

An Assessment of Urinary and Breast Milk Iodine Concentrations in Lactating Mothers from Gorgan, Iran, 2003

Hamid R. Bazrafshan,¹ Sakineh Mohammadian,¹ Arash Ordookhani,² Arezou Abedini,¹ Reza Davoudy,¹ Elizabeth N. Pearce,³ Mehdi Hedayati,² Fereidoun Azizi,² and Lewis E. Braverman³

Dietary iodine is essential for the production of thyroid hormones. Breast-fed infants are reliant on maternal iodine intake. The aim of this study was to evaluate iodine sufficiency in lactating women in Iran. The sample consisted of 100 lactating mothers referred to the Taleghani Hospital of Gorgan, Iran. Goiter was graded according to World Health Organization (WHO) classification. Spot urine and breast-milk samples were collected for the measurement of iodine concentrations. Urine iodine concentrations (UIC) less than 100 and breast-milk iodine concentrations (MIC) less than 50 $\mu\text{g}/\text{L}$ were considered consistent with iodine deficiency. Forty-three percent of women had grade 1 and 2 goiters, respectively. The median UIC was 259 $\mu\text{g}/\text{L}$. UIC was less than 100 in 16%. Grade 1 and 2 goiters were each present in 8% of mothers with UIC less than 100 $\mu\text{g}/\text{L}$. The median MIC was 93.5 $\mu\text{g}/\text{L}$. MIC was less than 50 $\mu\text{g}/\text{L}$ in 19%. Grade 1 and 2 goiters were present in 11% and 8%, respectively, of women with MIC <50 $\mu\text{g}/\text{L}$. MIC and UIC levels were significantly correlated ($r = 0.44$, $p < 0.0001$). Iodine deficiency and goiter were associated ($p < 0.0001$). UIC and MIC concentrations are sufficient in Gorgan, Iran. However, individual infants remain at risk for low iodine intake via breast milk.

Introduction

IODINE IS ESSENTIAL for thyroid hormone synthesis, normal growth, mental development, reproduction, and survival (1,2). In 1998, over one third of the world's population lived in areas of iodine deficiency (3). Neonates and young infants constitute the target population for the effects of iodine deficiency because the most important complications of iodine deficiency are irreversible brain damage and mental retardation, which result from iodine deficiency and thyroid failure during fetal and early postnatal life (4). This stems from the fact that the infant brain develops rapidly, especially from birth until 2–3 years of age, and thyroid hormone is essential for normal brain development (5–8).

Iodine is considered unique among the trace elements in milk because it is avidly concentrated by the lactating breast (9,10). It has been demonstrated that the main iodide transporter in the breast is the sodium iodide symporter (NIS), which is markedly increased during lactation, thereby providing the nursing infant with milk enriched with iodide (11,12). The iodide content in breast milk is dependent upon the mother's iodine intake. Despite the importance of iodine for infant health, there have been few studies evaluating human milk iodine concentrations (13,14).

Recently, Iran has been considered an iodine-sufficient area (15) as assessed by urinary iodine concentrations (UIC) among school-aged children (16). However, a recent study has demonstrated that pregnant women remain at risk for inadequate iodine intake despite universal salt iodization in Iran (17). There are no recent data regarding breast-milk iodine concentration (MIC) in lactating women in Iran. Therefore, the present study was conducted to evaluate iodine concentrations in the breast milk and urine of lactating women in the city of Gorgan, located in northern Iran, near the Caspian Sea.

Materials and Methods

From April to June 2003, healthy lactating mothers referred to the Taleghani Hospital of Gorgan for routine postpartum follow-up were randomly selected for study participation. All of the women enrolled had experienced uncomplicated pregnancies and deliveries. Informed consent was obtained from all participants. All procedures followed were in accordance with the ethical methods of the institutional committee on human experimentation. Those with no clinical signs or symptoms of hypothyroidism or hyperthyroidism were included in the study. Women who had used

¹Gorgan Faculty of Medicine, Golestan University of Medical Sciences, Gorgan, Iran.

²Endocrine Research Center, Shaheed Beheshti University of Medical Sciences, Tehran, Iran.

³Section of Endocrinology, Diabetes, and Nutrition, Boston University Medical Center, Boston, Massachusetts.

TABLE 1. PREVALENCE OF GOITER AMONG LACTATING MOTHERS BY URINARY IODINE CONCENTRATION IN GORGAN, IRAN, 2003

Urinary iodine concentration ($\mu\text{g/L}$)	Goiter grade			Total
	0	1	2	
Low (<100 $\mu\text{g/L}$)	0	8%	8%	16%
Adequate (100–199 $\mu\text{g/L}$)	13%	9%	0	22%
More than adequate (≥ 200 $\mu\text{g/L}$)	36%	26%	0	62%
Total	49%	43%	8%	100%

iodinated antiseptics for perineal or abdominal disinfection during the previous 14 days or who were taking thyroid medications during the postpartum period were excluded. None of the women studied were current or former cigarette smokers. Random sampling continued until 100 subjects were enrolled (18,19).

