Assessment of Iodine Status among Hostel Employees and Students of a University in Islamabad, Pakistan

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Summary: Iodine deficiency and related disorders are the major health hazard in the world, especially along the Himalayas. A study has been carried out to assess the status of iodine in students and employees living in the hilly area in the premises of a university in Islamabad, Pakistan. The study was carried out for 76 students living in university hostels and 32 employees serving in the hostels. Urinary iodide excretion (UIE) was used as the biochemical marker of iodine concentration in the donors. Catalytic kinetic method based on Sandell–Kolthoff reaction was employed for the measurement of iodine concentration in the samples of urine. Out of 76 students, 8% had UIE ≥ 100 μg/L, while 39% had between 50-99 μg/L, 49% had between 20-49 μg/L and 4% had < 20 μg/L, resulting in mild, moderate and severe iodine deficiency, respectively. Similarly, out of 32 employees, 22% had UIE ≥ 100 μg/L while 28% had between 50-99 μg/L, 44% had between 20-49 μg/L and 6% had < 20 μg/L, resulting in mild, moderate and severe iodine deficiency, respectively. Target groups of the study area were iodine deficient, indicating mild to severe iodine deficiency. The iodine level in the employees was relatively better than that in the students. Improvement of iodine status is recommended among the students and employees by the mandatory use of iodized salt in all the cafeterias of the university.

Introduction

Iodine deficiency has been recognized as the cause of many disorders that include brain damage, intellectual impairment, stillbirths, abortions, cretinism, mental retardation, goitre, abortion, congenital anomalies, low birth weight, etc. [1]. Iodine is required for regulation of cell metabolism throughout the life cycle and normal growth, especially of the brain, which occurs from foetal life to the end of postnatal year [2]. Iodine deficiency leads to lower metabolic rate, growth retardation, brain damage, and increased prenatal mortality, all these result in impaired thyroid function [3]. The prevalence of these disorders depends on the level of iodine concentration in human body.

The soil of Pakistan has low level of iodine, specifically the soil of northern parts of the country. The great arc of Himalayas from Pakistan across India and Nepal, into Northern Thailand and Vietnam and into Indonesia is one of most highly endemic regions of the world [4]. Iodine deficiency creates a disease called goitre (an enlargement of thyroid gland) [5]. Globally 2.2 billion people (38% of the world's population) live in areas with iodine deficiency and are at risk from goitre complications [6]. Most of iodine absorbed in the body eventually appears in urine, so UIE (urinary iodine excretion) is a good marker of very recent dietary intake [7]. In individuals, UIE can vary somewhat from day to day, even within a given day, but this variation tends to damp out in populations. The iodine concentration in urine specimens provides an adequate assessment of a population's iodine nutrition [8].

Several instrumental methods such as, high performance liquid chromatography (HPLC), spectrophotometery, neutron activation analysis, *etc.* have been applied for the determination of iodine in various media such as natural waters, milk, urine, *etc.* [9-14]. Spectrophotometric methods based on Sandell-Kolthoff have found widespread applications for the determination of iodine concentrations in urine and milk samples [11, 15]. The method depends on iodide's role as catalyst in the reduction of ceric ions in ammonium cerium sulfate having yellow colour to colourless cerous ions in the presence of arsenious acid, which is shown by the equation as:

$$2Ce^{4+} + As^{3+} \rightarrow 2Ce^{3+} + As^{5+}$$

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Organic substances in urine can be decomposed by many oxidizing agents [12, 16], and the mostly used one is ammonium persulfate.

Present study was designed to investigate the iodine concentration status among the students residing in the bachelor hostels of Pakistan Institute of Engineering and Applied Sciences (PIEAS), which has a degree awarding status of a university. In the following text "university" means PIEAS.

