

Socio-demographic characteristics and Iodine status of the school-going children of Suryodaya Municipality, Ilam

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Iodine Deficiency Disorder (IDD) is a major micronutrient deficiency problem in Nepal. This study was conducted to measure the Urinary Iodine Excretion (UIE) and attempts were made to relate urinary iodine with salt use and other sociodemographic variables of the household of primary school children of Suryodaya municipality of Ilam district of Nepal. A community-based cross-section study was conducted in two schools of study area selected randomly (lottery method). A total of 202 school children of 6-12 years were recruited for the study to collect urine and salt samples for Urine Iodine Content (UIC) and Salt Iodine Content (SIC) measurement respectively and detail information of the study population was achieved from their household. UIC was measured by ammonium persulphate digestion microplate (APDM) method and SIC was estimated by rapid test kit (RTK). Data were expressed in frequency, mean±SD, and median (IQR) according to the nature of data. Chi-square test, Mann-Whitney U test, and Kruskal-Wallis test were used to test the significance considering $p \leq 0.05$ at 95% confidence interval. It was found that the Median UIC of the study population was 152.14 µg/L. Overall; it was found that 30.7% of children had a urine iodine level less than the normal WHO levels. The availability of adequately iodized salt was 93.1% as measured by RTK. There was a statically significant association between consumed salt iodine content and urine iodine excretion level ($P < 0.05$).

Keywords: Iodine deficiency disorder, urinary iodine excretion, urine iodine content, salt iodine content

Introduction

Iodine is a micronutrient which is essential for human growth and normal functioning of the body and is needed in very small quantity regularly. Iodine deficiency is a major public health problem throughout the world, particularly in developing countries. A deficiency of iodine leads to hypothyroidism, impaired mental and physical development in infants, children and adolescents, goiter, impaired mental function and reduced productivity in adults (UNCEF,2002) and an increased risk of spontaneous abortion, stillbirths, and congenital abnormalities in pregnancy (WHO, 2012).

World Health Organization (WHO) estimated the worldwide prevalence of iodine deficiency using urinary iodine excretion (UIE) data collected for 92% of the world's population in the period from 1993 to 2003. Nearly two billion individuals have inadequate (UIE <100 µg/L) iodine nutrition, and the occurrence of iodine deficiency was observed in 36.4% of school-going children (WHO, 2007). Iodine deficiency is a major public health problem in Nepal, 19.4% of school-going children are at risk. The prevalence of iodine deficiency in hilly and plain regions is 18.9 % and 9.5% respectively shown by previous studies (Gelal *et al.*, 2010). The age group recommended by WHO for IDD survey was 6 - 12 years. This age group was recommended to be used in the surveys in all the countries because children in this age group have a high vulnerability, easy access, and also, affected children develop an enlarged thyroid, in response to iodine deficiency and can be readily examined in large numbers in school settings (ICCIDD *et al.*, 2007) and as a representation of iodine deficiency in the community (Biswas *et al.*,2006). " Several attempts have been made by the Government of Nepal to combat IDD by fortifying

salt with iodine, but the problem still persist, especially in Hilly and Mountainous region of Nepal"(MoHP, 2005 & 2007). This study is designed to access iodine nutrition status in Suryodaya municipality of Ilam by using different indicators i.e. UIE and Salt Iodine Content (SIC).

Materials and methods

Research design

The cross-sectional design was used to collect primary data from the selected sample by taking urine and salt samples of school-going children; household survey with the help of semi-structured questionnaires.

Study area

Study area was Suryodaya municipality of Ilam (VDCs- Phikkal, Panchakanya, and Kanyam), Nepal which has an elevation of 5135 ft with the total population of 17,240.

Descriptive statistics of schools

Out of a total of 202 school going children, 127(62.9%) children were enrolled from Saijyoti English Boarding school and 75 (37.1%) from Shree Krishna Uchha Ma Vi. A total of 121 (59.9%) were boys and 81 (40.1%) were girls.

Study variable

Dependent variable were Urinary Iodine Excretion and Salt Iodine content and **Independent variables** are socio-economic and demographic variables (head of households, ethnicity, religion, family size, income, education, occupation); Child characteristics (age, sex, height weight); Kitchen practices (a type of salt, type of salt container, time of adding salt while cooking, place of the store).

