Nutritional iodine status in gestation and its relation to geographic features in Urmia County of northwest Iran

Rahim Rostami, Asghar Beiranvend, and Jaffar Nourooz-Zadeh

Abstract

Background. *Iodine is an important component for the proper function of the thyroid and fetal development.*

Objective. *To evaluate the influence of geographic variation on nutritional iodine status during pregnancy.*

Methods. *Four hundred eighty-nine women in the first trimester of pregnancy were enrolled. Of these, 419 (85.5%) were from the plain districts and 70 (14.5%) from mountainous regions. Data were obtained on demographic characteristics and accessibility of iodized salt, and samples of table salt were collected. In the third trimester, 322 women remained in the study: 281 (87.2%) from the plains and 41 (12.8%) from the mountainous regions. Salt and urine samples were analyzed for iodine content.*

Results. *All participants stated that they used iodized table salt. The proportion of salt samples with optimal iodine content (30 ppm) from the plains and mountain regions were 68.7% and 88%, respectively. The median urinary iodine content (UIC) in the plains area in the first and third trimesters was 82 and 119 μg/L, respectively. The corresponding values in the mountain region were 34.5 μg/L and 76 μg/L. The prevalence of subjects with an inadequate iodine intake (UIC < 150 μg/L) in first and third trimester in the plains and mountain regions were 84.5% and 66.9% vs 98.6% and 90.2%, respectively.*

Conclusions. *The prevalence of pregnant women exhibiting UIC < 150 μg/L in the mountain region was substantially higher than those in the plain district. Our findings also show that the current strategy for eradication of iodine deficiency in school-aged children would not fulfill iodine requirements in pregnancy and that additional source(s) of iodine are required to prevent the adverse effects of iodine deficiency in pregnancy. Further studies are needed to address the cause(s) for the rapid depletion of iodine stores in pregnancy.*

Key words: Geographic variation, iodine, Iran, pregnancy, urinary iodine excretion

Background

Iodine is an essential micronutrient for the proper function of the thyroid. It is necessary for the synthesis of thyroid hormone, which plays an important role in the metabolic process and maturation of the central nervous system. Iodine deficiency in a critical period may result in hypothyroidism, brain damage, and mental retardation [1–3]. Extensive actions against iodine deficiency have been undertaken worldwide by implementing universal salt iodination (USI) [4]. Despite these efforts, nearly 38 million newborns are at risk for lifelong consequences of iodine deficiency annually [5, 6].

The USI program in Iran began in 1994. The country was subsequently declared free of iodine deficiency in 2000 [7]. Knowledge of nutritional iodine status during pregnancy in Iran is limited, with most studies focusing on monitoring nutritional iodine status as assessed by measuring urinary iodine concentration (UIC) among school-aged children residing in areas with adequate or more than adequate iodine status [8]. Azizi et al. reported that the median UIC among pregnant women in Tehran was slightly lower than of schoolchildren (186 vs. 196 μg/L), and only 28% of the subjects had a UIC < 150 μg/L [9]. It was also reported that the median UIC in the first and second trimesters was similar but 32% higher than that in the third trimester. Similar observations have been reported by Ainy and coworkers [10].

Urmia County is the capital of West Azarbaijan in the northwest of Iran. The second Iranian National Survey in 1996 reported that the values for median UIC and total goiter prevalence (TGP) by palpation were 130

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μg/L and 35%, respectively [11]. The corresponding values from Third Iranian National Survey were 140 μg/L and 7.1% [12]. Urmia has both plain districts with a maximum altitude of 1,806 to 2,151 m above sea level and inhabited mountainous regions with maximum altitudes of 3,370 m. The aim of this cross-sectional study was to explore the influence of geographic variations on UIC in pregnancy in Urmia County.

