

Status of iodine deficiency among pregnant mothers in Himachal Pradesh, India

Umesh Kapil^{1,*}, Shyam Prakash², Neha Sareen¹, Ajeet Singh Bhadoria¹, Preetika Khenduja¹, Sukirty Nigam¹ and Jyoti Vijay¹

¹Department of Human Nutrition, All India Institute of Medical Sciences, Ansari Nagar, New Delhi – 110029, India:

²Department of Gastroenterology and Human Nutrition, All India Institute of Medical Sciences, New Delhi, India

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Abstract

Objective: Iodine is an essential micronutrient needed for the production of thyroid hormones. Pregnant mothers who are deficient in iodine provide less iodine to the fetal thyroid. This results in low production of thyroid hormones by the fetal thyroid, thereby leading to compromised mental and physical development of the fetus. The current study aimed to assess the current status of iodine nutrition among pregnant mothers in Himachal Pradesh, India, a known endemic region for iodine deficiency.

Design: Three districts, namely Kangra, Kullu and Solan, were selected.

Setting: In each district, thirty clusters (villages) were identified by utilizing the population-proportional-to-size cluster sampling methodology. In each cluster, seventeen pregnant mothers attending the antenatal clinics were included.

Subjects: A total of 1711 pregnant mothers (647 from Kangra, 551 from Kullu and 513 from Solan) were studied. Clinical examination of the thyroid of each pregnant mother was conducted. Spot urine samples were collected from ten pregnant mothers in each cluster. Similarly, salt samples were collected from eleven pregnant mothers in each cluster.

Results: Total goitre rate was 42.2% (Kangra), 42.0% (Kullu) and 19.9% (Solan). The median urinary iodine concentration was 200 µg/l (Kangra), 149 µg/l (Kullu) and 130 µg/l (Solan). The percentage of pregnant mothers consuming adequately iodized salt (iodine content of 15 ppm and more) was found to be 68.3% (Kangra), 60.3% (Kullu) and 48.5% (Solan).

Conclusion: Pregnant mothers in Kullu and Solan districts had iodine deficiency as indicated by a median urinary iodine concentration less than 150 µg/l.

Keywords

Goitre
Iodine-deficiency disorders
Salt iodization
Urinary iodine concentration
Pregnant mothers

Iodine, an essential micronutrient, is required for the production of thyroid hormones and normal *in utero* neurological development. The dietary iodine requirement of pregnant mothers is higher (250 µg/d) than that of normal adults (150 µg/d)⁽¹⁾. During pregnancy, the iodine requirement is increased by 50% due to (i) the physiological increase in maternal and fetal thyroid hormone production and (ii) the increase in renal iodine loss⁽²⁾. The thyroid hormones are crucial for brain and neurological development. The severe form of iodine deficiency leads to cretinism and mental retardation, which are irreversible. If the pregnant mother is iodine deficient, there is decreased synthesis of thyroxine by the fetal thyroid which leads to compromised mental and physical development of the fetus⁽³⁾.

Iodine deficiency affects 2 billion people worldwide and is the main cause of preventable mental impairment.

Every year, 38 million newborns in developing countries are affected by iodine deficiency⁽²⁾. In India, iodine-deficiency disorders (IDD) are a public health problem. Out of the 457 districts in the country, 344 districts have been surveyed for IDD, of which 263 districts have been found to be endemic for IDD⁽⁴⁾. The state of Himachal Pradesh is a known endemic region for iodine deficiency. There are studies available in the literature on the status of iodine nutrition among school-age children; however, there are limited data on the status of iodine nutrition among pregnant mothers from Himachal Pradesh.

The present study was conducted with the objective to assess the current status of iodine nutrition among pregnant mothers in three districts (Kangra, Kullu and Solan) of Himachal Pradesh so that the evidence could be provided to state health authorities of Himachal Pradesh to strengthen the IDD programme, if required.

Materials and methods

Study participants

The study was undertaken in the year 2012 in Himachal Pradesh State. All three geographical regions, namely Kangra, Mandi and Shimla, were included. One district was selected from each region, i.e. Kangra (Kangra region), Kullu (Mandi region) and Solan (Shimla region). The study participants were selected by adopting a two-stage sampling technique. In each district, first thirty clusters (villages) were identified by utilizing population-proportional-to-size sampling methodology as recommended by WHO/UNICEF/International Council for the Control of Iodine Deficiency Disorders (ICCIDD)⁽¹⁾. In the second stage, in each cluster (village), seventeen pregnant mothers who were attending the antenatal clinics were included. Pregnant mothers who were consuming drugs that could influence their thyroid status were excluded from the study.