Sampling technique and target population

A simple random sampling procedure (lottery method) was used in the study. Two schools were randomly selected from the community. All school children (age group 6-12) from class 1 to 5 were selected as a study population. The total sample size was 202.

Exclusion criteria

Schools having the current history of micronutrient supplements, Children having a severe illness, Children who did not want to participate in the study

Sample size

The calculation of the sample size was done by using the statistical formula,

$$n = t^2 \cdot P \cdot (1-P) / m^2$$

Where, n = required sample size, t= confidence interval at 95% (standard value of 1.96), p=estimated prevalence of IDD, m = margin of error at 5% (standard value of 0.05) (Galel et al., 2009).

Research instrument

Equipment needed for performing the survey were: Child weighing machines (Seca scale):- Child weighing machines having a capacity of 100kg; Height measuring stand (Stadiometer):- The height measuring tape of 5ft capacity; Questionnaire: - A well-designed set of questionnaire to collect information on household characteristics, food availability and its consumption, health facility, etc.; Urine vile, plastic pouch for salt collection, rapid iodine test kit and icebox; Instrument used during analysis: Multi pipette, Sealing cassette, Microtitre reader.

Pre-testing

The pre-testing was conducted to establish the accuracy of the questionnaire and to check for consistency in the interpretation of questions and to identify ambiguous items. After a review of instruments, all suggested changes were made before being administered in the actual study.

Validity and reliability

The instruments were validated by a group of professionals from Department of Nutrition and Dietetics, Central Campus of Technology, The aspects tested in the questionnaire were also drawn from the available literature in nutrition education for young children. The questionnaire was also pre-tested before data collection to ascertain content and face validity. The questionnaire was checked daily for completeness, consistency, and clarity as mentioned earlier.

Data collection techniques: Before the sample collection, the purpose of the visit was explained to the Principal of the School. Students and parents were informed by the Principal regarding the purpose of the study.

Anthropometric measurements include height and weight

The **height** of the children was taken using a portable stadiometer calibrated in centimeters (cm) without shoes on a flat floor. A good standing posture was maintained before measurement. The heels were pulled together touching the base of the wall. The head was erect and hands naturally hung at their sides. The child's line of sight was in level with the ground for accuracy. The measurements were taken to the nearest 0.1 cm. after the head piece was placed on the head of each subject; the reading was taken to the nearest 0.1 cm.

The **weight** of the children with minimum clothing was taken using a Salter beam balance to the nearest 0.1 kg. Ages were recorded from the school records on admission.

Salt sample

Detailed instructions were given to children and were instructed to bring two teaspoonfuls (approximately 15 gram) salt samples from their houses which they used for everyday purposes. Each child was provided a clean, moisture-free, tightly closing plastic pouch to bring the sample prior one day of salt sample collection.

Urine sample

Spot urine samples were collected from all the eligible children in a clean, numbered, tightly screw-capped 15 milliliters plastic vial. The were transported in an ice pack to the biochemistry laboratory of BPKIHS and were analyzed by using ammonium persulfate digestion microplate method (ICCIDD *et al.*,2007).

Semi structured questionnaire

The questionnaires comprised mainly of details on household profiles like age, sex, education level and occupation of household members and household size, type of salt, consumption of goitrogenic food, etc. The interview was conducted with parents/care takers of the children to fill the questionnaire.

Data analysis

Microsoft Excel and IBM SPSS Statistics version 20.0 were used. Descriptive statistics (Frequency, Mean & Standard Deviation, and Median & Inter Quartile Range) and inferential statistics (Chi Square Test, Student's t-test, Mann-Whitney U test, and Kruskal-Wallis test) were applied whenever they needed at 95 % to 99 % significance level.

