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Original Research Article

Assessment of Iodine Status in Children of Bhuj, Gujarat

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ABSTRACT

Background: Iodine deficiency disorder results in avoidable brain damage, cognitive impairment, and inhibited growth and development among children. The aim of this study was to ascertain pervasiveness of IDD in the Bhuj City of Kutch district of Gujarat by measuring urinary iodine excretion levels(UIE) and iodine intake from salt among school-going children.
Material and methods: A cross-sectional investigation was conducted to evaluate iodine deficiency levels in 350 school children of both genders, 6-12 years of ages, from Bhuj Taluka, a subdivision of the Kachchh district. The evaluation involved estimating urinary iodine levels through the Sandell–Kolthoff reaction and determining the iodine levels in samples of cooking salt using Spot testing kit (STK).
Results: With a median iodine levels in urine of 166.93 µg/L, there appears to be no biochemical evidence of iodine deficiency in the region. Approximately 98.57% of salt samples found iodine levels exceeding 15 ppm, while only about 1.42% had iodine levels below 15 ppm, indicating that household salt samples contain adequate iodine levels.
Conclusions: The region's median concentration of Iodine content found in urine 166.93 µg/L, suggesting the absence of biochemical iodine deficiency. Analysis of salt samples revealed that approximately 98.57% contained iodine levels exceeding 15 ppm, while only about 1.42% had iodine content below this threshold. This indicates that household salt samples possess adequate iodine levels, aligning with criteria for monitoring progress in eradicating iodine deficiency disorders as a public health concern.

Keywords: Iodine deficiency disorder, School children, Urine iodine excretion, Iodized salt.

INTRODUCTION

Iodine stands as an indispensable micronutrient necessary for the production of thyroid hormones. In body fluids, iodine exists as iodide (I-). Within the thyroid gland, thyroid peroxidase facilitates the oxidation of iodide, which is then incorporated into the tyrosine molecules of thyroglobulin (Tg) to form mono & di-iodotyrosine. These compounds subsequently combine to produce T3 & T4, hormones critical for normal growth and mental development, with an average daily requirement of 100-150 µg. According to UNICEF, ICCIDD, and WHO, the suggested daily iodine intake is 90 µg for pre-school children, 120 µg for children aged 6-12 years, 150 µg for adolescents and adults, and 250 µg during pregnancy & lactation[1, 2].

Insufficient iodine intake below these recommended levels can prevent the thyroid gland from synthesizing adequate thyroid hormones, leading to hypothyroidism, which can affect individuals across all ages, sexes, and socioeconomic backgrounds. Conditions resulting from iodine deficiency are known as iodine deficiency disorders [3, 4, 5]. IDD is acknowledged worldwide as a notable public health issue and a primary cause of preventable mental retardation[6]. Severe iodine deficiency can cause permanent brain damage in infants and delayed psychomotor development, resulting in goiter (an enlarged thyroid gland) in children[7]. Crops grown in iodine-deficient soil lead to low iodine levels in the diet for both humans and livestock. It was once

thought that goiter and cretinism were the only outcomes of iodine deficiency, but it is now understood that the deficiency can cause a broad spectrum of disorders, including Hypothyroidism, cognitive impairment, and pregnancy complications, mental retardation, stillbirth, and psychomotor defects[8]. Urinary iodine concentration(UIC) is a widely accepted[9, 10] and cost-effective measure of iodine status, as most absorbed iodine is excreted in urine, making it a responsive indicator of present iodine intake and reflecting latest changes in iodine status[10, 11]. The significance of IDD highlights that the issue extends far beyond just goiter and cretinism. (Table-1)[12].

Table- 1: The range of IDD

Physiological categories	Health impacts of iodine deficiency
All age spectrums	Goitre Hypothyroidism
Fetus	Unbidden abortion Stillbirth Congenital defect Perinatal mortality
Neonate	Endemic cretinism including mental deficiency with a mixture of mutism, Hypothyroidism and stunted growth. Infant mortality
Child and adolescent	Impaired mental function Delayed bodily growth Iodine induced hyperthyroidism (IIH)
Adults	Impaired mental function Iodine-induced hyperthyroidism (IIH)

Since 1994, the WHO & the United Nations Children's Fund have advocated universal salt iodization as a safe, cost-effective, and justifiable strategy to make confirm adequate iodine intake for all individuals[13].

