Original Article

Evaluation of Factors Affecting Thyroid Levels and its Relationship with Salt Iodine to Suggest the Way Forward!

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Abstract

Background: In India, 42 million people suffer from thyroid diseases. One in 10 adults suffer from hypothyroidism. Although coverage of iodized salt utilization has increased after universal salt iodization, we are yet to achieve the goals of NIDDCP for which the present study was planned to identify the hidden factors. The aim is to identify the factors affecting thyroid hormone levels, their association with salt iodine content and suggest strategies for improvement based on patient perceptions. **Methods:** A hospital based prospective follow up study was conducted among 140 patients, with an in depth interview and testing of salt iodine content. Data were analyzed using the SPSS software. **Results:** 96 (69%) patients were of age 18–35 years. 129 (92%) were females, 120 (86%) were from rural areas, 95 (68%) were literate, 116 (83%) were unemployed, and 115 (82%) were of low socioeconomic status. Most of them had poor cooking practices and dietary habits. The T3, T4, and TSH levels were within the normal range in 84 (60%) patients. Only in 28 (20%) salt samples, the iodine content was adequate. The association between factors like intake of inadequately iodized salt ($P < 0.01$), rural distribution ($P < 0.05$), illiteracy, presence of the comorbid conditions ($P < 0.0001$), and thyroid hormone abnormality was found to be statistically significant. **Conclusion:** The factors that adversely affect thyroid levels were higher age, female gender, rural distribution, comorbid conditions and patients with low salt iodine were prone to abnormal levels. Monitoring salt iodine content, training of health care workers to create awareness were the key strategies proposed for improvement.

Keywords: *Added salt, goitrogen, Iodine deficiency disorders (IDD), iodized salt, knowledge, practice*

Introduction

Iodine deficiency has multiple adverse effects in humans, termed iodine-deficiency disorders (IDDs), globally, 2 billion individuals have an insufficient iodine intake.[1] The prevalence of goiter in areas of severe iodine deficiency can be as high as 80%.[2] About 42 million people in India suffer from thyroid diseases. Early diagnosis and treatment remain the cornerstone of management,[3] while one in 10 adults in India suffer from hypothyroidism.[4] In India, hypothyroidism-categorized IDDs, which were represented in terms of total goiter rates and urinary iodine concentrations, were typically assessed in school-aged children. Ever since India adopted the universal salt iodization program in 1983, there has been a decline in goiter prevalence. In 2004, a WHO assessment of global iodine status classified India as having "optimal" iodine nutrition. India is supposedly undergoing a transition from the iodine deficiency state to the sufficiency state. A recent review of studies conducted in the postiodization phase gives some indication of the corresponding change in the thyroid status of the Indian population.[3-5] However, still thyroid diseases are at the rise, especially the IDDs in rural areas of South India.[6]

The present study tried to find out the factors affecting thyroid levels among patients coming to the laboratory for thyroid profile and throws light on its relation with salt intake in terms of the impact of salt iodization programmes since years.

Objectives

1. To identify the factors affecting the thyroid hormone levels and their association with salt iodine content.
2. To suggest strategies for improvement based on patient perceptions.

Sample size calculation: (NFHS-4) P: 90.4% (households using iodized salt in

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Vishakhapatnam district). At 95% confidence interval and 5% margin error, sample size (n) = z2 x p x (1 - p)/ e2 = 134. It was then rounded up to 140 assuming 5% attrition.

Methodology

A hospital-based prospective follow-up study was conducted among patients coming to a central laboratory referred from various departments for checking their thyroid profiles (T3, T4, and TSH) between September–December 2018, who constituted the study population. A sample of 140 patients was selected randomly. The study was approved by the Institutional Ethical Committee. The study participants were interviewed in the first contact based on a predesigned, prevalidated, structured questionnaire after taking written consent.

The questionnaire had three sections for collecting demographic data, patient's clinical profile, specific dietary habits (use of added salt and cruciferous vegetables), and cooking practices. They were then requested to bring a sample of salt that they use regularly (using at least for the last 3 months) at home in an airtight container, in the next follow-up visit. The patients were reminded by a telephone call a day before the issue of reports about how to collect, store, and transport the sample of salt. In the follow-up visit, the salt sample was tested with the help of MBI KITs and the patient was informed about the results along with their thyroid profile report. It was followed by counseling of patients irrespective of the thyroid levels or iodine levels in the salt. They were counseled regarding better cooking practices, dietary habits, signs, and symptoms of thyroid abnormality (IDD) due to inadequate iodine in salt along with verbal feedback from the patient for improvement. The data thus collected were analyzed to get the results.