Chemical analysis of urine sample

Iodine concentration in the urine sample was measured by the ammonium persulphate digestion microplate method (Galel *et al.*, 2009). Briefly, to 50µL calibrators and urine samples in wells of a microtitre plate, 100µL fresh ammonium persulphate solution (35% w/v) was added. After that, Plate was set in sealing cassette, closed tightly, and was kept in an oven at temperature 110°C for 60 min for digestion. It was then cooled, opened and 50µL

of digested aliquot was transferred into other

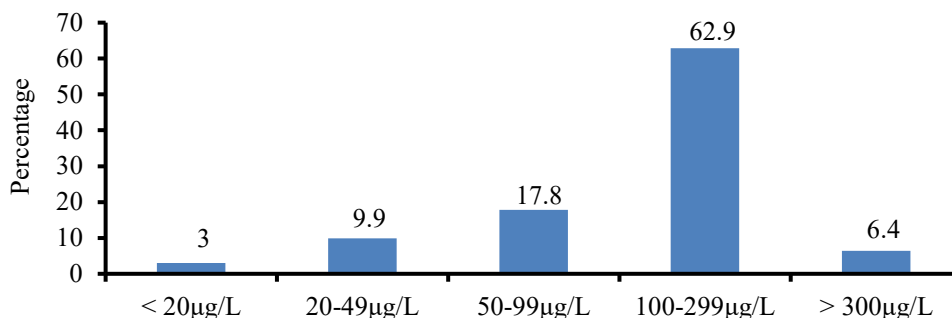


Figure 1. Iodine status of school going children

corresponding wells of the next plate. Then, 100µL arsenious acid solution (1% w/v, 0.05 mol/L) was added to each well and mixed properly followed by addition of 50µL ferric ammonium sulphate solution (1.2% w/v, 0.02 mol/L) in each well (within 1 min after addition of Arsenious acid solution) using multichannel pipette. The mixture was left for 30 min at 25°C. Finally, absorbance was measured at 405nm with a microtitre plate reader.

Standard iodine standard solution (100µg I/ml)

From stock solution (168.8 mg of KIO₃ per 100 mL), working solutions of 25 - 600 µg I/mL were prepared by diluting with distilled water.

Qualitative analysis of salt iodine content

Measurement of salt iodine content was carried out by MBI rapid test kit. Two drops of test solution were added on the surface of the salt from the white ampoules by gently squeezing. Color on the salt was compared with the color chart. Iodine content in salt was determined by comparing color between salt and color chart. (No color- No iodine; Light blue color <15 ppm iodine ; Dark blue color >15 ppm iodine).

Results and Discussion

Descriptive characteristics of school going children

The mean age group of study population (202) was found to be 9.51 ± 1.60 years where as mean height was 130.20 ± 14.07 cm and mean weight was 26.74 ± 6.90 kg.

Socio-demographic characteristic of house hold of school going children

The majority of the school children were non-vegetarian 176 (87.1%) and only 26 (12.9%) were vegetarian.

Among them, 93.1% of house heads were literate and only 6.9% were illiterate. All the families had heard of the iodized salt (*aayo nun*) with two child logo whereas NIDDS survey, 2005 had shown that 82.3% in Eastern and Central Hills had heard, and IDD survey 2007 had shown that 83% of the study population in nation level

had heard about iodized salt. On the contrary, only 63.4% of households knew the importance of iodized salt as compared to 75% of respondents of IDD survey 2007. The religion distribution showed mixed composition with a higher percentage of Hindu (59.9%), followed by Buddhist (24.8%), Kirat (11.4%), and Christian (8%).

The survey showed, 51.5% of the family head engaged in Agriculture, followed by Business (29.75%), Service (11.9%), and other (6.9%) respectively. Mean family size was 5.79±0.76 and mean food secured months in a year was 11.25±1.32 months. The survey revealed the fact that Goitrogenic food was not common in this study area. Gelal *et al* 2010, showed that in eastern hills, 16.5% of schools going children’s were Iodine deficient.

Type of salt for household consumption and livestock

Out of 202 salt samples, 196 (97%) used packet salt and 6 (3.0%) open salt for their consumption in their households, which showed the greatest achievement of the availability of packet salt in that area. The availability of packet salt was only 3.8% in Eastern Hills (NMSS, 1998) whereas the NIDDS survey 2005 reported 46.9% of study population in Eastern and central Hills used iodized packet salt. The IDD survey 2007 illuminated that the use of iodized packet salt was 29.0% in Eastern Hills.

