Original article

Iodine deficiency in primary school children and knowledge of iodine deficiency and iodized salt among caretakers in Hawassa Town: Southern Ethiopia

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Abstract

Background: More than two billion individuals worldwide have inadequate iodine intake and the adverse consequences of iodine deficiency are widely observed.

Objective: To assess the iodine status of primary school children and the knowledge of iodine deficiency disorders among their caretakers.

Methods: A cross-sectional study was conducted in Hawassa Town, Southern Ethiopia. The study participants were school children (n=116) aged 7-9 years. A two-stage sampling method was used to select participants. Goiter and urinary iodine concentration were measured in the children to evaluate their iodine status. Socioeconomic characteristics, dietary patterns and caretaker knowledge of iodine deficiency were assessed by using questionnaires. Household salt iodine concentration was also measured.

Results: Total goiter rate was 13.6% and was significantly associated with age [AOR=13.4 (3.2-55.7)]. Eighty two percent of the children had urinary iodine concentration below 50 μg/L, indicating the presence of moderate iodine deficiency. None of the households were using adequately iodized salt. More than half of the respondents did not know about the importance of iodized salt.

Conclusion: The observed degree of iodine deficiency in children and the limited knowledge about iodine in an urban area such as Hawassa stress the urgent need for implementing interventions to combat iodine deficiency. [*Ethiop. J. Health Dev.* 2012;26(1):30-35]

Introduction

Nearly two billion individuals worldwide live in areas of iodine deficiency and the adverse consequences of iodine deficiency are widely observed (1). Iodine is an essential element that enables the thyroid gland to produce thyroid hormones which are vital for growth and development of the brain and central nervous system. These hormones also play an important role in the regulation of major metabolic processes in the body (2). Iodine deficiency is mainly caused by low iodine content in the diet arising from low iodine levels in the soil, water and crops (3). All the ill effects caused by iodine deficiency are collectively called Iodine Deficiency Disorders (IDD). These disorders include stillbirth, miscarriage, endemic cretinism, goiter, mental retardation and hypothyroidism (4). An estimated 241 million school-age children worldwide have insufficient iodine intake (5). Even mild to moderate iodine deficiency has been shown to cause abnormalities in psychomotor and intellectual development in children (6-10). Iodine deficiency in school age children may also result in learning disabilities and a reduced achievement (8).

Ethiopia is one of the countries with a high prevalence of iodine deficiency. More than 4 million children (39.9%) are estimated to have goiter (11). The reported median urinary iodine concentration (UIC) for a national sample of school age children was 24.5 μg/L indicating the presence of moderate iodine deficiency (11). The Southern Nations, Nationalities and People's Region, (SNNPR) where the present study was done, had the highest goiter rates (56.4%) in the country among school children (11). The most widely used and successful method of combating iodine deficiency is universal salt iodization (12); however in a survey carried out in 2005, only 4.2 % of all households in Ethiopia used adequately iodized salt (11). The aims of this study were to assess the iodine status of school children, to evaluate the iodine content of household salt and to assess the knowledge of IDD among children's primary caretakers in Hawassa, the SNNPR's capital.

Methods

A cross-sectional study was carried out in Hawassa among school children. Hawassa is located in the Great Rift Valley, at an latitude of 7°3′N, a longitude of 38°28′E and an elevation of 1708 meters. Data were collected during January to February 2009. A two-stage-cluster sampling method was used for selection of study participants. In the first stage five schools were selected from all primary schools of the town using a Probability

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Proportional to Size (PPS) sampling method. In the second stage, a total of 116 school age children were selected from these schools using simple random sampling. GPower statistical software was used to calculate sample size (13). Estimations were made using a 0.05 alpha error probability, 90% power and an effect size of 0.4. The selected children were 58 boys and 58 girls with a median age of 8 years. Ethical approval for the study was granted by the Hawassa University Institutional Review Board.

Socio-demographic information, child dietary pattern and anthropometry

A structured questionnaire was administered to the children's primary caretakers to assess socio-demographic characteristics, child dietary habits and caretaker knowledge of IDD. Dietary diversity scores were calculated based on eight food groups. Scores were then categorized into: low (1-2 food groups), middle (3-4) and high (≥5).