Goiter size was determined by palpation, using a single experienced examiner (H.R.B.). According to World Health Organization (WHO) criteria, subjects without visible or palpable goiter were considered to have grade 0 goiter, those with palpable goiter but no visible goiter were classed as grade 1, and those with clearly visible goiter were classed as grade 2 (20). After a complete history and physical examination, 2–3 mL of urine and 5–10 mL of breast milk were collected and stored at 4–8°C. The samples were sent to the Endocrine Research Center laboratory in Tehran within 7–14 days of collection, where they were stored at –20°C until urine and milk iodine concentrations were measured.

Laboratory methods

After acid digestion in urine and alkaline incineration in milk samples, iodine concentrations were determined using the Sandell-Kolthoff method (21). Milk samples were carefully homogenized before being ashing (13). UIC levels 100 or more and less than 100 $\mu\text{g/L}$ were classified as iodine-sufficient and -deficient, respectively. In the latter group, iodine deficiency was classified as follows: mild, 50–99 $\mu\text{g I/L}$; moderate, 20–49 $\mu\text{g I/L}$; severe, less than 20 $\mu\text{g I/L}$. UIC values between 200–300 and more than 300 $\mu\text{g/L}$ were considered to reflect more than adequate and excessive iodine intake, respectively (20). MIC values or more 50 and less than 50 $\mu\text{g/L}$ were considered to be iodine-sufficient or -deficient, respectively. In the latter group, mild, moderate, and severe iodine deficiency were defined as follows: mild, 35–50 $\mu\text{g I/L}$; moderate, 20–36 $\mu\text{g I/L}$; severe, less than 20 $\mu\text{g I/L}$ (4).

Statistical analysis

Associations between the presence of iodine deficiency, according to either UIC or MIC values, and of goiter (grade 0 versus ≥ 1), maternal age (≥ 30 versus <30 years), parity (multiparous versus primiparous), occupation (unemployed versus employed), and education (high school graduates versus nongraduates) were tested using χ^2 and Fisher's exact tests. Because of the skewed distribution of iodine concentration values, correlation between UIC and MIC levels were tested using the Spearman's rank correlation. The Mann-Whitney test was used for the comparison of MIC values in the UIC less than 100 and 100 $\mu\text{g/L}$ or more groups. Statistical analyses were performed using the SPSS 9.05 software

package (SPSS Inc., Chicago, IL). *p* values less than 0.05 were considered significant.

Results

Mothers were 30–180 days postpartum. Seventy-nine percent were 30 years of age or younger and 21% were older than 30 years of age with a mean (\pm standard deviation [SD]) age of 25.6 (\pm 1.6) years; 52% were primiparous; 79% were unemployed. Only 12% were high school graduates. Grade 1 and 2 goiters were present in 43% and 8% of the mothers, respectively (Table 1).

The mean (\pm SD), median (range), and 95% confidence interval of the UIC were 250 \pm 123, 259 (35–519), and 226–275 $\mu\text{g/L}$, respectively. UIC was less than 100 in 16%, 50–99 in 13%, and 20–49 $\mu\text{g/L}$ in 3%. None of the mothers had UIC less than 20 $\mu\text{g/L}$. A total of 23% and 39% of mothers had UIC values between 200–300 and 300 $\mu\text{g/L}$ or more, respectively.

The mean (\pm SD), median (range), and 95% confidence interval of the MIC were 117 \pm 101, 93.5 (17–696), and 97.3–137.2 $\mu\text{g/L}$. MIC was less than 50 in 19%, 35–49 in 13%, 20–36 in 3%, and less than 20 $\mu\text{g/L}$ in 3%. In those women with MIC less than 50 $\mu\text{g/L}$, 11% had grade 1 and 8% had grade 2 goiters. Eleven percent and 3% of mothers had MIC levels between 200–300 and 300 $\mu\text{g/L}$ or more, respectively.

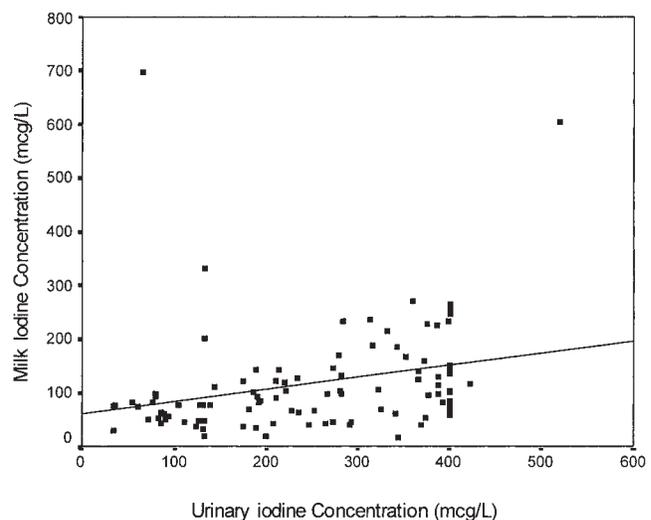


FIG. 1. Scatter plot showing moderate correlation between urine-iodine concentrations (UIC) and breast-milk-iodine concentrations (MIC) values in 100 lactating mothers, Gorgan, Iran, 2003 ($r = 0.44$, $p < 0.0001$).

