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A Survey of Urinary Iodine Concentration in South-east of Caspian Sea in Northern, Iran

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Abstract: The objective of this study was to evaluate the urinary iodine concentration in Gorgan located in northern Iran, which is a cosmopolitan society and on the basis of such determination the endemic goiter in the region could be estimated. The sample population were a total of 287 people (23.3% male, 76.7% female) referred to Danesh Medical Diagnostic Laboratory for the urinary iodine measurement, during 2004-05. Urinary iodine level was determined using acid digestion method. The results from this study indicated that 2.1, 3.8 and 9.8% of sample population had urinary iodine level of <2, 2-4.9 and 5-9.9 μg dL^{-1}, respectively which are defined as sever, moderate and mild iodine deficiency. Therefore 45 (15.7%) of the sample population in this study could be assessed for goiter prevalence, the mean differences of iodine concentration in male and female subjects were not significant. In conclusion, low urinary iodine of <10 μg dL^{-1} concentration may help to give a direction for a further examination in the thyroid gland abnormalities.

Key words: Urinary iodine, iodine deficiency, thyroid gland, thyroid hormone, goiter

INTRODUCTION

Iodine forms part of the thyroid hormones, thyroxin (T_4) and triidothyronine (T_3). these hormones are involved in the maintenance of metabolic rate, cellular metabolism and integrity of connective tissue. Thyroid hormones are necessary for the development of the nervous system in the fetus and infant. A variety of mechanisms exist to compensate of low levels of iodine intake. These include enlargement of the thyroid gland (goiter). Only when these mechanisms fail do the clinical signs of hypothyroidism also known as myxoedema develop. Endemic goiter and iodine deficiency are important public health problems in many countries in the world (Lamberg, 1993; Boyages, 1993; Ando *et al*., 1994).

Different nutritional and environmental factors are responsible for the pathogenesis of goiter, but iodine deficiency is the important factor (Boyages, 1993; Lancet, 1985; Dodd and Meena, 1992). Studies in Iran demonstrated a high prevalence of endemic goiter due to iodine deficiency (Emami *et al*., 1969; Azizi *et al*., 1990). Iodine status and goiter prevalence also have been reported in other part of the world, examples are countries such as Turkey (Bayram *et al*., 2003), West Africa (Dunn *et al*., 2001), Denmark (Andersen *et al*., 1993), Zimbabwe (Zvenyika *et al*., 1999), Poland (Gembicki *et al*., 1993; Kinalska *et al*., 1993). The iodine of a population is often assessed by measurements of iodine in urine (Lamberg, 1993; Delang, 1994). This provides information on the average iodine intake and on the frequency of low iodine excretion value. In areas with sever iodine deficiency the thyroid hormone synthesis decrease and an increase in iodine intake causes an increase in thyroid hormone level in serum and a decrease in serum thyroid stimulating hormone (Azizi *et al*., 1997; Tonglet *et al*., 1992; Gaitan *et al*., 1991). Thyroid volume, serum thyroglobulin concentration and urinary iodine concentration have all been suggested as useful iodine prophylaxis (Delang *et al*., 1997).

Urinary iodine concentration also is not a direct measurement of thyroid function, but to some extend it reflect the recent iodine intake and thyroid hormone catabolism (Delang *et al*., 1997). A sustainable control of iodine deficiency is occurred on the results of implementation of salt and bread iodization with subsequent improvement on the goiter prevalence (Azizi *et al*., 2002a,b; Wiersinga *et al*., 2001; Hetzel, 1993).

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On the basis of these concepts, in this study the urinary iodine concentration of subjects referring to Danesh Medical Diagnostic Laboratory located in Gorgan the capital city of Golestan province in the north of Iran was determined, the aim of this research project was to evaluate, the urinary iodine concentration, with ultimate, thyroid function assessment.

MATERIALS AND METHODS

This study was carried out on 287 subjects referred to Danesh Medical Diagnostic Laboratory in Gorgan which is a cosmopolitan town for the urinary iodine determination during 2004-05. The sample population, consist of 67 (23.3%) male and 220 (76.7%) female subjects from various ages. Urinary iodine concentration was measured on randomly collected urine samples, using acid digestion method, in this method, urinary iodine concentrations were measured, using strong choleric acid for urine digestion at 120°C heating oven, iodine was determined by it's catalytic reduction of ceric ammonium sulfate in the presence of arsenious acid, also known as sandell-kolthoff digestion reaction as following equations,

$$2Ce^{4+} + 2I \longrightarrow 2Ce^{3+} + I_2$$

$$I_2 + As^{3+} \longrightarrow As^{5+} + 2I^-$$

The iodine concentration was determined using spectrophotometric technique with wavelength of 405 nm (Dunn *et al*., 1993; Sandell and Kolhoff, 1937).