Methods

Data collection

Pregnant women (n = 1,078) attending their first prenatal care visit between October and December 2009 in Urmia County were interviewed. The exclusion criteria were a history of thyroid dysfunction or abortion. Sample size calculation (n = 393) was based on the prevalence of iodine deficiency in West Azarbaijan [12]. To enhance the statistical power of the study, the sample size was increased to 489 subjects. The sample was drawn from five districts that included 12 prenatal care centers. A map of Urmia County displaying the location and altitude of the districts assigned to plains and mountainous regions is shown in **figure 1**. The sample size for each prenatal care center was calculated according to the annual live birth rate in each district, employing the population proportionate sampling approach. The sample size fell to 322 cases in the third trimester due to unavailability, relocations, abortion, or unwillingness to continue the study. The percentage of loss to follow-up in the third trimester was 34% (n = 167). Data on demographic characteristics and accessibility of iodized salt were collected in the first trimester. A table salt sample was also obtained from each participant during the first visit to the prenatal care center. To facilitate accessibility of iodized salt in suburban areas including mountain regions of the county, fortified salt is provided free of charge by the local health authority.

Fasting urine samples were collected in the first and third trimesters. The samples were kept at –20°C until testing for UIC. UIC was assessed by the Sandell-Kolthoff reaction method A [13]. The coefficient of variation (CV) was 8%. The iodine content in table salt samples was determined by a field test for iodate in salt (Peyman Tashkhis, Iran). To ascertain the validity of the rapid test for iodine determination, 36 table salt samples were randomly selected and their iodine content was determined by titration [14].

Ethical approval

This investigation was approved by the Ethical Committee of Urmia University of Medical Sciences, Iran. The objectives of the project were orally explained to the pregnant women by prenatal care nurses. Oral consent was obtained from all patients before entering the study.

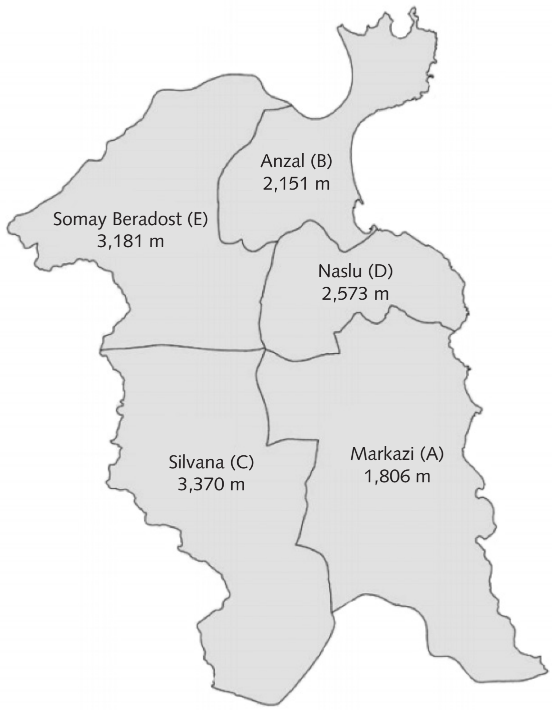

FIG. 1. Map of Urmia County showing location and maximum altitude of districts assigned to plains (A, B) and mountainous (C, D, E) regions

Data analysis

Descriptive and analytical statistics were performed with STATA/SE 10.0 for Windows. UIC values are presented as medians because the data are not normally distributed. The Mann-Whitney U test was used to evaluate the impact of geographic area on UIE, and the Wilcoxon signed-rank test was employed to examine differences in UIC between the first and third trimesters. The data were categorized according to geographic area to minimize a possible confounding effect of place of residence on intertrimester changes. A p value < .05 was considered to indicate a significant difference.

Results

The mean age of the pregnant women was 25.0 ± 5.4 years. In the first trimester, 419 participants (85.5%) were from the plains and 70 (14.5%) were from the mountains; in the third trimester, 281 (87.2%) were from the plains and 41 (12.8%) were from the mountains. The mean ages of inhabitants of the plain and the mountains were 25.0 ± 5.0 years and 27.0 ± 6.0 years, respectively. The body mass index (BMI) was 24.9 ± 4.1 kg/m^2 overall, 25.0 ± 4.6 kg/m^2 for residents of the plains, and 24.3 ± 3.6 kg/m^2 for residents of the mountains.

All the participants declared that they consumed only iodized table salt. The iodine content of salt samples from the plains was 0 ppm in 3.6% of samples, 8 ppm in 1.7%, 15 ppm in 26%, and 30 ppm in 68.7%. In samples from the mountains, the iodine content was 0 ppm in 1.4% of samples, 8 ppm in 10%, 15 ppm in 10%, and 30 ppm in 88.6%. **Figure 2** shows the distribution of table salt samples from the plains and mountainous regions of Urmia County according to iodine content.

