Original Article

Prevalence of goiter and associated factors among pregnant mothers residing in a district with poor socioeconomic status in Rajasthan state, India

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Abstract

Background: National survey documented that none of the Indian state is free from iodine deficiency (ID). Hence, the study was conducted with the objective to assess prevalence of goiter and associated factors among pregnant mothers (PMs) in a backward district of Indian state, Rajasthan. **Methods:** A cross-sectional survey was conducted during January to March 2015. Multistage random sampling was utilized to select PMs. A total of 1,183 villages were enlisted with their respective population, and 30 villages were selected using population proportionate to size sampling. Subjects were included from a cluster till the numbers reached to 17. PMs were clinically examined for goiter by palpation method. Casual urine (n = 226) and salt samples (n = 220), were collected from a subgroup of subjects, and iodine concentrations were analyzed by using wet digestion and iodometric titration methods, respectively. **Results:** The prevalence of goiter was found to be 14.2% (95% CI; 11.2–17.2). Goiter prevalence did not significantly differ with respect to trimesters of pregnancy (P = 0.09), iodine content in salt (P = 0.8), and urinary iodine concentrations (UIC, P = 0.69). The median UIC was 174 μg/L (IQR; 116–300 μg/L), which indicated adequate iodine intake. There was higher prevalence of goiter in PMs consuming salt with inadequate iodine than those with adequate, which was not significant (P = 0.8). Goiter prevalence was also insignificantly higher among PMs with UIC <150 μg/L than those with UIC ≥150 μg/L (P = 0.69). **Conclusion:** The study population is in transition phase from mild ID (goiter prevalence 14.1%) to sufficiency (median UIC 174 μg/L).

Keywords: Goiter, iodine deficiency, pregnant mothers, urinary iodine concentration

At a Glance Commentary

Scientific background on the subject

Iodine deficiency (ID) has been historically present in India. Evidences exist on the endemicity of ID in Himalayan belt and other hilly areas of the country among vulnerable groups: neonates, children, and pregnant mothers (PMs). India has not yet declared IDD free country even after five decades of implementation of universal salt iodization program.

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What this study adds to the field

In India, not only the population residing in conventional goiter belt, but even population residing in states like Rajasthan with entirely different terrain is suffering from iodine insufficiency. To achieve sustainable development goal, the overall nutritional status of PMs should be at the center of the goals. ID was present among PMs residing in plain area of the country. The study population is in transition phase documenting current sufficiency but mild chronic deficiency among PMs.

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Introduction

Iodine is an essential micronutrient required for the synthesis of thyroid hormones that is crucial for fetal growth and development. The thyroid hormones are crucial for the regulation of various physiologic processes like growth and brain development. Maternal thyroid hormone is the primary source for the fetus before development of its own functional thyroid and may account for 20–40% of cord blood thyroid hormone at birth.[1] If the diet of pregnant mother (PM) is insufficient in iodine, it leads to low production of thyroxin by the fetus,[2] resulting in irreversible negative impact on growth and mental retardation.[3] Iodine requirement increases during pregnancy due to physiologically increased maternal and fetal demand for thyroid hormones, to supply iodine and its hormones to the fetus, and increased maternal renal iodine clearance. Recommended dietary intake of iodine increases from 150 in nonpregnant females to 250 μg/d in pregnant females.[4]

Iodine is important element for fetal growth and development. Iodine deficiency (ID) adversely affects both PM and fetus, resulting in miscarriages, stillbirths, growth retardation, brain disorders, retarded psychoneuromotor development, speech, and hearing impairments. Severe form of ID leads to endemic goiter, hypothyroidism, decreased fertility rate, increased infant mortality, and mental retardation. The spectrum of these health consequences is known as iodine deficiency disorders (IDDs). World Health Organization (WHO) considers ID to the single most prevalent and preventable cause of mental retardation worldwide.[1] It has been estimated that ID ranks third in the list of causes that sets back children in their developmental potential.[5]

Urinary iodine concentration (UIC) is considered to be the good biomarker of iodine status in population [Figure 1]. It is an indirect index of iodine intake.[4] WHO/The United Nations Children's Fund (UNICEF)/International Council for Control of Iodine Deficiency Disorders (ICCIDD) recommended cutoffs to describe status of ID among population are a median UIC of below 150 μg/d indicating ID among pregnant mothers (PMs).[1]

