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Utilization of Adequately Iodized Salt and its Barriers Among Sub-Urban Households of Chengalpattu District- Tamil Nadu

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ABSTRACT

Background: Iodine is a crucial nutrient humans need for healthy mental and physical development. Iodine deficiency disorder (IDD) continues to pose a real threat to public health across several nations, including India. This study aimed to estimate the prevalence of the use of adequately iodized salt and to determine the barriers to the use of adequately iodized salt among suburban households.
Subjects and Method: A Community-based cross-sectional study was done among 250 sub-urban households using a multistage sampling technique in Chengalpattu district, Tamil Nadu. The study was carried out between the period of July to November 2023. Data was collected by both standardized and pre-tested semi-structured questionnaires. The iodine content of salt was assessed by an MBI spot testing kit. The dependent variable was adequately iodized salt and the independent variable was sociodemographic details and variables related to the utilization of iodized salt. Data were analyzed using SPSS version 25.
Results: The prevalence of utilization of adequately iodized salt was 76.8 % and barriers to the use of adequately iodized salt among sub-urban households were, using a wet spoon/hand to take salt from the container, container of the salt kept open / both ways, storing salt in the steel container and storing in the original salt pocket itself.
Conclusion: Specific education regarding proper storage, handling, duration, and the importance of iodized salt needs to be implemented to increase community awareness and to focus on behavior change communication to bring a positive attitude toward the utilization of iodized salt.

Keywords: Iodine, iodine deficiency, parts per million, cross-sectional, storage practices

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BACKGROUND

Iodine deficiency disorder (IDD) continues to pose a real threat to public health across several nations, including India. Iodine is a vital micronutrient for thyroid function; the recommended daily allowance (RDA) for iodine is 150 micrograms for healthy human growth, development, and well-being. Iodine Deficiency Disorders include a wide range of illnesses and conditions, including psychomotor abnormalities, hypothyroidism, cretinism, abortion, stillbirth, mental retardation, and goiter. Most of these consequences are irreversible and undetectable, yet they

are completely avoidable. The most affordable, practical, and efficient method of mass prophylaxis against iodine deficiency disorders is iodized salt (Jha et al., 2023).

Over 655 million people worldwide suffer from iodine deficiency disorders (IDD), out of the approximately 1.88 billion people who are in danger of developing IDD. Around 241 million children globally do not get enough iodine from their diets. Of which, half of the kids who don't get enough iodine come from South/South-East Asia and Africa (Deepika et al., 2019; Kaur et al., 2017).

The entire population of India is prone to IDD because of the absence of iodine in the soil and the crops grown there. In India, 1.2 billion individuals have been in danger of getting IDD in the last several years. About 264 million people are in high danger. Meanwhile, goiter, and other IDD-related illnesses affected about 71 million people (Karmakar et al., 2019). In India, 8 million newborns and 9 million expectant mothers are at risk of getting IDD annually. The greatest number of infants born exposed to IDD are in India. (Jeyaprabha et al., 2020).

Despite being the nation's third-largest salt production state, Tamil Nadu has the lowest utilization of iodized salt, according to a national survey measuring the availability of iodized salt (Nutrition International et al., 2019). Iodine deficiency disorders are a serious public health issue in India and across the world since they can lead to significant brain damage in humans. The International Council for the Control of Iodine Deficiency Disorders (ICCIDD), the World Health Organization (WHO), and UNICEF suggest that 90% of household salts be iodized at the recommended level, which is 15 parts per million (PPM) at the consumer level and 30 PPM at the production level. Globally, 89 percent of households are predicted to use iodized salt in 2021 ("Iodine," n.d.).

There are only a few studies done in India to assess the status of utilization of adequately iodized salt. With the above background, the study was carried out with the objective of finding the prevalence of Utilization of adequately iodized salt and to determine the barriers to use of adequately iodized salt among sub-urban households. This study aimed to estimate the prevalence of the use of adequately iodized salt and to determine the barriers to the use of adequately iodized salt among suburban households.

SUBJECTS AND METHOD

1. Study Design

A Community-based Cross-sectional study was conducted in a suburban area of Chengalpattu district, Tamil Nadu (South India). The study was carried out between the period of July to November 2023.

2. Population and Sample

According to a National Iodine Survey, the prevalence of adequately iodized salt was found to be 61.9%. (6) Taking this as P and applying the formula 4PQ/L2, with an absolute precision (L) of 7%, the minimum sample size required was 185. Adding a non-response rate of 10%, the required sample size was rounded off to 250. The sampling method applied to choose the study population was a multistage sampling method is used.

