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Assessment of Iodine Deficiency among School-Going Children of Age Group 6 to 12 Years in Kachchh District, Gujarat State: Cross-Sectional Hospital-Based Study

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Abstract

Aim Iodine deficiency disorder (IDD) is the cause of preventable brain damage, mental retardation, and stunted growth and development in children. This study aimed to detect the prevalence of IDD in Kachchh district, Gujarat, by testing urinary iodine excretion levels and iodine intake of salts in school-going children.

Methods A cross-sectional study was conducted and the level of iodine deficiency was assessed in 223 school children of both sexes, aged 6 to 12 years from four *talukas*, that is, subdivisions, of the Kachchh district by estimating urinary iodine using Sandell–Kolthoff reaction along with iodine content in edible salt samples by MBI kit (STK-Spot testing kit, MBI Kits International, Chennai, TN, India).

Results The median urinary iodine level was found to be 194 µg/L, indicating no biochemical iodine deficiency in the region. In the study areas, 1% of the population showed a level of urinary iodine excretion < 50 µg/L. About 83% salt samples had iodine level more than 15 ppm and the iodine content in salt samples less than 15 ppm was only about 17%, indicating the salt samples at households contain iodine in adequate level.

Conclusion There is a need of periodic surveys to assess the change in magnitude of IDD with respect to impact of iodized salt intervention.

Furthermore, to strengthen National Iodine Deficiency Disorders Control Program, factors should be identified. There is also a need to prevent and reimpose the ban on the sale of noniodized salts in Gujarat.

Keywords

- iodine deficiency disorders (IDD)
- school children
- prevalence of goitre
- iodized salts
- urine iodine excretion

Introduction

Iodine is an essential micronutrient for normal human growth and mental development with an average requirement of 100 to 150 µg/day. Inadequate or poor intake of iodine affects people of all ages of both sexes and of different socioeconomic backgrounds. The disorders caused due to deficiency of nutritional iodine in the food or diet are called

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iodine deficiency disorders (IDDs).[1,2] Urinary iodine is a well-accepted, cost-efficient, and easily obtainable indicator for iodine status. Since the majority of iodine absorbed by the body is excreted in the urine,[3,4] it is considered as a sensitive marker of current iodine intake and would reflect recent changes in iodine status.[4,5] IDD is a significant public health problem and is the most common cause of brain damage throughout the world (World Health Organization [WHO]/ United Nations Children's Fund [UNICEF]/International Council for Control of Iodine Deficiency Disorder [ICCIDD], 1992). Due to glaciations, flooding, rivers changing course, and deforestation, iodine present in topsoil is constantly leached, leading iodine deficiency in the soil. This, in turn, causes deficiency of iodine in crops grown on iodine-deficient soil, which results in low iodine in the diet for livestock and humans. In the past it was thought that only goitre and cretinism were caused by iodine deficiency. However, over the past, it has become increasingly clear that iodine deficiency leads to a much wider spectrum of disorders including goitre, cretinism, hypothyroidism, brain damage, abortion, still birth, mental retardation, psychomotor defects, and hearing and speech impairment.[6] In an attempt to eliminate iodine deficiency and act in accordance with the international goal of universal salt iodization, mandatory iodization of all table salts was introduced in India in 1983. In June 1992, the National Goitre Control Program (NGCP) was appropriately redesigned as "National Iodine Deficiency Disorders Control Programme (NIDDCP)" in recognition of the spectrum of disorders due to deficiency of iodine. The goal of NIDDCP was to lessen the prevalence of iodine deficiency disorders to below 10% in endemic districts of the country by the year 2000.[7] Since January 2001, the government of Gujarat state withdrew the notification of banning sale of noniodized salt. Afterwards, in November 2005, the central government issued a notification to ban the sale of noniodized salts for direct human consumption in the entire country, which was effective from May 17, 2006, under the Food Adulteration Act. From January 2001 to June 2006, there was no ban on the sale of noniodized salts.[8] In Kachchh district, IDD survey was done in 1990–1991, and then re-survey was done in 1999–2000 and in 2009 to document the prevalence of goitre in primary school children of the age group 6 to 12 years, determine median urinary iodine concentration in sample of children, assess the level of iodine in salt samples at retail trader level, and study the profile of salt sold at retail shops.[9] To know the current status of iodine nutrition, the present study was conducted to detect the prevalence of iodine deficiency disorder by knowing the pattern of urinary iodine excretion in primary school-going children, and level of iodine content in edible salt, in the Kachchh district.

