ORIGINAL ARTICLE

A study on estimate of Iodine Deficiency Disorders and adequacy of Iodized Salt Consumption in Begusarai district of Bihar, India

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Abstract	Introduction	Methodology	Results	Conclusion	References	Citation	Tables / Figures

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Abstract

Background: Iodine Deficiency Disorder is major public health problem causing increased perinatal mortality, mental retardation and goiter and all these morbidities are preventable. Most effective and inexpensive mode to prevent IDD is consumption of iodized salt. **Objectives**: To estimate the proportion of households using adequately iodized salt in Begusarai district, to assess the knowledge of households on consumption and storage of salt and to estimate Total Goitre Rate (TGR). **Material and Methods**: Community- based cross sectional study carried out on 412 household from 30 cluster in Begusarai district using cluster sampling technique. Children (6-12 years) were examined clinically for goitre status and sample of household salt was collected for testing iodine content. Iodine content estimation was done both quantitatively by titration and qualitatively by MBI kit. Statistical analysis was performed using SPSS version 22. **Result**: The respondents were mainly female (92.8%) of mean age 34 years. Three- fifth (61.6%) participants used packaged crushed salt for cooking purpose, followed by packaged crystal (30.5%). Only 12.1 % of the respondents gave affirmative answer for presence of label and logo. Storage of salt in container with lid was 78.5%. The proportion of household using adequately iodized salt was 78%. The sensitivity MBI kit was 61% and the Total goiter rate was 9.3%. **Conclusion**: The Begusarai district falls in mild public health problem for IDD as TGR is more than 5% and even after many decades of effort towards achieving an adequately salt iodization of more than 90%, it is 79% only.

Keywords

Goiter; Iodine; Deficiency

Introduction

Iodine Deficiency Disorder (IDD) is a major public health problem particularly for pregnant women and young children. The most devastating outcomes are increased perinatal mortality and mental retardation.(1) Iodine deficiency may lead to still births, abortion, congenital anomalies, increased infant mortality, mental deficiency, deaf, mutism, squint, dwarfism and goitre. The most effective and inexpensive mode recognized to prevent the broad spectrum of IDD is consumption of iodized salt daily.(2) However, globally, India has the largest number of children vulnerable to iodine-deficiency. Of the 325 districts surveyed in India, 263 districts are IDD-endemic, i.e. the prevalence of IDD is above 10 per cent in the population.(3) Government of India launched National Goitre Control Programme (NGCP) in 1962 which was later renamed as the National Iodine Deficiency Disorders Control Programme (NIDDCP). The goal of the program was to reduce the prevalence of IDDs to below 10 percent in endemic districts of the country by the year 2000. In order to eliminate iodine deficiency in India and to comply with the international goal of universal iodization, compulsory iodization of all table salt was introduced in 1983 and sale of non-iodate salt for direct human consumption was banned in the entire country in 2006.(2,4)

Tracking progress towards elimination of iodine deficiency disorders (IDD) is essential to accelerate as well as ensure sustainability of the progress made towards IDD elimination. Sound techniques are needed in order to reliably measure indicators of IDD, and these techniques must be applied using suitable epidemiological methods and indicators, suitable target populations, and geographical areas. The WHO/UNICEF/ICCIDD criteria are most commonly used for the conduct of IDD surveys.(5,6) It uses 3 indicators namely presence of goitre, estimates of Urinary Iodine Estimation(UIE), & iodization of salt to provide valid estimates for the district. The main objective of the study was to estimate prevalence of goitre and iodine content in salt used by households.

Aims & Objectives

1. To estimate prevalence of total goiter rate and iodine content in salt used by households
2. To assess the knowledge of households regarding iodized salt usage and iodine deficiency disorders

Material & Methods

Study type-The study was a community based cross sectional study.

Study area: conducted in Begusarai district of Bihar for a period of three months.

Study population: The study population was School going children (6-12 years), households (Head of family or any other responsible person present at time of visit) and retail shop owners.