ID affects 1.88 billion or approximately 28.5% population worldwide.[6] It has been considered to be a public health problem in our country. Of 386 surveyed districts, 335 were found to be endemic for IDDs (total goiter rate >5%).[7]

National survey documented that no state of India is free from ID. In India, it has always been believed that ID is prevalent to significant extent in the Himalayan goiter belt. In recent years studies from outside the conventional goiter belt have also identified endemic foci of ID in other parts of India.[8] There is paucity of data on the status of iodine nutrition among PMs in Indian state of Rajasthan. Against this backdrop, the present cross-sectional study was conducted with an objective to assess the current iodine status among PMs in a district of Rajasthan state, India.

Methods

The present cross-sectional study was conducted during the period January to March 2015 in Tonk district, which is situated in northeastern part of Indian state Rajasthan with 33 districts. In 2006, Tonk was named as one of the country's 250 most backward districts (of 640 districts) by the Ministry of Panchayati Raj.[9]

Calculation of sample size

At national level, various studies have documented the prevalence of goiter in PMs ranging from 0.17% to 45.0%, respectively.[10-16] Hence, for better representation of sample size we purely assumed the anticipated prevalence of goiter as 10%, a confidence level of 95%, power of 80%, absolute precision of 4, and a design effect of 2. A minimum of 510 PMs were estimated to be enrolled in the study after considering a nonresponse rate as 20%.

Sampling procedure

Multistage random sampling technique was adopted for selection of study participants. In the first stage, 1,183 villages were enlisted with their respective population. From the enlisted villages, 30 villages were selected using the population proportionate to size (PPS) sampling methodology recommended by joint consultation of WHO/UNICEF/ICCIDD.[3] Anganwadi centers were identified and enlisted from each selected village. If more than one anganwadi center was located in the selected village, one center was selected randomly. Subjects were included from a cluster till the numbers reached to 17. As 17 PMs from 30 clusters lead us to achieve our sample size of 510. Centers where desired numbers of PMs were not available, adjacent centers were selected to cover estimated sample size. Of the list of subjects enrolled for goiter assessment, six PMs were selected by using simple random sampling for urine and salt samples collection [Figure 1].

Inclusion and exclusion criteria

All the PMs who were present on the day of survey at center were included as participants of the study and those pregnant who were consuming hypertensive drugs that could influence their thyroid status or iodine metabolism were excluded from the study.

Data collection

Convenient date and time was decided for assessment of iodine nutrition status. PMs were prior informed to visit center on appointed date in order to ensure the presence of subjects at center. All the PMs were briefed about the objectives of the study. A pretested semi-structured questionnaire was used to elicit information of personal identification details, age, last menstrual period, and expected date of delivery. The clinical examination of goiter grades was carried out by using palpation method suggested by WHO as a most feasible method for community survey than ultrasonography.[1] Enrolled PMs were clinically assessed for goiter by single investigator. A goiter is a condition when "each of the lateral lobes of the thyroid gland is

larger than the terminal phalanges of the thumb of the person examined."[17] Total goiter rate (TGR) is the sum of subjects with goiter grades 1 and 2. The intraobserver variation was controlled by providing prior trainings, continuous monitoring, and retraining, if required. When in doubt, the immediate lower grade was noted. Goiter grading was done as per the criteria recommended by WHO/UNICEF/ICCIDD.[1] PMs selected for urine samples were provided sterile plastic bottles with screw caps to collect urine sample. These samples were transported to institution laboratory within 24 h of collection and stored at 4ºC to prevent bacterial growth. The analysis of iodine concentration was done within 2 months of collection of urine samples. Subjects selected for salt samples were requested to bring four tea spoons of salt (about 20 g) from their family kitchen. Salt samples were collected in autoseal polythene pouches. Identification details of enrolled PMs were filled in identification slips and kept in the pouches along with collected salt samples. Pouches were stored at an ambient temperature away from direct sunlight.

