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Urinary Iodine Concentrations For Determining Iodine Status In 6-12 Year Children in Kutch District, Gujarat

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Abstract

Aim: To evaluate the state of iodine nutrition in relation to its distribution, bioavailability and consumption of goitrogenic foods in selected area of Kutch, this study aimed to detect the prevalence of IDD in Kutch 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 level of iodine deficiency was assessed in 2100 school children of both sexes aged 6-12 years from 10 talukas 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).

Results: The median urinary iodine level was found 151.45 µg/L indicating no biochemical iodine deficiency in the region. In the study areas, 0.19 % of the population showed a level of urinary iodine excretion <50 µg/L. About 91.67 % salt samples had iodine level more than 15 ppm and the iodine content in salt samples less than 15 ppm was only about 8.28 % indicating the salt samples at house hold contain iodine in adequate level.

Conclusion:

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

Furthermore, to strengthen National Iodine Deficiency Disorders Control Programme (NIDDCP), factor should be identify and need to prevent and reimpose ban on sale of non-iodized salts in Gujarat.

Keywords: Iodine deficiency disorders (IDD), school children, iodized salts, urine iodine excretion

Introduction

Iodine is an essential micronutrient for normal human growth and mental development with an average requirement of 100-150 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 iodine deficiency disorders (IDDs). [1, 2] Urinary iodine is a well-accepted, cost-efficient and easily obtainable indicator for iodine status. Since, in the urine, the majority of iodine absorbed by the body is excreted [3,4] it is considered as sensitive marker of current iodine intake and would reflect recent changes in iodine status.[4,5] Iodine deficiency disorder (IDD) is a significant public Health problem and is the most common cause of brain damage throughout the world(WHO-World health organization/UNICEF-United nations children's fund/ICCIDD-International council for control of iodine deficiency

disorder,1992).Due to glaciations, flooding, rivers changing course and deforestation ,iodine present in top soil is constantly leached and couple to lead iodine deficiency in soil. In turn cause deficiency of iodine in crops grown on iodine deficient soil which results low iodine in the diet for livestock and humans. In the past was thought that goitre and cretinism was only caused by iodine deficiency. However, over the past, it has become increasingly clear that iodine deficiency leads to a much wider spectrum of disorders includes 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, it was mandatory iodization of all table salts was introduced in India in 1983. In June 1992, the National Goitre Control Programme (NGCP) was appropriately redesigned as "National Iodine Deficiency Disorders Control Programme (NIDDCP)" in recognition of 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 non-iodized salt. Afterwards in November 2005, the central government issued a notification to ban the sale of non-iodized salts for direct human consumption in the entire country, which was effective from May 17th, 2006 under the Food Adulteration Act. From January 2001 to June 2006, there was no ban on the sale of non-iodized salts.[8]In Kachchh district,IDD survey was done in 1990-91, and then re-survey was done in 1999-2000 and in 2009 to document the prevalence of goitre in primary school children of aged group 6-12 years; to determine median urinary iodine concentration in sample of children; to assess the level of iodine in salt samples at retail trader level; and to 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 Kutch 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 15, 83,225, as per 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 recommendation of WHO/UNICEF/ICCIDD [11], A cross sectional study of school children in the age group 6-12 yrs. 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 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 talukas of Kutch district was obtained from *Zila Panchayat*, Office of 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 the WHO grading system as per the revised guidelines under NIDDCP [13], WHO/UNICEF/ICCIDD, The child was examined by examiner in sitting position with neck in normal position. The following classification was used for goitre: Grade 0: no goitre; 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 1st to 7th grade were selected randomly for urine sampling. In each cluster, twenty five urine samples were collected including five samples from boys and five from girls on the

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spot according to the revised national guidelines for estimation of urinary iodine excretion (UIE). [12-15] In 30 clusters, total 2100 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 odour. 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 (colourless) (Sandell-Kolthoff reaction).[16] Colour 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, *i.e*. at least 50 per cent 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 and also collected from the houses of students from each cluster. These samples were tested qualitatively on spot with MBI kit provided by UNICEF, and iodine concentration was recorded as 0, <15, >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 analysed using the Epi Info software, version 3.5.1 [20]

Observation and Results:

Total 2100 urine samples were examined and obtained data was analyzed with the help of WHO/UNICEF/ICCIDD guideline [21] as given in Table 1.