Results and Discussion

The performance of the reagents and measuring system was judged through various testing parameters, the results of those are given as follows: The sensitivity of the method was determined to be 1.33 µg/L. The mean percentage recovery for 30 samples was 99.01%, having range as 84-118% and the coefficient of variance (CV) was 8.78%. The inter assay precision of the two samples showed the values of CV as 2.58% and 7.97%, whereas those of four samples depict the value CV as 10%. The value of control material was reproduced as 303 µg/ L with 3.95% CV against the supplier value of 304 (270–338) µg/L. A linear regression line on the calibration plot was drawn and the value of correlation coefficient R was obtained as R^2 = 99%. The determination of urinary iodine concentration was based on the calibration curve.

The urine samples and standard solutions were analyzed in duplicate in order to reduce the experimental error. The minimum, maximum, mean, and standard deviation in the concentration values of iodine in the urine samples of each of the group mentioned are given in Table-1. For the assessment of the severity of iodine deficiency in the donors, the criteria given by WHO (World Health Organization), UNICEF (United Nations Children's Fund) and ICCIDD (International Council for the Control of Iodine Deficiency Disorders) were followed [17-19]. The distribution of urinary iodine concentration in the study groups along with the epidemiological criteria based on the guidelines of WHO/UNICEF/ICCIDD are given in Table-2. The results were prepared on the bases of the criteria of these agencies and are shown in Fig. 1 for all the three category of people.

The mean values of UIE determined as 53.6, 69.8 and 78.5 µg/L for the Groups A, B, and C, respectively, given in Table-1, show that the hostel

Table1: Iodine concentration (µg/L) in different category of people.

Statistical value	Group A	Group B	Group C
No. of samples	54	22	32
Minimum	03	17	12
Maximum	318	147	443
Median	48.5	48	47.5
Mean	53.6	69.8	78.5
SD	43.1	31.8	92.7

Table 2: Distribution of urinary iodine concentration in the study groups according to epidemiological criteria based on the guidelines of WHO/ UNICEF/ ICCIDD [19].

Urinary Iodine concentration (µg/L)				Concentration level
WHO/ICCIDD	Group A N (%)	Group B N (%)	Group C N (%)	
< 20	2 (4%)	1 (5%)	2 (6%)	Severe deficiency
20–49	26 (48%)	11 (50%)	14 (44%)	Moderate deficiency
50–99	22 (41%)	8 (36%)	9 (28%)	Mild deficiency
100–199	4 (7%)	2 (9%)	7 (22%)	Optimal
200–299				More than adequate
> 299				Possible excess

employees are more iodine deficient than the students in the hostels. Urinary iodide values from populations usually do not follow normal distribution; therefore the estimation based on mean values is not a true reflection of the results. The median rather than the mean value is used as a measure of central tendency. The median values of UIE levels in Groups A, B, and C, were 48.5, 48 and 47.5 µg/L, respectively, which indicates that variation in the values is negligible for all the three groups, therefore, the study groups can be said to be having equal level of iodine deficiency. The findings based on mean values are quite different from those depended on median values. Due to such a discrepancy, WHO/ UNICEF/ ICCIDD have distributed iodine concentration into different ranges given in Table-2. Based on the criteria of these agencies the groups under study have different level of severity at different concentration values. Following these criteria, the slight variations of concentration level were observed which are shown in Fig. 1. The optimal level of iodine concentration in the employees is relatively better than that in the students.

Most of the employees reside in villages in the premises of the university where food items mainly come from self-grown crops. Iodine deficiency in the employees therefore indicates that the study area is deficient of iodine. The study area belongs to hilly terrain, which are iodine deficient due to erosion of soil by water [20]. The climate of

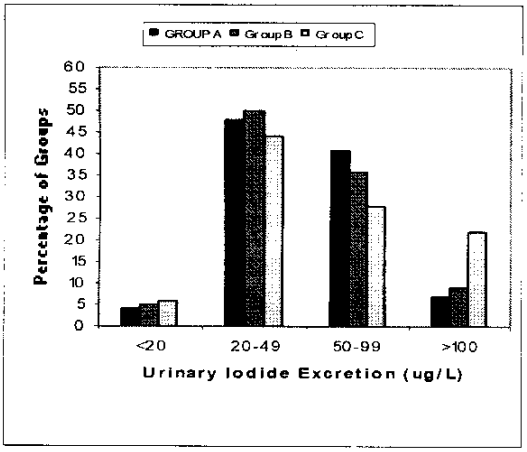

Fig. 1: Group Distribution of Urinary Iodide Excretion.