Anthropometric measurements were taken with children wearing light clothing and with no shoes. Height was measured to the nearest 0.1 cm using the Shorr measuring board (Shorr Productions, Olney, MD, USA). Weight was measured to the nearest 0.1g using a digital scale (SECA Uni-scale, UNICEF, Copenhagen). Height-for-age, weight-for-age and BMI-for-age Z scores were calculated from the measurements using WHO AnthroPlus Software Version 1.0.1.

Variables used to assess wealth in the 2005 Ethiopian Demographic and Health Survey (14) were tabulated to form wealth categories to characterize socioeconomic status of study participants. Variables used in the index were asset ownership, source of drinking water, type of toilet facility used, house type, number of rooms, presence of windows, and type of flooring. A higher value was assigned to a more favorable condition. The total score was divided into quintiles corresponding to wealth categories.

Iodine status determination

Casual urine samples were collected at school from each child for urinary iodine analysis. Samples were collected in disposable plastic cups and were transferred into capped polyethylene test tubes. Caps of test tubes were sealed with Parafilm® to prevent leakage and evaporation. Samples were frozen at -20°C before analysis. UIC was analyzed using a modification of the Sandell-Kolthoff reaction suggested by WHO/ICCIDD/UNICEF (15).

Occurrence of goiter was assessed by palpation by an experienced public health officer using the WHO/ICCIDD/UNICEF (15) classification. Salt samples were collected from participants' homes and iodine concentration was determined using an inductively coupled plasma mass spectrometer (ICP-MS) with tellurium as internal standard.

Quality control

In order to reduce variability, goiter grading was done by one health professional. All anthropometric data were collected by the lead investigator. Questionnaires were administered by data collectors who were undergraduate students. Training was provided for data collectors and data collection instruments were pre-tested.

Statistical analysis

Bivariate and multivariate logistic regression analyses were done using Statistical Package for the Social Sciences (SPSS, v 15.0, 2006, SPSS Inc.. Chicago, IL, USA). Variables which had a p-value less than 0.1 in the bivariate logistic analysis were considered for multivariate analysis. No effects of clustering on goiter rate or urinary iodine concentration were observed based on analyses using STATA 8 (StataCorp, College Station, Texas, USA).

Results

Child characteristics and dietary patterns

The age of study participants (n=116) ranged between 7 and 9 years. All of the participants consumed foods made from grains in the day preceding the survey. Consumption of animal source foods was low. Only 3.4% of the children consumed eggs and 13.8% consumed meat, poultry or fish. Kale and cabbage were consumed at least once or twice per week by 93% and 76% of the children, respectively. Sweet potato was less frequently consumed with only 33.6% of the participants consuming it as often as twice per month. About thirteen percent of the children were stunted, 12.9% were underweight and 5% were wasted (Table 1). Thirty-six percent of the children's primary caretakers had received no formal education, 35% had completed primary education, 23% completed secondary education and only 6% had some tertiary level education (data not shown).

Table 1: **Child characteristics in Hawassa, 2009 (n = 116)**

Characteristics	%
Age (Median (Inter-quartile range)	8 (7.1,8.0)
Child diet diversity	
Low (1-2 Food Groups)	12.90
Middle (3-4 Food Groups)	65.5
High (≥5 food groups)	21.6
Mean (SD)	3.8 (1.1)
Nutritional status	
Stunted	12.9
Male	15.5
Female	10.3
Wasted	5.2
Male	8.6
Female	1.7
Underweight	12.9
Male	19.0
Female	6.9

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Table 2: **Primary caretaker knowledge of iodine deficiency, type of salt used and household salt iodine concentration in Hawassa, 2009**

Variables	%
Knowledge of iodized salt (n=116)	
Yes	34.5
No	65.5
Type of salt used (n=116)	
Non- iodized salt	97.4
Iodized salt	2.6
Source of knowledge about iodine (n=40)	
Public announcement	17.5
Mass media	10
Health worker	47.5
Friend/relative	10
Other	15
Perceived consequence of iodine deficiency (n=40)	
Goiter	32.8
Mental retardation	0.9
Goiter and mental retardation	0.9
Household salt iodine concentration (n=108)	
< 1 ppm	89.8
1-4 ppm	9.3
> 5 ppm	0.9

Respondent's knowledge about the importance of iodized salt was higher in higher wealth categories compared to lower categories. Fewer than 5% of the respondents in the lowest wealth category knew about the importance of iodized salt compared with 75% in the highest wealth category; however this association was not significant [AOR=7.4 (95%CI 0.6-89.1)] when controlled for educational status (Table 3).

