Original Article

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On the Road of Universal Salt Iodization: The prevalence of Iodine Deficiency Disorder Among School going Children in Damoh District, Madhya Pradesh

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ABSTRACT

Background: With Universal Salt Iodization, district-wise monitoring of Iodine deficiency disorders (IDDs) along with potential toxic effects of excess Iodine intake is essential. This study was conducted with the objective of estimating the prevalence of IDD and prevalence of house-hold consuming adequate iodine in salt at consumer level, in Damoh district, Madhya Pradesh in 2016.

Methods: The cross-sectional study with cluster sampling was conducted, among school-going children (6-12 years of age). Overall, 30 schools (clusters) and 90 children from each cluster (30*90=2700) were selected to access Total Goiter rate (TGR). Total 540 salt samples and 270 urine samples were collected to estimate salt iodine content from their house-hold and Urine Iodine Excretion (UIE) respectively. Also, 150 households and 30 shopkeepers were interviewed to understand the awareness level for salt iodization.

Result: The TGR in Damoh was 2.08% with prevalence of Grade I&II as 1.67% and 0.41% respectively. The 26% of population had iodine deficiency, 28% had adequate iodine levels, while 46% population had either more than adequate or toxic level of Iodine. Besides, 72.4% of the population consume adequately iodized salt.

Conclusion: Damoh is no more endemic for IDD. However, we recommend monitoring is required to assess IDD as well Iodine-induced hyperthyroidism in future.

Keywords: *Endemic Goiter, Iodized Salt, Hyperthyroidism, Iodine Toxicity.*

Introduction

Iodine is an essential micronutrient required daily at 100-150 micrograms for normal human growth and development.[1] Its deficiency is the world's single greatest cause of preventable mental retardation. It is especially damaging during the early stages of pregnancy and in early childhood. In their most severe form, iodine deficiency disorders (IDD) include cretinism, stillbirth and miscarriage, and increase infant mortality.[2] Even mild deficiency of Iodine can lead to significant loss of cognitive abilities i.e.; about 13.5 intelligence quotient points at population level along with other symptoms such as goiter.[3] In addition to infringing on the rights of children, IDD results in a loss of economic productivity, social and cognitive development.[2] Majority of consequences of IDD are invisible and irreversible but at the same time preventable.[4]

Nearly 266 million school-aged children across 130 countries have insufficient iodine intake. IDD was found public health problem in 47 countries.[5] Worldwide every year approximately 38 million newborns in developing countries remain unprotected from the lifelong consequences of brain damage associated with IDD.[6] Traditionally the methods for assessment of iodine deficiency have been 'Goiter' which is only the "tip of iceberg" of this spectrum of problems. Since last one and half decade consensus has emerged to use median urinary iodine excretion (UIE), total goiter rate (TGR) and proportion of house-holds with adequately Iodized salts as assessment tools for monitoring and evaluation of IDD at community level.[7] Currently, 8 million neonates, 7.6 million infants, 36.5 million under five year children, 8.8 million pregnant female and overall 349.8 million population of India is at risk of IDD.[4,8,9]

According to National Iodine Deficiency disorder Control Programme (NIDDCP) of India, district level surveys are to be conducted in every district once every five years by rotation in the State using three indicators, viz. TGR, UIE and household level adequately iodized salt consumption. The target population recommended is school aged (6 to 12 years) children only.[4,10,11] As per the surveys, out of 390 districts across 29 States and 7 Union Territories, 333

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districts are endemic i.e. where the prevalence of IDDs (i.e. TGR>5%). Since last one and half decades studies from different parts of India has reported TGR from 2.4 to as high as 38.2% and UIE from 70 to 225 mcg/L[12–18]". The TGR was reported higher among female gender.[16,17]

Overall, the prevalence of IDD in Madhya Pradesh state was found 12%.[10] However, the studies from different parts of state have estimated TGR ranges from 2.4 to 21.3%, median UIE 109 mcg/l, 21% household with adequately Iodized salt and 8% salt samples were reported without Iodine. [12,17,18] The high TGR was reported from tribal districts.[12,18]

As per the revised guidelines of NIDDCP, Damoh district was previously enlisted as one of the fourteen endemic districts for goiter in Madhya Pradesh.[1] Further, no district wise survey was undertaken to find out IDD in the district since then. It is understood that IDD is still high in state. The district wise monitoring and evaluation of IDDs as well as potential toxic effects of excess Iodine intake in the population is essential. In this light, the present study was conducted with the objective to estimate the prevalence of IDD in Damoh district among school-going children in the age group of 6-12 years and to determine the prevalence of house-hold consuming adequate iodine in salt samples at consumer level in 2016.

