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Research Paper

Iodine Nutritional Status of Children of age between 6-12 years in Kutch district, Gujarat, India

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ABSTRACT
Aim: *Iodine deficiency disorder (IDD) is of vital public health issue in India. The deficiency of iodine has its effects on the developing brain, a preventable cause of brain damage and development in growing children. The objective of this study is to evaluate iodine deficiency disorder and deficiency status in a selected population by estimating urinary iodine excretion level, and nutritional intake of iodine and assess the magnitude of nutritional deficiency disease among school children by clinical observation.*
Materials and Methods*: This is a cross-sectional study of school children of age group 6-12 years. 30 clusters were selected by cluster sampling technique and 70 samples from one cluster havebeen taken and thus total sample size of 2100 has been concluded. The urinary iodine level is estimated by using the Sandell-Kolthoff reaction and the iodine content in edible salt samples was estimated bythe MBI kit.*
Results: *The median urinary iodine level was found adequate at 151.45 µg/L . 97.07% samples were found with urinary iodine excretion level of 100 µg/L or more while the prevalence has been found at 2.90% which has been in the epidemiological criteria based on the WHO/UNICEF/ICCIDD guidelines. 91.67 % of salt samples had iodine levels 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 household contain adequate levels of iodine. The goiter prevalence rate was found 0.66% which was done by assessing general clinical observation by palpation method.*
Conclusion: *The present study showed no biochemical iodine deficiency in the studied region as per WHO/UNICEF/ICCIDD guidelines. Despite adequate consumption of iodine at the household level, the existing micro goiter prevalence among school children may possible by some other environmental factors in the population. Hence, it is suggested to have a periodic assessment to assess the change in the proportion of the iodine deficiency disorder.*
Keywords: *Iodine deficiency disorders, school-going children, iodized salts, UIE (urine iodine excretion)*

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I. INTRODUCTION

Iodine is an essential micronutrient used by the body to make thyroid hormones. Iodine is present as iodide (I^-) in body fluids. In the thyroid gland, through the action of thyroid peroxidize, I^- is oxidized and incorporated into tyrosine residues of thyroglobulin forming mono- and di-iodotyrosine. These are then coupled to produce T3 and T4 hormones for normal human growth and mental development with an average requirement of 100-150 µg/day.

Recommended iodine intake as per United Nations Children's Fund (UNICEF), International Council for the Control of Iodine Deficiency Disorders (ICCIDD) Global Network now known as the Iodine Global Network, and World Health Organization (WHO), daily intake of iodine should be as follows: 90µg for pre-

school children (0 to 59 months); 120 µg for school children (6 to 12 years); 150 µg for adolescents (above 12 years) and adults; 250 µg for pregnant and lactating women[2,3].

Inadequate or poor intake of iodine and falls below recommended levels, the thyroid gland may no longer be able to synthesize sufficient amounts of thyroid hormone, and this resultsin a low level of thyroid hormones in the blood affecting people of all ages of both sexes and different socioeconomic classes. The disorders caused due to deficiency of nutritional iodine in the food or diet are called iodine deficiency disorders (IDDs)[4,5,6]. IDD has been identified as a global public health problem and the main cause of preventable mental retardation[7]. The most important consequences of iodine deficiency are permanent brain damage in the fetus and infant and retarded psychomotor development, which give rise to goiter in the child[8]. Over the past, deficiency of iodine causes a range of disorders like cretinism, hypothyroidism, goiter, brain damage, stillbirth, mental retardation, and psychomotor defects.[9]Excretion of iodine in urine is a well valid and recognized, cost-effective, and easily available indicator for the status of iodine since the majority of iodine absorbed by the body is excreted in the urine[10,11]. hence it is accepted as a sensitive parameter of the current intake of iodine and would reflect the latest changes in the status of iodine[11,12]. To know the current status of iodine nutrition, the present study was conducted to detect the prevalence of IDD by estimating urinary iodine excretion level, and nutritional intake of iodine and assess the magnitude of nutritional deficiency disease among school children by clinical observation in the Kutch district.

