

## A Review of Tracking Progress towards Elimination of Iodine Deficiency Disorders in Tamil Nadu, India

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### Abstract

**Background:** Iodine deficiency disorders (IDD) are significant health problem in India. But there is dearth of regional/ state level information for the same. **Objective:** This study was designed to study the current status of IDD in Tamil Nadu. **Materials and Methods:** A cross-sectional community-based survey was conducted in the state of Tamil Nadu. The study population was children in the age group of 6-12 years and the probability proportional to size 30 cluster methodology was used for sample selection. The parameters studied were prevalence of goiter, urinary iodine excretion, and iodine content in salt at the household level. **Results:** A total of 1230 children aged between 6 and 12 years were studied. The total goiter rate was 13.5% (95% CI: 11.1-14.9). The median urinary iodine excretion was found to be 89.5 µg/L (range, 10.2-378 µg/L). The 56% of the urinary iodine excretion values were <100 µg/L. The proportion of households consuming adequately iodized salt (iodine content ≥ 15 parts per million) was 18.2% (95% CI: 16.1-20.5). **Conclusion:** The total goiter rate of 13.5% and median urinary iodine excretion of 89.5 µg/L is indicative of iodine deficiency in Tamil Nadu.

**Key words:** Iodine Deficiency Disorders, Salt, Urinary Iodine Excretion

### Introduction

Iodine deficiency in humans leads to mortality and a wide spectrum of disability. According to the World Health Organisation (WHO), it is the single most preventable cause of mental retardation and brain damage. Iodine deficiency disorders (IDD) are estimated to result in loss of 2.5 million disability adjusted life-years (DALYs) (0.2% of total) globally.<sup>1</sup> More than 2 billion people worldwide continue to be at risk of IDD due

to insufficient dietary intake (<150 µg per person per day).<sup>2</sup> Recognizing the importance of preventing IDD, the World Health Assembly adopted in the year 1990 the goal of eliminating iodine deficiency as a public health problem. In 1993, WHO and UNICEF recommended Universal Salt Iodization (USI) as the main strategy to achieve elimination of IDD.<sup>3</sup>

In India, it is estimated that more than 71 million individuals suffer from IDDs, while another 200 million people are at risk for IDD.<sup>4</sup> Considering the public health importance of IDD in India, National Goiter Control Program (NGCP) was launched by Government of India in 1962. The program was renamed as National Iodine Deficiency Disorders Control Programme (NIDDCP) in 1992 and USI was identified as the main strategy to eliminate IDD from India. In 1997, salt iodization was made mandatory in India. Although the ban on the sale of non-iodized salt was lifted in 2000, it was again reinstated in 2005.

Despite mandatory salt iodization, in India only half of households (51%) are currently using sufficient amount

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of iodized salt ( $\geq 15$  ppm).<sup>5</sup> There is a wide variation in the state level consumption across country ranging from 92.4% (Manipur) to 28.7% (Andhra Pradesh). More worryingly over last few years, there is the stagnation (NFHS-2, 1998-1999 to NFHS-3, 2005-2006) in percentage of households using adequately iodized salt, with few states such as Madhya Pradesh, Haryana, and Uttar Pradesh reporting actual decline.

All health interventions require an effective system for monitoring and evaluation. For IDD control program, this is even more important as it has been demonstrated in various setting that in the absence of sustained monitoring, the gains made toward USI are readily lost.<sup>6</sup> Monitoring iodine levels of salt and iodine status of population are the two important components of IDD program monitoring.

In Tamil Nadu, the IDD control cell was established with Central Government assistance and is functioning since 1<sup>st</sup> July 1994. Goiter surveys and resurveys of all the districts are being carried out periodically since 1991. According to the data available with the Department of Public Health and Preventive Medicine, 27 of the 28 districts in Tamil Nadu are endemic for IDD. There has been no state level study to assess the status of IDD in Tamil Nadu. In this special situation, it is important to study the current status of IDD and the knowledge, attitudes, practices, and behavior of the people toward IDD and iodized salt. The information gathered by using quantitative and qualitative survey methodology will help us understand the current status of IDD and people's perception about IDD and iodized salt.