There were four wards in the urban field practice area of the private medical college in Chengalpattu district, Tamil Nadu. Each ward consists of approximately 60 streets. Among these, two wards were selected randomly. Among the two wards, five streets were selected from each ward using the random-number method. From each street, 25 households were selected randomly, and household utilization of ade-

quate iodized salt was assessed by face-to-face interviews which were done among the head of the family or his wife or the household members, with the criteria that they must be knowledgeable about the cooking process in the house. If the members of the household consume food from outside in hotels/restaurants for more than 4 days in a week, then that household was excluded. the next household was selected.

3. Study Variables

The dependent variable was adequately iodized salt and the independent variable was socio-demographic details and variables related to the utilization of iodized salt.

4. Operational Definition of Variables

Salt that has been adequately iodized: is defined as having 15 ppm or more of iodine ("Households consuming adequately iodized salt (≥15 parts per million)," n.d.). The MBI spot testing kit's purple-blue color change signifies this. No colour change-non-iodized salt, Grey/light blue colour change - Inadequate iodine, the Blue colour will be compared with the shades which are given with the MBI spot testing kit. As the blue colour deepens, the iodine content increases at 7ppm,15ppm, and >30ppm.

5. Study Instruments

The data related to adequately iodized salt and related variables was collected using the standardized pre-tested structures questionnaire. In this study, the iodine content of the salt was measured by an MBI spot-testing.

6. Data Analysis

Data was entered in Microsoft Excel and analyzed using SPSS version 25. Descriptive statistics are to be presented in the form of frequency tables. A Chi-square test was used to find the association between adequately iodized salt and related variables. Logistic regression Analysis was used to eliminate the confounders and determine the barriers to utilization of iodized salt in households.

7. Research Ethics

Ethical approval was obtained from the Institutional Human Ethics Committee of the private medical college Ref. No.002/-SBMCH/IHEC/2022/1832. Informed consent was obtained from each study participant before they were enrolled.

RESULTS

Half of the households use both crystal and refined salt (50.4%), followed by refined salt (27.6%) and the least utilized was Himalayan pink rock salt (2.4%) (Figure 1) The majority of households utilize adequately iodized salt (76.8 %) (Figure 2).