Figure 1 demonstrates that there was a statistically significant correlation between milk and urine iodine concentrations ($r = 0.44$, $p < 0.0001$). The median MIC value in mothers with UIC less than $100 \mu\text{g/L}$ was significantly lower than the median MIC value for mothers with UIC $100 \mu\text{g/L}$ or more (41.5 versus $101 \mu\text{g/L}$ respectively, $p < 0.0001$). There was a significant association between the presence of goiter and iodine-deficiency ($p < 0.0001$). Iodine status was not related to maternal age, parity, educational level, or occupational status.

Discussion

This is the first study in Iran assessing breast-milk iodine in nursing women during the first few months postpartum. The median UIC of lactating mothers was consistent with sufficient iodine consumption. However, MIC levels were inadequate in some women whose infants may be at risk for iodine deficiency.

Neonates and infants are target populations of major concern for iodine-deficiency disorders. They are particularly sensitive to iodine deficiency because of the low iodine content of their thyroids and an extremely fast turnover of intrathyroidal iodine (22). By contrast, in adults, iodine deficiency, unless severe, does not adversely affect the thyroid iodine stores (23). Therefore, iodine deficiency is more likely to cause decreased thyroid function in neonates and infants than in adults (22). Maternal, fetal, and neonatal hypothyroxinemia may result in irreversibly low IQ scores in affected infants (24). Breastfed infants are reliant on the iodine content of breast milk. To date, only limited attention has been paid to breast-milk iodine content despite its importance in the intellectual development of young infants (13,14).

A law requiring the mandatory production of iodized salt for households was passed in 1994 in Iran and 2 years later an extensive study of UIC in school-aged children in 26 provinces revealed iodine sufficiency, with 85% of children having urine iodine levels $100 \mu\text{g/L}$ or more. However, grade 1 goiter remained endemic in all provinces (16,20). The median UIC in neonates and their mothers were consistent with sufficient dietary iodine in a recent screening program for congenital hypothyroidism (25). However, the iodine content of breast milk in women from Iran has not previously been reported.

The present study demonstrated that 51% of nursing women had goiter but the majority of goiters were small (grade 1). Although there was a significant association between the presence of iodine deficiency and goiter, only 16% of goitrous subjects had low UIC levels. Mothers in our study were questioned about their consumption of several dietary goitrogens. National survey data have shown that fresh fruits and vegetables are generally consumed only in small quantities by the Iranian population (26), and none of the study subjects reported consuming more than one serving of cabbage, turnip, maize, sweet potato, lima, or millet per month during the perinatal or postnatal period. Therefore, it is most likely that the presence of goiter in women with normal UIC levels reflects a history of iodine deficiency prior to the era of nationwide salt iodization.

Median and 95% confidence interval UIC values in our lactating women were within the normal range (22) and a large number had adequate or excessive UIC levels (20). Al-

though iodine is avidly concentrated by the lactating breast (9,10), unexpectedly, 19% of these iodine rich mothers had low breast-milk iodine content, with 3% having MIC values compatible with severe iodine deficiency (20). In addition, median MIC levels in our study were lower than the recommended adequate iodine intake for infants, that is, $110\text{--}130 \mu\text{g}$ of iodine per day (27). The relatively weak correlation between UIC and MIC (Fig. 1) emphasizes the discrepancy and suggests that adequate maternal UIC values do not completely guarantee sufficient dietary iodine for breastfed infants. Of note, a recent study from Australia reported that there was a weak correlation between UIC expressed as micrograms of iodine per grams of creatinine and MIC but not between UIC and MIC (28). It has also been noted that breast-milk iodine content is lower in women who smoke (29), however, all women in this study were non-smokers.

We conclude that some breast-fed infants in Iran are still at risk for dietary iodine deficiency and that iodine supplementation, by means other than that obtained from iodized salt, may be warranted in nursing mothers. Measurements of MIC are not routinely clinically available for the detection of individual at-risk infants. Therefore a population-based approach is necessary. Increasing the amount of iodine added to salt is not appropriate because of the high number of excessive UIC values recently reported in the Iranian population and the problem of iodine-induced hyperthyroidism in adults (16,22). Perhaps nursing mothers should be advised to ingest iodine-containing multivitamin preparations (22). Further studies from other parts of Iran and elsewhere will be required to develop a definitive public health approach.

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Address reprint requests to:

Lewis E. Braverman, M.D.

Boston Medical Center

88 East Newton Street, Evans 201

Boston, MA 02118

E-mail: lewis.braverman@bmc.org