Iodine nutritional status and goiter prevalence in 6-12 years primary school children of Saurashtra region, India

Rajesh K Chudasama, Pramod B Verma, Rajkumar G Mahajan
Gujarat, India

Background: **Iodine deficiency disorder (IDD) or goiter 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 Rajkot district, India by testing urinary iodine excretion levels and iodine salt intake of school children.**

Methods: **A cross-sectional study was conducted in 2940 school children of both sexes aged 6-12 years from 14 talukas subdivisions of the district. Thirty clusters were selected by using cluster sampling technique. Goiter was assessed in all the studied children along with biochemical analysis of iodine in 420 urine samples and iodine content in 840 edible salt samples in the studied area.**

Results: **Goiter was reported from all talukas subdivisions of the studied area. Goiter prevalence ranged from 1% to 35%, and the overall prevalence was 8.8% (grade 1: 7.6%; grade 2: 1.2%), indicating a mild public health problem. In the study areas, 18.1% of the population showed a level of urinary iodine excretion <50 μg/L. The median level of urinary iodine in the studied areas was 110 μg/L (range 10-415 μg/L). The iodine level of more than 15 ppm was found in 81% of salt samples tested at the household level.**

Conclusion: **There is mild goiter prevalence in primary school children of Rajkot district, which is due to the inadequate iodine intake or content from salt at the household level.**

World J Pediatr 2010;6(3):233-237

Key words: **goiter survey; household level; iodine deficiency disorder; prevalence; primary school children**

Author Affiliations: Department of Community Medicine, Government Medical College, Rajkot, Gujarat, India (Chudasama RK, Verma PB, Mahajan RG)

Corresponding Author: Dr. Rajesh K Chudasama, Vandana Embroidary, Mato Shree Complex, Sardar Nagar Main Road, Rajkot – 360 001, Gujarat, India (Tel: +91 94284 52080; Fax: +91 281 2455810; Email: dranakonda@yahoo.com; dranakonda@gmail.com)

doi:10.1007/s12519-010-0221-0

Introduction

Iodine is an essential micronutrient required in a minute amount for normal growth and development of human beings. Iodine deficiency disorder (IDD) or goiter is the most common cause of preventable brain damage, mental retardation, and stunted growth and development in children. Since thyroid gland does not have the capacity to amass this amount, a small quantity of iodine must be eaten regularly through a balanced diet over a period of time. Globally, 2.2 billion people live in areas with iodine deficiency and have relevant complications. In India 167 million people are at risk for IDD, 54.4 million people have goiter, and 8.8 million people suffer from IDD related mental/motor handicaps.[1] In India, IDD prevails in all states and union territories out of 587 districts. In 282 districts surveyed for IDD, 241 were found endemic for goiter.[2] Several studies conducted in India showed a high prevalence of goiter.[3-5] In 1983 iodization of salts was made compulsory as an attempt to eliminate iodine deficiency in this country. The Indian government re-launched a National Iodine Deficiency Disorders Control Program (NIDDCP) in 1992 for lowering the prevalence of IDD to a non-endemic level. After implementation of the NIDDCP, India has made considerable progress in IDD elimination. A goiter rate of lower than 5% was found in 9 of 15 districts studied in 11 states by the Indian Council of Medical Research (ICMR).[6] The NIDDCP included IDD surveys, supply of iodized salt, re-surveys every five years, monitoring iodized salt consumption, laboratory monitoring of iodized salt, urinary iodine concentration, and health education.

In February 2009, the government of Gujarat state started IDD re-survey in all the districts. Rajkot district

was selected in the Saurashtra region under Gujarat state for study as it geographically and socio-culturally represents the whole region. In the Rajkot district, the first baseline IDD survey was conducted in 1989, and then re-survey was performed in 1998-1999.

The government of Gujarat state withdrew the notification banning the sale of non-iodized salt since January 2001. Afterwards in November 2005 the central government also issued a notification to ban the sale of non-iodized salt for direct human consumption in the entire country, which was effective from May 17th, 2006 under the Food Adulteration Act.[7] From January 2001 to June 2006, there was no ban on the sale of non-iodized salt. To know the current status of iodine nutrition, the present study was conducted to detect the prevalence of goiter, the pattern of urinary iodine excretion in primary school children, and iodine content in edible salt in the Rajkot district.