Materials and Methods

Selection of Study Area and Population

The present study was done in Kachchh district of Gujarat state. The main source of water is rain and all type of routine vegetables are available and consumed by the people. The district has a total populations of 1,583,225, as per the 2001 census.[10] The national program was implemented in the district in 1992 after the result of baseline survey conducted in 1990, which indicated low goitre prevalence. As per the recommendation of WHO/UNICEF/ICCIDD,[11] a cross-sectional study of school children in the age group 6 to 12 years was done and children from both sexes were selected. The study included school survey and community survey. Five boys and five girls from each grade were selected randomly in a class on the day of visit for examination.

Sampling Method

The villages were selected using cluster sampling method.[12] A list of villages of all *taluka*s of Kachchh district was obtained from the *zila panchayat* office of the district health office (DHO).Then cumulative population was counted by using MS Excel. By calculating cluster interval, four villages were selected from the list. Only rural areas were included and confined and urban population was excluded in calculating cumulative population. When the desired sample size of five boys and five girls from each grade was not achieved, a primary school of the nearest village was approached and similarly, community survey was also done.

Training and Survey Technique

School children were clinically examined for the enlargement of thyroid (goitre) by palpation method endorsed by the current survey included in the WHO grading system as per the revised guidelines under NIDDCP[13] and WHO/UNICEF/ICCIDD. The child was examined by the examiner in sitting position, with neck in normal position. The following classification was used for goiter—grade 0: no goiter, grade 1: thyroid palpable but not visible, and grade 2: thyroid visible with the neck in normal position.[14]

Iodine in Urine

Five boys and five girls from first to seventh grade were selected randomly for urine sampling. In each cluster, 25 urine samples were collected, including 5 samples from boys and 5 from girls on the spot, according to the revised national guidelines for estimation of urinary iodine excretion (UIE).[12–15] In 30 clusters, total 223 urine samples were collected and tested for urinary iodine excretion. To collect urine samples, plastic bottles with screw caps were used and added with few drops of toluene to inhibit bacterial growth and to minimize bad odor. Ammonium persulfate titration method was used to detect the urinary iodine excretion level. The method is based on the principle that urinary iodine is released after the ingestion of urine with ammonium persulfate. The released iodine catalyzes the reduction of ceric ammonium sulfate (yellow) to cerous form (colorless) (Sandell–Kolthoff reaction).[16] Color disappearance was measured by a spectrophotometer in form of optical density (OD), which was subsequently measured by constructing a standard curve on graph paper by plotting iodine concentration in µg/L. Median iodine concentration of > 100 µg/L defines a population with no iodine deficiency, that is, at least 50% of the samples should be above 100 µg/L according to the epidemiological criteria.[17] In adults, under steady state conditions, a urinary iodine concentration of 100 µg/L corresponds roughly to a daily intake of about 150 µg/L.

Iodine in Salt

As per the protocol during the school survey to monitor iodine content in salt samples, marked air-tight plastic containers were distributed[18] randomly to the students and they were asked to bring edible salt samples from their households. Samples were also collected from the houses of students from each cluster. These samples were tested qualitatively on the spot with MBI kit provided by UNICEF, and iodine concentration was recorded as 0, < 15, or > 15 ppm.[19] One retail shop in each village was also visited and samples were purchased and tested with the use of spot salt testing kit for the presence of iodine.