The urinary iodine concentration ≤1.9 μg dL^{-1} was accepted as severe level between 2.0-4.9 μg dL^{-1} as moderate level between 5-9.9 μg dL^{-1} as mild iodine deficiency and urinary iodine ≥10 μg dL^{-1} was considered to be as normal. Statistical analysis was performed using Spss 11.5 statistical software. The chi-square test, was used to analyze the findings of this research project.

RESULTS

In this study the mean, standard deviation and median, urinary iodine concentration in the total sample population, were 23.05, 15.45 and 18 μg dL^{-1}, respectively. The number of male subject 67 (23.3%) and female subjects were 220 (76.7%). The mean value of urinary iodine concentration 22.88 μg dL^{-1} with standard deviation of 15.16, for the male subjects and for the females the mean value and standard deviation were 23.10 and 15.57 μg dL^{-1}, respectively. According to statistical analysis there was not a significant differences between urinary iodine concentration among male and female subjects (Table 1). The minimum and maximum urinary level among male and female subjects were 1.80, 58 μg dL^{-1} and 1.50, 65 μg dL^{-1}, respectively, as whole the minimum and maximum level of iodine were 1.50, 65 μg dL^{-1}. There was not also any significant differences among male and female in this regard. The distribution of urinary iodine in this sample population according to various defined concentration of <2, 2-4.9, 5-9.9, 10-14.9. 15-19.9, 20-29.9, 30-39.9, ≥40 μg dL^{-1} were Shown in Table 2.

Table 1: The urinary iodine concentration, according to gender

Gender	<10 (μg dL^{-1})	10-29.9 (μg dL^{-1})	≥30 (μg dL^{-1})	Total
Male	12(17.9)	33(49.3)	22(32.8)	67(23.3)
Female	33(15)	121(55)	66(30)	220(76.7)
Total	45(15.3)	154(53.7)	88(30.7)	287(100)

Values in parenthesis represent percentage

Table 2: Urinary iodine level according to various concentration

Urinary iodine (μg dL^{-1})	No.	Percent
<2	6	2.1
2-4.9	11	3.8
5-9.9	28	9.8
10-14.9	105	36.6
15-19.9	49	17.1
20-29.9	38	13.2
30-39.9	34	11.8
≥40	16	5.6
Total	287	100%

The frequency of urinary iodine with<10 μg dL^{-1} concentration include 45 persons (15.7%) which according to standard protocol are considered to be iodine deficient, the frequency of urinary iodine concentration with≥10 μg dL^{-1} were 243 subjects (84.3%). The other finding in this study indicated that the majority of sample population 154 persons (53.7%), had the urinary iodine concentration of 10-29.9 μg dL^{-1} but, in this range 105 subjects (36.6%) had the urinary concentration of 10-14.99 μg dL^{-1} and the subjects with≥30 μg dL^{-1} include 88 persons (30.7%) of all the sample population in this study Table 1.

DISCUSSION

The measurement of urinary iodine has been recognized as the most common and reliable biochemical test for assessing the iodine status of population (May *et al*., 1997; Follis, 1964). Eighty to ninty percent of daily iodine is excreted via urine, therefore urinary iodine level is one of the most important parameter that reflects iodine level of an area, The chronic iodine deficiency also effect thyroid gland volumes and thyroglobulin (Tg) levels are good criteria. There are some reports about the inverse ratio between urinary iodine level and goiter prevalence (Delang *et al*., 1997). It is known that in iodine deficient area fT_3 levels are normal or high fT_4 levels are low-normal or low and Thyroid Stimulating Hormone (TSH) are generally normal or slightly high. Because of