Methods

Selection of study areas

The present study was conducted in the Rajkot district of the state of Gujarat. The district is centrally located in the Saurashtra region of Gujarat and surrounded by Kutchh, Jamnagar, Surendranagar, Bhavnagar and Amreli districts. The Rajkot district is an industrial hub of Gujarat. Rain is the main source of water. Almost all common vegetables are available and consumed by the people. The district is divided into 14 talukas, having a total population of 3 157 676.[8] The national program was implemented in the district in 1992 after the baseline survey conducted in 1989 indicating a low goiter prevalence. A resurvey was conducted in 1998 to 1999 and again in 2009.

Study population and sample size

The survey was primarily based on the WHO/UNICEF/ICCIDD criteria for school & community based studies.[9] Little modification has been made for the guidelines provided by the State Nutrition Cell, Ministry of Health & Family Welfare, and the government of Gujarat. Children aged 6-12 years in primary schools of rural areas were selected for a cross-sectional study. The study included school survey and community survey. Five boys and five girls from each grade present in class on the day of visit were selected randomly for examination. A total of 70 students were examined at each school in selected villages. Almost 30% of school children were considered absent at any given time; therefore 28 students (2 boys and 2 girls from each grade in age group of 6-12 years) were examined out of schools in the community from each selected village. Thus a total of 2100 students were examined in schools and 840 students were examined out of schools in the selected villages.

Sampling method

The cluster sampling method was used to select villages.[10] A list of villages of all talukas of the Rajkot district was obtained from Jilla Panchayat, District Health Office (DHO). Then cumulative population was counted using MS excel. By calculating cluster interval, 30 villages were selected from the list. Only rural areas were included and urban population was excluded in calculating cumulative population. The primary schools of the 30 selected villages were visited. When the desired sample size of 5 boys and 5 girls from each grade was not achieved, a primary school of the nearest village was approached. Goiter was classified as: grade 0: not visible and not palpable; grade 1: palpable but not visible; and grade 2: palpable and visible according to the revised national guidelines on NIDDCP.[10]

Urine samples

One boy and one girl from 1st to 7th grade were selected randomly for urine sampling. In each cluster, 14 urine samples were collected including 7 samples from boys and 7 from girls on the spot according to the revised national guidelines for estimation of urinary iodine excretion (UIE).[10] In 30 clusters, 420 urine samples were collected for testing urinary iodine excretion. Plastic bottles with screw caps were used to collect the urine samples, which were stored and transported under refrigeration to the state IDD laboratory at Surat for testing by an expert technician. Few drops of toluene were added to each urine sample to inhibit bacterial growth and to minimize bad odor. Child number, cluster number, and date of urine collection were recorded on every bottle of urine sample. An ammonium persulfate titration method was used to detect the level of urinary iodine excretion. The method is based on the principle that urinary iodine is released after the digestion of urine with ammonium persulfate. The released iodine catalyzes the reduction of ceric ammonium sulfate (yellow) to cerous form (colorless) (Sandell-Kolthoff reaction).[11] 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.

Salt samples

According to the guidelines, 28 salt samples from the children of 6-12 years were examined for goiter during the community survey at their homes in each village.

A total of 840 salt samples were tested qualitatively on the spot with the MIB kit provided by UNICEF and the iodine concentration was recorded as 0, <15, and >15 ppm.[12] One retail shop in each village was visited and a total of 31 salt samples were purchased and assessed for iodine status.

Data analysis

All the data were entered in MS excel 2007 and analyzed using the Epi Info software, version 3.5.1.[13]

Results

The goiter prevalence was 8.8% among primary school children in the Rajkot district (Table 1). The prevalence of severe goiter was only in Jamkandorna taluka but moderate in Upleta taluka. Age specific goiter prevalence was seen in the Rajkot district (Table 2). As the age increased the goiter prevalence also increased except in the age group of 12 years; but there was no statistical significance. A total of 420 urine samples were collected in the Rajkot district, and 18.1% of them showed a level of <50 μg/L for UIE, while 81.9% samples showed a level of ≥50 μg/L (Table 3).

Iodine consumer level was lowest in Jasdan taluka where more than half of the salt samples were found to contain <15 ppm iodine or no iodine at all (Table 4). At the consumer level, 81% of the 840 tested salt samples contained >15 ppm iodine.