Data Analysis

All the data were entered in MS Excel 2007 and analyzed using the Epi Info software, version 3.5.1 (Centers for Disease Control and Prevention, Atlanta, Georgia).[20]

Observation and Results

Total 223 urine samples were examined and obtained data were analyzed with the help of WHO/UNICEF/ICCIDD guidelines[21] as given in ►**Table 1**.

Table 1 Epidemiological criteria based on the World Health Organization/United Nations Children's Fund/International Council for Control of Iodine Deficiency Disorder guidelines

Urine iodine in children (µg/L)	Iodine intake	Iodine status
< 20	Insufficient	Severe deficiency
20–49	Insufficient	Moderate deficiency
50–99	Insufficient	Mild deficiency
100–199	Adequate	Optimal
200–299	More than adequate	Risk of iodine-induced hyperthyroidism
≥ 300	Excessive	Risk of hyperthyroidism and autoimmune thyroid disease

Results

The present cross-sectional study assessed the iodine status of 6- to 12-year-old school-going children (*N* = 223), by estimating urinary iodine using Sandell–Kolthoff reaction. Out of the 223 urine samples collected, 99% samples were found with urinary iodine excretion (UIE) level 100 µg/L or more, while 1% showed less than 100 µg/L (depicted in ►**Table 2**). The median urinary iodine level was found to be 194 µg/L, indicating no biochemical iodine deficiency in the region (depicted in ►**Table 3**). In the study areas, 1% of the population showed a level of urinary iodine excretion < 50 µg/L (depicted in ►**Table 4**). About 83% salt samples had iodine level more than 15 ppm and the iodine content in salt samples less than 15 ppm was only about 17%, indicating the salt samples at households contain iodine in adequate level (depicted in ►**Table 5**) but fall below criteria for monitoring progress toward eliminating IDD as a public health problem.

Table 2 Distribution of urinary iodine (*n* = 223)

Urinary Iodine (µg/L)	*n* (223)	% (percentage)
< 100	2	1
100–200	108	48
200–490	102	46
500–990	11	5
< 1,000	0	100
≥ 1,000	0	0

Note: Out of the 223 urine samples collected, 99% samples were found with urinary iodine excretion (UIE) level 100 µg/L or more, while 1% showed less than 100 µg/L.

Table 3 Median urinary iodine excretion (UIE) level in Kachchh district (µg/L)

Taluka	Median UIC (µg/L)
Bhuj	185
Nakhatrana	192
Khothara	196
Anjar	225
Median	194

Note: The median urinary iodine level was 194 µg/L, indicating no biochemical iodine deficiency in the region.

Table 4 Urinary iodine excretion (UIE) level in rural areas of Kachchh district

Taluka	*n*	Urinary iodine excretion (UIE)	
		< 50 µg/L (%)	> 50 µg/L (%)
Anjar	50	1 (2)	49 (98)
Nakhatrana	50	0	50 (100)
Kothara	53	0	53 (100)
Bhuj	70	0	70 (100)
Total	223	1	222 (99)

Note: 1% showed urinary iodine excretion (UIE) level < 50 µg/L, while 99% showed a level ≥ 50 µg/L.

Table 5 Salt Iodization level in rural areas of Kachchh district

Taluka	No. of salt samples tested	Iodization of salt (ppm) (MBI kit)			
		0 ppm	< 15 ppm	> 15 ppm	Percentage (%) of salt samples adequately iodized
Anjar	50	0	8	42	84
Nakhatrana	50	0	8	42	84
Kothara	53	0	12	41	77
Bhuj	70	0	10	60	86
	Total		17%	82%	

Note: The iodine content of 223 salt samples was assessed by the MBI kit method provided by UNICEF, out of which 82% salt samples showed adequate iodine (> 15 ppm) and 17% showed < 15 ppm iodine.