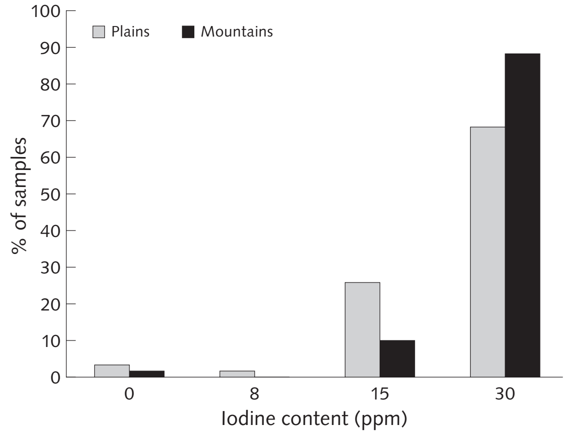

FIG. 2. Distribution of iodine content in household salt samples obtained from plains and mountain populations. Samples with iodine contents of 0, 8, 15, and 30 ppm are considered uniodized, not adequate, adequate, and optimal, respectively

In the plains regions, the median UIC in the first trimester was 82 μg/L (range, 0 to 286 μg/L; mean, 87.6 ± 56.0 μg/L). The respective values for third trimester was 119 μg/L (range, 1 to 276 μg/L; mean, 114.3 ± 65.4 μg/L). In the first trimester, the distribution of subjects with UIC: < 50 μg/L, 50 to 99 μg/L, 100 to 149 μg/L, 150 to 199 μg/L and > 200 μg/L were 27.7%, 36%, 20.8%, 11.9% and 3.6%, respectively. The respective figures for the third trimester were 18.9%, 20.6%, 27.4%, 23.5% and 9.6%. The distribution of UIC among pregnant women from the plains region in the first and third trimesters is shown in **figure 3**.

In the mountain regions, the median UIC in first trimester was 34.5 μg/L (range, 1 to 159 μg/L; mean, 40.8 ± 31.0 μg/L). The median UIC in third trimester was 76 μg/L (range, 8 to 159 μg/L; mean, 80.0 ± 42.7 μg/L. In the first trimester, the frequencies of individuals with UIC: < 50 μg/L, 50 to 99 μg/L, 100 to 149 μg/L, 150 to 199 μg/L and > 200 μg/L were 65.7%, 28.6%, 4.3%, 1.4% and 0%, respectively. The corresponding values for the third trimester were 34.1%, 34.1%, 22.0%, 9.8% and 0%. The distribution of UIC among pregnant women from the mountain region in the first and third trimesters is shown in **figure 4**.

Pairwise comparison of UIC values in the first and third trimesters for the studied population as a whole revealed that the differences were statistically significant ($p < 0 .05$). This pattern remained valid even

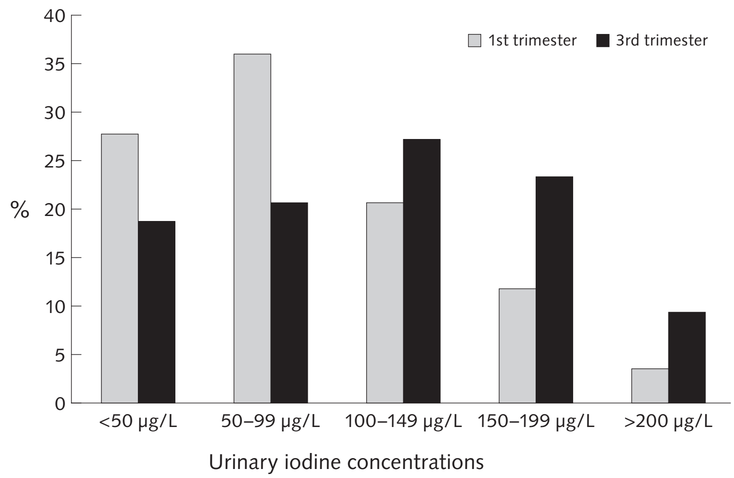

FIG. 3. Change in iodine status (ioduria) in plains regions from the first to the third trimester. World Health Organization criteria for the grading of urinary iodine concentration (UIC) as the primary indicator of nutritional iodine status in school-aged children are as follows: < 50 μg/L, severe iodine deficiency; 50 to 99 μg/L, moderate iodine deficiency; 100 to 149 μg/L, mild iodine deficiency; 150 to 199 μg/L, adequate iodine intake; > 200 μg/L, more than adequate iodine intake. UIC < 50 μg/L is considered to indicate inadequate iodine status