All were branded salts, in powder form and well packed, with proper manufacturer address. Among the tested salt samples, 71% were found to have ≥30 ppm iodine, 19% have <30 ppm iodine, and 10% no iodine at all.

Table 1. Goiter prevalence in different areas of Saurashtra region, India

Study talukas	No. of children examined	No. (%) of children with goiter			Severity*
		Grade 1	Grade 2	Total (1+2)	
Dhoraji	196	13 (6.6)	0	13 (6.6)	Mild
Gondal	294	23 (7.8)	6 (2.0)	29 (9.9)	Mild
Jamkandorna	98	31 (31.6)	3 (3.1)	34 (34.7)	Severe
Jasdan	490	19 (3.9)	9 (1.8)	28 (5.7)	Mild
Jetpur	196	6 (3.1)	0	6 (3.1)	No
Kotdasangani	196	12 (6.1)	0	12 (6.1)	Mild
Lodhika	98	6 (6.1)	0	6 (3.1)	Mild
Maliya	98	1 (1.0)	0	1 (1.0)	No
Morbi	294	25 (8.5)	11 (3.7)	36 (12.2)	Mild
Padadhari	98	10 (10.2)	0	10 (10.2)	Mild
Rajkot	294	5 (1.7)	1 (0.3)	6 (2.0)	No
Tankara	196	32 (16.3)	2 (1.0)	34 (17.3)	Mild
Upleta	98	20 (20.4)	0	20 (20.4)	Moderate
Wankaner	294	21 (7.1)	3 (1.0)	24 (8.2)	Mild
Total	2940	224 (7.6)	35 (1.2)	259 (8.8)	Mild

*: severity as a public health problem: <5%, no; 5%-19.9%, mild; 20%-29.9%, moderate; >30%, severe.[10]

Table 2. Age specific goiter prevalence in Saurashtra region, India

Age (y)	No. of children examined	Goiter prevalence		
		Grade 1 (%)	Grade 2 (%)	Total* (%)
6	420	27 (6.4)	3 (0.7)	30 (7.1)
7	420	25 (6.0)	4 (0.9)	29 (6.9)
8	420	32 (7.6)	5 (1.2)	37 (8.8)
9	420	37 (8.8)	6 (1.4)	43 (10.2)
10	420	36 (8.8)	6 (1.4)	42 (10.0)
11	420	38 (9.0)	9 (2.1)	47 (11.2)
12	420	29 (6.9)	4 (0.9)	33 (7.9)
Total	2940	224 (7.6)	35 (1.2)	259 (8.8)

*: $P>0.05$, not significant.

Table 3. The level of urinary iodine excretion (UIE) level in different areas of Saurashtra region, India

Study talukas	*n*	UIE level (μg/L)*	
		<50.0 (%)	≥50.0 (%)
Dhoraji	28	3 (10.7)	25 (89.3)
Gondal	42	8 (19.0)	34 (81.0)
Jamkandorna	14	2 (14.3)	12 (85.7)
Jasdan	70	25 (35.7)	45 (64.3)
Jetpur	28	0	28 (100.0)
Kotdasangani	28	11 (39.3)	17 (60.7)
Lodhika	14	2 (14.3)	12 (85.7)
Maliya	14	2 (14.3)	12 (85.7)
Morbi	42	4 (9.5)	38 (90.5)
Padadhari	14	0	14 (100.0)
Rajkot	42	10 (23.8)	32 (76.2)
Tankara	28	6 (21.4)	22 (78.6)
Upleta	14	1 (7.1)	13 (92.9)
Wankaner	42	2 (4.8)	40 (95.2)
Total	420	76 (18.1)	344 (81.9)

*: The median UIE level in Saurashtra region was 110 μg/L.

Table 4. Taluka specific assessment of iodine in salt samples by spot kit at household level in Saurashtra region, India

Talukas	No. of samples tested	Iodization of salt in ppm			Adequately iodized (%)
		0 ppm	<15 ppm	>15 ppm	
Dhoraji	56	5	2	49	87.5
Gondal	84	9	8	67	79.8
Jamkandorna	28	1	2	25	89.3
Jasdan	140	27	59	54	38.6
Jetpur	56	7	10	39	69.6
Kotdasangani	56	3	0	53	94.6
Lodhika	28	0	0	28	100.0
Maliya	28	4	1	23	82.1
Morbi	84	5	3	76	90.5
Padadhari	28	0	1	27	96.4
Rajkot	84	2	1	81	96.4
Tankara	56	6	0	50	89.3
Upleta	28	1	0	27	96.4
Wankaner	84	0	4	80	95.2
Total	840	70	91	679	80.8

Discussion

In evaluating the severity of IDD in a region, the most widely accepted marker is the prevalence of endemic goiter in school children. WHO/UNICEF/ICCIDD[14] recommended this prevalence to understand the severity of IDD as a public health problem in a region. A prevalence rate of 0-4.99% is considered as none, 5.0%-19.9% as mild, 20%-29.9% as moderate, and above 30% as severe public health problem.

