

Effects of salted food consumption on urinary iodine and thyroid function tests in two provinces in the Islamic Republic of Iran

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آثار تناول الطعام المملح على مستوى اليود البولي واختبارات وظائف الدرقية في إقليمين متجاورين في جمهورية إيران الإسلامية

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خلاصة: سعينا إلى تقييم مصادر الاختلاف في مستوى اليود البولي بين إقليمين إيرانيين متجاورين هما كيلان ومازندران. فتم اختيار 340 و343 مشاركا بطريقة العنقود (أخذ العينات) العنقودي في مدينتي رشت (كيلان) وساري (مازندران) على التوالي. وقد وجدنا أن مستوى اليود البولي في مدينة رشت أعلى بدرجة يُعتد بها إحصائياً عنه في ساري (31 ميكروغرام/ديسيلتر، في مقابل 21 ميكروغرام/ديسيلتر). وكانت مستويات الصوديوم والبوتاسيوم في البول أعلى في مدينة رشت عنها في ساري. ولم يكن هناك اختلاف يُعتد به إحصائياً في اليومي الوسطي من الملح الميودن واختبارات وظائف الدرقية. وكان متوسط الاستهلاك السنوي من بعض الأغذية المملحة أعلى بدرجة يُعتد بها إحصائياً في رشت عنها في ساري. وخلاصة القول إن استهلاك الأغذية المملحة بمقادير أكبر في رشت، هو المسؤول عن زيادة مستوى اليود في عينات البول.

ABSTRACT We evaluated sources of difference in urinary iodine between two neighbouring Iranian provinces, Gilan and Mazandaran. In the cities of Rasht (Gilan) and Sari (Mazandaran), 340 and 343 participants respectively were selected by cluster sampling. Urinary iodine in Rasht was significantly higher than in Sari (31 µg/dL versus 21 µg/dL). Sodium and potassium urine levels in Rasht were also higher than Sari. Mean daily intake of iodized salt and thyroid function tests were not significantly different. Average annual consumption of some salted foods was significantly higher in Rasht than Sari. We conclude that higher consumption of salted foods in Rasht is responsible for an increase in urinary iodine.

Effets de la consommation d'aliments salés sur les tests pour l'iode urinaire et la fonction thyroïde dans deux provinces voisines de la République islamique d'Iran

RESUME Nous avons évalué les sources de différence dans l'iode urinaire entre deux provinces iraniennes voisines, Gilan et Mazandaran. Dans les villes de Rasht (Gilan) et Sari (Mazandaran), 340 et 343 participants respectivement ont été sélectionnés par échantillonnage en grappes. L'iode urinaire à Rasht était significativement plus élevé qu'à Sari (31 µg/dl contre 21 µg/dl). Les niveaux de sodium et de potassium dans l'urine à Rasht étaient également supérieurs à ceux de Sari. L'apport journalier moyen de sel iodé et les tests de la fonction thyroïde n'étaient pas significativement différents. La consommation annuelle moyenne de certains produits salés était significativement plus élevée à Rasht qu'à Sari. Nous concluons que la consommation plus élevée d'aliments salés à Rasht est responsable d'une augmentation de l'iode urinaire.

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Received: 28/02/00; accepted: 18/07/00

Introduction

The Islamic Republic of Iran has been recognized as an area of iodine deficiency since 1969 [1]. Extensive studies in the 1980s found goitre to be hyperendemic in many areas [2,3]. Complications of severe iodine deficiency, such as retardation in physical and mental development, severe neurological, psychomotor and auditory deficits, and hypothyroidism have also been observed [4,5]. In 1989, after the establishment of the National Committee for Control of Iodine Deficiency Disorders in the Islamic Republic of Iran, salt iodization was adopted as the main strategy for prevention of iodine deficiency. Integration of iodine deficiency disorders (IDD) control programmes in the country's primary health care system helped to increase the general knowledge of the population and the level of iodized salt consumption.

