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A survey of factors related to urine iodine levels in elementary school children, Kurdistan, Iran

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Original Article

Abstract

BACKGROUND: Iodine deficiency disorders (IDD) control program has two important factors: annual monitoring of urine iodine levels and controlling iodized salt consumed in the community. Preserving the iodine indexes in different level is important now too. This survey determined factors affecting median levels of urine iodine levels in students of Kurdistan Province (Iran).

METHODS: This cross-sectional study selected 255 8-10-year-old students using cluster random sampling. Data was obtained by a questionnaire and urine analysis. The collected data was analyzed by Mann-Whitney and Kruskal-Wallis tests, Spearman correlation, and multiple regression. All analyses were performed using SPSS.

RESULTS: The median urine iodine level of the studied school children was 9.7 µg/dl. There was no significant relation between urine iodine level and sex, place of residence (rural/urban areas), and household iodized salt intake ($r = 0.188$, $P = 0.003$). Overall, 119 families (46.7%) did not appropriately protect their iodized salt. The amount of iodine in salt and the condition in which salt is kept had relationships with children's urine iodine levels.

CONCLUSION: Low median level of urine iodine in students, low household iodized salt, and high use of salt with lesser iodine than the standard value showed that the IDD program in Kurdistan Province has not been successful. Therefore, there is a risk for increased prevalence of Goiter in the region. We recommend interventional programs to improve the current status in the province.

KEYWORDS: Goiter, Urine Iodine, Iran

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Introduction

Iodine is an essential element for human body which changes to thyroid hormones (triiodothyronine and thyroxine) after absorption in the thyroid gland. Thyroid hormones are necessary for normal brain development and brain function, especially during pregnancy. Iodine deficiency disorder (IDD) leads to various types of diseases such as goiter, hypothyroidism, mental retardation, psychosomatic disorders, neural auditory disorders, and cretinism.[1-3] According to the World Health Organization (WHO), about 1.6 billion men are at risk of IDD in over 130 countries of the world. Approximately 50 million of these people have different degrees of mental disorders due to IDD.[4,5] Since iodine is mainly excreted through urine, urinary iodine is a major indicator of iodine deficiency and a simple method to monitor iodine status of a community.[6,7] In 1994, the national IDD prevention and control program made the production of iodized salt mandatory in Iran.[3,6] Consequently, the WHO introduced Iran as one of the two IDD-free Middle Eastern countries. Unfortunately, assessments of iodized salt consumption and urinary iodine in the national

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monitoring of goiter revealed increasing number of students with iodine levels lower than 50 µg (moderate and severe iodine deficiency). In recent years, the prevalence of severe, moderate, and mild forms of IDD in Kurdistan (a province in Iran) has been as high as 11.6-31.6%.[8,9] This change can be considered as a warning about the reducing effects of the IDD prevention and control program and the probable recurrence of high prevalence of goiter. Kurdistan is a mountain province in Iran whose people are likely to develop iodine deficiency. This study evaluated the factors related to the urine iodine excretion in elementary school students of Kurdistan Province.

Materials and Methods

This cross-sectional survey was performed after obtaining approval from the ethics committee of Kurdistan University of Medical Sciences (Sanandaj, Iran). The statistical population consisted of 8-10-year-old schoolchildren and their parents who lived in Kurdistan Province in 2010. In total, 48 clusters (elementary schools) were systematically selected. After referring to the attendance office in each school and accessing student lists, one subject was randomly selected from the second grade, two from the third grade, and two from the fourth grade. The participants' parents were asked for their permission and urine samples were then collected according to national guideline and regulations. A questionnaire was filled out for each household. The questionnaire consist of observation and sampling of salt and measuring of iodine concentration in salt by iodine kit. For better accuracy, iodine content of salt samples was also determined by iodometry. The purity of samples was analyzed in the Food and Drug Laboratory of Kurdistan University of Medical Sciences.

Based on standard definitions, urine iodine levels lower than 2.0 µg/dl, between 2.0-4.9 µg/dl, and 5.0-9.9 µg/dl represent severe, moderate, and mild iodine deficiency, respectively. On the other hand, levels above 10 µg/dl are considered normal. Salts containing less than 20 gammas iodine lack the standard level of salt. Salt iodine levels of 20-55 and over 55 gammas are standard and higher than standard, respectively. Iodized salt should be kept in dark and closed containers away from light.