While tracking of progress toward elimination of IDD, it is necessary to first document the magnitude, and then to sustain elimination thereafter. The emphasis will shift to ensuring that these achievements are permanently sustained. Progress toward the elimination of IDD can only be demonstrated if it is measured. The objectives of this study were to estimate the prevalence of IDD in the State of Tamil Nadu, to assess the availability and cost of adequately iodized salt at the retail shops and household level and to study the perceptions of the community and traders about IDD and iodized salt in Tamil Nadu.

## Materials and Methods

**Study Setting:** Tamil Nadu is one of the four southern states of India and it is the eleventh largest state by area. The current population of state is 62.4 million.<sup>7</sup> The 44%

of the population of Tamil Nadu live in urban areas.<sup>7</sup> The literacy rate is 73.4% and sex ratio is 939 girls for 1000 boys (0-6 years) (2001 census).<sup>7</sup> Tamil Nadu is the second largest producer of common salt in India with annual production of 1.9 million tons.<sup>8</sup> The majority of salt producers are small-scale producers with limited access to technology to iodize salt. The predominant form of salt consumed in Tamil Nadu is crystalline salt.

**Study Design:** A cross-sectional community-based field survey was carried out as per the protocol recommended by the ICCIDD/WHO/UNICEF.<sup>9</sup>

**Study Duration:** The study was undertaken between June 2002 and February 2003. Field surveys were conducted between December 2002 and February 2003.

**Study Participants:** Children in the age group of 6-12 years, health care providers, community leaders, primary school teachers, women in the community, retail shop keepers, and salt manufacturers constituted the study participants. Doctors from both the government and private health care settings, village health nurses (VHNs), health inspectors (HIs) and integrated child development services (ICDS) workers were the health care providers who participated in the study.

**Sample Size:** The sample size was calculated based on the results of the National Family Health Survey—2 (1998-1999).<sup>10</sup> Considering the prevalence of consumption of adequately iodized salt in Tamil Nadu to be 20%, absolute precision of 4%, design effect of 3% and confidence interval of 95%, the sample size calculated was 1200. Forty-one target children were studied from each of the 30 selected clusters (41 children  $\times$  30 clusters).

**Selection of Households and Children:** All the inhabited villages and urban areas (wards in urban areas) in the state were listed with their population. Thirty clusters were selected from this list using probability proportional to size (PPS) technique. Children in the age group of 6-12 years constituted the target population for the study. Forty-one children (6-12 years) per cluster were selected. In the selected clusters, households were selected as per the modified Expanded Programme on Immunization (EPI) methodology. In the selected household, if a target child was not available, adjacent houses were visited till a house with a child in target age group was found. In houses with more than one eligible child, only one of them was selected using a random selection method.

This was done to provide a wider scatter of households.

**Selection of Retail Shops:** Purposive sampling was carried out to select one state owned (fair price shop/ration shop) and one private retail shop per cluster.

**Variables:** Total goiter rate, urinary iodine excretion, iodine content of salt (household level and retail shop level), knowledge, attitude, and practices regarding IDD and iodized salt were the variables studied.

**Data Collection Tools and Data Collection:** Data collection was done by the six Regional Health and Family Welfare Training Institutes (RTIs). Each Regional Health and Family Welfare Training Institutes was allotted five clusters. In the household of each selected subject, the physician administered the household questionnaire. The enlargement of the thyroid gland was examined by the physician and graded according to the WHO/UNICEF/ICCIDD classification.<sup>9</sup> In case of uncertainty, the lower grade was recorded. For the estimation of urinary iodine excretion, on-the spot causal urine samples from all the study subjects were collected in wide-mouthed plastic bottles. The samples were transported safely to the International Council for Control of Iodine Deficiency Disorders (ICCIDD) reference laboratory at the Centre for Community Medicine, AIIMS, New Delhi, for the estimation of urinary iodine. Salt samples that were used in cooking on the same or previous day were collected from households in sealed plastic bags and transported to the state food laboratory/regional food laboratories. Retail shops owners were administered a retail shopkeeper questionnaire and salt samples of the various varieties of salt being sold in the shop were collected and sent for analysis.