II. MATERIALS AND METHODS

Selection of Study Area and Population

This study is done in the Kutch district of Gujarat. The main source of water is rain and all type of routine vegetables are available and consumed by the people. The Kutch district has a total populations of 2, 092371, (male: 1,096,737 and females: 995,634).The rural population is 1,363,836 and the urban population is 728,535. This district has 10 Taluka and the total number of Villages is 924 (877 inhabited villages and 47 uninhabited villages). Kutch has the lowest density Population per sq. km of 46 in the state and has the longest coastline of about 406 km.as per the 2011 census [13] Low goiter prevalence was reported after the national program was implemented in the district in 1992 as per the recommendation of WHO/UNICEF/ICCIDD[14]. As per guidelines provided by State Nutrition Cell, Ministry of Health & Family Welfare, Government of Gujarat[1], a cross-sectional study of children aged 6-12 years age groups studying in 1st to 7th standard in primary schools of rural areas from both sexes five boys and five girls were selected randomly on the day of visit for examination.

Sampling method

The cluster sampling technique was used for the selection of villages as per guidelines. A list of villages of alltalukas of the Kutch district was obtained from *ZilaPanchayat*, Office of District Health Office (DHO).2100 total sample size has been taken by selecting 30 clusters and from each cluster 70 sample has been selected. Only rural areas were included and confined and the urban population was excluded in calculating the cumulative population.

Training and survey technique

School children were clinically examined for the enlargement of the thyroid by palpation method endorsed by the current survey including the WHO grading system as per the revised guidelines under NIDDCP/WHO/UNICEF/ICCIDD[15]. The child was analyzed by the examiner in a sitting position with the neck in a 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 [16].

Iodine in Urine

Ten samples of urine were obtained from students randomly of standard 1st to 7th (5 boys and 5 girls from each standard respectively), hence 70 samples per cluster, so a total of 2100 samples were selected for urine iodine estimation, maintaining an equal ratio for both gender.These samples were collected in labeled plastic bottles (50 ml capacity) with a screw cap which is labeled with name, age, sex, and the date and after collection of urine from them, a few drops of toluene as a preservative were added to each urine sample to inhibit bacterial growth and to minimize bad odor.Median iodine concentration of >100 µg/L defines a population with no iodine deficiency, i.e. at least 50 percent of the samples should be above 100µg/L according to the epidemiological criteria for assessing iodine nutrition based on median urinary iodine concentration in school-aged children [15, 17](dipcted in Table-1). The most practical and straightforward method involves mild acid digestion and timed colorimetric procedures. “Method A”, this method is one of the classical methods of determining iodine status based on the Sandell-Kolthoff reaction after digesting the urine with ammonium persulfate under mild conditions. Iodine is the catalyst in the reduction of ceric ammonium sulfate to the cerous

form, which changes the color from yellow to colorless. The actual iodine concentration is detected by color disappearance, which is measured by the use of a spectrophotometer. Normally, Method A is considered a good method because of its simplicity, precision, and safety along with a low start-up cost. Color form of optical density (OD), was subsequently measured by constructing a standard curve on graph paper by plotting iodine concentration in µg/L.

Iodine in Salt

As per the guidelines provided, salt samples were collected and tested of all the children of 6-12 years during the survey and examined for prevalence of goiter in each cluster. These samples were tested qualitatively on the spot testing kit (MIB kit) recommended by UNICEF and iodine concentration was recorded as 0, <15 &>15 ppm[18]. In this method, estimation of the iodine content of salt is done with the help of a standard starch solution provided in the Spot Testing Kit (STK). This method has been advocated as a method for the quantitative estimation of iodine in salt.

Observation and Results

Total 2100 urine samples were examined and obtained data were analyzed with the help of WHO/UNICEF/ICCIDD guidelines [19]as given in Table-2.