Biochemical analysis

Urine and salt samples were transported to WHO regional laboratory, Human Nutrition Unit, All India Institute of Medical Sciences, New Delhi for analysis of iodine concentrations. Urine samples were transported in one shipment in cold boxes. Iodine concentrations of urine samples were analyzed by utilizing wet digestion method.[18] Median UIC less than 150 μg/L were considered as the indicator of ID.[1] The iodine content of the salt was analyzed by standard iodometric titration method.[19] Salt samples with iodine content <15 ppm were categorized as samples with inadequate iodine.[1]

Quality control measures

The Internal Quality Control (IQC) methodology was adopted during UIC analysis. A pooled urine sample was prepared. This was considered the IQC sample, and it was stored in a refrigerator. It was analyzed 100 times with standards and blank in duplicate. The mean UIC and standard deviation of the pooled sample were calculated. The 95% confidence interval for the mean UIC of the IQC sample was then calculated. This was used as the operating control range. The methodology adopted was as follows:

Sample mean (X) ±2 SD

X – 2 SD = the lower confidence limit or lower concentration value (LCV)

X + 2 SD = the upper confidence limit or upper concentration value (UCV)

A regular linear graph paper was utilized to prepare Levey–Jennings plot. Figure 2 shows that the operating control range for the IQC sample was 8.9–12.5 μg/L. The mean UIC of the IQC sample was plotted as a continuous horizontal line on the y-axis. The LCV was 8.9 μg/L, which was plotted

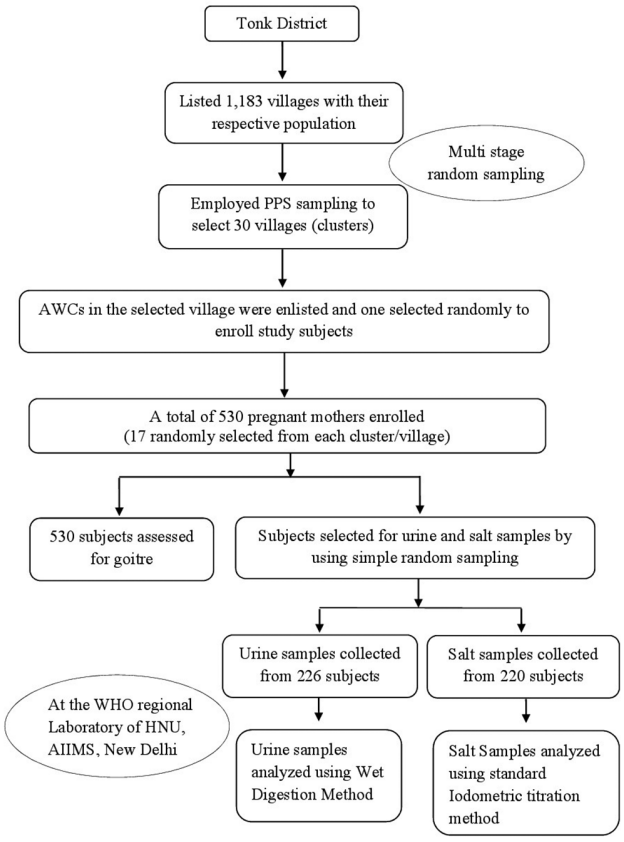

Figure 1: Flow chart of study design

below the mean line on the y-axis scale and the UCV was 12.5 μg/L, plotted above the mean line on the y-axis scale. The x-axis was used to plot the date on which the IQC sample was analyzed. This chart was used to plot the date-specific analysis. The pooled urine sample was analyzed with every batch of samples submitted for UIC estimation. The obtained UIC value of the IQC sample was between the two limit lines of LCV and UCV.[20]

Statistical analysis

SPSS version 22.0 was used for the statistical analysis of data. Categorical data were presented as proportion with 95% of confidence interval. Continuous data were presented as either mean with standard deviation or median with inter quartile range (IQR). Histogram with normal curve was plotted to show the frequency distribution of UIC and iodine content of salt consumed by subjects. A one way analysis of variance (ANOVA) was utilized to determine the difference between the means of age and UIC at Ist, IInd, and IIIrd trimesters, respectively. Chi square was used to compare two proportions whereas Fisher exact was used when the expected value was less than 5 in any cell. Kruskal–Wallis H was used to compare more than three groups whereas Mann–Whitney U was used to compare two groups with nonparametric distribution. The difference was considered significant at P value <0.05. Chi square test and odds ratio (OR) was calculated to document association between goiter, UIC, and salt iodine content.