Semi-structured interviews were carried out with a range of stakeholders such as health care providers (Doctors, VHNs, HIs, and ICDS workers), Community leaders, primary school teachers, traders and community retail shop keepers, and salt manufacturers to understand the wider dynamics of iodized salt consumption and its determinants at the community level by eliciting information on specific issues pertaining to that particular stakeholder group. Focus group discussions were carried out with women in the community to understand people's knowledge, awareness, and preferences for using a certain salt, their awareness of potential health hazards associated with non-use of iodized salt, and socio-cultural beliefs that influence usage of salt.

**Quality Control of the Field Study:** Trained and experienced physicians examined clinically all the 41 children in each cluster for thyroid enlargement. Goiter was graded as per the criteria recommended by WHO/UNICEF/ICCIDD.<sup>9</sup> To standardize the survey technique and to minimize the intra- and inter-observer variability for grading goiter, two training workshops were conducted before the actual field survey. State Training Orientation Workshop was held at the Institute of Public Health in Ponnammallee, Tamil Nadu, for the team leaders to impart practical training in goiter examination and other details of survey methodology. As a validation exercise, two supervision teams were formed, which independently visited 30% of the clusters to validate the data collected in the field.

**Laboratory Analysis:** Salt samples from households and retail outlets were analyzed in Food Analysis Laboratories at Guindy, Coimbatore, and Palayamkottai by the standard iodometric titration method.<sup>9</sup> Urine samples were analyzed at the ICCIDD Laboratory at the Centre for Community Medicine, All India Institute of Medical Sciences, New Delhi, by the simple microplate method using the Sandell Kolthoff Reaction.<sup>11</sup>

**Quality Assurance:** Internal Quality Assurance Protocols for salt iodine estimation was followed by all the state laboratories. An internal quality control sample having a known concentration range of iodine content was run with every batch of test samples. If the results of the internal quality control sample were within the range, the test was deemed in control and if the results were outside the range, the whole batch analysis was repeated. External Quality Assurance of salt iodine estimation was carried out by the National Institute of Nutrition, Hyderabad. For urinary iodine estimation, ICCIDD Laboratory in AIIMS followed a similar protocol for internal quality assurance and for its external quality assurance it collaborated with EQUIP Laboratory Network of CDC Atlanta, USA.

**Data Processing and Analysis:** The quantitative data were entered in an Excel spreadsheet. Data analysis was conducted at the National Institute of Epidemiology (NIE), Chennai, using SYSTAT and Microsoft Excel. Mean, median, proportions with standard deviation, range, and 95% confidence interval were calculated where appropriate. For qualitative study, the responses to open-ended questions were free listed. The main domains were identified; the individual responses were categorized and finally summarized by using qualifiers.

For the open-ended questions, the observations were expressed in a semi-quantitative manner.

## Results

A total of 1230 households and 64 retail shops were covered in 30 selected clusters. There were a total of 6207 family members in the selected households with 71% households having less than 5 family members. A total of 1230 urine samples were collected and 1228 salt samples were collected from households and 167 salt samples from retail shops.

The mean age of children sampled was 8.8 years (SD  $\pm$  1.9 years). There were 602 boys and 628 girls with a mean age being 8.8 years (SD  $\pm$  1.9 years) for boys and 9.2 years (SD  $\pm$  1.9 years) for girls. The total goiter rate was 13.5% (95% CI: 11.1-14.9), prevalence of Grade I goiter being 12.9% (95% CI: 11.1-14.9) and Grade II being 0.6% (95% CI: 0.2-1.1) among 1230 children [Table 1]. The total goiter rate in boys and girls was 12% (95% CI: 9.4-14.8) and 15% (95% CI: 12.2-18.0), respectively, and the difference between the two was not statistically significant ( $P = 0.124$ ).