Data collected via questionnaires was analyzed using Mann-Whitney and Kruskal-Wallis tests and Spearman correlation. Variables with a significance level of less than 0.25 were entered into the multiple regression model. All analysis were performed in SPSS for Windows (version 19.0, SPSS Inc., Chicago, IL, USA).

Results

As the quantitative variables did not have a normal distribution, they were expressed as median and range. The median urine iodine level was 9.7 µg/dl among the schoolchildren of Kurdistan Province (9.9 µg/dl in boys and 9.5 µg/dl in girls; P = 0.386). Children in urban areas had higher urine iodine levels than those in rural areas (10.5 vs. 8.3 µg/dl; P = 0.054). There was no significant correlation between urine iodine level and weight (r = -0.078; P = 0.220) or height (r = -0.016; P = 0.800). However, a positive significant correlation was found between urine iodine level and bulk salt (r = 0.188; P = 0.003). A negative significant correlation was also detected between urine iodine level and body mass index (BMI) (r = -0.173; P = 0.006). The urine iodine level lower and higher than 10 µg/dl were seen in 51.8% and 48.2% of the participants, respectively (Table 1, Figure 1).

The median of urine iodine level was 10.4 µg/dl in eight-year-olds, 8.9 µg/dl in nine-year-olds, and 10.5 µg/dl in 10-year-olds (P = 0.627). Parents with higher levels of education had children with higher median urine iodine. About 119 families (46.7%) did not keep their salts in appropriate conditions and the median iodine was 27.8 (range: 0-105.5) gamma in their salts. In 90 salt samples (35.3%), iodine was lower than the standard range. Moreover, 175 families (68.6%)

Table 1. Urine iodine levels in schoolchildren of Kurdistan Province, Iran

Variables	n (%)	Median	Minimum	Maximum	P
Sex					
Male	128 (50.2%)	9.9	2.0	40	0.380
Female	127 (49.8%)	9.5	1.0	40	
Place of residence					
Rural	114 (44.7%)	8.3	2.0	40	0.050
Urban	141 (55.3%)	10.5	1.0	40	
Age (years)					
8	62 (24.3%)	10.4	2.3	40	0.620
9	97 (38.0%)	8.9	1.0	40	
10	96 (37.6%)	10.5	2.0	40	
Salt usage					
In the beginning of cooking	175 (68.6%)	9.7	1.0	40	0.900
At the end of cooking	80 (31.4%)	9.5	2.0	40	
Salt storage conditions					
Good	136 (53.3%)	11.1	2.0	40	0.010
Poor	119 (46.7%)	8.9	1.0	40	
Father's education					
Not educated	30 (11.8%)	8.0	2.0	40	
Elementary school	99 (38.8%)	8.7	1.0	38.5	0.090
Junior high school	49 (19.2%)	10.5	2.9	40	
High school	12 (4.7%)	11.1	3.5	16.5	
College	65 (25.5%)	11.9	2.6	35.2	
Mother's education					
Not educated	95 (37.3%)	9.3	1.0	40	
Elementary school	84 (32.9%)	8.0	2.3	40	0.150
Junior high school	24 (9.4%)	11.4	3.2	39.1	
High school	10 (3.9%)	13.6	6.0	40	
College	42 (16.5%)	11.8	2.6	34.2	

