age group of the children. In another study[19] conducted on a wide range of age groups 20 years ago from same area, the mean urinary iodine level was 30.2 µg/dl (N=36) as compared to the current report which is 2.8 µg/dl (N =95) while total goiter rate was 29.8%. Although the method of selection of subjects in this study is different from that of Neka-Tibeb [19], total goiter rate had increased and urinary iodide level has decreased. The trend shows that iodine level in soil is depleting from time to time as the area is of high altitude with heavy rain fall and run-off. Urinary iodide level is indicative of recent dietary iodine consumption while goiter prevalence tells of iodine deficiency spanning months and years. From the prevalence of goiter in both children and women in the lower age category, it can be concluded that the problem is recent and might have some other factors apart from usual iodine deficiency observed all over the country[1,11]. In general, the prevalence of severe total goiter rate in both children and women of the two districts is becoming worse, specifically with in the last two decades. One possible factor could be the diet shift from Teff (*Eragrostis tef*), barley and wheat-based to millet, sorghum and other crops which are known to interfere with the metabolism of iodine and the formation of the thyroid producing hormones [5].

From the focus group discussion, it was learnt that the area is under ever increasing use of pesticides and herbicides in the last two decades. Dichlorodiphenyltrichloroethane (DDT), an organochlorine insecticide, Aluminium phosphide and malathion are the widely used pesticides to preserve maize, beans and barley. A known herbicide; 2, 4-Dichlorophenoxyacetic acid (2,4-D) is also used to control weeds in millet and Teff farms. Studies conducted by Goldner and his colleagues [20] show elevated odds of hypothyroid disease for organochlorine insecticides including aldrin, chlordane, DDT, heptachlor, and lindane as well as the organochlorine fungicide chlorothalonil. A separate study from Jonathan and his colleagues [21] also shows a decrease in iodine uptake by the thyroid gland in acute exposure to DDT in experimental animals. According to Environmental Protection Agency (EPA) of United States [22], in longer-term studies, at dose levels above the threshold of saturation for renal clearance, 2, 4-D is toxic to the thyroid and can alter its normal function. From the findings, the agrochemicals used can be suspected as possible aggravating factors of iodine deficiency observed in the area in addition to the low level of iodine intake. However, the issue of agrochemicals needs further investigation on type of the chemicals, amount applied, portion entering daily diet and their total fate.

CONCLUSION

The prevalence rate of goiter in both children (54.5 %) and biological mothers (31.7%) is more than cut-off point (30%) of WHO/UNICEF/ICCIDD guidelines for severe iodine deficiency disorder. The very low median urinary iodine level observed in school age children also confirms the severity of iodine deficiency disorders in the

community. Food sources such as roots and tubers which are known to contain goiterogenic chemicals are not available except millet and sorghum which may aggravate iodine deficiency. Distribution and use of iodized salt is rare in the area and only few people have knowledge of the benefit of iodated salt.

RECOMMENDATION

- Because the study subjects were iodine deficient, in order to reverse the grave consequence of the problem, an immediate distribution of iodine capsule or iodated salt and establishing a sustainable source are the best options. Moreover, immediate action to prohibit direct application of pesticide and banned pesticides on food crops and awareness creation on adverse effects of iodine deficiency disorders especially on children, pregnant and lactating women, benefit and appropriate use of iodized salt is highly recommended.

- Continuous and concerted efforts should also be made to strengthen information communication and education (ICE) activities need to be undertaken in order to create awareness about the detrimental effects and prevention of IDD, and encourage iodated salt consumption.

- Further investigation for presence of goitrogenic factors in the diet of the people is equally important to fundamentally solve the problem.

- Further study should be conducted using larger sample size and biomarkers to verify factors influencing iodine deficiency disorder in Burie and Womberma communities. From the results it is clear that the problem is of major public health concern which kills a nation. Therefore, collaborative swift of governmental, non-governmental and concerned bodies is needed.

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Table 1: Total Goiter rate *o*f children by sex (N = 513)

	Goiter grade ,%		***Total* goiter rate, %**	***Remark***
Sex	**Visible**	**Palpable**		
Male	11.3	34.4	45.7	P = 0.001
Female	21.6	38.7	60.3	
Total	***17.5***	***37.0***	***54.5***	
Biological mothers	14.7	17.0	31.7	

Table 2: Proportion of children by Urinary Iodine Excretion WHO cutoff points [15]

Cut off points	**Categories**	**% children in this study (n = 95)**
< 2 µg/ dl	Severe	64.4
2 – 4.9 µg/ dl	Moderate	31.2
5 - 9.9 µg/ dl	Mild	2.2
10 µg/ dl and above	Normal	2.2
Median Urinary Iodine (MUI)		*0.5µg/dl*
Mean ± STDEV		*2.8 ± 7.5 µg/dl*

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Table 3: Knowledge, Attitude and Practices of the households (N = 390)

Parameters	**Category**	**%**
Trends in salt addition during cooking	In the process	95.1
	At the beginning	2.9
	At the end	2.0
Salt tested for iodine level	Not iodated	98.9
	iodated at 25ppm	1.1
% biological mother reported having knowledge on cause of goiter	Yes	12
	No	88
% biological mother reported having knowledge on importance of iodized salt	Yes	1.3
	No	98.7
Household practices in pretreatment of salt	Washing	2.1
	Sun drying	2.6
	Roasting	23.9
	No pretreatment	71.5
Use of contraceptives	Not at all	48.2
	Injection	44.2
	condom	6.2
	Pills, IUCD	1.3
Women with goiter (122) (p=0.05)	Use contraceptives	58.2
	Don't use contraceptives	41.8

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