Ethical consideration

All procedures performed in the study involving human participants were in accordance with the ethical standards and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. Informed written consents were obtained from all the study subjects.

Results

A total of 530 PMs were included in the study. Median (IQR) numbers of the PMs enrolled per cluster were 18 (17–19). The proportion of subjects in Ist, IInd, and IIIrd trimester of pregnancy were 13.8%, 50.4%, 35.8%, respectively. Mean (±SD) age of PMs was 23.4 (±3.3) years. The age of PMs ranged from 18 to 42 years. There was no significant difference in the mean age of PMs with respect to three trimesters of pregnancy ($P = 0.97$).

Total goiter rate

The TGR was found to be 14.2% (95% CI 11.2–17.2), which indicated mild ID as per WHO criteria.[3] Of 75 (14.2%) subjects with goiter, 72 (13.6%) had grade 1 goiter and the remaining had grade 2. Table 1 shows that goiter prevalence was not significantly different in three trimesters ($P = 0.09$).

Urinary iodine concentration

A total of 226 casual urine samples were collected from PMs. Median UIC was found to be 174 μg/L, indicating adequate iodine nutrition status, and the IQR was 116–300 μg/L. Around 33% subjects ($n = 75$) had UIC <150 μg/L, showing ID.

Mean (±SD) UIC did not significantly differ among three trimesters of pregnancy ($P = 0.08$). The median UIC of PMs was 300 μg/L in Ist trimester and it was 174 μg/L in each of IInd, and IIIrd, respectively. The IQR (μg/L) of UIC was 132–300 μg/L, 116–300 μg/L, and 111–272 μg/L in three trimesters, respectively. Subjects with insufficient iodine intake (UIC <150 μg/L) were more in IInd trimester (33.9%) and almost similar in Ist (33.3%) followed by IIIrd (29.6%). The range of UIC was from 66 to >300 μg/L, 5 to >300 μg/L, and 15 to >300 μg/L in Ist, IInd, and IIIrd trimesters, respectively.

Histogram in Figure 3 shows the frequency distribution of UIC of subjects. The mean UIC of 226 urine samples was 192.7 ± 90.6 μg/L. The skew is slighlty negative that showed that more urine samples had their values in category of iodine intake that was more than adequate and excess.

Salt iodine content

A total of 220 salt samples were collected from PMs. Three salt samples (1.4%) had no iodine at consumption level. The proportions of salt samples with inadequate (<15 ppm) and adequate (≥15 ppm) iodine content were found to be 20% and 80%, respectively.

Subjects consuming salt with inadequate iodine were 3.7%, 22.1%, and 22.5% in Ist, IInd, and IIIrd trimesters, respectively. Figure 4 shows the frequency distribution of iodine content of salt consumed by the PMs. The mean iodine of 220 salt samples was 25.5 ± 13.4 ppm. The distribution was symmetrical. Few salt samples had their iodine content at 0 ppm.