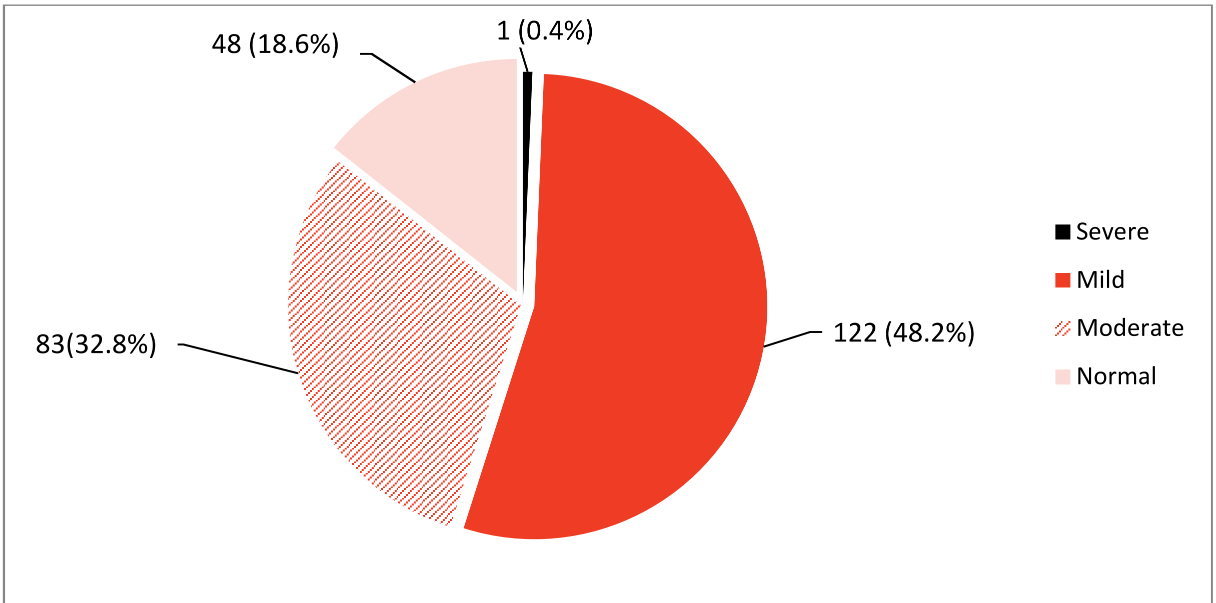

Figure 1. Severity of iodine deficiency according to urine iodine levels (< 2.0 µg/dl: severe deficiency; 2.0-4.9 µg/dl: moderate deficiency; 5.0-9.9 µg/dl: mild deficiency; and ≥ 10 µg/dl: normal range).

Table 2. Results of multiple regression analysis to evaluate the potential relations between urine iodine level and different factors (father's education, place of residence, salt storage conditions, salt iodine, and body mass index were entered into the model but the last three finally remained).

Model	Unstandardized Coefficients		Standardized coefficients	95% confidence interval for beta		P
	Standard Error	Beta		Lower bound	Upper bound	
Constant	4.127	19.342	-	27.473	11.211	< 0.001
Salt storage conditions	1.185	-2.847	-0.153	-0.512	-5.182	0.017*
Salt iodine	0.035	0.095	0.168	0.165	0.025	0.008†
Body mass index	0.234	-0.487	-0.132	-0.026	-0.948	0.038‡

* Inappropriate storage conditions lead to decreased urine iodine level; † Higher iodine content of salt correlated with higher urine iodine level; ‡ Higher body mass index correlated with lower urine iodine level

added salt to food in the beginning of cooking (wrong use).

After controlling confounding factors by multiple regressions, urine iodine level was found to have positive, significant relations with iodized salt consumption and appropriate method of keeping salt. On the other hand, urine iodine level was negatively related with BMI (Table 2).

Discussion

We found the median urine iodine level to be 9.7 µg/dl in the students of Kurdistan Province (51.8% had urine iodine levels lower than 10 µg/dl). On the other hand, 46.7% of families did not keep iodized salts in suitable conditions and 68.6% added salt to food incorrectly. The median iodine content of salts was 27.8 gamma. Urine iodine level was significantly related with iodized salt consumption, appropriate protection of salt, and BMI.

