Iodine nutrition status of pregnant women in an iodine-sufficient area

Husref Tahirović, Alma Toromanović, Adem Balić, Sanja Grbić, and Daniella Gnat

Abstract

Background. *Iodine is necessary for the synthesis of thyroid hormones, which play a decisive role in the development of the brain during fetal and early postnatal life.*

Objective. *To evaluate whether prophylaxis with 20 to 30 mg of iodine per kilogram of salt is enough to ensure optimal iodine nutrition during pregnancy in an iodine-sufficient area.*

Methods. *A cross-sectional study of pregnant women was conducted in 2007. The urinary iodine concentration (UIC) was measured in 300 randomly selected women in Tuzla, Bosnia, and Herzegovina, in all three trimesters of pregnancy.*

Results. *The median UIC of the pregnant women was 142 μg/L, ranging from 27 to 1,080 μg/L. The median UIC of the pregnant women in each trimester of pregnancy who were not restricting their salt intake was consistent with adequate iodine nutrition, as defined by the World Health Organization Technical Consultation, whereas the median UIC of women who were restricting their salt intake was insufficient.*

Conclusions. *Pregnant women in the urban area of Tuzla had adequate iodine status except for those with restricted salt intake, which presents an increased risk to the mother as well to as the unborn child. Women in the rural area of Tuzla were found to be iodine-deficient, regardless of whether they had restricted their salt intake or not. However, for those pregnant women who have been advised to restrict their salt intake and who thus face the risk of iodine deficiency, the use of salt with higher concentrations of iodine could be advised.*

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Introduction

Iodine is a micronutrient contained in small amounts (10 to 20 mg) in the human body. It is necessary for the synthesis of thyroid hormones, which play a decisive role in many metabolic processes, especially the maturation of the central nervous system. Therefore, iodine deficiency, if severe enough to affect thyroid hormone synthesis during this critical period, will result in hypothyroidism and brain damage. The clinical consequence will be irreversible mental retardation [1, 2]. Because fetal thyroid gland development and hormone production are delayed during gestation, the fetus is totally dependent in early pregnancy on maternal thyroxine for normal brain development, and it may also benefit from maternal dietary supplementation of iodine during the rest of pregnancy [3]. According to a World Health Organization (WHO) Technical Consultation, the recommended daily intake of iodine for pregnant women is 250 μg, and the median urinary iodine concentration (UIC) for adequate iodine intake is 150 to 249 μg/L [4].

In Bosnia and Herzegovina, the first law requiring an obligatory iodization of all salt for human and animal consumption with 3.75 to 11.25 mg of iodide as potassium iodide (KI) per kilogram of sodium chloride was proclaimed in 1953 [5]. Later studies showed evidence of iodine deficiency [5–7]. On 25 October 2001, the Federal Minister of Energy, Mining and Industry, in an agreement with the Federal Minister of Health, promulgated the new Regulations on Edible Salt Quality, which require iodization of salt with 20 to 30 mg of iodine per kilogram of salt [8]. Since then universal salt iodization has been fully operative in the whole Federation of Bosnia and Herzegovina. Two years after the introduction of the new mandatory salt iodization, it was determined that the increased iodine supplementation of salt in 2001 was successful and that the Federation of Bosnia and Herzegovina was iodine sufficient [9]. However, the iodine status of pregnant women after the achievement of iodine sufficiency in the Federation of Bosnia and Herzegovina is not known. Nevertheless, it is well known that in countries that have achieved iodine sufficiency, the iodine status of pregnant women may still be inadequate [10].

Since pregnant and lactating women need higher levels of iodine, the aim of the present study was to evaluate whether prophylaxis with 20 to 30 mg of iodine per kilogram of salt is enough to ensure optimal iodine nutrition during pregnancy.

Subjects and methods

The study included 300 pregnant women (100 in each trimester) who attended the antenatal clinic at the Dr Mustafa Šehović Health Center and Polyclinic in Tuzla, Bosnia and Herzegovina, between 1 June and 30 October 2007. The women were randomly selected when they came in for routine checkups. The inclusion criteria were pregnant women who were 15 to 45 years of age, lived in Tuzla city, and did not have thyroid or other disorders. As the city of Tuzla has both urban and rural areas, and the patterns of buying and storing salt vary between these areas, pregnant women were selected from both rural and urban areas.