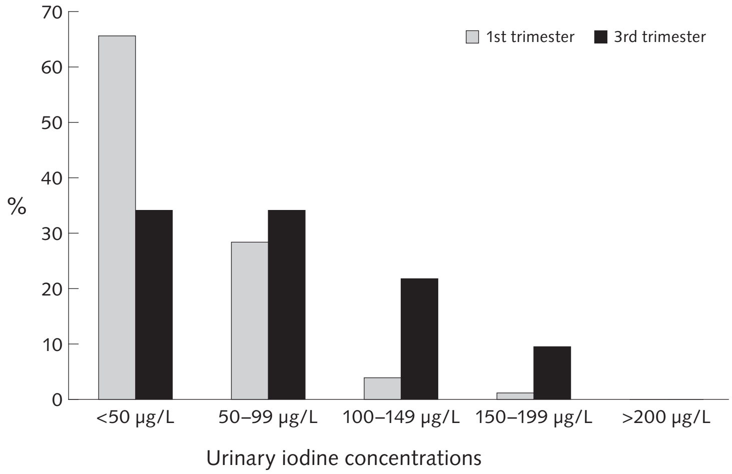

FIG. 4. Change in iodine status (ioduria) in mountain regions from the first to the third trimester. World Health Organization criteria for the grading of urinary iodine concentration (UIC) as the primary indicator of nutritional iodine status in school-aged children are as follows: < 50 µg/L, severe iodine deficiency; 50 to 99 µg/L, moderate iodine deficiency; 100 to 149 µg/L, mild iodine deficiency; 150 to 199 µg/L, adequate iodine intake; > 200 µg/L, more than adequate iodine intake. UIC < 50 µg/L is considered to indicate inadequate iodine status

when the participants were segregated according to geographic residence.

Discussion

In 1980, iodine-deficiency disorder was recognized as a priority health problem in Iran [15]. A national program of iodine fortification by means of USI was initiated in 1989. By 1994, accessibility of iodized salt was more than 95% at household level [16]. To the best of our knowledge, no documented information is available on monitoring and enforcement of USI in West Azarbaijan Province beyond that published in Iranian national surveys [12]. However, there is an article from a neighboring province (East Azarbaijan) dealing with the monitoring and enforcement of USI strategy. The study showed that enforcement policies were weakest in 2000, as shown by a significant decline in UIC among schoolchildren and increased frequency of use of table salt with inadequate iodine content (< 15 ppm) [17]. This problem was resolved in 2006 by increasing collaboration between the manufacturers and the deputy of public health in the province.

In this investigation, 100% of the participants declared that they used iodized salt. The proportion of iodine-free samples and the mean iodine content were in close agreement with values reported by Kousha et al. [17] (5% vs. 4% and 25.1 ± 8.1 ppm vs. 32.4 ± 16.7 ppm). Our data show that the quality of iodized table salt in West Azarbaijan, in terms of the percentage of samples with optimum iodine content (30 ppm) and the prevalence of samples with inadequate iodine content, was better than that in East Azarbaijan (71.6% vs. 55.9% and 6.7% vs. 14.2%, respectively) [17].

Interestingly, the percentage of salt samples with optimum iodine content was higher in the mountains than in the plains (88% vs. 68.7%), and the percentage of non-iodinated table salts was lower in the mountains than in the plains (1.4% and 3.6%). A likely explanation for the difference between the mountains and the plains in the percentage of non-iodinated salt samples is that iodized salt in suburban areas in Iran is still provided free of charge by the deputy health authority in each province. Taken together, this study demonstrates that the quality of distributed iodized table salt in Urmia is acceptable in terms of having a high percentage of samples with optimum iodine content and a low percentage with inadequate iodine content compared with the neighboring province of East Azarbaijan.