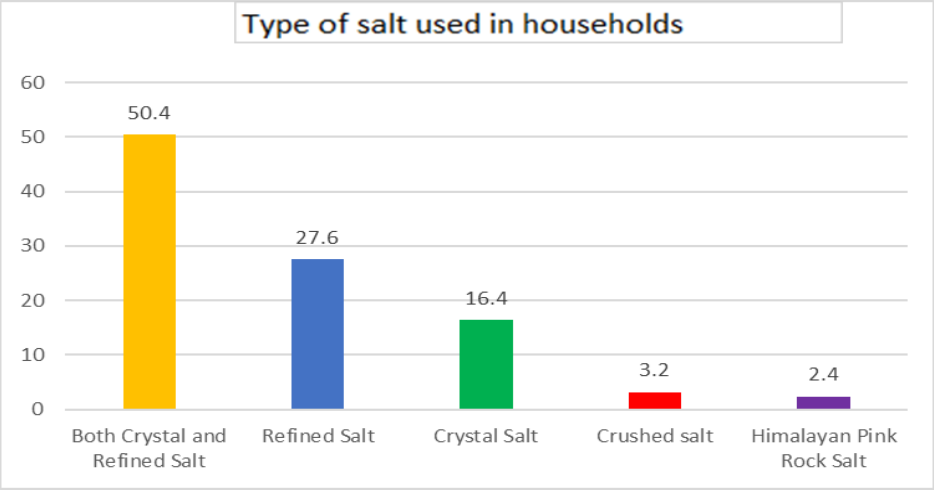

Figure 1. Type of salt used in households

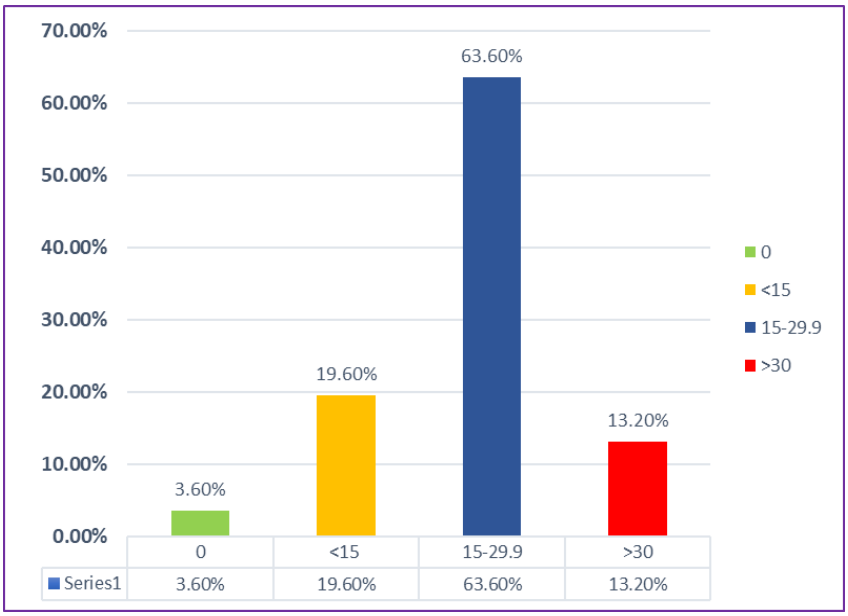

Figure 2. Iodine content in the salt used in households of study participants

The mean age of the 250 households' participants was (Mean= 37.54; SD= 4.20) and the majority of them were female (98.8%). The majority of households buy salt from a nearby shop (37.2%) followed by provisional stores (31.6%), supermarkets (30%) & local vendors in the street (1.2%). Decisions on purchasing type of salt are made by mostly wives (77.2%), husbands (9.2%), anyone who goes to purchase (12.8%), and whatever the shopkeeper gives (0.8%) Most of the households buy salt based on palatability (34.4%) & brand (24%). In the majority of households, they were using iodized salt (97.2%). On enquiring the reason for using iodized salt, the majority of them responded that it is good for health (61.2%), prevents goiter (17.6%), prevents hypothyroidism (12%), and 9.2% responded that they didn't know.

When enquired about knowledge about iodine deficiency-related health problems, the majority of households mentioned goiter (43.2%), mental and growth retardation in children (31.6%) & around 16.8% were not aware of any problems. The source of information about the importance of taking iodized salt & iodine deficiency disorder was mostly from health professionals (44%) and Friends/ relatives (20%). Among 250 households 52.8% of the participants who were interviewed were graduated and the majority of them were married (96%). Half of the participants are employed (50.4%). In Socioeconomic status, 53.6% belong to upper & upper middle class. The majority of households store salt in plastic boxes & porcelain jars (84.8%) & close the container in air-tight conditions (71.6%). Interestingly the majority of households use wet spoons/hands to take salt from containers (61.2%). Most of the households added salt as soon as the process of cooking started (61.2%). The opened salt packet lasted for more than four weeks in certain households (66.8%).

Table 1. Socio-demographic variable related to adequately iodized salt (N=250)

Characteristics	Category	Frequency	Percentage
Education	Up-to-school education	118	47.2
	Graduate	132	52.8
Marital status	Unmarried	10	4
	Married	240	96
Occupation	Unemployed	124	49.6
	Employed	126	50.4
Socioeconomic status	Middle, lower middle & lower	116	46.4
	Upper & upper middle	134	53.6
What type of container do you store salt in?	Steel container & salt pocket itself	38	15.2
	Plastic box & porcelain jar	212	84.8
Do you close the container air tight / keep it open?	Open /both ways	71	28.4
	Airtight close	179	71.6
Do you use a wet spoon / hand to take salt from the container?	Yes	82	61.2
	No	168	38.8
At what phase of cooking do you add salt?	As soon as the process starts	153	61.2
	In the middle and towards the end of the preparation	97	38.8
How long does one open packet lasts?	≥4 weeks	167	66.8
	<4 weeks	83	33.2

The factors that were found to have a statistically significant association with the utilization of inadequately iodized salt were those not married (OR=5.42; 95%CI=1.47 to 19.93), individuals who added salt as soon as the process of cooking started (OR=2.39; 95%CI=1.23 to 4.65), those who use a wet spoon or hand to take salt from the container (OR= 26.23; 95%CI= 11.74 to 58.59), individuals who keep salt in steel containers or the original salt packets (OR= 7.75; 95%CI= 3.68 to 16.32). It was interesting to find that, those who kept the salt container open or both ways were at higher odds of not using iodized salt adequately (OR=29.90; 95%CI=18.66 to 37.47) and the association was also found to be statistically significant.