Table 1
Iodine of salt content affecting by different factors

Statistics	Subgroup	Iodine content of salt			P value*
		>15ppm (n=188)	<15ppm (n=11)	0 ppm (n=3)	
Salt container	Air Tight Container	180 (95.7%)	6 (54.5%)	1 (33.3%)	0.001
	Open Container	8 (4.3%)	5(45.5%)	2 (66.6%)	
Salt storage in kitchen	Shelf	152 (80.9%)	2 (18.2%)	1 (33.3%)	0.001
	Window Plane	18 (9.6%)	6 (54.5%)	2 (66.7%)	
	Near Fire	18 (9.6%)	3 (27.3%)	0 (0.0%)	

Table 2

Comparison of UIE among different demographic characteristics.

Group	Subgroup	UIE ($\mu\text{g/L}$)			P Value*
		Median	Percentile 25	Percentile 75	
Dietary habit	Veg	172.95	102.52	248.44	0.394
	Non Veg	145.17	78.75	212.09	
Education status	Literate	158.10	90.86	217.94	0.327
	Illiterate	83.55	61.88	239.39	
Importance	Yes	149.81	88.97	209.21	0.838
	No	160.51	72.41	233.10	
Livestock	Yes	196.61	145.17	242.59	0.015
	No	139.49	75.10	210.65	
Type of salt for household	Packet salt	159.30	86.14	220.91	0.041
	Open salt	83.55	61.88	133.91	
Type of salt for livestock	Packet Salt	94.69	94.69	116.74	0.067
	Open Salt	142.88	74.20	212.09	
Religion	Buddhist	128.45	76.01	206.35	0.030
	Kirat	92.77	61.88	203.53	
	Christain	161.24	78.29	203.65	
	Hindu	174.15	102.52	233.10	

Type of salt for household consumption and livestock

Out of 202 salt samples, 196 (97%) used packet salt and 6 (3.0%) open salt for their consumption in their households, which showed the greatest achievement of the availability of packet salt in that area. The availability of packet salt was only 3.8% in Eastern Hills (NMSS, 1998) whereas the NIDDS survey 2005 reported 46.9% of study population in Eastern and central Hills used iodized packet salt. The IDD survey 2007 illuminated that the use of iodized packet salt was 29.0% in Eastern Hills.

Type of salt used for livestock in household

Out of 202 samples, 34 (16.8 %) had no livestock in their households, the remaining 163 (80.7%) households used open salt for livestock and only 5 (2.5%) used packet salt for their livestock. This finding was comparable with the finding of NIDDS survey, 2005 in Eastern and central Hills in which 20.4% of households used iodized salt and 44.4% used open salt for live stocks.

Salt related practices in household of participants

Salt practices in household varied widely in respect to their container used for storing, place of storing in kitchen, and time of adding salt in food while cooking. All these factors directly or indirectly affect the iodine content in salt and its availability for us. Majority, 126 (62.4%) added salt in food in the beginning while cooking food,

only a few 9 (4.5%) added at the end, and rest of the household added in the middle of the cooking. Most of the households 155 (76.7%) used a wooden shelf to store salt while remaining kept near fireplace (10.39 %) and in window plane (12.87%). The majority of household 187 (92.6 %) used air tight containers for storage of salt and 15 (7.4%) used open for storage.

Salt iodine content (SIC) of salt samples tested by rapid kit test

The household consuming adequately iodized salt (SIC >15 ppm) were 93.1%, whereas 5.4% (SIC < 15 ppm) and 1.5% household were using salt having SCI 0 ppm .

Table 3

Comparison of UIE among different salt using practices

Group	Subgroup	UIE ($\mu\text{g/L}$)			P Value
		Median	Percentile 25	Percentile 75	
Salt container	Air Tight Container	159.30	87.07	220.91	0.189*
	Open Container	51.72	51.72	51.72	
Salt storage in kitchen	Shelf	152.15	81.49	217.94	0.883**
	Window Plane	138.39	92.77	220.91	
Time of adding salt while cooking	Near Fire	187.14	90.86	212.09	0.301**
	Beginning	158.10	76.01	223.91	
	During	159.30	94.69	212.09	
	At the End	90.86	49.71	145.17	

**Kruskal Wallis test was applied to test the statistical significance between the groups; *Mann Whitney U test was applied to test the statistical significance between the groups.