A national survey to monitor IDD control was carried out in 1996. In each province, 2400 schoolchildren, aged 8–10 years, were studied. The survey showed that median urinary iodine exceeded 15 $\mu\text{g}/\text{dL}$ in all provinces [6]. Surprisingly, urinary iodine levels differed significantly among schoolchildren from two northern provinces, Gilan and Mazandaran, despite ecological and ethnic similarities. In the 1996 IDD survey, median urinary iodine in Gilan was about three times that of Mazandaran. Since monthly monitoring of iodized salt in these provinces had shown no significant difference in the iodine content of salt produced in different factories, it was reasonable to attribute the observed difference to differences in iodized salt consumption. Our study was carried out in 1998 in Rasht and Sari, the capital cities of Gilan and Mazandaran provinces, to assess the reproducibility of the 1996 results and to compare nutritional habits regarding the intake of salted foods in the two provinces.

Methods

This was a cross-sectional study, with the study population consisting of members > 2 years of age of 75 households from Rasht (340 participants: 172 male, 168 female) and 75 households from Sari (343 participants: 184 male, 159 female). The households were chosen by cluster sampling from all Rasht and Sari households. The two cities were divided, according to location, into three districts (north, centre and south in Rasht, and east, centre and west in Sari). After determining the proportion of the number of households in each district to the total number of households in the city, the required clusters in each district were chosen by random sampling.

The nature of the study was explained and informed consent from the household members obtained on the first visit. Personal identification data were collected and a food frequency questionnaire (FFQ) for certain salted foods was filled out. The FFQ detailed a comprehensive list of all common salted foods in the two study regions. We then asked the women of the house about the frequency of consumption of these items. To determine annual consumption, daily, weekly and monthly consumption were multiplied by 365, 52 and 12 respectively. A 1 kg pack of iodized salt was then delivered to each household with the recommendation that it be the only source of cooking and table salt.

After 2 weeks, the remaining salt was weighed and total household salt intake determined. This was divided by the number of family members to calculate salt intake per person. In addition, a urine sample was taken from all participants to measure urinary sodium, potassium and iodine levels.

A non-fasting 5 mL venous blood sample was drawn from participants > 20 years of age for measuring serum triiodothyro-

nine (T_3), thyroxine (T_4), thyroid stimulating hormone (TSH) and T_3 resin uptake (T_3 RU), and anti-thyroid antibodies. Blood and urine samples were rapidly delivered to the laboratories of health care centres in Rasht and Sari, where serum was extracted and frozen as were the urine samples. The specimens were kept at -20° C until they were thawed by the Endocrine Research Centre Laboratory at Shaheed Beheshti University of Medical Sciences, where the tests were performed.

Urinary iodine level was determined by the Sandell Kolthoff digestion method [7] and urinary sodium and potassium were measured by flame photometer. Measurements of T_3 , T_4 , and T_3 RU (by radioimmunoassay) and TSH (by immunoradiometric assay) were performed using laboratory kits from Orion Diagnostic, Finland. Levels of anti-thyroglobulin antibodies (anti-TgAb) and anti-thyroid peroxidase antibodies (anti-TPOAb) were determined using an enzyme-linked immunosorbent assay (Radim, Italy).

Results of urinary iodine, sodium, potassium, serum thyroid hormones and anti-thyroid antibodies were compared between the two cities by Student *t*-test. To assess the correlation between urinary iodine and the other variables, the Pearson correlation coefficient was used. A value of $P < 0.05$ was considered significant.

Results

Study population

The study population consisted of 340 individuals (172 male, 168 female) from Rasht and 343 (184 male, 159 female) from Sari. Mean age \pm standard deviation of the study population was 26.1 ± 16.5 years and 24.9 ± 15.3 years respectively.

Mean daily salt intake \pm standard deviation for each person was 7.2 ± 4.7 g in Rasht and 7.7 ± 4.0 g in Sari ($P > 0.05$). However, mean concentration of iodine in urine was significantly higher in Rasht than in Sari (31.2 ± 17.3 μ g/dL versus 21.3 ± 15.0 μ g/dL) ($P < 0.001$). Urinary levels of sodium (210 ± 89 mEq/L versus 188 ± 92 mEq/L) ($P < 0.01$) and potassium (67 ± 38 mEq/L versus 54 ± 30 mEq/L) ($P < 0.001$) were also significantly higher in Rasht (Table 1).