Urine samples (5 to 10 mL) were collected between 9 and 11 AM, the period when UIC is lowest [11], and were kept in a freezer at –20°C until analysis, which was performed 2 to 3 months after collection.

A structured questionnaire was used to collect demographic data (place and date of birth, address, number of members of household, duration of pregnancy) and a self –report of whether or not salt intake was limited during pregnancy. Specific data about household salt consumption was also requested: the type of salt used in the household, and the monthly consumption of salt in kilos per member of household. (This type of information can be easily calculated, due to the way that salt is labeled and packaged. In Tuzla, only two types of salt are sold: Tuzla salt and sea salt from Croatia. All salt is labeled by name (Tuzla vs. Sea salt), iodine concentration, and weight of the bag (eg., one kilo), so participants were able to calculate and respond to the questions accordingly.)

The women completed questionnaires in the first, second, and third trimesters of pregnancy. Before completing the questionnaire, the women were told what it was for and the fact that by filling in the questionnaire they were agreeing to take part in the study. The Ethics Committee of the Health Center and Polyclinic "Dr Mustafa Mujbegovic" gave approval for this research.

Determination of UIC

UIC was measured by the Sandell–Kolthoff reaction [12] based on the catalytic property of iodine in the reduction of ceric ammonium sulfate (yellow) to the cerous form (colorless) in the presence of arsenious acid with the use of an Autoanalyzer Technicon II at the Division of Biochemistry, Centre Hospitalier Universitaire St.-Pierre, Brussels, Belgium.

Statistical analysis

The nature of the distribution of quantitative variables was assessed by the Shapiro–Wilks test. Differences in medians were assessed by the Kruskal–Wallis and Mann–Whitney tests. Significance was defined as $p < .05$. Analyses were performed with the statistical package Arcus QuickStat.

Results

The median age of the pregnant women was 26.2 years, ranging from 15.4 to 45 years. The median duration of pregnancy was 17 weeks, ranging from 5 to 39 weeks.

Of the 300 women, 175 were from urban and 125 from rural areas. Two hundred ninety-six women (98.6%) consumed salt containing 20 to 30 mg of iodine per kilogram, whereas only four women consumed salt containing 14.8 to 18.5 mg of iodine per kilogram. During pregnancy, 148 women reported that they had limited their intake of salt and 152 did not. Of the 148 women with limited salt intake, 116 (73%) were advised to limit their salt intake by doctors or nurses, and only 3 (2.3%) were advised how to supplement their diet with an adequate quantity of iodine.

We calculated the monthly and daily salt intakes for each member of the family from which the pregnant woman came, on the basis of the monthly salt intake for the entire family and according to the number of members in the family, for women with and without limited salt intake during pregnancy. The median daily consumption of salt per household member was 5.1 g in families of pregnant women with limited salt intake and 6.4 g in families of pregnant women with unlimited salt intake ($p > .05$). Based on the data for daily consumption of salt per household member, we estimated that the intake of iodine from iodized salt per household member was 127.5 μg in families of pregnant women with limited salt intake and 160.0 μg in families of pregnant women with unlimited salt intake.

The median UIC of the 300 pregnant women was 142 μg/L, ranging from 27 to 1.080 μg/L.

As shown in **table 1**, among pregnant women from urban areas, those whose salt intake was unlimited had a significantly higher UIC than those with limited salt intake ($p < .05$). However, in rural areas, although the

UIC of pregnant women with unlimited salt intake was higher than that of women with limited salt intake, the difference was not significant.

Table 2 shows the median, range, and distribution of UICs of women for each trimester of pregnancy. The general distribution figures are used for trimester-specific analysis. The median UIC was consistent with adequate iodine nutrition, as defined by WHO [4]. The median UIC of the pregnant women who did not restrict salt intake in each trimester of pregnancy was within the limitations of the reference value [4] (**table 3**). At the same time, the median UIC of pregnant women who had restricted salt intake in each trimester of pregnancy was in the category of insufficient iodine intake [4] (**table 4**).