In the studied district, the total prevalence of goiter was 8.8% (grade 1: 7.6%; grade 2: 1.2%) indicating that IDD is a mild public health problem. A similar study from another district of Gujarat reported a total goiter prevalence of 20.5%,[4] which was higher than the present study mentioning the withdrawal of notification banning the sale of non-iodized salt from Gujarat since January 2001. The present study found that the lower prevalence was probably due to availability and consumption of iodized salt at all places from cities to smallest villages. That may be one of the reasons that there was no association between the age of school children and the high prevalence of goiter as reported early.[3,4] In addition, the prevalence of goiter was lower in girls than in boys.[4,5] The National Family Health Survey (NFHS)-3 revealed that the prevalence of goiter or other thyroid disorders was 2.5 times higher in women than in men, and the number of patients with goiter or thyroid disorders increases with age, especially in women.[15]

The level of urinary iodine excretion ≥50 μg/L was found in 81.9% of urine samples. According to the national guidelines,[1] the severity of IDD was classified into three categories: <20 μg/L, severe; 20-49.9 μg/L, moderate; and 50-99.9 μg/L, mild. The value of 100 μg/L or above was considered normal. The median level of urinary iodine was 110 μg/L in the current study. Moreover mild severity was found in 30% of the children, moderate in 13%, and severe in 5%. These findings indicate that iodine deficiency is prevalent in totally 48% of the children. It is also indicated that inadequate efforts were made to ensure a supply of iodized salt to the community. Different levels of median urinary iodine were reported, indicating iodine deficiency or no deficiency in various areas.[16-19]

WHO/UNICEF/or ICCIDD also recommends that 90% of household salts should be iodized at a recommended level of 15 ppm,[20] but 81% of households were consuming salts at an adequate level in contrast to 11% of households consuming iodized salt not at the recommended level. Chandra et al[5] reported more than 95% of households consuming salts at an adequate level, while others[21,22] reported only 50% of households respectively consuming salts at an adequate level. These results suggest that it is necessary to strengthen the system of monitoring the quality of salt to ensure the availability of 15 ppm of iodine at household level.

In the present study, only 71% of branded packed salt samples claiming iodization showed a iodine level of ≥30 ppm sold at retail shops (consumer level), while 19% of the samples had an iodine level of less than 30 ppm. Misra et al[4] reported that 39% of salt samples claiming iodization had an iodine level of less than 30 ppm at retail shops.

In conclusion, the present study showed mild prevalence of goiter in primary school children in the Rajkot district of Gujarat, which is due to inadequate iodine intake or content from salt at the household level. This finding calls for further evaluation of the problem in these area to strengthen the national program.

Acknowledgements

We are thankful to the government of Gujarat for providing financial assistance, Chief District Health Officer, Rajkot and District Education Department for providing technical support.

Funding: The government of Gujarat.
Ethical approval: State Nutrition Cell, Ministry of Health & Family Welfare, Government of Gujarat has given ethical permission to conduct this study.
Competing interest: None stated.
Contributors: Chudasama RK involved in designing the study, preparation and analysis, is the guarantor of the study. Verma PB and Mahajan RG assisted in analysis and drafting the paper.