Material and Methods:

Study Setting: Study was conducted at Damoh district of Madhya Pradesh which is predominately caters rural population. It is situated at 250 km east of state capital Bhopal. The district covers an area of 7306 km². It is divided into 7 tehsils and has 1229 villages. It caters a total population of 12, 64,219 with literacy rate of 69.73%. [8,19] The percentage of boys and girls, aged 6-17 years attending schools are 94.7% and 96.4% respectively.[19]

Study Population and Period: The study was conducted from May to June 2016 among school-going children aged 6-12 years, in Damoh district of Madhya Pradesh.

Study Design: It was a cross sectional study.

Sampling Method And Sample Size: *Clinical goiter survey:* A sample of 30 schools was selected from the district by cluster sampling technique, using the method of '*probability proportionate to size'* sampling in each school. A sample of 90 children (45 boys and 45 girls) of age group 6-12 years was selected from each school. Thus a total of 2700 (90X30) children were examined for goiter in the district.[11,20] The children identified from respective schools were clinically examined for goiter by technical persons specially trained for the survey.

Salt samples: Every 5th child, selected from the sample of 90 children in the earlier steps for goiter survey, was covered for collection of salt sample by visiting their corresponding houses. Therefore, 18 salt samples were collected from each cluster. A total of 540 (18X30) salt samples were collected for estimation of iodine level in the district. These salt samples were tested qualitatively on spot with MBI kit and iodine concentration was recorded.

Urine samples: On the spot urine samples were collected from every alternate child out of those 18 selected children in the previous step. Total nine urine samples were henceforth collected for estimation of UIE level from each school. A total of 270 (9X30) urine samples were collected for estimation of UIE in the district. Iodine concentration was determined by wet digestion method.

Qualitative phase: Total 150 households & 30 shopkeepers were interviewed with the help of pre-designed semi-structured interview guide to understand the knowledge and practices on iodized salt during house visit to collect the salt samples.

Data collection and Variables: Data was collected through structured, pretested questionnaire in local language i.e. Hindi. The information about independent were obtained by interview of child by visiting the selected schools. The information was validated during house-holds visit and during interview with shopkeepers regarding USI. The assessment of goiter and their grade was done through clinical examination by technical persons specially trained for the survey. On the spot urine sample was collected from selected child at school for assessment of UIE. The sample of salt was obtained for biochemical estimation of iodine by visiting the corresponding house of selected child.

Analysis and Statistics: Data was collected through paper-based proforma then enterd in Microsoft Office Excel 2010 and analyzed using STATA (version 12.1 STATA Corp., College Station, TX, USA). The key analytic outputs were presence of *Goiter (Grade I and II)*, house-hold with *'inadequate iodized salt'* and child with *'insufficient UIE'*. The UIE <200mcg/L was considered as 'insufficient Urine Iodine Excretion' and <15 ppm of Iodine in house-hold salt was considered as house-hold with 'inadequate iodized salt'.[10,20] The association with key analytic outputs were calculated using Odds ratio (OR) and 95% confidence intervals (CI). The STROBE guideline was used for reporting the quantitative component of the study.[21]

Ethics Approval: Ethics approval was obtained from the Institutional Ethics Committee of the All India Institute of Medical Sciences, Bhopal, India. The written consent

was obtained from children and ascent from their legal guardians after explaining them the purpose of study.