Results

Of 140 patients, 96 (69%) belonged to the 18–35 yr age group. 129 (92%) were females, 120 (86%) were from rural areas, 95 (68%) were literate, 116 (83%) were unemployed (House makers), and 115 (82%) belonged to the lower socioeconomic status [Table 1].

The reason for visiting the hospital was explored, which showed that 52 (37%) came for routine thyroid profile checking, followed by other problems. Only 18 (13%) patients had the habit of using tobacco either in the form of gutkha, paan, or alcohol. Dietary habits disclosed intake of specific foods (Goitrogens) that were locally available and constitute a major portion of their routine diets like corn (68%), bean (54%), ragi (57%), cruciferous vegetables (71%), and other foods like sweet potato, cassava, spinach, bamboo shoots etc., (78%). A majority (49%) had a body mass index in the normal range (18 to 25). [Table 2]

Among all, 64 (46%) were with comorbid conditions, 53 (38%) were diabetics, 59 (42%) were hypertensive, 17 (12%) had chronic kidney disease, and 11 (8%) cardiac problems. Most of the patients were using packet salt 92 (66%) and the rest all were using rock salt (crystals). Out of those using packet salt, 78 (56%) did not have any idea about the iodization of salt. Only 45 (32%) were aware and using iodized salt, followed by 17 (12%) who were using low sodium salt substitute (LSSS). Salt consumed

Table 1: Sociodemographic profile of patients

Variable	Frequency	Percentage
Age in years		
<18	4	3%
18-35	96	69%
36-65	31	22%
>65	9	6%
Gender		
Female	129	92%
Male	11	8%
Geographic area		
Rural	120	86%
Urban	20	14%
Literacy status		
Literate	95	68%
Illiterate	45	32%
Employment		
Employed	24	17%
Unemployed	116	83%
Socioeconomic status (SES)		
High/middle	25	18%
Low	115	82%

Table 2: Clinical profile of patients

Variable	Frequency	Percentage
Reason of visiting hospital		
Routine thyroid profile	52	37%
Menstrual problem	34	24%
Minor ailments	29	21%
Antenatal check-up	19	14%
Infertility	6	4%
Addiction		
Smoke Less Tobacco	15	11%
Alcohol	12	9%
Both	9	6%
No addiction	122	87%
Dietary habits		
Corn	95	68%
Bean	76	54%
Ragi	80	57%
Brassica (Cabbage & Cauliflower)	99	71%
Other foods (sweet potato, cassava, spinach, bamboo shoots)	109	78%
Body mass index (BMI)		
Normal	69	49%
>25	63	45%
<18	8	6%

per month in the family was 1 to 2 kg in 104 (74%) cases, <1 kg in 17 (12%), and 20 (14%) were not sure. 63 (45%) cases had a habit of taking added salt intake in terms of pickle and salted stored food. Overall, three-fourth of the population was aware of the use of iodized salt.

About the cooking practices, although 76 (54%) people were keeping the salt container away from the stove and only 46 (33%) were using airtight closed containers for storage. 119 (85%) had the habit of adding salt before or during the cooking process and 126 (90%) were washing the vegetables after cutting them. 84% were married and 72% were having children. Out of all female patients of the reproductive age group (n = 92), only 52 (37%) had regular/normal menstruation and the rest were having some or other kind of menstrual abnormalities. Around 108 (77%) study participants had normal bowel and bladder habits and 115 (82%) were having sound sleep.

84 (60%) were having T3, T4, and TSH levels within the normal range as interpreted based on their thyroid levels in the report [Figure 1].

The salt iodine testing was done using MBI KITs and the results were found by comparing the intensity in the provided color chart. Only 28 (20%) salt samples had adequate iodine content (15 PPM at the consumer level) [Figure 2].

The association between the rural distribution of cases and lower socioeconomic status with thyroid abnormality was found to be statistically significant ($P < 0.05$). Patients with known cases of thyroid disease were more aware and their thyroid levels were normal. ($P < 0.05$). The inadequate salt iodine content was associated with abnormal thyroid levels and was more prevalent in rural areas. ($P < 0.01$) Abnormal thyroid levels were reported more in patients who are illiterate, with comorbid conditions, taking added salt. ($P < 0.0001$) [Table 3].