the area is in favour of water erosion due to relatively more annual rainfall in the study area. Moreover, iodine deficiency has already been declared in water sources of the area [21]. The students of groups A and B had been residing in the hostels for the last two and one year respectively, who take their meal from the hostel cafeterias. Iodine deficiency in the students is an indication that the meal is deficient of iodine.

The recommendations of WHO/ UNICEF/ ICCIDD are that not more than 20% of urine samples in a population should have iodine levels < 50 μg/L. According to the results given in Table-2, there are 52%, 55% and 50% samples of groups A, B, and C, respectively which have UIE < 50 μg/L, therefore in general the study groups are iodine deficient. The epidemiological criteria for assessing severity of iodine deficiency based on median of urinary iodine excretion shows that median UIE < 50 μg/L in all three groups; indicating moderate level of iodine deficiency. Iodine deficiency is considered to be a public health problem in countries in which the median urinary iodide is below 100 μg/L [22]. From the given results it can be inferred that the target people under study are iodine deficient as far as the overall iodine status is concerned.

In order to compare the data of present study with that of other countries of the world, data on iodine concentration have been complied from literature for some counties of Asia and is represented in Table-3. The value given against the present study is the average of the median values of the three study groups. Iodine concentration level measured in the present study is three times that determined in an earlier study and both are smaller than that for all the countries in comparison [23]. There is a small difference in the values of present study than that given for Azerbaijan and Bangladesh but the deviation is larger for the other countries in comparison. The value of iodine for Iran, the western neighbour, is about twice and India, the eastern neighbour, is more than three times that of Pakistan [23].

The prevalence of iodine deficiency among the study people demands that in addition to rectification of the deficiency, the iodine level must be increased in the food items used in the hostel and university campus cafeterias. The rapid step in this direction is the immediate use of iodized salt in the meals. The current preliminary assessment of iodine deficiency provides the baseline for future estimates for the study area. The challenge now is to improve data quality in order to trigger appropriate and timely interventions and to track progress more accurately and rapidly. A more in-depth and extensive study on iodine status particularly in study area and generally in Pakistan is important for the near future.

Experimental

Study Area

The university is located at Nilore on Lehtrar road within the territory of Islamabad, the

Table 3: Worldwide iodine concentration level [23].

Location/ Country	Iodine concentration Median UI (μg/L)	Proportion of population with UI< 100 μg/L (%)	Level of severity
Azerbaijan	54	74.4	Mild Iodine Deficiency
Bangladesh	54	70.4	Mild Iodine Deficiency
India	133	31.3	Optimal Iodine Nutrition
Iran	205	14.9	More than adequate
Kazakhstan	97	53.1	Mild Iodine Deficiency
Nepal	144	35.1	Optimal Iodine Nutrition
Pakistan	16	90.4	Severe Iodine Deficiency
Present study	48	87.4	Moderate Iodine Deficiency

capital of Pakistan, at the latitude of 33° 40′ N, and longitude of 73° 10′ E. The area has hot summers with monsoon rains during July and August. The average humidity level of this area is 55% with an average rainfall of 1143 mm each year. The maximum average temperature is 28.9 °C and goes down to average minimum of around 14.4 °C with average daily maximum temperature 21.65 °C. June is the month of maximum temperature, day temperature sometimes reaches 45 °C and December is the month of minimum temperature, night temperature occasionally approaches 0 °C. Islamabad and its adjoining areas are divided into three structural zones. In the north, the mountainous Margala Hills consist of Jurassic through Eocene limestone and shale that are complexly folded and thrust along the Hazara zone. South of the mountains is underlain primarily by truncated folds in the sandstone and shale. In the southernmost part of the area, the Soan River flows generally along the axis of the Soan syncline [17]. A small dam has been made on the Soan River near the village Simly and water supply of the area is managed from the Simly Dam.