Sample size: The sample size was calculated using the formula: $N = (Z\alpha)2\ P\ Q/L2$, Where Zα for 5% α error is 1.96, so $(Z\alpha)2 = 4$ approximately. P = Percentage of household using adequate salt (based on findings of a Panda et al 66%) . $Q = 1 – P = 0.34$, L = Allowable error = 10% of P = 6.6. The sample size came out to 206. The cluster sampling technique was adopted for selection of village as a cluster. To allow for the design effect a multiplying factor of 2 was used and hence the sample size came to be 412 children ages 6-12 years.

Strategy of Data collection: A total of 419 households were visited against a minimum sample size calculated 412.The two-stage cluster sampling was performed. Block wise Village list was obtained from the Government of Bihar for preparing a sampling frame. The selection of village was done by using PPS (Probability proportional to size) assuming village as cluster and a total of 30 clusters was selected randomly from the sampling frame. From each selected village, 14 children in 14 household was selected randomly from each cluster. All children were examined clinically for their goitre status and graded as grade 0,1 and 2 as per standard protocol. The sample of household salt collected for testing the level of Iodine. Only one child per household was examined to cover the maximum number of households in the village. Salt samples were collected from all the households and at one retailer shop from each cluster visited for estimation of iodine content. The clusters where there is more than one retail-shop, a maximum of 5 were selected randomly. In the households, the type of salt that is used, information on the quantity purchased at a time, price, method of storage, and other knowledge regarding iodized salt was collected using a semi structured questionnaire. The information on procurement, storage, re-packing and pricing of salt was collected from the retail shops using an interview schedule. In addition, storage and packing was also be observed.

Consent: Informed written consent was obtained from the adult study participants.

Testing of Salt samples: The salt samples were tested by iodometric titration in state USI lab which is situated in Patna Medical college. The samples were also tested by MBI KITS for rapid field test method at household level and finding was communicated to the head of the household. Training and Orientation Workshop was conducted to orient the field staff and impart practical training in goiter examination and others details of survey methodology.

Ethical clearance: The study was approved by the Institute Ethical committee of AIIMS Patna

As per WHO/UNICEF/ICCIDD criteria, Urinary Iodine Excretion could not be carried out due to lack of logistics and funds for transporting urine samples.

The district is declared as endemic district if the total goitre rate (TGR) is above 5% in the children of the age group 6-12 year surveyed. Severity of Public Health is graded as: Mild (TGR 5-19.9%); moderate (TGR 20-29.9%) and severe (TGR>30%). Iodine level of salt samples should be > 15 ppm at the consumer/ household level. Proportion of households consuming adequately iodized salt (>15ppm) should be> 90%. (5)

Statistical analysis: The statistical analysis was done using SPSS version 22(IBM). The data was analyzed in a descriptive manner and result was expressed as proportion. The chi square test was performed to test the difference in the proportion and a p value less than 0.05 was considered significant. The validity (sensitivity and specificity) of MBI kit was assessed using the iodometric titration method as gold standard.

Results

Socio- demographic features:

A house to house survey was conducted in Begusarai district. The respondents were mainly female participants (92.8%) of mean age 34.2 years. Less than two- fifth of the participants were literate (38.4%). Female members of the household are mainly concerned with preparation of the meal. [Table-1].

Purchase and storage of iodised salt in the household:

The salt sample was collected from all the 419 study participants and were enquired about purchase and storage of salt. The response thus obtained was mutually exclusive. About three- fifth (61.6%) participants used packaged crushed salt for cooking purpose, followed by packaged crystal (30.5%). Small proportion of participants used loose crystal (2.2%) and loose powered salt (1.7%). Approximately 4.1 % participants were unaware of the type of salt used at their home. The study participants were asked for the presence of logo and the label as iodised salt on the salt packet and about three -fourth of them were unaware of it. The affirmative answer for both label and logo were given by only 12.1% of the respondents. The salt is mainly procured from retail shop.