the adaptation mechanisms due to iodine deficiency TSH levels increase and thyroid volumes increase due to elevation of TSH. On the other hand there are two reports which indicate that, T_3, T_4 and TSH level were not significantly different between endemic and control area but in both studies, It is demonstrated that Tg level were higher in endemic area (Veinpalu *et al*., 1996; Martino *et al*., 1994). In a study on the variation in urinary iodine excretion and thyroid function, it is reported that the participant men, in Turkey with moderate iodine deficiency showed clear signs of substrate deficiency for thyroid hormone synthesis while subjects with mild iodine deficiency did not (Anderson *et al*., 2001). In other study on the urinary iodine concentration and serum thyroid function test on school children it was indicated that, serum Tg and urinary iodine concentration are the indicators most influenced by a changing iodine supply. In this later study which was carried out in West Africa, the changes in the iodine supply to their sample population through iodized oil supplementation and consumption through iodized oil salt was reflected in considerable changes in the concentration of iodine in urine and Tg in the serum and to a lesser extent in the serum concentration of TSH and fT_4 (Van den Briel *et al*., 2001).

In a study on the assessment of goiter prevalence iodine status and thyroid functions in school age children, in Turkey (Ozkan *et al*., 2004). The overall goiter was found in 47.6% children, in 22.8% of girls and in 24.8% of boys. Mean thyroid volumes did not differ significantly according to sex but a negative correlation was found between urinary iodine concentration and thyroid volume, also in Turkey study it was indicated that, median urinary iodine concentration in subjects with goiter were consistent with sever-moderate iodine deficiency, levels in subjects without goiter were comparable to moderate-mild iodine deficiency. In present study also there was not any significant differences between urinary iodine concentration between male and female, subjects. In Turkey study the individuals with goiter were investigated etiologically, it was shown that biochemical hypothyroidism was detected in 2%, compensated hypothyroidism in 12.6%, autoimmune thyroiditis in 2%, nodular goiter in 3% and isolated high TSH level with thyroiditis in 0.08%. It can concluded from Turkey investigation that 14.6% of goiter can be related to iodine deficiency. In this study 15.7% of subjects had urinary level below 10 μg dL^{-1} and were considered to be iodine deficient. Correlating our results with Turkey study, we can assume that part of our sample population which were iodine deficient (15.7%) may be also listed as subjects with abnormality in the thyroid gland. In other study in Poland (Gembicki *et al*., 1993) it was indicated that the mean urinary iodine excretion was 9.6 and 8.7 μg dL^{-1} for urban and rural subjects, which were much lower than our urinary iodine mean concentration (23.05 μg dL^{-1}) in Polish study iodized salt was only used by 37.1% of subjects, but the salt iodization is compulsory by law, in Iran (Azizi *et al*., 2002a).

In the former study 28% goiter was reported, out of this number of goiter 17.7%, were not used iodized salt and only 10.3% of cases, goiter appeared, despite the use of iodized salt. It means that 7.4% of goiter was recovered using ionized salt on the other hand in Polish study 7.2% of subject the goiter was due to iodine deficiency which are related with urinary iodine deficiency. If we correlate also present urinary iodine findings with Polish study we may assume that part of our 15.7% of the sample population in our study may had goiter and part of the problem could have been resolved if this subjects were taken iodized salt properly. In Turkish study (Ozkan *et al*., 2004) it was shown that overall goiter prevalence was found to be of moderately or severely iodine deficiency and they found a negative correlation between thyroid size and the urinary iodine level, lowest mean urinary iodine excretion was detected in subjects with the largest thyroid size.

The finding from later study also was confirmed by other worker (Urgancioglu and Hatemi, 1989) although some studies failed to show any correlation between the urinary iodine level and thyroid volume (Semiz *et al*., 2000), on the other hand, there are also various reports in the literature, which indicated that normal urinary iodine level seen in subjects with goiter just as reports of low iodine levels have also been reported in subjects with goiter (Semiz, 2000; Furnee *et al*., 1994). This situation has been explained by the fact that urinary iodine level is not the unique factor in forming of goiter, although urinary iodine excretion is an important epidemiological factor. In our early study we also found that part of those subjects with low iodine level had high Thyroid Stimulation Hormone (TSH) and low thyroxin (T_4), was found to have sever to moderate-mild urinary iodine concentration (unpublished report).