References

1 Directorate General of Health Services (DGHS). Policy guidelines on national iodine deficiency disorders control programme, New Delhi: DGHS, Ministry of Health & Family Welfare, Government of India; 2003: 1-10.
2 Kapil U. Progress made in elimination of IDD and possible impact of lifting ban on sale of non iodized salt. J Acad Hosp Admin 2000;12:33-41.
3 Chandra AK, Bhattacharjee A, Malik T, Ghosh S. Goitre prevalence and iodine nutritional status of school children in a sub-Himalayan Tarai region of Eastern Uttar Pradesh. Indian Pediatr 2008;45:469-474.
4 Misra S, Kantharia SL, Damor JR. Prevalence of goitre in 6-12 years school going children of Panchmahal district in Gujarat, India. Indian J Med Res 2007;126:475-479.
5 Chandra AK, Singh LH, Tripathy S, Debnath A, Khanam J. Iodine nutritional status of children in North East India. Indian J Pediatr 2006;73:795-798.
6 Toteja GS, Singh P, Dhilon BS, Saxena BN. Iodine deficiency disorders in 15 districts of India. Indian J Pediatr 2004;71:25-28.
7 Kishore J. National health programmes of India, 7th ed. New Delhi: Century Publications, 2007: 370-373.
8 2001 census Rajkot, Gujarat, India. Office of District Health

Officer; 2008. http://www.educationforallinindia.com/page163.html (accessed August 6, 2009).
9 WHO/ICCIDD/UNICEF. Assessment of iodine deficiency disorders and monitoring their elimination: a guide for programme managers. Geneva: World Health Organization, 2007. www.iccidd.org/media/assessment%20tools/survey_sites.pdf (accessed January 18, 2010).
10 Ministry of Health & Family Welfare, Government of India. Revised policy guidelines on national iodine deficiency disorders control programme, 2006. www.mohfw.nic.in/Revised%20Policy%20Guidelines%20On%20NIDDCP.htm (accessed January 21, 2010)
11 WHO/ICCIDD/UNICEF. Assessment of iodine deficiency disorders and monitoring their elimination: a guide for programme managers. Geneva: World Health Organization, 2007. www.iccidd.org/media/assessment%20tools/urinary_iodine-method_a.pdf (accessed January 18, 2010).
12 WHO. A guide for programme manager: assessment of iodine deficiency disorders and monitoring their elimination, 2nd ed. Geneva: World Health Organization, 2001.
13 Centers for Disease Control & Prevention. Epi Info version 3.5.1, 2008. www.cdc.gov/epiinfo/ (accessed August 15, 2008).
14 WHO/ICCIDD/UNICEF. Assessment of iodine deficiency disorders and monitoring their elimination: a guide for programme managers. Geneva: World Health Organization, 2007. http://whqlibdoc.who.int/publications/2007/9789241595827_eng.pdf (accessed January 15, 2010).
15 Ministry of Health and Family Welfare: National Family Health Survey 3, India, 2007. http://mohfw.nic.in/nfhs3/NFHS-3%20NKF/Report.pdf (accessed December 20, 2009).
16 Kapil U, Sharma TD, Singh P, Dwivedi SN, Kaur S. Thirty years of a ban on the sale of noniodized salt: impact on iodine nutrition in children in Himachal Pradesh, India. Food Nutr Bull 2005;26:255-258.
17 Chandra AK, Singh LH, Debnath A, Tripathy S, Khanam J. Dietary supplies of iodine & thiocyanate in the etiology of endemic goitre in Imphal East district of Manipur, north east India. Indian J Med Res 2008;128:601-605.
18 Shankar R, Moorthy D, Pandav CS, Tiwari JS, Karmarkar MG. Tracking progress towards sustainable elimination of iodine deficiency disorders in Bihar. Indian J Pediatr 2006;73:799-802.
19 Chandra AK, Tripathy S, Ghosh D, Debnath A, Mukhopadhyay S. Iodine nutritional status & prevalence of goitre in Sundarban delta of South 24 Parganas, West Bengal. Indian J Med Res 2005;122:419-424.
20 ICCIDD/UNICEF/WHO. Assessment of iodine deficiency disorders and monitoring their elimination. A guide for programme managers, 2nd ed. WHO/NHD/01.1, 2001. http://www.who.int/nutrition/publications/en/idd_assessment_monitoring_elimininationpdf (accessed January 12, 2010).
21 Kamath R, Bhat V, Rao RSP, Das A, Ganesh KS, Kamath A. Prevalence of goiter in rural area of belgaum district, karnataka. Indian J Community Med 2009;34:48-51.
22 Biswas AB, Chakraborty I, Das DK, Chakraborty A, Ray D, Mitra K. Elimination of iodine deficiency disorders—current status in Purba Medinipur district of West Bengal, India. Indian J Public Health 2008;52:130-135.

Received August 24, 2009
Accepted after revision March 1, 2010