In this context, the study aims to evaluate the frequency of iodine insufficiency in rural regions of the Bhuj district and to analyze the general status of growth and development among children attending school in the community.

MATERIAL AND METHODS

This study is a cross-sectional examination involving school-age children aged 6-12 years. Given that salt iodization serves as the primary intervention against IDD and school-aged children primarily consume foods prepared at home, surveying this specific demographic could be the most efficient approach. This is particularly true if a significant portion of children within the age range attend school, as the IDD status of school-going children should reflect the IDD status within the population. Hence, this study is conducted in the Bhuj region of Gujarat state to fulfill this objective.

- **Place of study:**

This study was supervising at the Biochemistry Department, GAIMS & GKGH, Bhuj in Kutch region.

- **Consent form:**

Informed written consent was attained from carers of participating children.

- **Sample size:**

Five clusters were selected using the cluster sampling technique, following the guidelines provided by the Government of Gujarat[14]**.** In accordance with these guidelines, 70 samples were taken from each cluster, resulting in a total sample size of 350.

- **Inclusion criteria:**
  - Age between 6-12 years
  - Rural area of Bhuj city of Kutch District

- **Exclusion Criteria:**
  - All children below 6 years or above 12 years, as documented in the school records.
  - Individuals with diagnosed thyroid disease and/or other chronic illnesses.

Participants who had been exposed to any iodine-containing medications, except for multivitamin and mineral supplements.

- **Sampling and methodology:**

This cross-sectional study adheres to the WHO/UNICEF/ICCIDD guidelines for school and community-based[15] research among children enrolled in various primary schools. A comprehensive village-wise population list for the entire district was obtained from the CDHO office, along with data on the number

of students enrolled in each village's schools from the District Education office.

- **Urine iodine concentration:**

Five urine samples were randomly collected from students of standards 1st to 7th. To ensure equal representation of both genders, five boys and five girls from each standard were selected for the estimation of urinary iodine levels. Various methods are available for evaluating urinary iodine levels using different procedures.

One of the most practical and straightforward methods entails mild acid digestion coupled with timed colorimetric procedures. "Method A"[16-17], is a classical technique for assessing iodine levels through the Sandell-Kolthoff reaction after digesting the urine with ammonium persulfate under mild conditions. In this method, iodine serves as a catalyst in the reduction of ceric ammonium sulfate to its cerous form, causing the color to change from yellow to colorless.

The actual iodine concentration is determined by the disappearance of color, which is measured using a spectrophotometer. Method A is widely regarded as a reliable technique due to its simplicity, precision, safety, and low start-up cost. The optical density(OD) of the color formed is typically measured, and a standard curve is constructed on graph paper by plotting the concentration of iodine in µg/L.

Analyzing UIC serves as a parameter for to evaluate iodine status in a population and is strongly endorsed by the World Health Organization. It has been utilized as an indicator in numerous studies worldwide. The epidemiological criteria for evaluating iodine nutrition based on the median UIC of school-aged children (>6 years) are outlined in (Table-2).

Table-2: Summary of criteria for monitoring progress towards sustainable elimination of IDD as a public health problem

Indicators	Goals
Salt iodization Proportion of households utilizing salt that is sufficiently iodized	>90%
Urinary iodine Median in the general population	100–199 µg/L

Table-3: The Epidemiological criteria for assessing iodine nutrition determined by median urinary iodine concentration of school aged children (> 6 years).

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	Likely to provide adequate intake for pregnant/lactating women, but may pose a slight risk of more than adequate intake in the overall population.
≥ 300	Excessive	Risk of unfavorable health consequences (iodine induced hyperthyroidism, autoimmune thyroid diseases)

- **Clinical examination of Goiter:**

Training and survey technique:

The current study incorporated the World Health Organization grading system as per the amended guidelines under NIDDCP[3].Thyroid palpation, a clinical method, was conducted by an examiner while the child was seated with the neck held in a normal position. Goiter indication was categorized as follows:(i) Grade 0 - not visible, not palpable, (ii) Grade 1 - palpable but not visible, and (iii) Grade 2 - palpable and visible, in accordance with the WHO/UNICEF/ICCIDD guidelines[18] depicted in Table-4.