Table 1.Epidemiological criteria based on the WHO/UNICEFF/ICCIDD 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 auto immune thyroid disease

Table 2.Out of the total 2100 urine sample collected ,97.07% samples were found with urinary iodine excretion (UIE) level 100 µg//L or more, while 2.9% sample shown less than 100 µg//L.

Distribution of Urinary Iodine (n = 2100)		
Urinary Iodine (µg/L)	**n**	**%**

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< 20	0	0
20-49	4	0.19
50-99	57	2.71
100-199	1881	89.57
≥ 200	158	7.50

Table 3. In this 0.19% of them showed a level of <50 µg//L for UIE, While 99.80% Samples showed a level of ≥50 µg/L.

Taluka	**n**	**Urinary Iodine excretion(UIE)**	
		>50 µg/L (%)	**<50µg/L (%)**
Anjar	210	210 (100)	0 (0)
Nakhatrana	210	210 (100)	0 (0)
Bhuj	210	210 (100)	0 (0)
Lakhpat	210	210 (100)	0 (0)
Rapar	210	209 (99.52)	1 (0.47)
Bhachau	210	210 (100)	0 (0)
Abdasa	210	210 (100)	0 (0)
Mandvi	210	210 (100)	0 (0)
Mundra	210	208 (99.04)	2 (0.95)
Gandhidham	210	209 (99.52)	1(0.47)

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TOTAL	**2100**	**2096 (99.80)**	**4 (0.19)**

Table 4.The median urinary iodine level was 151.45 µg/L indicating no biochemical iodine deficiency in the region.

Median Urinary Iodine Excretion (UIC) level in Kachchh district(µg/L)	
Talukas	**Median UIC (µg//L)**
Anjar	146.53
Nakhatrana	136.11
Bhuj	166.93
Lakhpat	142.28
Rapar	151.45
Bhachau	168.01
Abdasa	169.41
Mandvi	158.85
Mundra	151.45
Gandhidham	137.25
Median	**151.45**

Table 5.The iodine content of 2100 salt samples was assessed by the MBI kit method provided by UNICEF ,out of which 91.67 % salt samples shown adequate iodine >15 ppm & 8.28 % less than 15ppm Iodine.

Taluka	**No .of Salt Samples tested**	**Iodization of salt in ppm**			
		0 ppm	**<15ppm**	**>15ppm**	**% of salt samples adequately iodized**
Anjar	210	0	16	194	92.38
Nakhatrana	210	0	13	197	93.8
Bhuj	210	0	5	205	97.61
Lakhpat	210	0	17	193	91.9
Rapar	210	0	12	198	94.28
Bhachau	210	0	24	186	88.57
Abdasa	210	0	42	168	80

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Mandvi	210	0	7	203	96.66
Mundra	210	0	30	180	85.71
Gandhidham	210	0	8	202	96.19
Total	**2100**	0	**8.28%**	**91.67%**	

Table 6.Criteria for monitoring progress towards eliminating 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%

Table 7: Goitre Prevalence Rate in Various Talukas of kachchh District.

Taluka	**Sex**	**Grade 0**	**Grade 1**	**Grade 2**	**Total Cases**	**Total children examined**	**Prevalence rate (%)**
Anjar	Male	0	0	0	0	105	0
	Female	0	0	0	0	105	0
Nakhatrana	Male	0	0	0	0	105	0
	Female	0	0	1	1	105	0.95
Bhuj	Male	0	0	0	0	105	0
	Female	0	0	0	0	105	0
Lakhpat	Male	0	1	0	1	105	0.95
	Female	0	0	1	1	105	0.95
Rapar	Male	0	1	0	1	105	0.95
	Female	0	1	0	1	105	0.95
Bhachau	Male	0	1	0	1	105	0.95
	Female	0	0	0	0	105	0
Abdasa	Male	0	3	1	4	105	3.8
	Female	0	3	1	4	105	3.8
Mandvi	Male	0	0	0	0	105	0
	Female	0	0	0	0	105	0