Sampling

The study was conducted in 2007-08 for the MS (Master of Science) students residing in bachelor hostels of the university and the employees working in the hostels. Urine donors were selected randomly who had the age range 22–45 years. A total of 108 volunteers agreed to participate in the study and gave urine samples. The donors of 108 urine samples were divided into three groups. The distribution of donors was as follows: Group A (54 MS students of session 2005-2007); Group B (22 MS students of session 2006-2008); and Group C (32 employees of the university in hostels). The students originally belonged to different regions of Pakistan and the employees were from nearby villages. Casual (untimed) urine samples were taken in 13 mm x 100 mm clean test tubes. The samples were analyzed on the next day for the determination of urinary iodine concentration.

Apparatus and Reagents

A UV-Vis spectrophotometer (Shimadzu model 1201) with a 100 mm optical path length was employed for the determination of iodine concentration in the urine samples. The spectrophotometric measurements were performed at 420 nm for catalytic kinetic method based on Sandell–Kolthoff reaction. A heating block having the temperature range of 90–98 °C was used for digestion of organic matter in urine samples with ammonium persulphate.

The chemicals used in this experimental work consisted of ammonium persulphate, $(NH_4)_2S_2O_8$, (Merck, Germany); ammonium cerium (IV) sulphate dihydrate, $(NH_4)_4Ce(SO_4)_4 \cdot 2H_2O$, (Merck, Germany); potassium iodate, KIO_3, (Fluka, Switzerland); arsenious oxide, As_2O_3, (Fluka, Switzerland); sodium chloride, NaCl, (Ridel, Germany); sulphuric acid, H_2SO_4, (BDH, UK). All the chemicals obtained from commercial sources were of analytical grade. The aqueous solutions were prepared using doubly distilled water. The iodide stock solution, 1000 µg/L was prepared from KIO_3. Working standards were prepared from stock solution on daily basis.

System Performance

The sensitivity of the employed method [18] was calculated as the concentration that can be statistically distinguished from the zero standards, which is 2σ (σ = standard deviation) below the mean absorbance of the blank solutions. In order to check the accuracy of the method, the recoveries of the iodide were examined. The precision was tested by repetitive analysis of the same samples. Two samples were analyzed for intra assay precision on the same day and four samples on different days. Ten replicates for each sample were made. The reproducibility of the method was checked by analyzing the Seronorm freeze-dried human control material produced from human urine. A total of 17 different assays were performed in duplicate. A calibration curve was prepared for each assay by plotting the logarithmic conversion of the means of absorbance at 420 nm (n = 2) on the y–axis vs. the iodine concentrations on the x–axis.

Sample Assaying

To each 250 µL urine sample in the 13 mm x 100 mm test tubes, 1.0 mL of $(NH_4)_2S_2O_8$ solution was added, followed by heating at 95 °C for 60 minutes. The tubes were cooled to room temperature and then 3.5 mL of As_2O_3 solution was added

followed by vortex mixing. To each test tube, 400 µL of $Ce(NH_4)_4(SO_4).2H_2O$ solution was added at an interval of 30-second time between successive tubes; exactly 30 minutes after first addition, absorbance was taken at 420 nm wavelength.

Conclusion

The study groups of students and employees of the University or PIEAS (Pakistan Institute of Engineering & Applied Sciences) are iodine deficient. Deficiency of iodine in the study groups may be due to the use of non iodized salt. . Use of iodine in meals and water should be increased and the simplest method is to provide iodized salts to the employees and prepare food with iodized salt.

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Ethical Approval

Prior to carry out this study, approval was taken from the Ethical Committee of the Department of Medical Sciences, Pakistan Institute of Engineering and Applied Sciences, Nilore, Islamabad.

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Competing Interests

Nil

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