About three- fourth of the study participants (78.5%) stored the salt in the container with lid, which is a good practice and only about 6% stored it without lid. While 13.3% participants stored the salt in its packet itself. [Table-2]

Knowledge of household on Iodised salt and Iodine deficiency disorder:

The respondents were also asked for their knowledge on Iodine deficiency disorder and only one- fifth(21.5%) had heard about it. On being asked about their perception about importance of iodized salt, about 71.4% respondents did not provide any response. One sixth (16%) had knowledge that it prevents goiter. However, only 3% of the participants knew about its role in improving child intelligence, pregnancy outcome and health of infant and children and only a few participants were aware of its role in child growth (1.7%) and brain development (0.7%).

The main source of the knowledge about iodised salt for the respondents were health personnel's (8.1%) and advertisements on television (8.8%). The other source of information was through friends/ family members (5.3%), school and colleges (4.8%), radio (4.8%), newspaper (2.6%) and retailer shops (1.9%).

For majority of the respondents, the perception for good quality of salt was good taste (50.4%) and white color (43.7%). Other criteria were packaged/branded (22.2%), powdered (8.8%), attractive looking (7.2%), free flow (6.7%), granular (5.5%) and iodised salt (4.5%). The responses were mutually exclusive. [Table-3]

Prevalence of Iodine Deficiency Disorder:

Thyroid palpation was carried out for 6- 12 years of children in the selected household. The total goiter rate was 9.3%.[Table-4]

Iodine content in household salt:

The salt samples collected from all the households were subjected for iodine estimation by both

titration method and MBI test kit. 79% salt samples were found to be adequately iodised.

Zero PPM was found on MBI kit for 59 salt samples, for which repeat testing was conducted and then 00 PPM was found in four samples only. Mean iodine content in salt assessed by iodometric titration and MBI kit was not comparable (p 0.0008). [Table-5]

The Iodine content of salt samples (N= 413) was calculated by Titration method and it was compared with result of Rapid field test. The salt samples were tested twice with MBI kit and result of second test was considered final. The iodine content of >15 ppm was taken as positive and <= 15 ppm was taken as negative. Thus, 200 samples tested positive with both titration and RFT while 52 samples had iodine content <= 15 ppm by both methods. [Table- 6]

The sensitivity and specificity of the MBI kit against titration method was found to approximately 60%. The sensitivity and specificity of MBI kit were calculated taking titration method as gold standard [Table-7]

Discussion

Salt iodization was started as an attempt to eliminate iodine deficiency disorder. Of the different Iodine deficiency disorder outcome indicators recommended by WHO, palpation of thyroid in school -age children and monitoring of salt iodine content at the community level was carried out in our survey. According to the criteria, total goiter rate is used to calculate IDD prevalence and the rate between 5- 19.9% is considered mild, 20.0- 29.9% moderate and >30.0% severe public health problem.(6)

Most of the respondents in our study were females who are mainly engaged with preparation of meals in our setting. Thus, this survey was used as a platform to create awareness among households about iodised salt and iodine deficiency disorder.

In our survey, the overall prevalence of goitre was found to be 9.3%. Thus, the district has the total goitre rate, which indicates that the public health problem is mild. However, the surveys done in 2010 in Udupi district reports overall prevalence to be 19.8%. and 23.35% in various talukas of Panchmahal district of Gujrat.(7,8)

Unlike the above findings, the total goitre rate reported from Jamnagar is only 4.8%.(9)

Adequacy of salt iodization programme is assessed by monitoring salt iodine content at consumer level (household) which should be >90%. In the survey, about four- fifth of the households were using adequately iodized salt. This finding corroborates with studies done in Jamnagar (81.9%) (9) and Kangra (83.5%).(10) While the study done in Narmada district of Gujrat reported that, 93.7% households were using adequately iodized salt.(11)