NMSS, 1998 reported that 50.6% salt samples from the Eastern Hills had adequate iodine but NIDDS, 2005 found the only 63.4% salt samples from Eastern and Central Hills were adequately iodized. Adequately iodized salt was present in 77% of households in 2006 and 80% of households in 2011 (MOHP, 2005). The adequately iodized salt was 81.3% in Dhankuta and 89.6% in Dharan (Gelal *et al.*, 2009). Also this study illuminated the fact that Eastern Nepal is continuously progressing towards the sustainable elimination of iodine deficiency disease as illustrated by a normal median UIE and the majority of households consuming adequately iodized packet salt.

Median urine iodine excretion (UIE)

Median UIE of the study population was 152.14 µg/L which indicated the adequate iodine intake and optimal iodine status of the population. Iodine status of the area was lower than the result of a national survey and the study conducted in western Nepal. The median UIE measured at a national level was 193.10 µg/L (Gelal *et al.*, 2009); at Dharan city was 157.1 µg/L (Gelal *et al.*, 2010); Dhankuta and Sunsari districts were 238.00 µg/L and 294.96 µg/L respectively (Chaudhari *et al.*, 2012).

Iodine status of the school going children

The proportion of school children (fig. 1) with some degree of iodine deficiency (UIE <100 µg/L) is 30.7% (n=62) which is comparable (25.3%) to all hills reported in NMSS 1998 in all Hills, 27.3% in eastern and Central Hills in NIDDS, 2005 and 18.9% in Eastern Terai in IDD survey 2007. According to Gelal *et al* 2009, in school going children in Dhankuta and Dharan district of eastern Nepal found that 22.0% of the study population had shown to be iodine deficient (UIE <100 µg/L). Gelal *et al* 2010, showed that in eastern hills, 16.5% of schools going children's were Iodine deficient.

Factors affecting salt iodine content (SIC)

From chi-square test analysis, it was found that there is a statically significant (p<0.001) association between a salt container and SIC i.e salt samples stored in air tight container had a higher amount of iodine as compared to open container. Statically significant (p<0.001) association was found between the place of salt storage in kitchen and iodine content of salt. There's a significant (p<0.5) difference between salt iodine content in the salt samples stored in shelf as compared to the window plane and near fire. Salt containers stored in the shelf had a higher concentration of iodine as compared to salt stored in window planes or near a fire.

Factors affecting urinary iodine excretion

Demographic factors affecting urinary iodine excretion

The Mann Whitney test revealed that the households having livestock (P = 0.015), type of salt for households (p=0.041), and religion (p=0.03) was significantly associated with median UIE. While there was no significant association between annual dietary habit (P=0.394), parents' educational status (P=0.0327, knowing the importance of iodized salt (P=0.388), and type salt for livestock (P=0.067) with median UIE. (table 2).

Salt using practices affecting urinary iodine concentration (UIE)

The time of adding salt while cooking (p=0.301) and place of salt storage in the kitchen (p=0.883) salt container (p=0.626) were not significantly associated with UIE. (table 3).

Association between salt iodine content (SIC) and urine iodine excretion (UIE)

There was a significant (p =0.025) correlation between iodine intake (indicated by the SIC consumed) and UIE. UIE level increases among individuals consuming salt that contain more iodine. The median UIE level was high among school going children from households consuming adequately iodized salt. (table 4)

Table 4

Association between SIC and UIE

Statistics	Categories	Median UIE (µg/L)	P Value**
Iodine content of salt	>15ppm	159.30	0.025
	<15ppm	133.91	
	0ppm	92.77	

**Kruskal Wallis test was applied to test the statistical significance between the groups

Conclusion

The majority of the school children consumed packet salt (97%) and the household with salt iodine concentration >15 ppm. was 93.1%; which shows the greatest achievement of the availability of packet salt in that Suryodaya Municipality, Ilam. The iodine content of the salt and Urine Iodine Excretion (UIE) were significantly associated. The time of adding salt while cooking, place of salt storage in the kitchen, and salt container type are not significantly associated with UIE. Salt stored in air tight containers had a higher amount of iodine as compared to open containers. Similarly, salt stored in the shelf of the kitchen showed higher iodine content than salt kept in window plane and near a fire. The survey revealed the fact that Goitrogenic food was not common in the study area, therefore there was no effect of goitrogenic food in median UIE. The findings of this study are of great importance as they identify potential actions that can be taken for the improvement of iodine status children. A number of populations at this municipality still uses crystal salt which is insufficient in iodine. Awareness about the importance of iodized salt is required in areas.

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