Urine samples were collected from 1230 children and 9 samples were of insufficient quantity. Thus, 1221 urine samples were sent for analysis. However, 15 urine samples could not be analyzed due to sediment and turbidity. The remaining 1206 urine samples were analyzed for iodine content. The median urinary iodine excretion was found to be 89.5  $\mu$ g/L (range, 10.2-378  $\mu$ g/L). The proportion of the population with urinary iodine excretion below 100  $\mu$ g/L was 56% (95% CI: 53.2-58.8) and the proportion of the population with a urinary iodine excretion below 50  $\mu$ g/L was 22% (95% CI: 19.9-24.6) [Table 1].

**Table 1: Iodine status assessment indicators of children and households in Tamil Nadu**

Indicator	Value
Total goiter rate	13.5% (95% CI: 11.1-14.9)
Goiter grade I	12.9% (95% CI: 11.1-14.9)
Goiter grade II	0.6% (95% CI: 0.2-1.1)
UIE ( $\mu$ g/L) (median)	89.5 $\mu$ g/L (range: 10.2-378 $\mu$ g/L)
Proportion < 100 $\mu$ g/L	56% (95% CI: 53.2-58.8)
Proportion < 50 $\mu$ g/L	22% (95% CI: 19.9-24.6)
Proportion of households consuming adequately iodized salts	18.2% (95% CI: 16.1-20.5)

A total of 1228 salt samples collected at household level were analyzed. The proportion of households consuming iodized salt were 65.7% (95% CI: 63.0-68.3) and those using adequately iodized salt (iodine content of  $\geq$  15 ppm) were 18.2% (95% CI: 16.1-20.5) [Table 1]. The iodine levels in household salt samples varied from 0 to 80.4 parts per million (ppm) [Table 2].

A total of 45% of household respondents said that they did not know, whether their salt contained iodine and only 16% reported use of iodized salt. The 75% of households used crystalline salt, 13% used powdered salt, and 12% households reported use of both crystalline and powdered salts. The majority (65%) of household respondents were aware that iodized salt is good for health. Regarding the specific benefits of iodized salt consumption, 14% respondents knew that iodized salt prevents goiter, 5% knew that it prevents cretinism, and 22% knew that it promotes intelligence or cognitive function. The main source of information about iodized salt was television (48%), followed by radio (20%).

Out of 64 retail shops included in the study 40% (95% CI: 32.6-47.4) were selling adequately iodized salt. Shop owners reported that the iodized salt constituted 31% of total salt sold at their shops. The average sale of salt per retail shop per month was 146.7 kg. The cost of non-iodized salt (crystalline or powdered) was Rs. 2.50 per kg whereas cost of iodized crystal salt was Rs. 3.00 per kg and iodized powdered salt Rs. 6.00 per kg.

The 72% of retail shop owners opined that iodized salt must be taken and the reasons for taking iodized salt according to them were "prevents goiter" (24%), "prevents cretinism" (4%), "increases growth" (9%), "increases intelligence" (20%), and "it is good for health" (80%). The 22% of retail shop owners mentioned cost factors as the reasons for not taking iodized salt.

## Discussion

As evident from this study, the total goiter rate was

**Table 2: Distribution of iodine content of salt at household level, Tamil Nadu**

Iodine content (PPM)	Number of samples	Percentage
0	421	34.3
<15	583	47.5
15-29.9	110	9.0
$\geq$ 30	114	9.2
Total	1228	100

13.5% in 6-12 years children, the median urinary iodine excretion was 89.5 µg/L with 22% of children having a urinary iodine excretion <50 µg/L. and the proportion of households using adequately iodized salt was only 18.2% [Table 3]. Based on WHO/UNICEF/ICCIDD criteria (goiter prevalence, urinary iodine excretion, and iodine content of salt), IDD continue to be a public health problem in Tamil Nadu.

The predominant type of salt consumed in Tamil Nadu was crystalline (75% of the population). The proportion of retail shops selling adequately iodized salt was 40%. Only a small percentage of the population was aware of the importance of iodized salt. The role of health care providers in spreading message of IDD appeared minimal. Commercial advertisements on television and radio were the major source in promoting use of iodized salt in preventing IDD. Cost, ease of use, availability, and appearance were important factors influencing the use of salt. The iodized salt was regarded as more expensive.