The mean annual frequency of consumption for foods containing high levels of iodized salt in Rasht and Sari is shown in Figure 1. The mean annual consumption of pickled cucumbers, pickled garlic and *dadal* (a vegetable food with a high salt content) was not statistically different between the two cities, but tomato paste, mixed pickles, tuna fish, olives, seasoned olives, broad beans, salted fish and salted caviar were eaten more frequently in Rasht than in Sari. The difference was especially significant for mixed pickles (98 ± 110

Table 1 Urinary levels of sodium, potassium and iodine in the study populations in Rasht and Sari, 1998

Mineral	Sari (n = 343)	Rasht (n = 340)	P-value*
Sodium (mEq/L)	188.0 \pm 92.0	210.0 \pm 89.0	<0.01
Potassium (mEq/L)	54.0 \pm 30.0	67.0 \pm 38.0	<0.001
Iodine (μ g/dL)	21.3 \pm 15.0	31.2 \pm 17.3	<0.001

*Student *t*-test.

Results are given as mean \pm standard deviation.

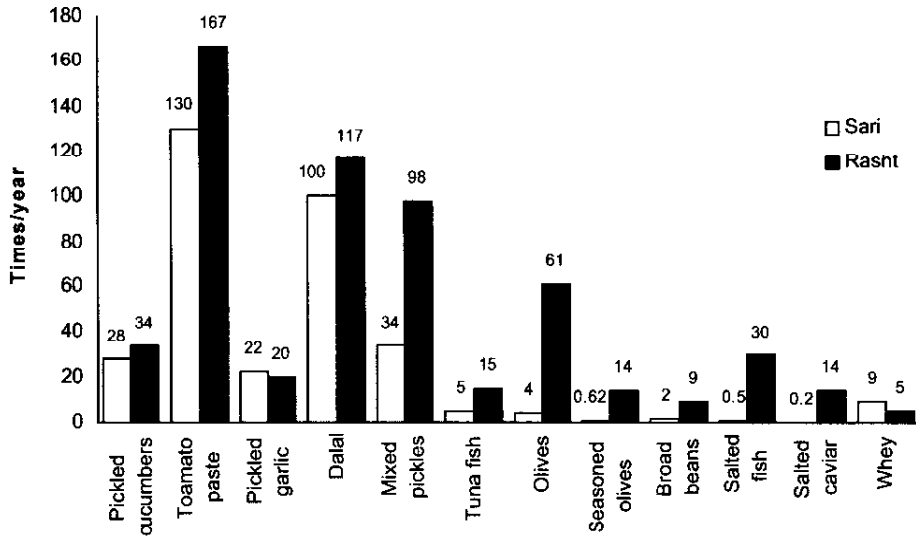


Figure 1 Mean frequency of annual intake of some salted foods in households of Sari and Rasht in 1998. *Datal* is a food with high salt content. All foods were salted by iodized salt.

Table 2 Thyroid hormones, anti-thyroid antibodies and TSH levels in participants > 20 years in Rasht and Sari, 1998

Variable	Sari (n = 185)	Rasht (n = 190)	P-value*
T ₄ (µg/dL)	7.4 ± 1.9	8.1 ± 1.9	<0.010
T ₃ (ng/dL)	103.0 ± 33.0	107.0 ± 28.0	NS
TSH (µU/mL)	1.9 ± 1.5	1.8 ± 2.2	NS
T ₃ RU (%)	28.5 ± 2.9	27.9 ± 2.6	NS
Free T ₄ index	232.0 ± 153.0	226.1 ± 56.5	NS
Anti-TPOAb (IU/mL)	6.0 ± 139.0	66.0 ± 91.0	NS
Anti-TgAb (IU/mL)	65.0 ± 63.0	112.0 ± 130.0	<0.001

* Student t-test.

T₄ = thyroxine.

TSH = thyroid stimulating hormone.

Anti-TPOAb = anti-thyroid peroxidase antibodies.

NS = not significant.

Results are given as mean ± standard deviation.

T₃ = triiodothyronine.

T₃RU = T₃ resin uptake.

Anti-TgAb = anti-thyroglobulin antibodies.

times per year versus 34 ± 68) ($P < 0.001$); olives (61 ± 78 times per year versus 4 ± 25) ($P < 0.001$); and seasoned olives (14 ± 24 times per year versus 0.62 ± 6.7) ($P <$

0.001). The only consumption rate higher in Sari than in Rasht was for dried whey (9 ± 14 times per year versus 5 ± 7) ($P < 0.001$).

