# Current Iodine Nutritional Status amongst School Age Children in Uttarakhand, India

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Abstract-Background: Uttarakhand state is a known endemic to iodine deficiency. Objective: to assess the current iodine nutritional status amongst School Age Children (6-12 years) in districts: Udham Singh Nagar (USN), Nainital (N) and Pauri (P) of Uttarakhand state, India. Materials and Methods: Thirty clusters from each district were selected by utilizing the population proportionate to size cluster sampling methodology. A total of 6143 School Age Children (SAC) from USN (1807), N (2269) and P (2067) were included. The clinical examination of the thyroid of each child was conducted. Urine and salt samples were collected from a sub samples of SAC enlisted for thyroid clinical examination. Results: The Total Goiter Rate (TGR) were found to be 13.2 (USN), 15.9 (N) and 16.8 (P) percent. The median Urinary Iodine Concentration (UIC) levels were found to be 150µg/L (USN), 125µg/L (N) and 115µg/L (P), respectively. The percentage of SAC consuming salt with iodine content of 15ppm and more was found to be 46.7 (USN), 57.7 (N) and 40.4 (P) percent. Conclusion: The findings of the present study revealed that the SAC in all three districts had adequate iodine nutritional status as revealed by median UIC level of more than 100µg/L.

*Index Terms*—iodine, total goiter rate, urinary iodine concentration level, Uttarakhand, India

# I. INTRODUCTION

Iodine is an essential micronutrient required for production of thyroid hormones. Iodine Deficiency (ID) is the principal factor responsible for abnormal physical and mental development among children [1]. All age groups are affected by ID, but growing children and Pregnant Mothers (PMs) are the most vulnerable as they are sensitive to even marginal ID [2].

World-wide, Iodine Deficiency Disorders (IDD) is public health problem that needs utmost attention [3].

ID affects more than 2 billion people world-wide [4]. People living in an areas affected by severe ID may have an Intelligence Quotient (IQ) of up to 13.5 points below that of those from areas where there is no ID [1]. Iodine Deficiency Disorders has been found to be associated with at least six of the 8 millennium development goals [5]. ID directly affects human resource development which in-turn greatly affects the human productivity and country's development at large.

Iodine Deficiency Disorder (IDD) has been recognized as a major public health problem in India. In India, more than 200 million people are at risk of IDD [6]. Out of 587 districts in the country, 282 have been surveyed for IDD and 241 have been found to be goiter endemic [7]. The surveys conducted by central and state health directorates, Indian Council of Medical Research and medical institutes have demonstrated that not even a single State/UTs is free from problem of IDD [6]. India has made considerable progress towards elimination of IDD [7]. In 1983-84, the Government of India adopted a policy to achieve universal iodization of edible salt by 1992 [8].

Iodine deficiency is a major public health problem in Uttarakhand, India. In 1962, the National Goitre Control Programme was launched in eight hilly districts (Uttarkashi, Chamoli, Pithoragarh, Tehri Garhwal, Pauri Garhwal, Dehradun, Nainital, and Almora) - and in Bijnor district - in Uttarakhand [9]. In State of Uttarakhand - according to NFHS-3 survey - 46% households were using iodized salt with iodine content of 15 ppm or more [8]. Earlier surveys conducted amongst SAC in Uttarakhand districts reported a prevalence of goiter as 38.1% (Udham Singh Nagar) and 6.9% (Nainital), respectively [10], [11].

There is a lack of recent data on magnitude of ID in SAC of Uttarakhand state. Hence, the present study was conducted to assess the current iodine nutritional status amongst SAC in three districts of Uttarakhand state, India. The aim of the study was to provide scientific evidence to the state government, so that the corrective measures can be initiated to improve iodine nutritional status amongst school age children, if required.

# II. METHODOLOGY

The present study was conducted in the year 2013-2014 in state of Uttarakhand, which has 13 districts distributed in three geographical regions namely: Garhwal, Kumaon, and Tarai (plain), one district was selected randomly from each region, i.e., Udham Singh Nagar, Nainital and Pauri, respectively. In each district, 30 clusters were identified by utilizing population proportionate to size sampling methodology recommended by WHO/UNICEF/ICCIDD [1].

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The school enrollment of primary classes was more than 90 percent and hence the school based approach was adopted. All the primary schools in rural and urban area in the district with their respective\child enrollment were Thirty schools (clusters) were selected enlisted. according to population proportionate to size cluster sampling methodology [1]. In each school, the children were briefed about the objectives of the study and the informed consent was undertaken. The date and time for the survey was decided as per the convenience of the school. In each identified school (cluster), 60 children were included using Random Number Table (RNT). In each school, children were serially arranged according to their age groups  $6 \le 8$ ,  $8 \le 10$  and 10-12 years. With the help of RNT, a total of 20 children were selected from each of the age group. If the desired sample of children could not be covered from the selected school, the nearest adjoining school was included to complete the sample size.

#### Α. Clinical Examination

The clinical examination of thyroid of each child was conducted. The grading of the goiter was done according recommended to the criteria jointly bv WHO/UNICEF/ICCIDD (a) Grade 0 - not palpable and not visible (b) Grade I - palpable but not visible (c) Grade II - palpable and visible). When in doubt, all the investigators recorded the immediate lower grade. The intra and inter observer variation was controlled by repeated training and random examinations of goiter grades by the investigator. The sum of Grade I and II provided the Total Goiter Rate of the study population [1].

## **B.** Laboratory Measurements

Urine Sample: From each cluster, "On the spot" urine samples were collected from 19 children selected randomly, with the help of RNT from the list of children enrolled for clinical thyroid examination. Plastic bottles with screw caps were provided to each child for the urine samples. The samples were stored in the refrigerator until analysis. The analysis was done within 2 months. The UIC levels were analyzed using the wet digestion method [12].