Discussion

Hypothyroidism is common among females and the reproductive/middle age group. Many studies concur with this statement along with ours.[4,7]

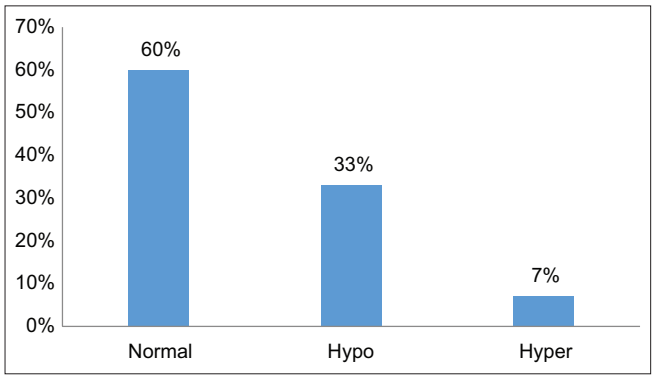

Figure 1: Status of patient based on thyroid hormonal levels

A majority came for routine check-up of their thyroid levels followed by menstrual problems and diseases other than thyroid. Among those having comorbid conditions, a majority were diabetic and hypertensive. Impaired function of the thyroid gland is commonly associated with hypertension. Also, a higher incidence of salt sensitivity was found in patients with hypothyroidism before treatment. Similarly, insulin resistance bears an indispensable role in connecting T2DM and thyroid dysfunction.[8-10] In this context, few people were found using (LSSS) low sodium salt substitute (where sodium would be replaced by potassium) without any knowledge of its contraindications. Although the relationship was not significant, inadvertent use of LSSS in patients with renal disease, cardiac problems, and diabetes and patients on K-sparing diuretics and painkillers may be harmful.[11]

A majority were practicing faulty cooking techniques like keeping salt near the stove as it comes handy, salt in open containers, adding salt while cooking on flame, and washing vegetables after cutting them. However, a majority showed good knowledge and practice related to iodized salt consumption at the household level but the time of adding salt while cooking was still faulty in most of them.[12]

Our study revealed that for most of the patients, ragi, corn, cruciferous vegetables along with cassava, spinach, and bamboo shoots were the common food categories in diet, which are goitrogenic. This could be attributed to food fads, availability, and food habits in these geographic areas. Studies have associated high consumption of cruciferous vegetables with thyroid hormonal abnormality and cancer[13]

A majority of the study participants were presented with no addiction. This could be due to more female patients with thyroid problems and quite a number of the females presented with menstrual irregularities attributed to s/s of thyroid hormonal imbalance. Similar conclusions were drawn in another study where thyroid dysfunction was

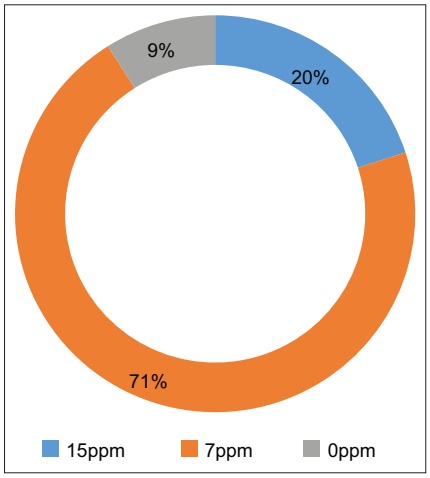

Figure 2: Iodine content in salt at consumer level

Table 3: Association of different factors with thyroid levels

Thyroid Hormone levels	Abnormal	Normal	*P*
Salt iodine content			
≥15 ppm	6	30	*P*=0.0007**
<15 PPM	53	51	
Literacy status			
Literate	26	64	*P*<0.0001***
Illiterate	33	17	
Geographic area			
Rural	52	58	*P*=0.0319*
Urban	7	23	
Comorbid conditions			
Present	40	26	*P*<0.0001***
Absent	19	55	
Socioeconomic status			
High/middle	5	20	*P*=0.0244 *
Low	54	61	
Intake of added salt			
Yes	42	22	*P*<0.0001***
No	17	59	
Known case of thyroid disease			
Yes	16	39	*P*=0.0193*
No	43	42	
Body mass index			
Normal	27	42	*P*=0.5889
Abnormal	32	39	
	Aware of iodized salt use	**Unaware**	
Known case of thyroid disease			
Yes	41	14	*P*=0.0465*
No	48	37	
	Rural	**Urban**	
Salt iodine content			
≥15 ppm	20	16	*P*=0.0002**
<15 PPM	90	14	