WHO has recommended UIC from 150 to 249 µg/L as an indicator of iodine sufficiency during gestation [18, 19]. Because of the absence of a pregnancy-specific reference range for adequate iodine status, the UIC reference range in school-aged children is employed as an index [18]. The National Health and Nutrition Studies (NHAES) 2001/02 reported that the median UIC in pregnant women was lower than that in school-aged children (176.2 vs. 221 µg/L). On the other hand, Azizi and coworkers have shown that median UICs during pregnancy in regions with adequate iodine intake were slightly lower than those of reference populations (186 to 212 vs. 193 to 250 µg/L) [9]. The median UIC among pregnant women in the present study was 93.7 µg/L, which is markedly lower than that of the reference population (i.e., school-aged children) in West Azarbaijan Province (144 μg/L) [12]. In the current study, median UIC in gestation is also lower than that reported for pregnant women residing in an area of mild iodine deficiency [20].

Another interesting finding from the present investigation is that median UIC during pregnancy among inhabitants of the mountain region was markedly lower than that of plain district (55 μg/L vs 100 μg/L). Accordingly, the prevalence of pregnant women exhibiting UIC < 150 μg/L among mountain residents was higher when compared with those from plain district (94.4% vs 75.7%). The latter values are considerably higher than that (27.3%) obtained for regions with adequate iodine intake in Iran [9]. In this study, the low median UIC, particularly in the mountains, is not explained by differences in the accessibility of iodized salt. A possible explanation is inadequate total body iodine stores in this borderline iodine-sufficient region of the country [20].

Intertrimester variations have extensively been explored by various investigators. Some have reported a fluctuation in ioduria with advanced gestation, whereas others have reported a decreasing trend or even a rising pattern. An example of the fluctuating pattern is that found by Azizi et al., who explored changes in UIC in Isfahan, a city with adequate iodine intake (212 μg/L), and reported that the median UIC in the second trimester was 11.6% higher than that in the first trimester [9]. The median UIC in the third trimester was 27% lower than that at the first trimester. Another example of a time-dependent decline in ioduria is that of Ainy et al., who addressed variations in UIC in Tehran, a city with adequate iodine intake (186 μg/L) [10]; they reported a gradual decline in UIC with advancing pregnancy (declines of 21% and 27% in the second and third trimesters when compared to the first trimester, respectively). Similarly, Stilwell et al. [20], studying the profile of iodouria in a mildly deficient population in Tasmania, reported a decline in UIC after the first trimester, with the largest decline in the second trimester.

In this cross-sectional investigation, data on median UIC in the second trimester are not reported, because the participants were not entitled to attend routine prenatal care clinics in the second trimester. However, unlike the studies of Ainy et al. [10] and Stilwell et al. [20], our study shows an overall trend toward increasing median UIC with advancing pregnancy. This pattern remained valid even when the data were analyzed separately according to geographic location. In this context, it is worth mentioning that the difference in UIC between the first and third trimesters was more pronounced in the mountains than in the plains (120% vs. 45%).

Our findings on the dynamics of UIC during gestation seem to be similar to those obtained in an iodine-sufficient population in Hong Kong [21]. The reason(s) for differences in iodine homeostasis with advancing pregnancy, even in populations with similar nutritional iodine status, is unclear. Although Stilwell et al. [20] suggested that the clinical setting of sample collection has no impact on UIC variation during gestation, further studies are needed to address the relationship between glomerular filtration rate and iodouria during pregnancy.

Conclusions

Even though iodized salt has been provided in Iran for two decades as an efficient and cost-effective intervention to eliminate iodine deficiency, the prevalence of iodine deficiency among pregnant women in northwest Iran is more than 70%. The current strategy for elimination of iodine deficiency does not fulfill the special requirements for iodine during pregnancy among women in West Azarbaijan, and additional iodine is needed to prevent the adverse effects of iodine deficiency in pregnancy. This recommendation does not deny the impact of educational programs on utilization of iodized salt as a long-term strategy.

Acknowledgments

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