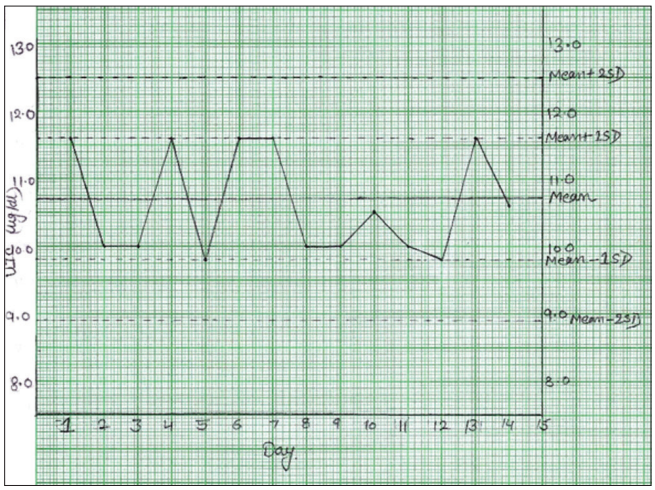

Figure 2: Levey-Jenning plot

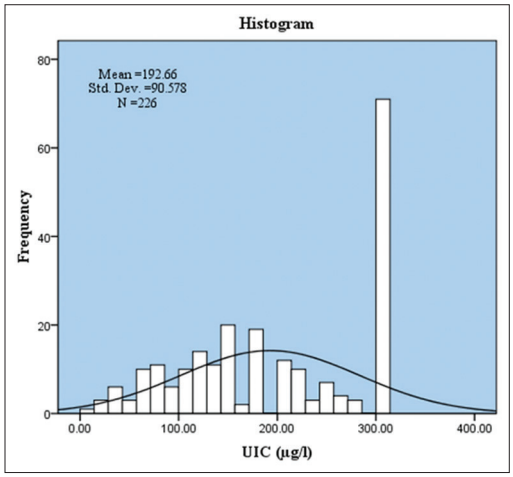

Figure 3: Frequency distribution of urinary iodine concentration of pregnant mothers

Table 1: Goiter prevalence in three trimesters of pregnancy

Parameters	Trimesters of pregnancy			Total (n=530), n (%)	P*
	Ist (n=73), n (%)	IInd (n=267), n (%)	IIIrd (n=190), n (%)		
With TGR	16 (21.9)	32 (12.0)	27 (14.2)	75 (14.2)	P=0.09
Without TGR	57 (78.1)	235 (88.0)	163 (85.8)	455 (85.8)	χ^2=4.66 df=2

*P<0.05. TGR: Total goiter rate

Table 2 depicts that there was no significant difference of means of UIC with respect to categories of subjects consuming salt with iodine content 0, 0.1–14.9, 15.0–29.9, and ≥30 ppm ($P = 0.17$). The median UIC of PMs in different categories of iodine content of salt indicated adequate iodine intake among population. As the iodine content of salt increased, median (IQR) UIC also increased ($P = 0.16$), except in the category of salt without iodine were consumed by the subjects, who had high median UIC that may be due to less sample size in this category. As the iodine content of salt increased the level of starting range also increased from 5 to 40 μg/L.

No significant difference was found in mean UIC of subjects consuming salt with either inadequate or adequate iodine content ($P = 0.42$). The median (IQR) UIC was found to increase as the subject consumption of iodine content of salt increased from inadequate (<15 ppm) to adequate (≥15 ppm) ($P = 0.55$). The minimum value of UIC range also increased as the iodine content of salt increased from inadequate to adequate [Table 3].

The prevalence of goiter was not significantly different with respect to inadequate and adequate category of iodine content of salt consumed by PMs ($P = 0.79$). There was higher prevalence of TGR in those consuming salt with inadequate iodine than those with adequate, which was not statistically significant ($P = 0.79$; OR = 1.13; 95% CI = 0.47–2.67).

There was no significant difference in the prevalence of goiter with respect to UIC <150 and ≥150 μg/L ($P = 0.69$).

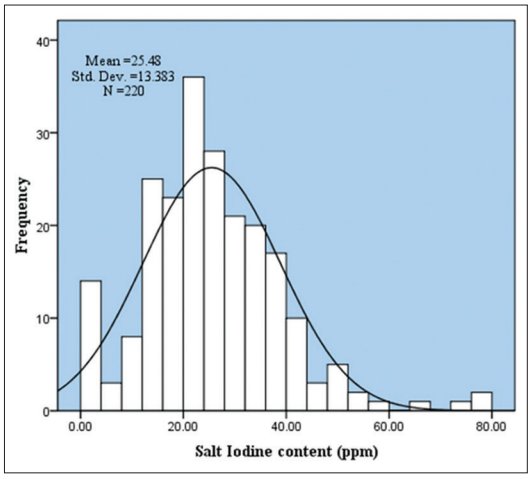

Figure 4: Frequency distribution of iodine content in salt consumed by pregnant mothers

There was higher goiter prevalence in those with inadequate iodine status (UIC <150 μg/L) than those with adequate (UIC ≥150 μg/L), which was not statistically significant ($P = 0.69$; OR = 1.15; 95% CI = 0.57–2.32).