Table 3: **Variables associated with caretaker knowledge of importance of iodized salt in Hawassa, 2009**

Variables	Knowledge of Iodized salt		Crude OR (95%CI)	Adjusted OR (95%CI)
	Yes n (%)	No n (%)		
Caretaker education	10 (7,12)[1]	0.0 (0,4)[1]	8.2 (2.3-28.4) *	1.4 (1.2-1.6) **
Wealth category				
Lowest	1(4.5)	21(95.5)	1	
Second	1(9.1)	10(90.9)	2.1 (0.1-37.1)	3.3 (0.2-65.8)
Middle	4(20.0)	16(80.0)	5.2(0.5-51.6)	1.4 (0.1-18.1)
Fourth	16(41.0)	23(59.0)	14.6(1.7-119.9) **	4.4 (0.5-43.0)
Highest	18(75.0)	6(25.0)	63.0(6.9-573.5) *	7.4 (0.6-89.1)

[1] (Median (Inter-quartile range); ** p<0.001; * p<0.05

Salt and tap water iodine concentration

All salt samples had iodine concentration below the recommended level. Ninety percent of salt samples had iodine concentration below 1 ppm (1 mg iodine per kg of salt) (Table 2). The two highest iodine values, 6.3 ppm and 3.3 ppm, came from households that reported use of iodized salt. Iodine concentration in drinking water can be an indication of iodine levels in the soil and can parallel iodine deficiency (16). The tap water iodine concentration taken from each school ranged from 6.9 to7.2 µg/L. Water iodine concentration ranging from 4 to 0 mg/l was characterized as indicative of moderate iodine deficiency (17).

Urinary iodine concentration and goiter rate

The median urinary iodine concentration of the study participants was 34.2 µg/L (ranging from 1 to 177 µg/L). Distribution of urinary iodine values according to the epidemiological criteria for assessing iodine nutrition (15) showed that 18.9% had UIC indicating severe iodine deficiency (< 20 ug/L). Sixty three percent (63.2%) had values indicating moderate iodine deficiency (20 - 49 µg/L) and 16% had UIC between 50 and 99 µg/L indicating mild iodine deficiency (Table 4).

Table 4: **Goiter rate and urinary iodine concentration (UIC) of children in Hawassa, 2009**

Variables	**%**
Median UIC (inter-quartile range), µg/L	34.2 (22.5, 46.6)[1]
Distribution of urinary iodine concentration (n=112)	
< 20 µg/L	18.9
20-49 µg/L	63.2
50-99 µg/L	16
>100	1.9
Total Goiter rate (n=110)	
Goiter rate (95% CI)	13.6 (7.3-20.1)

[1](Median (Inter-17artile range)

The observed Total Goiter Rate (TGR) was 13.6% which is well beyond the 5% cutoff that indicates iodine deficiency is a public health concern (15). TGR was determined by screening for both visible and palpable goiter. However, because no visible goiter was observed TGR represents only palpable goiter for these children. Age was significantly associated with goiter [AOR=13.4 (3.2-55.7)] (Table 5). Older children (8-9 years old) were more goitrous (17.6%) compared to younger (age 7) children (5.6%). Goiter rate was 18.5% among females and 8.9% among males, but the difference was not that significant. A higher goiter rate was seen in the school located in the periphery of the town which was considered as semi-urban [AOR= 6.8 (95%CI 1.6-27.8)] compared with schools more centrally located in the town. Anthropometric measurements and urinary iodine concentration (UIC) were not significantly associated with goiter.