Table 6 Goitre prevalence rate in various talukas of Kachchh district

Taluka	Grade 0	Grade 1	Grade 2	Total cases	Total children examined	Prevalence rate (%)
Anjar	0	1	0	1	50	2
Nakhatrana	0	1	1	2	50	4
Kothara	0	1	0	1	53	1.88
Bhuj	0	1	0	1	70	1.42

Discussion

The most widely accepted marker for the evaluation for severity of IDD is the prevalence of endemic goitre in school-going children. WHO/UNICEF/ICCIDD[22] and on the basis of IDD prevalence, the criteria to understand the severity of IDD as a public health problem. As per this criteria, the prevalence rate for mild deficiency is 5.0 to 19.9%, 20 to 29.9% is moderate, and 30% and above is considered as severe. In the present study, the median urinary iodine level is 194 µg/L, indicating no biochemical iodine deficiency in the region. A study done from another district of Gujarat showed prevalence of goitre to be 20.5%,[23] which was very high compared with the present study (depicted in ►**Table 6**). Since January 2001, the ban on the sale of noniodized salts in Gujarat was withdrawn, and in November 2005 the central government issued notification to ban the sale of noniodized salts for direct consumption in the entire country.[8] Chandra et al[24] reported more than 95% of population consuming salts at adequate level, while Kamath et al[25] and Biswas et al[26] reported only 50% of community consuming salts at adequate level. Mishra et al[23] reported 39% with less than 30 ppm iodine level at retail shops, which indicates higher availability of iodine in iodized salts in the present study. As per WHO/UNICEF/ICCIDD, proportion of households consuming iodized salts effectively should be more than 90% and the recommended level of iodized salts should be more than 15 ppm[27] (depicted in ►**Table 7**); the present study shows 83% salt samples had more than 15 ppm iodine present. Hence the present study indicates the need to continue adequate effort of supplying iodized salts to the region and strengthen the system of monitoring.

Table 7 Criteria for monitoring progress toward eliminating iodine deficiency disorder (IDD) as a public health problem[14]

Indicator	Goal
Urinary iodine*	
Proportion below 100 µg/L	< 50%
Proportion below 50 µg/L	< 20%
Salt iodization	
Proportion of households consuming effectively iodized salts	> 90%

Conclusion

The results of the present study indicate that the lowest urinary iodine excretion was seen in the age group of 11 years, whereas highest urinary iodine excretion was seen in the age group of 6 to 10 years (depicted in ►**Table 8**).

There is a need of periodic surveys to assess the change in magnitude of the IDD with respect to the impact of iodized salt intervention. Furthermore, this calls for the identification of factors to strengthen NIDDCP and the need to reimpose the ban on the sale of noniodized salts in Gujarat.

Ethics Approval

This study was approved by the Institutional Ethical Committee of Gujarat Adani Institute of Medical Sciences, Bhuj, and the authors received no funding for this study.

Consent to Participate

Written informed consent were obtained from parents.

Conflict of Interest

None declared.

Table 8 Age-wise analysis of urinary iodine excretion

[A]												
Age-wise distribution of urinary iodine (*n* = 223)												
Age (y)	*n*	< 200 µg/L		200–490 µg/L		500–990 µg/L		< 1,000 µg/L		> 1,000 µg/L		
		n	%	*n*	%	*n*	%	*n*	%	*n*	%	
6	10	6	60	3	30	1	10	10	100	0	0	
7	27	14	52	12	44	1	4	27	100	0	0	
8	19	11	58	7	37	1	5	19	100	0	0	
9	34	14	41	19	56	1	3	34	100	0	0	
10	32	14	44	16	50	2	6	32	100	0	0	
11	53	26	49	25	47	2	4	53	100	0	0	
12	48	25	52	20	42	3	6	48	100	0	0	

[B]			
Age (y)	**Urinary iodine excretion**		
	> 100 µg/L (%)	**< 100 µg/L (%)**	**Total**
6	10 (100)	0	10
7	27 (100)	0	27
8	19 (100)	0	19
9	34 (100)	0	34
10	32 (100)	0	32
11	52 (98.11)	1 (1.92)	53
12	47 (97.91)	1 (2.0)	48
Total	221 (99.10)	2 (0.89)	223

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