Discussion

We found that the median UIC of pregnant women in Tuzla city who had unlimited salt intake was consistent with adequate iodine nutrition according to the recommendations of the WHO Technical Consultation [4]. Our data also show that the median UIC in the group of pregnant women who had limited salt intake during pregnancy was 133 μg/L. These results showed that, according to the WHO recommendations [4], pregnant women in this group had insufficient iodine intake, which may lead to maternal hypothyroxinemia resulting in suboptimal fetal neurodevelopment [13].

In both groups in this study, the median UIC decreased during pregnancy. However, among the women who did not restrict salt intake, the median UIC

TABLE 1. Urinary iodine concentrations of pregnant women according to salt intake and place of residence

	Urban			Rural		
		UIC (μg/L)			UIC (μg/L)	
Salt intake	No.	Median	Range	No.	Median	Range
Unlimited	82	163[a]	38–800	66	147[b]	27–1.080
Limited	93	130[c]	30–294	59	134	43–300
Total	175	147[d]	30–800	125	142	27–1.080

UIC, urinary iodine concentration

a. K –Wχ^2 = 1.973, d.f. = 173, p = .0251 compared with urban women with limited salt intake and K –Wχ^2 = 1.973, d.f. = 146, p = .150 compared with rural women with unlimited salt intake.

b. K –Wχ^2 = 1.979, d.f. = 123, p = .213 compared with rural women with limited salt intake.

c. K –Wχ^2 = 1.975, d.f. = 150, p = .586 compared with rural women with limited salt intake.

d. K –Wχ^2 = 1.967, d.f. = 298, p = .142 compared with rural women.

TABLE 2. Urinary iodine concentrations of pregnant women according to trimester and distribution of concentrations

Trimester	No. of urine samples	UIC (μg/L)		Distribution (%)			
		Median	Range	< 150 μg/L	150–249 μg/L	250–499 μg/L	≥ 500 μg/L
1	100	151	34–1.080	46.0	36.0	15.0	3.0
2	100	146	28–550	55.0	33.0	11.0	1.0
3	100	126	27–800	64.0	1.0	6.0	1.0
All	300	142	27–1.080	55.0	32.7	10.6	1.6

UIC, urinary iodine concentration

TABLE 3. Urinary iodine concentrations of pregnant women without restriction of salt intake according to trimester and distribution of concentrations

Trimester	No. of urine samples	UIC (μg/L)		Distribution (%)			
		Median	Range	< 150 μg/L	150–249 μg/L	250–499 μg/L	≥ 500 μg/L
1	50	167	34–1.080	40.0	38.0	16.0	6.0
2	52	156	28–550	46.1	36.5	15.4	1.9
3	46	150	27–800	50.0	35.2	6.5	2.2
All	148	156	27–1.080	45.2	36.5	13.5	3.5

UIC, urinary iodine concentration

TABLE 4. Urinary iodine concentrations of pregnant women with restriction of salt intake according to trimester and distribution of concentrations

Trimester	No. of urine samples	UIC (µg/L)		Distribution (%)			
		Median	Range	< 150 µg/L	150–249 µg/L	250–499 µg/L	≥ 500 µg/L
1	50	145	50–300	52.0	34.0	14.0	0
2	48	132	30–294	64.5	29.2	6.3	0
3	54	125	44–264	74.1	20.4	5.5	0
All	152	133	30–300	63.8	27.6	8.6	0

UIC, urinary iodine concentration

was within the range of values that indicate adequate iodine intake. Interestingly, in both groups, the percentage of women with UICs below 150 µg/L rose with advancing gestation and the percentage with UICs between 150 and 249 µg/L decreased. The decreasing level of UIC during pregnancy is a result of the increase in renal iodine clearance [14] and inadequate dietary compensation [15].

In conclusion, based on the data presented, the iodine nutriture of pregnant women in Tuzla city is adequate, unless there is a restriction of salt intake, which presents an increased risk to the mother as well as to the unborn child. However, for those pregnant women who have been advised to restrict their salt intake and who therefore face the risk of iodine deficiency, the use of iodized salt with higher concentrations of iodine could be advised. The concentration of iodine need not be more than 50 to 75 ppm. These concentrations will deliver enough iodine to reach sufficiency, since they are only fractionally short of the cutoff of 150 µg/L. If universal salt iodization is not working for this high-risk group, supplementation is a second alternative.

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