Adequacy of iodised salt also depends upon the storage and keeping quality of salt, which is further influenced by the knowledge of the household. Thus, the households were enquired for the purchase, storage and usage of iodised salt. Studies have shown that the concentration of iodine content of refined salt is higher than crude salt. (12)

Loss of Iodine from the salt is enhanced at high humidity and unlimited access to air.(13) Three-fourth of the participants stored the salt in container with lid. Similar practice was observed to be followed by about 80% of respondents in Assam.(14)

Most of the respondents were ignorant towards iodine deficiency disorder and only a few of them knew about the role of iodised salt in preventing goiter. The invisible brain damage due to iodine deficiency was known to still a handful of respondents. These findings implicate that poor knowledge about iodised salt can be a limiting factor in achieving elimination target of iodine deficiency disorder. Although a large percentage of respondents were unaware of importance of iodized salt but more than in our study, had heard about iodine deficiency disorder.(15) This difference in lack of knowledge may be attributed to low literacy rate in the state.

However, a study done in Ghana reports remarkable improvement in knowledge with continuing education and communication in local dialects.(16) Thus, intensified education and communication in local dialects should be targeted in these pockets for the sustainability of elimination programme.

The recommended and reliable method for iodine estimation of salt is titration method, but it requires man- power and laboratory set- up. Spot testing kits are being advocated to be used in field as it is simple, easy to use and has high sensitivity (96.5%).(17) However, in our study the sensitivity of MBI kit was calculated to be only 61%.

Conclusion

In spite of the continuous awareness generated through print as well as electronic media about iodised salt in community the use of iodised salt still remains below 90%. The sensitivity of the kit was also

low, thus, efforts should be made to increase the validity of the kit, so that it can be utilized in field for qualitative assessment of iodised salt.

Recommendation

The knowledge and awareness of the respondents about the storage and usage of iodised salt was unsatisfactory and this was reflected in 79% of households using inadequately iodised salt. The sustainability of NIDDCP depends largely on the adequacy of iodised salt used at household level. Thus, effective IEC and periodic monitoring of iodised salt is recommended.

Limitation of the study

The urinary iodine estimation could not be performed due to lack of funds and logistics.

Relevance of the study

It has been more than two decades of NIDDCP programme, but goiter still remains public health problem. Periodic surveys to assess iodine deficiency disorders and monitoring of salt samples to assess the magnitude of iodine deficiency disorders is warranted and this community- based survey was undertaken to uncover various factors associated with knowledge of households regarding proper storage and usage of iodised salt. In addition this study attempted to measure the validity of MBI kits.

Authors Contribution

PK: Substantial contribution to conception and design, acquisition of data, analysis and interpretation, revising the article for intellectual content. NA: Substantial contribution to conception and design, acquisition of data, analysis and interpretation, revising the article for intellectual content, Final approval of the version to be submitted. AR: Substantial contribution to conception and design, acquisition of data, analysis and interpretation, revising the article for intellectual content. PV: Analysis and interpretation of data, drafting the article. SKN: Analysis and interpretation of data, drafting the article. SP: Substantial contribution to conception and design, revising the article for intellectual content. CM: Substantial contribution to conception and design, acquisition of data, analysis and interpretation, revising the article for intellectual content.

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Tables

TABLE 1 SOCIO- DEMOGRAPHIC CHARACTERISTICS OF HOUSEHOLDS [N= 419]

Demographic characteristics	No.	Proportion
	(n)	(%)
Gender		
Female	389	92.8
Male	30	7.2
Religion		
Hindu	381	90.9
Muslim	29	6.9
Others	09	2.2
Age group		
[Mean ± SD: 34.15 + 10.27]		
15- 49 years	380	90.7
> 50 years	39	9.3
Literacy		
Illiterate	253	61.6
Literate	158	38.4

TABLE 2 DISTRIBUTION OF HOUSEHOLDS BASED ON STORAGE OF IODIZED SALT [N=419]