The combination of use of the crystalline salt (which is more often non iodized), poor implementation of ban on the sale of non-iodized salt, and poor awareness among household regarding iodization of salt resulted in overall mild-to-moderate iodine deficiency in the study population.

Our study results are robust and are internally valid as standard laboratory quality assurance and control procedures were followed. The ICCIDD laboratory at AIIMS is one of the internationally accredited laboratories and is part of the International Resource Laboratories for Iodine (IRLI) network.<sup>12</sup> The study results are generalizable to whole of Tamil Nadu as the sample drawn was representative of the population as whole and was selected following recommended standard criteria by WHO/UNICEF/ICCIDD.

**Table 3: Criteria for tracking progress toward eliminating IDD as a public health problem in Tamil Nadu**

Indicator	Goal	Tamil Nadu
1. Thyroid enlargement (Age group, 6-12 years)	<5%	13.5%
2. Urinary iodine		
Median urinary iodine excretion (µg/L)	>100	89.5
Proportion below 100 µg/L	<50%	56%
Proportion below 50 µg/L	<20%	22%
3. Salt iodization		
Proportion of households consuming adequately iodized salt (≥15 ppm)	>90%	18.2%

The results of this study showed similar results to an earlier school-based survey from the same state where 16.2% of the population was consuming salt with the stipulated level of iodine, i.e., 15 ppm and more. The NFHS-2 (1998-1999) survey documented that 21.5% of population consumed adequately iodized salt (≥15 ppm of iodine) which were measured using spot iodine kits. The percentage of population reporting urinary iodine excretion less than 100 µg/L was 15.6%, less than 50 µg/L was 4.3% in study by Kapil *et al.*<sup>13</sup> This was markedly different from our study where population reporting urinary iodine excretion less than 100 µg/L was 56%, less than 50 µg/L was 22%. The estimates by Kapil *et al.* could have been on lower side as their study was a school-based survey and iodine status of school going children is likely to be better as compared to children who do not go to school. Moreover they used a different method of estimation of urinary iodine (the wet digestion method) as compared to ours. In a national level survey conducted by ICMR in 1989 goiter prevalence of 6.9% (all age groups) and 14.1% (in 5-14 years age group) was reported in Nilgiri district of Tamil Nadu.<sup>14</sup> District surveys carried by State Goiter cell from 1995 to 2001 reported greater than 5% goiter prevalence in 28 out of 29 districts in Tamil Nadu.

A dissemination workshop was held after the completion of survey. The objective of the workshop was to “Link Research to Policy and Program in context of IDD in state of Tamil Nadu.” A detailed plan to address both demand and supply of iodized salt was developed. Advocacy and monitoring mechanism was established involving government functionaries and Panchayat Raj Institution (PRI) members. A meeting of common salt producers and iodized salt producers was held to sensitize them to the importance of IDD.

Due to the unique approach of involving various stakeholders and inculcating a sense of ownership among them regarding the results of IDD survey, the state survey was followed up by focused initiatives on part of different stakeholders to increase the coverage of iodized salt consumption. The decision makers, the Department of Public Health and Family Welfare, who themselves had conducted the study, promoted increased distribution and uptake of iodized salt through a public distribution system. In addition, major national bodies such as the National Institute of Epidemiology, National Institute of Nutrition, All India Institute of Medical Sciences, and Indian Clinical Epidemiology Network also contributed

to the study. International organizations such as ICCIDD, MI, and UNICEF supported this effort. The partnerships that were built during the survey contributed substantially to production and distribution of iodized salt in the state.

The amount of iodized salt distributed through public distribution supply increased ten folds from 2000 to 2004 in state of Tamil Nadu. Compared to 2000 (4200 tons), distribution increased to 48,829 tons in 2004. Quality iodized crystal salt was distributed through Public Distribution System at a price of Rs. 2.50 per kg. As a result, 3.5 million below poverty line population benefitted by consuming adequately iodized salt in Tamil Nadu. It also had a spin-off effect of covering additional 2.0 million and 1.5 million below poverty line population in neighboring states of Karnataka and Andhra Pradesh, respectively. This demonstrated a successful model of linking research to policy and program.

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