A survey in Tehran (Iran) reported the median urine iodine as 9.4 µg/dl (10.9 µg/dl in urban areas and 8.0 µg/dl in rural areas) with no difference between the two sexes. While urine iodine levels higher than 10 µg/dl were seen in 45.6% of the subjects, the corresponding values were 5-9.9 µg/dl in 33.6% and lower than 4.9 µg/dl in 20.8%. The majority of the study sample (54.9%) used non-iodized salt and 47.9% kept salt in inappropriate conditions. Iodine content was less than 15 gamma in 62.5%, 15-30 gamma in 25.6%, and 30-50 gamma in 31.3% of the study sample.[10] A study in Azerbaijan (Iran) found the median urine iodine and the mean iodine of salt samples to be 11.9 µg/dl and 32.36 ppm, respectively.[11] The median urine iodine in schoolchildren of Yazd (Iran) was 24.8 µg/dl (5.8% of urine samples had iodine levels lower than 5 µg/dl). Almost half the studied families (48.0%) kept salt in good conditions.[9]

In France, Pouessel et al. suggested median urine iodine level not to be related with age, sex, place of residence, social status, or job.[12] Gur et al. reported urine iodine levels lower than 10 and 5 µg/dl in 46.2% and 13.9% of Turkish students, respectively. The prevalence of IDD increased in families with low-educated parents and poor and more populated families. While 44.4% of families used iodized salt, it did not affect IDD rate.[13]

In order to control IDD in a region, the WHO policies and regulations have to be followed. Accordingly, IDD is controlled when over 90% of families have urine iodine levels higher than 10 µg/dl through the use of iodized salt, urine iodine levels below 10 µg/dl are found in less than 50% of the population, and urine iodine levels below 5 µg/dl among are only detected in less than 20% of the population.[14] The median urine iodine levels in schoolchildren of Kurdistan Province were recorded as 25.8, 16.0, and 14.7 µg/dl in 1992, 2001, and 2007, respectively.[8,9,15,16] As it is seen, the values have had a decreasing trend. While 51.8% of urine samples had less than 10 µg/dl iodine, the rates were 14.2%, 19.7%, and 35.0% in 1992, 2001, and 2007, respectively.[8,9,15,16] Differences in the findings of various studies could have been due to behavioral and environmental factors. In general, the above-mentioned trends indicate insufficient iodine supply in Kurdistan Province. We found level of iodine in salt to be correlated with urine iodine levels, i.e. iodized salt is a very important source of iodine for human body.

Lowe levels of urine iodine in children of rural areas confirms their access to non- or low-iodized salt, and inappropriate keeping of salt, and low knowledge in rural society. Therefore, the IDD prevention and control program has not been successful.

The mean iodine content of salts used in the studied households was 27.8 gammas. However, this amount has been calculated as 30 gammas in 2007.[15] In spite of public education programs and collection of non-iodized salts at the provincial level, 35.5% of salt samples in the present study had less iodine than the standard range. Hence, either a lot of non-iodized salt is still in the market or salt is not kept in good conditions. Although a previous study revealed that 87.5% of salts used in Kurdistan Province are iodized, demographic data collected by health employees in villages suggested the rate to be as high as 98.0%[17]. Since this very high rate seems to be the result of inaccurate measurements performed by health employees, it is necessary to find out the exact rate of iodized salt consumption through census in the beginning of each year and to assess the iodine content of salts using iodine measurement kits.

In the present study, inappropriate conditions of storing salt was related to decreased iodine level in urine. Considering the fact that 46.7% of families did not store salt in suitable conditions, public education in this field is warranted. Adding salt in the beginning or end of cooking does not affect urine iodine level. The observed relation in this study was probably caused by using non-iodized salt for cooking since iodized salt changes the taste of foods. Thus, qualitative research would be is essential to better clarify this relation.

Reducing urine iodine is important since studies in some countries have shown increased prevalence of IDD and its complications as a result of previously implemented IDD control programs. For example, the former Soviet Union produced a lot of iodized salt and designed an exact plan to control and monitor iodine deficiency during 1955-70. Consequently, the prevalence of goiter was reduced to less than 5% in a national survey in 1969. However, the gradual increase of iodine deficiency was again observed in the 1970s when the surveillance system and preventive programs had terminated. Finally, by 1991, the whole IDD control system had been inactived.[18] A similar trend was seen in Australia after reduced production and use of iodized salt.[19,20]

Conclusion

Our findings indicated the possible failure of the IDD control program in Kurdistan Province. Therefore, iodized salt production factories have to be supervised and the public has to be educated on appropriate use of iodized salt. In the absence of periodic revisions to IDD control programs, the incidence of goiter and other iodine-related disorders may start to increase again.

Conflict of Interests

Authors have no conflict of interests.

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