Variables	Number	Proportion [%]
Type of salt used for cooking in house:		
Packaged Crushed	258	61.6
Packaged Crystal	128	30.5
Don't know	17	4.1
Loose Crystal	09	2.2
Loose Powdered	07	1.7
Is the salt used to cook meals in the household is labelled as iodized?		
Don't know	297	70.9
Labelled as Iodised	66	15.8
Label and logo both present	51	12.1
No label, no logo	05	1.2
Source of procurement of salt:		
General store	391	93.3
Local market	16	3.8
PDS shop	10	2.4
Vendor	00	0.0
Storage of salt:		

Container with lid	329	78.5
Salt packet	56	13.3
Container without lid	25	6.0
Don't know	07	1.7
In sacks/ bags	02	0.5

TABLE 3 KNOWLEDGE AND PRACTICE AMONG HOUSEHOLDS ABOUT IODISED SALT [N=419]

Response to knowledge- based questions	Frequency	Proportion (%)
Ever heard of Iodine deficiency ever	90	21.5
Perception about role of Iodine:*		
Prevents goiter	66	15.8
Improves child intelligence	15	3.6
Improves pregnancy outcomes	13	3.1
Improves health in infants and children	11	2.6
Improves Child growth	07	1.7
Improves health in adolescents and adults	05	1.2
Improves brain development	03	0.7
Perception about the most effective way to prevent iodine deficiency		
Don't know	366	87.4
Use of Iodised salt	53	12.7
Source of knowledge about iodised salt		
Don't know	267	63.7
TV	37	8.8
Health Personnel	34	8.1
Friends/ Family	22	5.3
Radio	20	4.8
School/ College	20	4.8
Newspaper/ Magazine	11	2.6
Retailer	08	1.9
Perception about characteristics of good quality of salt		
Good taste	211	50.36
Looks white	183	43.7
Packaged/ Branded	93	22.2
Powdered	37	8.83
Looks attractive	30	7.16
Free flow/ refined	28	6.68
Crystal/ granular	23	5.49
Less moisture contents	22	5.25
Iodised salt	24	4.53
Loose/ Unbranded	5	1.19
Mutually exclusive		

TABLE 4 DISTRIBUTION OF GRADE OF GOITER OF STUDY DISTRICT [N=419]

Grade Of Goiter	No. (n)	Proportion (%)
Grade "0"	380	90.7
Grade"1"	36	8.6
Grade "2"	03	0.7
Total Goiter (1+ 2)	39	9.3

TABLE 5 COMPARISON OF SALT IODINE CONTENT BY IODOMETRIC TITRATION AND RAPID TEST KIT METHODS

Salt Iodine content	Mean + SD	0 PPM	1- 15 PPM	>15 PPM	p- value
		n, (%)	n, (%)	n, (%)	
Titration (n= 418)	18.72 + 5.64	00 (00)	88 (21.0)	330 (79.0)	0.0008
Rapid Field Test (n=414)	17.04 + 9.06	59 (14.3)	142 (34.3)	213 (51.4)	
Repeat Rapid Field Test (n= 414)	16.98 + 8.89	04 (1.0)	174 (42.0)	236 (57.0)	

TABLE 6 COMPARISON OF RESULTS OF TITRATION AND RAPID FIELD TEST [N= 413]

		Titration		
Rapid Field Test		>15*	<= 15*	Total
	> 15*	200	36	236
	<= 15*	125	52	177
		325	88	413
* > 15 PPM is taken as positive and <= 15 PPM is taken as Negative				

TABLE 7 VALIDATION OF THE IODINE SPOT-TESTING KIT AS A QUALITATIVE METHOD[N=413]

Validity Result	(95% confidence interval)	
Iodine adequate versus Iodine Inadequate		
Sensitivity	61.5%	(56.0- 66.9)
Specificity	59.1%	(48.1- 69.5)
PPV	84.7%	(79.5- 89.1)
NPV	29.4%	(22.8- 36.7)