According to present findings, on the urinary iodine concentration in this study and the our early study of thyroid function test, we also can confirm that although the urinary iodine level is not a precise factor in confirming hypothyroidism, but to some extend the urinary iodine concentration is a very helpful tool for the diagnosis of hypothyroidism. The other conclusion, which can be drawn from this work and comparing the

urinary iodine concentration with other region such as Turkey and Poland it seem that a salt iodination program in our region has been followed more carefully, this statement can be clarified by other researcher in Iran (Azizi *et al*., 2002a), which showed the consumption of iodized salt improved the thyroid function, this worker indicated that Iran has reached a sustainable control program for iodine deficiency. The information out of this later study in Iran on the urinary iodine level is very similar results to our findings. Their median urinary level was 20.5 μg dL^{-1}, also 85.1% of people had urinary level ≥10 μg dL^{-1}, on the other hand 14.9% had low urinary level. In our study, the mean and median urinary iodine concentration were 23.05 and 18 μg dL^{-1} and 15.3% of people had low urinary level<10 μg dL^{-1}. The mean urinary concentration in our study was 23.05 μg dL^{-1} but in Poland study (Gembicki *et al*., 1993), the mean value was about 9 μg dL^{-1}, although it should be mentioned that the later study was carried out on children of age between 7 and 12 years of age also the age do not play a significant role. Iran was reported to be an area with iodine deficiency (Emami *et al*., 1969) and also there were reports of endemic goiter in many part of the country (Kimiagar *et al*., 1989; Azizi *et al*., 1990). In Iran salt iodization programme was started as obligatory procedure and consequently there are reports of higher urinary iodine in this country. In this study also about 85% of population had≥10 μg dL^{-1} urinary iodine, various urinary iodine was presented in Table 2. In another study in two province in the northern Iran, in the south of Caspian sea the effect of salted food consumption on urinary iodine and thyroid function tests was studied and found that salted food in one province was responsible for the an increase in the mean urinary iodine, 31 μg dL^{-1} in province with higher consumption of salted food compared to the other province which was 21 μg dL^{-1}, (Azizi *et al*., 2001). The mean and median of our samples urinary iodine concentration were 23.05 and 18 μg dL^{-1} which were almost similar to the value of later province, which bordering Golestan province in the south-east of Caspian sea, where this study was carried out. In another study in Denmark (Knudsen *et al*., 2000) on the goiter prevalence and thyroid abnormalities, it has been mentioned that the association between sever iodine deficiency and endemic goiter is well established, but little information is available on the relation between milder degrees of iodine and deficiency of goiter prevalence, the result from the Denmark study indicated that marked differences in the prevalence of thyroid abnormalities were found with modest difference in iodine excretion. It has also indicated that thyroid enlargement was found in 15% (mild urinary iodine concentration) and 22.6% (moderate urinary iodine concentration), in our study the ratio of sever, moderate, mild urinary iodine deficiency were, 2.1, 3.8 and 9.8% μg dL^{-1}, respectively, (Table 1). Present urinary iodine concentration findings may be correlated with some other reportes, like the later in which thyroid volume was determined using ultrasonography, on the basis such comparison we may conclude that those subjects with low urinary iodine concentration, in present study should be followed up for goiter incidence, therefore the subjects with low urinary iodine concentration have the indication for further examination for the goiter and thyroid function test assessments. In another study in Netherlands on a survey of iodine intake and thyroid volume in Dutch school children of 6-18 years, it was indicated that iodine intake and thyroid size was assessed by inspection and palpation as well as ultrasound, iodine intake was evaluated mainly by measurement of urinary iodine concentration. Their findings showed that their median urinary iodine concentration was about 16 μg dL^{-1} and goiter prevalence by inspection and palpation as whole was about, 3.4%.

The researchers in Dutch study concluded that on the basis of their results, iodine deficiency disorder no longer exist in the Netherland (Wiersinga *et al*., 2001). In this study the median urinary concentration was 18 μg dL^{-1}, which is slightly more than the Dutch study, by comparison, still it can be concluded that at least on the best optimistic guess, about 11 subject (3.8%) in our study, had the goiter, but in our study still we had, sever, moderate and mild urinary iodine concentration in the ratio of 2.1, 3.8, 9.8%, respectively, therefore, the possibility of goiter incidence due to iodine deficiency can be even much higher than 3.8%.

In conclusion the following points are highlighted, from the present study in the northern Iran.

- The urinary iodine concentration also is not the unique tool for the diagnosis of thyroid dysfunction, but to some extend, it may help to give a direction, for further investigation of the thyroid abnormalities.
- Although a salt iodination is a mandatory law, on the basis of this research project still about 15% of people in this region considered to be iodine deficient, among the reasons, the consumption of rocky salt may be the cause.
- Further investigations on the nutritional habits, dietary regiments and comprehensive thyroid examinations are required to have a clear evaluation of any possible disorder in the thyroid gland.

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