Figures 5 and 6 demonstrate the distribution of UIC among PMs with consumption of salt with iodine content as either inadequate (<15 ppm) or adequate (≥15 ppm). The mean UIC (μg/L) of PMs consuming inadequately iodized salt (180.6 ± 88.5) at their home was slightly less than those consuming adequately iodized salt (188.6 ± 91.5) ($P = 0.42$). There were no major changes observed in the shape of the curve with respect to iodine content of salt.

Discussion

The prevalence of TGR among PMs was found to be 14.2%, which indicates that the study area is mildly endemic for goiter as per WHO criteria.[1] A study from desert area of Rajasthan among 384 PMs found 3.1% goiter prevalence, which indicated that ID is not of public health significance.[14] Recently, Sareen *et al.* documented the TGR as 16.1% among PMs of Udham Singh Nagar (USN), Uttarakhand that is almost similar to our finding[13] whereas in 2003, the similar goiter prevalence (14.2%) was reported in the same areas among 151 rural adolescent PMs.[12] The similar mild endemicity of ID was also found in Solan district (19.9%) of Himachal Pradesh.[15]

Our study found no significant difference in goiter prevalence with respect to trimesters of pregnancy, which is in line with the findings of a study from Bangalore, where no significant differences of thyroid volume was seen with different trimesters of pregnancy.[21]

The present study found the level of median UIC as 174 μg/L implying that IDD was not a public health problem among PMs. Similarly, a recent study from northern India (Ballabgarh, Haryana) showed sufficient iodine intake (median UIC 260 μg/L).[16] Findings of the present study were strongly supported by a study from Bangalore where iodine sufficiency (median UIC 172 μg/L) was found among PMs.[21] Studies from other parts of the country have also documented no ID.[22-24] Previous studies from Rajasthan have shown lower median UIC as compared to the present study.[14,25] Recently, ID was documented in three districts of Uttarakhand[13] and two districts of Himachal Pradesh,[15] respectively.

Table 2: Mean, median (inter quartile range), and range of urinary iodine concentrations in different groups of iodine content of salt consumed by pregnant mothers

UIC (μg/L)	Iodine content of salt (ppm)				*P**
	0 (*n*=2)	0.1-14.9 (*n*=40)	15.0-29.9 (*n*=99)	≥30 (*n*=62)	
Mean±SD	217.05±117.45	178.83±88.40	176.70±90.52	207.74±90.65	0.17
Median and IQR	217; 134-300	162; 111-291	174; 100-300	224; 132-300	0.16
Range	134-300	5->300	15->300	40->300	

*P<0.05. UIC: Urinary iodine concentrations; IQR: Inter quartile range; SD: Standard deviation