*Statistically significant at *P*<0.05, **extremely statistically significant at *P*<0.01, ***extremely statistically significant at *P*<0.0001

considered as an important causative etiology of menstrual abnormalities.[14]

Iodine deficiency disorders (IDDs) are linked to iodine-deficient soil. IDDs constitute the single largest cause of preventable brain damage worldwide leading to learning disabilities and psychomotor impairment. In India, the majority of the population is prone to IDD; an estimated 350 million people are at risk of IDD as they consume salt with inadequate iodine. Every year nine million pregnant women and eight million newborns are at risk of IDD in India.[15] The introduction of dietary iodine in the form of fortification of table salt with iodine as a public health measure in the early 20th century eliminated endemic goiter in many countries including the US, but it appears that it spawned a new problem related to thyroid health in the form of hypothyroidism.[16]

Iodination of table salt is one of the best methods to eliminate iodine deficiency disorders (IDDs). A significant proportion of iodine is lost from salt after production and during consumption. There should be more awareness regarding the importance of using iodized salt, and education for consumers about salt storage. The iodine content in salt packages should be monitored by regulatory authorities.[17] Although three-fourth of the population was aware of the iodization of salt, only 22% were actually using it in the study and a majority were unaware of iodization, which can be attributed to illiteracy and ignorance. Similar findings were noticed in few other studies where people's awareness was low regarding the use of iodized salt. Also, a positive impact of education and awareness on iodized salt consumption in a hard-to-reach, marginalized community was noticed.[18,19]

Patients with thyroid disease were more aware of iodized salt use and their thyroid levels were normal, which could be attributed to the improved knowledge and practice through mass media, health workers, treating physicians, or family and friends.[18]

The association between inadequate iodine in salt, rural distribution, lower SES, comorbid conditions, added salt,

and illiteracy with thyroid abnormality in the study could be either due to the unawareness of rural people, lack of health education, easy availability of local low-cost salt, or cultural norms at those specific areas. Likewise, inadequate iodine content in salt was noticed in rural patients with low SES which is attributed to the use of agricultural or coarse salt.[20]

The normal average intake of salt by an adult is 10 g/day and hence iodized salt must contain at least 15 ppm of iodine at the consumer level and 30 ppm at the manufacturing point to meet the daily requirement of 150 μg/day.[21] The present study found that around 80% patients were using salt having <15 ppm iodine at the consumer level which was inadequate due to their ignorance, unawareness, cooking practices, or cultural behavior. Studies have shown iodine deficiencies are a major public health problem. Kapil *et al*. found iodine content less than 15 ppm in the salt consumed by 53% of school-going children.[22]

Based on the patient's perception, the following key strategies were recommended for improvement:

1. Health education of rural/vulnerable population.
2. Awareness toward the use of iodized salt as health promotion.
3. Training health-care workers for capacity building and appropriate use of salt.
4. Availability of iodized salt with mention of indication and contraindication.
5. Facilities for testing iodine content in salt at approachable places.
6. Subsidized or free-of-cost supply of iodized salt at PDS.
7. Stringent action to prohibit the use of noniodized salt.

Conclusion

There are multiple factors that affect thyroid levels like higher age group, female gender, rural distribution, literacy, cooking practices, dietary habits, presence of comorbid condition, low iodine content in salt, and use of local noniodized salt hindering the iodine sufficient state. Thus, the study recommends few key strategies like health education, adequate training of health care staff, stringent rules along with the availability of facilities for salt testing to improve the current situation as perceived by patients.

Limitations

Small sample size, only patients coming to visit hospital were chosen, and the unavailability of urinary iodine concentration estimation facility.

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Declaration of patient consent

The authors certify that they have obtained all appropriate patient consent forms. In the form, the patients have given their consent for providing clinical information to be reported in the journal. The patients understand that their names and initials will not be published, and due efforts will be made to conceal their identity.

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Conflicts of interest

There are no conflicts of interest.

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