Clinical thyroid examination

Clinical examination of the thyroid of each pregnant mother was conducted by two trained field investigators. The grading of goitre was done according to the criteria recommended jointly by WHO/UNICEF/ICCIDD: (i) grade 0, not palpable and not visible; (ii) grade I, palpable but not visible; and (iii) grade II, palpable and visible⁽¹⁾. The sum of grades I and II provided the total goitre rate (TGR) in the study population. When in doubt, both investigators recorded the immediate lower grade. The intra- and inter-observer variation was minimized by repeated training of the two field investigators and by random examinations of goitre grades by the first author. The intra-observer variation was 10% and the inter-observer variation was 30% at the beginning of the study. This was minimized to less than 5% by repeated training before the data collection was started.

Laboratory measurements

In each cluster, a minimum of ten pregnant mothers were selected (from pregnant mothers who were enrolled for clinical thyroid examination) and casual urine samples were collected from them into plastic bottles with screw caps. Similarly, a minimum of eleven pregnant mothers were selected and salt samples were collected from them in auto-seal polythene pouches. Pregnant mothers were requested to bring four teaspoons of salt (about 20 g) from their kitchen. The iodine content of the salt was analysed by the standard iodometric titration method⁽⁵⁾.

The urine samples were stored in a refrigerator until analysis. The analysis of urinary iodine concentration (UIC) was done within 2 months using the wet digestion method⁽⁶⁾. Estimations of UIC and the iodine content of salt were done in the laboratory of the Human Nutrition Unit at the All India Institute of Medical Sciences.

Urine samples from Solan were found to have comparatively low UIC values in comparison with samples from Kangra and Kullu, and hence urine samples from Solan District were sent to the reference laboratory of the Indian Council of Medical Research, New Delhi, for re-analysis. In the current paper we present the UIC values obtained by the reference laboratory.

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 analysed twenty-five times with standards and blank in duplicate. The mean UIC and standard deviation of this 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) \pm 2SD

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

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

The operating control range for the IQC sample was between LCV and UCV. A regular linear graph paper was utilized to prepare Levey-Jennings plots. The mean UIC of the IQC sample was plotted as a continuous horizontal line on the y -axis. The LCV was plotted below the mean line on the y -axis scale and the UCV was 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 analysed. This chart was used to plot the date-specific analysis. The pooled urine sample was analysed with every batch of samples submitted for UIC estimation. The UIC was obtained for the IQC sample analysed with each batch. If the UIC value of the IQC sample was between the two limit lines of LCV and UCV, then the UIC test was deemed in control and all results were accepted. If any value of the IQC sample was plotted outside the two limit lines of LCV and UCV, then the test was considered as out of control and the entire batch was repeated⁽⁷⁾.

Sample size

Keeping in view the anticipated prevalence of 5%, confidence level of 90%, absolute precision of 15% and design effect of 2, a sample size of 500 was calculated to be required from each district from thirty clusters; i.e. a minimum of seventeen pregnant mothers from each cluster (510 pregnant mothers from each district). However, the present study included 647 pregnant mothers from Kangra, 551 from Kullu and 513 from Solan.

Results

Total goitre rate

A total of 1711 pregnant mothers were included in the study for clinical examination of the thyroid gland from the districts of Kangra (*n* 647), Kullu (*n* 551) and Solan (*n* 513) in Himachal Pradesh. The mean age of the pregnant mothers was 25.1 (SD 3.3) years (Kangra), 23.3 (SD 3.4) years (Kullu) and 24.7 (SD 3.7) years (Solan).

The prevalence of goitre grade I was found to be 40.2% (Kangra), 41% (Kullu) and 19.7% (Solan). The prevalence of goitre grade II was found to be 2.0% (Kangra), 1.0% (Kullu) and 0.2% (Solan). The TGR was found to be 42.2% (Kangra), 42.0% (Kullu) and 19.9% (Solan) (Table 1).

Urinary iodine concentration

The UIC levels of the pregnant mothers and the percentage of pregnant mothers who consumed adequately iodized salt (salt with iodine content of 15 ppm or more) are depicted in Table 1. A total of 1118 urine samples were collected from the districts of Kangra (*n* 368), Kullu (*n* 439) and Solan (*n* 311). The median UIC levels were 200 µg/l (Kangra), 149 µg/l (Kullu) and 130 µg/l (Solan; Table 1).