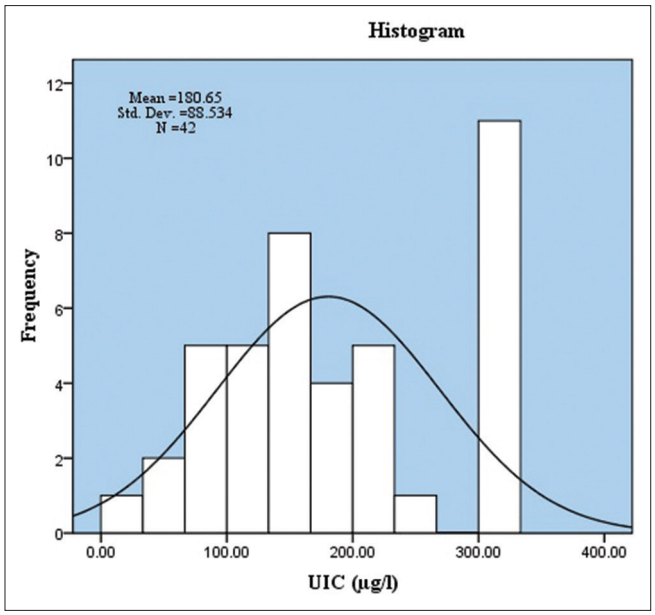

Figure 5: Frequency distribution of UIC in PMs with iodine content <15 ppm

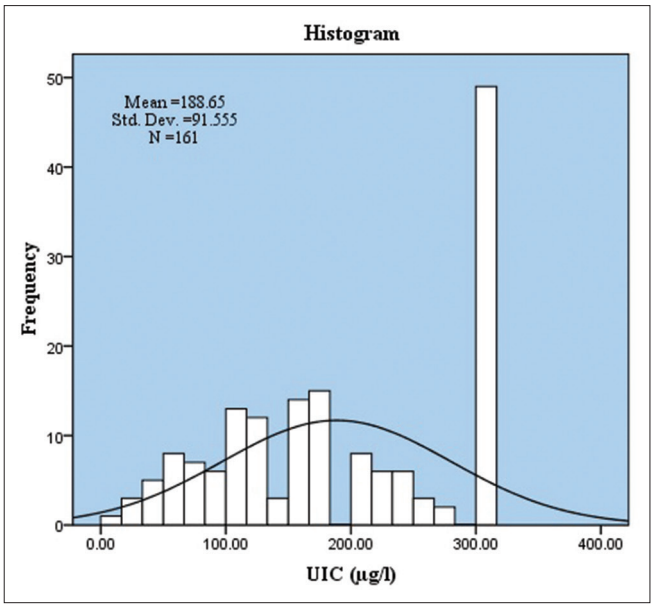

Figure 6: Frequency distribution of UIC in PMs with iodine content ≥15 ppm

Table 3: Mean, median (inter quartile range), and range of urinary iodine concentrations in inadequate (<15 ppm) and adequate (≥15 ppm) iodine content of salt consumed by pregnant mothers

UIC (µg/L)	Iodine content of salt (ppm)		*P**
	<15 (*n*=42)	≥15 (*n*=161)	
Mean±SD	180.65±88.53	188.65±91.55	0.42
Median and IQR	162; 114-300	174; 116-300	0.55
Range	5->300	15->300	

*P<0.05. UIC: Urinary iodine concentrations; IQR: Inter quartile range; SD: Standard deviation

It was found that around 33% of PMs had UIC <150 µg/L. Earlier studies from Jodhpur district, Rajasthan, Kolkata, Haryana reported median UIC less than the optimal value among 58.8%, 56%, 37%, and 38% PMs, respectively.[14,25-27]

The median UIC (174 µg/L) was similar in IInd and IIIrd trimester whereas the level of UIC was more in Ist trimester (300 µg/L). This is strongly supported by a study from Nagpur where Menon *et al.* reported 107 µg/L median UIC at first visit (17 weeks), which reduced to 71 µg/L at second visit (34 weeks) in the same subjects.[28] The authors, Jaiswal *et al.* found no significant difference of median UIC among trimesters[21] and; Grewal found no significant difference in median UIC among Ist (285 µg/L), IInd (318 µg/L), and IIIrd trimesters (304 µg/L) of pregnancy, respectively.[23]

Subjects with inadequate iodine nutrition was found to be more in IInd (33.9%) and IIIrd trimesters (33.3%) followed by Ist (23.6%), which was supported by the study from Kolkata where around 37% and 40% of subjects with insufficient iodine nutrition were in IInd and IIIrd, whereas 30% in Ist trimester, respectively.[26]

WHO/UNICEF/ICCIDD recommends that household coverage of iodized salt should be more than 90%. Whereas our study showed that around 80% of PMs were found to be consuming sufficiently iodized salt that is somewhat not satisfactory. The contrary findings were reported earlier from Jodhpur where around 80% PMs were consuming salt with insufficient iodine.[14] The other study from Rajasthan found that 59.6% of the salt samples with inadequate iodine were consumed by PMs.[25] In Haryana, a nearby state of Rajasthan, more than 70% households were using salt with stipulated iodine, which supports our study findings.[27]

Conclusion

The study concludes that population in Tonk District of Rajasthan State is in transition phase from mild ID (goiter prevalence 14.2%) to sufficiency (median UIC 174 µg/L). There is further necessity to reinforce the regular monitoring and evaluation of the National Iodine Deficiency Disorder Control Program (NIDDCP).

Role of primary care physicians is vital to control ID disorders, by both, early diagnosis and prompt management. This paper will add to the knowledge of primary care physicians in better understanding the parameters utilized to assess iodine nutritional status in the community. Primary care physicians may further contribute in evaluating national program on IDD.

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Conflicts of interest

There are no conflicts of interest.

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