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Mundra	Male	0	0	0	0	105	0
	Female	0	0	0	0	105	0
Gandhidham	Male	0	0	0	0	105	0
	Female	0	0	0	0	105	0
Total		0	10	4	14	**2100**	**0.66**

Table 8: Age wise analysis of Urinary Iodine excretion (n=2100)

Table 8.1

Age-wise Distribution of Urinary Iodine (n = 2100)											
Age (Yrs)	**n**	**< 20 µg/L**		**20-49 µg/L**		**50-99 µg/L**		**100-199 µg/L**		**>200 µg/L**	
		n	**%**	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**
6	182	0	0	0	0	4	2.19	163	89.56	15	8.2
7	292	0	0	1	0.34	5	1.71	263	90.06	23	7.8
8	304	0	0	1	0.32	5	1.64	275	90.46	23	7.5
9	302	0	0	0	0	5	1.65	262	86.75	35	11.5
10	303	0	0	0	0	5	1.65	279	92.07	19	6.2
11	412	0	0	2	0.48	18	4.36	372	90.29	20	4.8
12	305	0	0	0	0	15	4.91	267	87.54	23	7.5

Table 8.2: Age-wise Distribution of Urinary Iodine (n = 2100)

Age (years)	**Urinary Iodine excretion**	
	>100 µg/L (%)	**<100µg/L (%)**
6	178 (97)	4 (2.19)
7	286 (97.94)	6 (2.05)
8	298 (96.05)	6 (1.97
9	297 (98.34)	5 (1.65)
10	295 (97.35)	8 (2.64)

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11	390 (94.66)	22 (5.33)
12	289 (94.75)	16 (5.24)
Total	**2033 (96.80)**	**67 (3.19)**

TABLE 9: IDD prevalence indicators in school children and criteria for a significant public health problem. [28]

	Severity of public health problem		
Indicators	Mild	Moderate	severe
Median urinary iodine (µg//L)	50-99.9	20-49.9	<20

Results:

The present cross-sectional study assessed the iodine status of 6-12 years school going children (N=2100), by estimating urinary iodine using Sandell-Kolthoff reaction. The median urinary iodine level was found 151.45 µg/L indicating no biochemical iodine deficiency in the region. In the study areas, 0.19 % of the population showed a level of urinary iodine excretion <50 µg/L. About 91.67% salt samples had iodine level more than 15 ppm and the iodine content in salt samples less than 15 ppm was only about 8.28 % indicating the salt samples at house hold contain iodine in adequate level and follow criteria for monitoring progress towards eliminating IDD as a public health problem.

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 (depicted in Table-9) for mild is 5.0-19.9%, 20-29.9% as moderate and 30% and above considered as severe. In the present study the median urinary iodine level is 151.45 µg/L indicating no biochemical iodine deficiency in the region. A study done from another district of Gujarat which showed prevalence of goitre 20.5% [23] which was very high compared to the present study. Since January, 2001 in Gujarat, the ban on sale of non-iodized salts was withdrawn and in Nov 2005 central government issued notification to ban sale of non-iodized salts for direct consumption in 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's, et al.[23] reported 39% 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 effectively iodized salts should be more than 90% and recommended level of iodized salts should be more than 15ppm [27] (depicted in Table 6) and the present study shows 91.67 % salt samples had more than 15ppm iodine present. Hence the present study indicate still need to continue and adequate effort of supplying iodized salts to the region and strengthen the system of monitoring.

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Conclusion:

The results of the present study indicated that the lowest urinary iodine excretion was seen in age group of nine years whereas highest urinary iodine excretion was seen in age group of six to ten years.

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

Ethics approval

This study was approved by The Institutional Ethical Committee of Gujarat Adani Institute of Medical Sciences, Bhuj and funding done by self.

Consent to participate

Written informed consent were obtained from parents

Consent to Publish

The participant has consented to the submission of article for the publication.

Confidentiality:

Should be maintained as per the Indian council of medical research (ICMR) guidelines.

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