Table-4: Simplified classification of goiter by palpation

Grade 0	No visible goitre or palpable
Grade 1	A goitre that is palpable but not visible When the neck is in its usual position (i.e, thyroid is not visibly enlarged) Thyroid nodules in a thyroid which is otherwise not enlarged fall into this category.
Grade 2	A visible swelling in the neck that is apparent when the neck is in its typical position, indicative of an enlarged thyroid upon palpation.

- **Salts sample:**
  According to the provided guidelines, salt samples were collected and assessed from all children aged 6-12 years during the survey to examine the prevalence of goiter in each cluster. These samples were qualitatively evaluated using the MIB kit recommended by UNICEF, and the concentration of iodine was recorded as 0, <15, and >15 ppm[19]. In this method, the analysis of iodine content in salt is conducted using a standard starch solution provided in the Spot Testing Kit (STK). This method has been recommended for the quantitative assessment of iodine presence in salt.

- **Data analysis:**

  Epi Data Entry 3.1 was used to prepare data sheets foe minimising data entry errors. Data was analysed using professional statistical package EPI Info 7.0 version for windows. Descriptive data represented as mean ±for numeric variables and proportions for categorical variables.

RESULT

Table-5: Median Urinary Iodine Excretion (UIC) level in Bhuj City of Kachchh district (µg/L)

Median Urinary Iodine Excretion (UIC) level in Bhuj of Kutch district(µg/L)	
Talukas	Median UIC (µg//L)
Bhuj	166.93
Median	166.93

Table-6: Urinary iodine excretion level in rural areas of Bhuj city of Kachchh district

Taluka	n	Urinary Iodine excretion(UIE)	
		>100 µg/L (%)	<100 µg/L (%)
Bhuj	350	350 (100)	0 (0)
TOTAL	350	350(100)	0(0)

Table-7: Taluka specific assessment of iodine in salt samples by spot kit at retail trader levels in Bhuj rural area of Kachchh district

Taluka	No .of Salt Sample tested	Iodization of salt in ppm			
		0 ppm	<15 ppm	>15 ppm	% of salt samples adequately iodized
Bhuj	350	0	5	345	98.57%
Total	350	0	1.42 %	98.57 %	

Table-8: Goitre Prevalence Rate in Bhuj Talukas of Kachchh District

Taluka	Children examined	Goiter Cases	Prevalence Rates (%)
Bhuj	350	0	0
Total	350	0	0

Table-9: Goitre prevalence rate among males and females in Bhuj Talukas of Kachchh District

Taluka	Sex	Grade=G*					Prevalence rate (%)
		G 0	G 1	G 2	Total Case	Total children examined	
Bhuj	M	0	0	0	0	175	0
	F	0	0	0	0	175	0
Total		0	0	0	0	350	0

DISCUSSION

As per epidemiological criteria for assessing iodine nutrition based on median urinary iodine concentration of school aged children (mentioned in Table -3), iodine status should be considered optimum when the concentration of median urine iodine in children is found between 100-199 µg//L which indicate the proper iodine intake. In this research study, the median UIC is found 166.93 µg//L which is found in the optimal range.

In the present study, salts sample were collected and tested of all the children of 6-12 years during the survey and examined for the prevalence of goitre.

In the present study, 98.57 % of salt samples had iodine levels more than 15 ppm and the iodine content in salt samples less than 15 ppm was only about 1.42% indicating the salt samples at household contain adequate levels of iodine.

In present study, out of 350 samples, Bhuj has been reported 0% prevalence rate (depicted in Table-8).

CONCLUSIONS

The region's median concentration of iodine in urine measured 166.93 μg/L, suggesting the absence of biochemical iodine deficiency. Analysis of salt samples revealed that approximately 98.57% contained iodine levels exceeding 15 ppm, while only about 1.42% had iodine content below this threshold. This indicates that household salt samples possess adequate iodine levels, aligning with criteria for monitoring progress in eradicating iodine deficiency disorders as a public health concern. The results of the present study indicate that Periodic surveys are essential to assess changes in the magnitude of iodine deficiency disorders (IDD) in response to the impact of iodized salt interventions. Additionally, it is crucial to identify factors that can strengthen the National Iodine Deficiency Disorders Control Program.

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