Table 2. Association between adequately iodized salt and related variables among the study participants

Variable	Adequately Iodized Salt				95% CI		OR	p
	No		Yes		Upper Limit	Lower Limit		
	N	%	N	%				
Education								
Up-to-school education	27	22.9	91	77.1	1.74	0.53	0.96	0.961
Graduate	31	23.5	101	76.5				
Occupation								
Unemployed	30	24.2	94	75.8	2.01	0.62	1.11	0.714
Employed	28	22.2	98	77.8				
Socioeconomic status								
Middle, lower middle & lower	29	25	87	75	2.17	0.67	1.20	0.532
Upper & upper middle	29	21.6	105	78.4				
How long does one open packet last?								
>4 weeks	35	21	132	79	1.27	0.37	0.69	0.236
<4 weeks	23	27.7	60	72.3				

Variable	Adequately Iodized Salt				95% CI		OR	p
	No		Yes		Upper Limit	Lower Limit		
	N	%	N	%				
At what phase of cooking do you add salt?								
As soon as the process starts.	44	28.8	109	71.2	4.65	1.23	2.39	0.009
In the middle and towards the end of the preparation	14	14.4	83	85.6				
Do you use a wet spoon/hand to take salt from the container?								
Yes	49	59.8	33	40.2	58.59	11.74	26.23	<0.001
No	9	5.4	159	94.6				
Do you close the container air-tight/ keep it open?								
Open / both ways	47	66.2	24	33.8	65.47	13.66	29.90	<0.001
Airtight close	11	6.1	168	93.9				
What type of container do you store salt in?								
Steel container & salt pocket itself	23	60.5	15	39.5	16.32	3.68	7.75	<0.001
Plastic box & porcelain jar	35	16.5	177	83.5				

Variables that were statistically significant in bivariate analysis were further analyzed using Logistic Regression to control for confounding factors. The major predictors of using inadequately iodized salt were, leaving the salt container open or both ways (OR= 16.01; 95%CI=11.76 to 21.52), storing salt in steel containers or the original salt packets (OR=4.74; 95%CI=1.25 to 18.00) and using wet spoon or hand to take the salt from the container (OR= 25.11; 95%CI= 20.45 to 30.56).

Table 3. Logistic Regression Analysis in the utilization of adequately iodized salt and related variables

Variable	Adequately iodized salt				95% CI		AOR	p
	No		Yes		Upper Limit	Lower Limit		
	N	%	N	%				
Education								
Up-to-school education	27	22.9	91	77.1	3.99	0.43	1.32	0.612
Graduate	31	23.5	101	76.5				
Occupation								
Unemployed	30	24.2	94	75.8	4.43	0.52	1.52	0.431
Employed	28	22.2	98	77.8				
Socioeconomic status								
Middle, lower middle & lower	29	25	87	75	1.50	0.20	0.54	0.241
Upper & upper middle	29	21.6	105	78.4				
How long does one open packet last?								
≥4 weeks	35	21	132	79	2.80	0.33	0.96	0.940
<4 weeks	23	27.7	60	72.3				
At what phase of cooking do you add salt?								
As soon as the process starts.	44	28.8	109	71.2	3.68	0.44	1.28	0.646
In the middle and towards the end of the preparation	14	14.4	83	85.6				
Do you use a wet spoon/hand to take salt from the container?								
Yes	49	59.8	33	40.2	30.56	20.45	25.11	<0.001
No	9	5.4	159	94.6				

Variable	Adequately iodized salt				95% CI		AOR	p
	No		Yes		Upper Limit	Lower Limit		
	N	%	N	%				
Do you close the container air-tight/ keep it open?								
Open / both ways	47	66.2	24	33.8	21.52	11.76	16.01	<0.001
Airtight close	11	6.1	168	93.9				
What type of container do you store salt in?								
Steel container & salt pocket itself	23	60.5	15	39.5	18.00	1.25	4.74	0.022
Plastic box & porcelain jar	35	16.5	177	83.5				

DISCUSSION

The utilization of adequately iodized salt is paramount for safeguarding public health. Adequate iodine intake supports thyroid function, prevents iodine deficiency disorders, and promotes overall well-being. By incorporating iodized salt into daily consumption habits, individuals ensure they meet their iodine requirements effortlessly. This simple dietary adjustment can have profound effects, particularly in regions where iodine deficiency is prevalent. Universal access to adequately iodized salt is essential for promoting healthy communities and preventing the long-term consequences of iodine deficiency.