Results

A total of 2700 primary school children aged 6-12 years were examined for TGR. Overall, for Damoh district TGR was found 2.08% with prevalence of Grade I&II was 1.67% and 0.41% respectively. Among different blocks, TGR was highest in Bathiyagarh (2.6%) and lowest in Jabera (1.12%). The highest prevalence of grade-I Goiter was in Tendukhera block and grade-II was in Hatta block. **(Figure1)**

Out of total analyzed 270 urine samples the Median UIE level among the studied children was 175 mcg/L. On UIE level, the proportion of children found with *mild, moderate and severe iodine deficiency* was 17, 8 and 1% respectively. Total 28% children were with *Adequate* Iodine Nutrition. The proportion of children with *more than adequate Iodine intake* was 10% along with that 36% children found with *toxic level of iodine* in UIE estimation **(Figure2)**

The presence of Goiter (Grade I&II) was not found to statistically associated with any of socio-demographic factor.**(Table1)** Total 27.6% house-holds were consuming *inadequate Iodised salt* i.e. iodine content <15 ppm.The house-holds of male children had higher odds of *inadequate Iodised salt* in comparison to children of female gender**.** **(Table2)** The children of Muslim religion had higher odds of *insufficient UIE* in comparison to Hindu religion (OR 7.4[95%CI 2.77-19.87]). **(Table3)**

Out of 150 households interviewed were using packet salt. 117 (78%) families and 20 (66.7%) shopkeepers were aware about iodized salt. All 30 shopkeepers interviewed were selling packet salt.

Discussion

Damoh district was previously (October 2006) enlisted as one of endemic districts for IDD in Madhya Pradesh (MP) but the TGR in present study was found to be 2.08%, suggestive that it is no more an endemic for IDD as per the guideline of NIDDCP (i.e.TGR >5%).[1] This prevalence is concordance with the study from Jabalpur (2.4%) which is a neighboring district so it may be presumed that the socio-demographic and economic status of community may not be very different.[17] The Couple of studies from MP has reported high TGR almost a decade ago, these districts need surveys to reassess IDD and the impact of iodated salt after every 5 years.[10,12,18]

Approximately 26% population is having 'Iodine deficiency' but at the same time approximately 46% population has either 'more than adequate iodine intake' or 'toxic level of iodine' so, the challenge for the programme will be to increase the population with 'adequate iodine

Table 1: Socio-demographic determinants of children with Goiter in Damoh district, 2016.

Variable		Goiter		OR [95%CI]
		Present	Absent	
Age (In years)	6-9	31	1652	Ref
	10-12	25	992	1.3[0.79-2.29]
Sex	Male	25	1325	Ref
	Female	31	1319	1.2[0.73-2.12]
Religion	Hindu	55	2613	Ref
	Muslim	1	31	1.5[0.20-11.42]
Caste	General	4	111	Ref
	OBC*	40	1705	0.6[0.22-1.85]
	SC^	10	624	0.6[0.23-1.85]
	ST#	2	204	0.3[0.05-1.50]
Block	Bathiyagarh	14	526	1.3[0.54-3.36]
	Damoh (Rural)	7	353	Ref
	Hatta	11	439	1.2[0.48-3.29]
	Jabera	2	178	0.6[0.11-2.76]
	Patera	13	617	1.1[0.42-2.69]
	Pathariya	5	355	0.7[0.22-2.26]
	Tendukhera	4	176	1.1[0.33-3.96]

Footnote: OBC* Other backward caste, SC^ Schedule Caste, ST# Schedule Tribe, OR¥ Odds ratio, Ref Reference

Table 2: Socio-demographic determinants of children of Household with adequately Iodidised salt in Damoh district, 2016.

Variable		Household with Iodidised salt		OR [95%CI]
		Inadequate	Adequate	
Age (In years)	6-9	265	61	Ref
	10-12	167	47	0.8[0.53-1.25]
Sex	Male	215	56	Ref
	Female	52	217	0.1[0.04-0.09]
Religion	Hindu	423	108	Ref
	Muslim	9	0	-
Caste	General	20	4	Ref
	OBC*	297	70	0.8[0.28-2.56]
	SC^	87	27	0.64[0.20-2.05]
	ST#	28	7	0.8[0.20-3.10]
Block	Bathiyagarh	68	40	0.2[0.12-0.59]
	Damoh (Rural)	62	10	Ref
	Hatta	50	40	0.2[0.09-0.44]
	Jabera	35	1	5.6[0.69-45.96]
	Patera	113	13	1.4[0.58-3.38]
	Pathariya	69	3	3.7[0.98-14.09]
	Tendukhera	35	1	5.6[0.69-45.96]

Footnote: OBC* Other backward caste, SC^ Schedule Caste, ST# Schedule Tribe, OR¥ Odds ratio, Ref Reference

Table 3: Socio-demographic determinants of Urine Iodine Excretion of children in Damoh district, 2016.