III. RESULTS

The present cross-sectional study assessed the iodine status of 6-12 years school-going children (N=2100), by estimating urinary iodine using the Sandell-Kolthoff reaction. The median urinary iodine level was found adequate at 151.45 µg/L (given in Table-3) . 97.07% samples were found with urinary iodine excretion level of 100 µg/L or more while the prevalence has been found at 2.90% which has been in the epidemiological criteria based on the WHO/UNICEF/ICCIDD guidelines (dipcted in Table-4). 91.67 % of salt samples had iodine levels 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 household contain adequate levels of iodine (given in Table-5). The goiter prevalence rate was found 0.66% which was done by assessing general clinical observation by palpation method (dipcted in Table-6).

IV. DISCUSSION

The most widely accepted marker for the evaluation ofthe severity of IDD is the prevalence of endemic goiter in school-going children WHO/UNICEF/ICCIDD[20]and based on 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-7) 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 was conducted from another district of Gujarat which indicated the prevalence of goiter was 20.5% [21] which was found high compared to the present study. In Gujarat, in January 2001, the ban on the sale of non-iodized salts was withdrawn and in November 2005,the central government of India issued a notification to ban the sale of non-iodized salts in the entire country. [23] Chandra, et al [22]outlined in their study more than 95% of the population consumes salts at an adequate level, while Kamath, et al. [24] and Biswas et al, [25] reported only 50% of community-consuming salts at an adequate level. Mishra, et al.[21]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 [26](depicted in Table-1) and in the present study 91.67 % of salt samples had more than 15ppm iodine present. 0.19% of them showed a level of <50 µg//L for UIE, While 99.80% of Samples showed a level of ≥50 µg/L in which seven talukas had 100% excretion more than 50% (dipcted in Table-8). The maximum urinary iodine excretion was seen in 9 year old age group i.e 98.34% (dipcted in Table-9)and the adequate range i.e between 100-199 µg/L as per the guidelines of urinary iodine excretion was 92.07% fall in 10 year age group of children (depicted in Table-10).Hence the present study indicates a still need to continue an adequate effort of supplying iodized salts to the region and have a periodic assessment of iodine status.

V. CONCLUSION

The present study showed no biochemical iodine deficiency in the studied region as per WHO/UNICEF/ICCIDD guidelines. Despite adequate consumption of iodine at the household level, the existing micro goiter prevalence among school children may possible by some other environmental factors in the population. Hence, it is suggested to have a periodic assessment to assess the change in the proportion of the iodine deficiency disorder.

Ethical consideration and informed patient consent

Ethical permission was obtained from the Institutional Ethics Committee (IEC) of Gujarat Adani Institute of Medical Sciences and GK General Hospital, Bhuj – Kachchh, Gujarat, India.

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Nil

Conflicts of interest

There are no conflicts of interest.

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TABLES

Table -1: Criteria for monitoring progress towards eliminating IDD as a public health problem[16].

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

Table – 2: Epidemiological criteria based on the WHO/UNICEF/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 autoimmune thyroid disease

Table - 3: 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- 4: Out of the total 2100 urine samples collected,97.07% samples were found with urinary iodine excretion (UIE) level of 100µg//L or more, while 2.9% samples showed less than 100µg//L.

Distribution of Urinary Iodine (n = 2100)		
Urinary Iodine (µg/L)	**n**	**%**
< 20	0	0
20-49	4	0.19
50-99	57	2.71
100-199	1881	89.57
≥ 200	158	7.50

Table - 5: The iodine content of 2100 salt samples was assessed by the MBI kit method provided by UNICEF, out of which 91.67 % of salt samples showed 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
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: Goitre Prevalence Rate in Various Talukas of Kutch 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
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 - 7: IDD prevalence indicators in school children and criteria for a significant public health problem [27].

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

Table – 8: In this0.19% of them showed a level of <50 µg//L for UIE, While 99.80% of 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)
TOTAL	**2100**	**2096 (99.80)**	**4 (0.19)**

Table - 9: 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)
11	390 (94.66)	22 (5.33)
12	289 (94.75)	16 (5.24)
Total	**2033 (96.80)**	**67 (3.19)**

Table - 10: Age-wise analysis of Urinary Iodine excretion (n=2100)

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