The Present study found that usage of adequately iodized salt (>15 ppm) is 76.2%. In a study, all India-level iodized salt > 15 ppm is 76.3% and in Tamil Nadu is 61.9% (Nutrition International et al., 2019). In a study done in Himachal Pradesh, usage of adequately iodized salt was found to be 83.7% (Kumar et al., 2021). In a study done in a tribal area of North India by Chauhan et al. (2021), it was found that 75 % of the study population used adequately iodized. In a study done by Deepika et al. (2019) 75% of the study population used adequately iodized salt. A study done by Sarah et al. (2016) shows adequate iodine is more than 15ppm 92.3 %. These findings suggest that around one-fourth of the population still does not use adequately iodized salt and may be prone to develop morbidity due to the same.

The current study found Half of the households use both crystal and refined salt with crystal salt utilization being 50.4%, followed by refined salt (27.6%), and the least utilized was Himalayan pink rock salt (2.4%). In India iodine survey in 2019 by Nutrition International shows the majority of participants (82.1%) utilize refined salt, followed by crystal salt (12.7%) and crushed salt (5.2%) (Nutrition International et al., 2019). In Hohoe Municipality, Ghana, Sarah et al. (2016) show that 25.8% use fine salt, and half of them utilize coarse salt. A study done by Pandav et al. (2010) shows that 75% of homes reported using crystalline salt, thirteen percent using powdered salt, and twelve percent reported using both types of salt. As these findings suggest majority of households use crystalline salt, it is imperative to understand that the stability of iodine in household salts can be affected by various factors such as storage duration, crystal size, impurities, moisture content, storage temperature, humidity levels, and exposure to sunlight. These factors would play a major role in the iodine content of the salt consumed by various households (Zimmermann et al., 2008).

The present study shows Most of the households add salt as soon as the process of starting cooking (61.2%). Similar results were obtained in studies done by Datta et al. (2018) and Abebe et al. (2017)in Ethiopia. A

study done by Mekonnen et al. (2018), Jaiswal et al. (2015) and Deepika et al. (2019) in Andhra Pradesh found that most of the study participants added salt in the middle of the cooking process. A study found that most add salt at the end of cooking (Bazezew et al., 2018). Though findings are different in different parts of India, it is advised that salt has to be added at the end of cooking as opposed to the beginning or in the middle, as followed in most parts of India, to prevent iodine losses as evident from a study done by Rana and Raghuvanshi (2013).

The present study found a statistically significant association between using a wet spoon/hand to take salt from the containers and the usage of inadequately iodized salt. It's well-known that iodine is a volatile element and can be lost through various means, including contact with skin oils. Handling salt with bare hands introduces the possibility of transferring oils and contaminants, which could contribute to iodine loss over time. Using wet spoons can make the salt susceptible to degradation when exposed to moisture in the spoons. These findings were supported by a study done by Maramag et al (2007).

In this study, container kept open or both ways increased the odds of not using iodized salt adequately and the present study found that storing salt in steel containers and salt pockets itself increased the odds of not using iodized salt. In a Tribal area of Himachal Pradesh, Chauhan et al. (2021) show Half of the participants were utilizing open steel containers. Similar results were found in a study done by Antenah et al. (2017), in which the mode of storage of salt (open/closed) had a statistically significant association with the iodine content of the salt. These findings were supported by a study done by Gebremariam et al. (2013) in which, keeping the salt in an open container tends to absorb moisture, leading to clumping and the settling of iodide at the bottom of the container. Additionally, in warmer environments, salt can release surface moisture, potentially resulting in iodine loss through volatility when being stored in open containers.

The findings of this study provide light on both the progress and obstacles associated with the usage of appropriately iodized salt in suburban families. With a prevalence rate of 76.8%, it is clear that a sizable proportion of families benefit from the intake of iodized salt, which protects against iodine deficiency illnesses. However, impediments such as using damp utensils, inappropriate storage methods such as leaving containers open, and storing salt in steel containers or pockets remain, thereby jeopardizing attempts to assure widespread access to appropriately iodized salt. Addressing these barriers through focused education, improved packaging, and community involvement efforts is critical to increasing iodized salt use and improving public health outcomes in suburban regions. Finally, more research is needed in this area. Furthermore, the World Health Organization (WHO) suggests measuring urinary iodine concentration (UIC) as an important biomarker for determining iodine nutrition levels in a community.

AUTHOR CONTRIBUTION

All the authors contributed to the study conception, study design, data collection, data analysis and interpretation, and manuscript preparation.

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CONFLICT OF INTEREST

There are no conflicts of interest.

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