Variable		Urine Iodine Excretion		OR [95%CI]
		Insufficient	Sufficient/Toxic	
Age (In years)	6-9	40	1643	Ref
	10-12	30	987	1.2[0.77-2.02]
Sex	Male	30	1320	Ref
	Female	40	1310	1.3[0.83-2.17]
Religion	Hindu	65	2603	Ref
	Muslim	5	27	7.4[2.77-19.87]
Caste	General	2	113	Ref
	OBC*	49	1696	1.6[0.39-6.79]
	SC^	13	621	1.18[0.26-5.31]
	ST#	6	200	1.69[0.34-8.53]
Block	Bathiyagarh	14	526	1.5[0.59-4.12]
	Damoh (Rural)	6	354	Ref
	Hatta	15	435	2.03[0.78-5.29]
	Jabera	4	176	1.3[0.37-4.81]
	Patera	13	617	1.2[0.47-3.29]
	Pathariya	14	346	2.4[0.91-6.28]
	Tendukhera	4	176	1.3[0.37-4.81]

Footnote: OBC* Other backward caste, SC^ Schedule Caste, ST# Schedule Tribe, OR¥ Odds ratio, Ref Reference

nutrition'. Despite of that fact, the programme seems to be in road of achieving both of its goal, at least in Damoh district.[10] This was also ascertained by the fact that all the households interviewed were using packet salt, 78% families, almost one third shopkeepers were aware about iodized salt and all 30 shopkeepers interviewed were selling packet salt. For the remote district like Damoh, this is an achievement of NIDDCP but programme need to be vigilant through continuous monitoring and five yearly evaluation of USI.[10,11]

May be this is the high time that NIDDCP should monitor not only USI but also the toxic effect of the Iodine intake. Studies from different parts of globe have reported iodine toxicity associated with USI. Countries like Zimbabwe, Denmark, Costa Rica and Guangxi Zhuang Region exposed to iodine excess, through iodine salt amalgamated with poor monitoring of the quality of the iodized salt led to increase prevalence of Iodine-induced Hyperthyroidism after the introduction of USI in these countries.[22-24]

Our study had several strengths. First, we employed a rigorous study design which measured and quantified the IDD through internationally accepted tools.[1,11] We used large sample size with appropriate sampling design so that sample should be the reprehensive of whole district. Third, we used internationally accepted guideline for reporting the study.[21] There were a few limitations like clinical evaluation of goiter may have led to misclassification of grades of goiter. We couldn't compare the prevalence of IDD of district as the information of previous years was not available. We presume that due to USI the prevalence has decreased in last one decade.

The study has several programmatic implications and we make the following recommendations to the NIDDCP. First, USI should be mandatory for every district especially for tribal districts of MP where utilization of packaged salt is still inaccessible. Second as per objective of NIDDCP we emphasize on Resurveys to assess IDDS and the impact of iodated salt after every 5 years in the districts. Third, there has to inbuilt mechanism to monitor the iodine toxicity like Iodine-induced hyperthyroidism.

Conclusion

To conclude, Damoh district is no more an endemic area for IDD. However, district is yet to achieve (Currently 74.6%) the minimum target of universal salt iodization (>90%).Approximately 26% population is having 'Iodine deficiency' but at the same time approximately 46% population has either 'more than adequate iodine intake' or 'toxic level of iodine'. We recommend, apart from routine activities under NIDDCP, strict monitoring and evaluation through surveys to assess not only IDDs but also for Iodine-induced hyperthyroidism after every 5 years in the district.

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What This Study Adds?

Contrary to previous categorization by NIDDCP (October2006), Damoh district of Madhya Pradesh was not found with endemic goiter and there is no biochemical iodine deficiency in this population.

The Urinary iodine concentrations of 46% population of district were either more than 'adequate' Iodine intake or Toxic level of Iodine.

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