Salt Sample: Similarly, a minimum of eighteen SAC were selected and salt samples were collected from them in the auto-seal polythene pouches. They were requested to bring four tea spoons of salt (about 20g) from their kitchen. The iodine content of the salt was analyzed by using standard Iodometric Titration (IT) method [13].

#### Quality Control Measures С.

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)  $\pm 2$  (SD)

The X - 2(SD) = The lower confidence limit or Lower Concentration Value (LCV)

X + 2(SD) = The upper confidence limit or Upper Concentration Value (UCV)

# The operating control range for 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 [14].

# D. Sample Size

Keeping in view the anticipated prevalence of 15%, a confidence level of 95%, absolute precision of 2.0, and a design effect of 1.5, a total sample size of 1800 was calculated for each district. We included 1807 (Udham Singh Nagar), 2269 (Nainital) and 2067 (Pauri Garhwal) of SAC in the present study.

## E. Ethical Clearance

The project was approved by ethical committee of All India Institute of Medical Sciences, New Delhi.

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Parameters	Udham Singh Nagar (n=1807)	Nainital (n=2269)	Pauri (n=2067)
Goitre Grade			
0	1568(86.7)	1908(84.0)	1719(83.2)
Ι	235(13.0)	361(15.9)	346(16.7)
II	4(0.2)	0	2(0.1)
Total Goitre Grade (TGR)	239(13.2)	361(15.9)	348(16.8)
Urinary Iodine Concentration level (µg/l)	(n=587)	(n=611)	(n=580)
<20	0	0	0
20-49.9	35(6.0)	72(118)	147(25.3)
50-99.9	125(21.2)	152(24.9)	100(17.2)
>100	427(72.7)	387(63.3)	333(57.4)
Median UIC	150	125	115
Iodine content of salt (ppm)	(n=660)	(n=642)	(n=562)
<15	352(53.3)	271(42.3)	335(59.6)
15 and more	308(46.7)	371(57.7)	227(40.4)
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TABLE I. TOTAL GOITRE RATE, MEDIAN URINARY IODINE CONCENTRATION AND PERCENTAGE CONSUMING ADEQUATELY IODIZED SALT AMONG SCHOOL AGE CHILDREN IN UTTARAKHAND, INDIA

Figures in parenthesis denotes the percentages

# III. RESULTS

## A. Total Goiter Rate

A total of 6143 SAC were included in the study for clinical examination of the thyroid gland from the districts of Udham Singh Nagar (n=1807), Nainital; (n=2269) and Pauri (n=2067). The TGR was found to be 13.2% (USN), 15.9% (N) and 16.8% (P), respectively (Table I).

## B. Urinary Iodine Concentration

The UIC levels and percentage of iodized salt (salt with iodine content of 15 ppm or more) consumed by SAC is depicted in Table I.

A total of 1778 urine samples were collected from districts of Udham Singh Nagar (n=587), Nainital (n=611) and Pauri (n=580). The median UIC levels were found to be  $150 \,\mu\text{g/l}$  (USN),  $125 \,\mu\text{g/l}$  (N) and  $115 \,\mu\text{g/l}$  (P), respectively (Fig. 1).



Figure 1. Median urinary iodine concentration level among school age children in Udham Singh Nagar, Nainital and Pauri Districts of Uttarakhand. India

# IV. DISCUSSION

According to WHO/UNICEF/ICCIDD, if >5% schoolage children (6-12 years) are suffering from goiter, the population should be classified as endemic to ID. The present study found TGR as 13.2% (USN), 15.9% (N) and 16.8% (P), respectively indicating that the population had mild iodine deficiency. Earlier studies conducted amongst SAC reported the TGR as 38.1 (USN), 6.9% (N), 3.7% (N), respectively [10], [11], [15].

The TGR in a population indicates past iodine status and chronic low intake of iodine and median UIC level indicates the current intake of iodine. Urinary Iodine Concentration is currently the most practical biochemical marker for iodine nutrition. According to WHO/UNICEF/ICCIDD, the median UIC level of <100 µg/l amongst SAC indicates ID in the community [1]. The present study found median UIC level of >100 µg/l amongst SAC in all the three districts surveyed indicating adequate iodine nutritional status. Earlier studies conducted in the year 1999 and 2003 from adjoining districts reported the median UIC level of 175µg/l and 110µg/l, respectively [16], [17].

A recent study conducted in United Kingdom 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 [18].

In Uttarakhand state, the use of adequately iodized salt by the population has decreased from 60% in NFHS-2 (1989-99) to 46% in NFHS-3 (2005-06) [8]. Similarly, in the present study only 46.7 (USN), 57.7 (N) and 40.4 (P) percent of families were consuming salt with iodine content of 15ppm and more. Thus, the increase in TGR in all the three districts surveyed could be due to consumption of salt with low iodine content by a higher percentage of population.

Thus, Urinary Iodine Concentration indicates the current iodine status and TGR indicates past chronic iodine status. Thus in the present study, UIC levels were adequate and TGR was more than 5%, indicating that the three districts in Uttarakhand are in the transition phase from iodine insufficiency (as revealed by TGR) to iodine sufficient nutriture (as revealed by median UIC levels).

# V. CONCLUSION

Findings of the present study documented the successful implementation of iodized salt in three districts of Uttarakhand. There is a need of sustaining the efforts of universal salt iodization, so that the school age children have adequate iodine content in their diet.

#### VI. LIMITATIONS OF THE STUDY

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 grades I and vice versa.

We could not assess the size of the thyroid gland using ultrasound due to a lack of resources.

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