Table 5: **Variables associated with presence of goiter in children from Hawassa, 2009**

Variables	**Goiter present (n= 15)**	**No goiter (n=95)**	**Crude OR (95%CI)**	**Adjusted OR (95%CI)**
	n (%)	**n (%)**		
Age	8 (7.1,8.0)[1]	8.1(8.0,8.9)[1]	8.2 (2.3-28.4) *	13.4 (3.2-55.7) **
Sex				
Female	10(18.5)	44(81.5)	2.3(0.7-7.3)	
Male	5(8.9)	51(91.1)	1	
School Area				
Semi-urban	6(28.6)	15(71.4)	3.5 (1.1-11.4) *	6.8 (1.6-27.8) *
Urban	9(10.1)	80(89.9)	1	
Knowledge of iodized salt				
Yes	3(7.9)	35(92.1)	0.4(0.1-1.6)	
No	12(16.7)	60(83.3)	1	
Wealth category				
Lowest	5(25)	15(75)	1	
Second	3(27.3)	8(72.2)	1.1 (0.2-5.9)	
Middle	2(11.1)	16(88.9)	0.4(0.1-2.2)	
Fourth	5(13.5)	32(86.5)	0.5(0.1-1.8)	
Highest	0	24(100)	0	

[1](Median (Inter-quartile range)); ** $p<0.001$; * $p<0.05$

Discussion

The observed low urinary iodine concentration shows that the study children currently had inadequate iodine intake. This finding was supported by the extremely low levels of iodine in household salt samples. A parallel long-term iodine deficiency was also underlined with a goiter rate of 13.6% in the children.

The study children were moderately iodine deficient. Only two children had adequate urinary iodine concentration values (> 100 µg/L). Moderate iodine deficiency was also reported for a national sample of Ethiopian school children (11). However TGR in our study was lower than the previously reported 39.9% national rate (11). The fact that the study children were younger than children in the national sample and the urban location of the study area could be factors contributing to the lower goiter rate we observed. In the present study age was significantly associated with goiter with the likelihood of occurrence increasing by 13.4 (95%CI 3.2-55.7) for each additional year of age. Moreover, children form a school located in a semi-urban location were 6.8 (95%C have goiter than children in urban schools. TGR prevalence was within the prevalence seen in two urban centers included in the national sample, Addis Ababa (19%) and Dire Dawa (6%) (11). The recommended iodine concentration in salt at the household level is 20 to 40 mg of iodine or 34-66 mg of potassium iodate per kg of salt (15). In our study all households were not using adequately iodized salt. A previous semi-quantitative analysis of salt samples in Ethiopian households reported that only 4.2% used adequately iodized salt (11). None of the children consumed cassava which has documented goitrogenic properties (3). Consumption of cassava has been shown as a risk factor for goiter development among children in southern Ethiopia (18). However, kale, cabbage and sweet potato, which also have some goitrogens, were consumed by the study subjects. Goitrogens in foods can block the absorption and utilization of the available iodine from the diet (3,19).

Caretaker knowledge about iodine was limited. Low public awareness about Iodine Deficiency Disorders (IDD) and the severity of its consequences have been identified as major constraints that African countries face in its elimination (20). Although the invisible brain damage caused by iodine deficiency is not limited to those with goiter (14, 21), almost all of the respondents who knew that iodized salt was important identified goiter as the only major consequence of iodine deficiency. The effect of iodine deficiency on brain development needs to be emphasized in order to accelerate efforts to eliminate IDD (22). Caretakers, who were less educated and had less resources, had the least knowledge about the importance of iodized salt. Limited knowledge of iodine nutrition among low socio-economic groups has also been reported elsewhere (23). Of the caretakers, who had some knowledge about the importance of iodized salt, only two reported use of iodized salt indicating a huge gap in knowledge and practice.

In order to successfully eliminate IDD it is necessary to recognize that its consequences may be manifested even in mild deficiency. Iodine deficiency in the study children is an indication that these children may not develop their full cognitive capabilities. Public knowledge about iodine deficiency disorders is also critical for the successful elimination of the disorders. The common belief that goiter is the only consequence of iodine deficiency needs to be corrected, and the effects of iodine deficiency on brain development and its subsequent effects on productivity and economic development need to be understood by the general public. Education campaigns should target the less educated since they are the ones with the most limited knowledge about IDD. Schools can be used as platforms to deliver education about iodine deficiency disorders. The absence of adequate iodine in the salt used by all households clearly stresses the need for universal salt iodization in Ethiopia.

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