The mean T_4 level was $7.4 \pm 1.9 \mu\text{g/dL}$ in Sari and $8.1 \pm 1.9 \mu\text{g/dL}$ in Rasht ($P < 0.001$). Other thyroid function tests (T_3 , TSH, $T_3\text{RU}$ and FT_4I) did not show any statistically significant difference between the two cities (Table 2). The mean level of anti-TgAb was $112 \pm 130 \text{ IU/mL}$ in Rasht ($n = 190$) and $66 \pm 63 \text{ IU/mL}$ in Sari ($n = 185$) ($P < 0.001$). Mean anti-TPOAb did not show any statistically significant difference between the two cities (Table 2).

There was a significant correlation between urinary iodine level and the following variables: age ($r = 0.1$, $P < 0.02$); urine potassium level ($r = 0.2$, $P < 0.001$); and consumption of mixed pickles ($r = 0.2$, $P < 0.001$), broad beans ($r = 0.2$, $P < 0.001$) and salted fish ($r = 0.2$, $P < 0.001$). No significant correlation was observed between urinary iodine level and the following variables: mean daily salt intake, urine sodium level, T_4 , T_3 , anti-TPOAb, anti-TgAb, and consumption of pickled cucumber, olives and salted caviar.

Discussion

The present study investigated the cause of the difference in urinary iodine levels in two cities in neighbouring provinces in northern Islamic Republic of Iran and found that, although the consumption of table and cooking salts by inhabitants of each city was comparable, Rasht families ate larger amounts of salted foods and thus had increased iodine intake.

Iodine added to dietary salt is in the form of potassium iodate. Urinary sodium level is a good indicator of daily salt intake. In the present study, urinary sodium and potassium levels were higher in Rasht than in Sari, indicating a higher daily salt intake. The fact that there was no considerable difference in the amount of salt used as an additive in food preparation and in daily

consumption, suggested the difference might lie in the amount of salted food consumed. This was confirmed by the FFQ study, which showed a higher consumption of such foods in Rasht.

It is of interest that the only source of added iodine in the Islamic Republic of Iran is household iodized salt because the Iranian National Committee for IDD Control has insisted on excluding the use of iodized salt in the food industry, thereby avoiding the increase in iodine intake observed in some countries [8]. However, in cities like Rasht, people use iodized salt to prepare salted foods such as broad beans, caviar, pickled garlic, cucumbers, olives, mixed pickles and *dalal*. Lack of correlation between urinary iodine levels and reported salted food consumption is because the FFQ is qualitative — it does not include the amount consumed of each food. Additionally, food saltiness varies among households and was not measurable. Finally, although the study was carried out in summer, the FFQ considers annual consumption, and most of the salted foods are eaten during the cold seasons. If the samples for urinary iodine level assessment had been collected in the cold seasons, a stronger correlation could possibly have been detected between urinary iodine levels and salt-rich foods.

The results of thyroid function tests did not differ between the inhabitants of Rasht and Sari. Although total T_4 was higher in Rasht, the free T_4 index was not significantly different between the two cities. Therefore, increased thyroxine-binding globulin might be an explanation for the higher T_4 levels in Rasht compared with Sari. We also observed higher levels of anti-thyroglobulin antibodies in Rasht. Higher levels of anti-thyroid antibodies have been reported after iodized oil administration [9]. However, this finding has not been confirmed by others [10, 11]. The same

trend was not observed with regard to anti-TPOAb levels in Rasht.

The results of this study demonstrate that the inhabitants of both Rasht and Sari receive sufficient iodine, with a higher level in Rasht. Daily household consumption for food preparation and table salt is similar in both cities, but salted foods are more commonly eaten in Rasht than in Sari. Furthermore, our study indicates the important role of the dietary habits of different populations in the interpretation of results ob-

tained from nutritional and epidemiological studies.

Acknowledgements

This work was supported in part by grants from the World Health Organization Regional Office for the Eastern Mediterranean. We wish to thank the employees of the Endocrine Research Centre for their help and Dr Farbod Raeeszadeh for his help in the preparation of this manuscript.

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