The distribution of pregnant mothers according to trimester and the UIC level in each trimester are depicted in Table 2. In Kullu District, the median UIC value of pregnant mothers in the second and third trimester was 140.0 and 145.0 µg/l, respectively; while in Solan District, the median UIC value of pregnant mothers in the first, second and third trimester was 123.7, 135.0 and 132.5 µg/l, respectively. These values are lower than 150 µg/l, indicating iodine deficiency among pregnant mothers of Kullu and Solan districts.

Discussion

Pregnant mothers are the most vulnerable group for iodine deficiency as they have increased requirement for iodine due to the increase in BMR and increased renal excretion of iodine that accompany pregnancy. The assessment of UIC in pregnant mothers provides their current iodine nutritional status. It also suggests the likely occurrence of IDD among their newborns⁽¹⁾. UIC is an indicator of recent dietary intake of iodine in the last 24 h, as most of the iodine absorbed in the body appears in the urine. UIC is currently the most practical biochemical marker for iodine nutrition⁽²⁾. According to the WHO, a median UIC level of <150 µg/l among pregnant mothers indicates iodine deficiency in the community⁽¹⁾. The present study found low iodine status among pregnant mothers in Kullu and Solan districts. This could be due to the consumption of salt with less than 15 ppm iodine (the stipulated level in the country) by more than 30% of the pregnant mothers.

A recent study in the UK has documented that children of mothers who had iodine deficiency during pregnancy are more likely to have low verbal intelligent quotient and poor reading accuracy and comprehension⁽⁸⁾.

We are unable to compare the findings of our study on iodine status among pregnant mothers with other similar studies in India due to a lack of published data.

The TGR in a population indicates past iodine status and chronic low intake of iodine. Earlier studies conducted among pregnant mothers in the neighbouring states of Uttaranchal and Delhi reported a TGR of 15% and 1.9%, respectively^(9,10).

Our earlier studies conducted among school-age children reported a TGR of 12.1% (2000), 19.8% (2007) and 15.8% (2013) in Kangra District, 23.4% (2013) in Kullu District, and 11.3% (1999) and 15.4% (2013) in Solan District⁽¹¹⁻¹⁶⁾.

Table 1 Total goitre rate (TGR), median urinary iodine concentration (UIC) and percentage consuming adequately iodized salt (salt with iodine content of 15 ppm or more) among pregnant mothers in Kangra, Kullu and Solan districts of Himachal Pradesh, India, 2012

	Kangra		Kullu		Solan	
	% or median	<i>n</i>	% or median	<i>n</i>	% or median	<i>n</i>
TGR	42.2	647	42.0	551	19.9	513
Median UIC (µg/l)	200	368	149	439	130	311
Percentage consuming adequately iodized salt	68.3	511	60.3	436	48.5	336

Table 2 Distribution of pregnant mothers in different trimesters of pregnancy and median urinary iodine concentration (UIC) at each trimester in Kangra, Kullu and Solan districts of Himachal Pradesh, India, 2012

Trimester	Kangra (<i>n</i> 368)			Kullu (<i>n</i> 439)			Solan (<i>n</i> 311)		
	<i>n</i>	%	Median UIC (µg/l)	<i>n</i>	%	Median UIC (µg/l)	<i>n</i>	%	Median UIC (µg/l)
First	19	5.2	200.0	46	10.4	162.5	35	11.2	123.7
Second	219	59.5	200.0	263	60.0	140.0	186	59.8	135.0
Third	130	35.3	200.0	130	29.6	145.0	90	29.0	132.5

Limitations of the study

1. The intra- and inter-observer variation in goitre examination was controlled by repeated training and random examination of goitre grades by an expert. However, despite all of the training for quality control, there is still the possibility for misclassification of a normal thyroid gland as goitre grade I and vice versa.
2. We could not assess the size of the thyroid gland using ultrasound due to a lack of resources.
3. Iodine deficiency can be detected using maternal free thyroxine during the first trimester of pregnancy. We could not assess the same due to a lack of resources for this investigation.

Conclusion

The findings of the present study indicate that there is an urgent need to strengthen the IDD control programme for prevention of iodine deficiency among pregnant mothers in Kullu and Solan districts, Himachal Pradesh, as this could lead to IDD among their newborns. This can be achieved by efficient implementation of universal salt iodization with 15 ppm iodine or more.

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Ethics: The project was approved by the All India Institute of Medical Sciences, New Delhi.

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