Original Article

COMPARISON OF URINARY IODINE EXCRETION IN NEONATES AND THEIR MOTHERS IN ISFAHAN, IRAN

Mahin Hashemipoor, MD,[1] Masoud Amini, MD,[2] Allale Gheisari, MD,[2] Shahryar Sharifei, MD,[1] Ramin Iranpour, MD,[1] and Ashraf Aminorroaya, MD[2]

ABSTRACT

Objective: To determine the urinary iodine excretion of neonates (28 days of age or younger) and their mothers in Isfahan, a centrally located city in Iran, in 1997 after 8 years of iodized salt distribution in an effort to ameliorate iodine deficiency.

Methods: Through a cross-sectional study and by means of convenient sampling, 146 mother-neonate pairs were selected among neonates born in Shahid Sadoughi Hospital in Isfahan. In order to eliminate the effect of povidone-iodine on breast milk and urinary iodine, Savlon antiseptic solution was used in normal vaginal delivery and on the umbilical cord. Normal values of urinary iodine concentration for the mothers and their neonates were ≥10.0 μg/dL and >5.0 μg/dL, respectively. The data were analyzed and compared by the Student *t* test and Pearson correlation coefficient in SPSS software. *P* values <0.05 were considered statistically significant.

Results: In only 3% of the neonates and 14% of the mothers, urinary iodine excretion was below the normal range. No mother or neonate had severe iodine deficiency. In 2% of the mothers and 2% of the neonates, mild iodine deficiency was found. The mean urinary iodine concentration of neonates whose mothers were iodine deficient was significantly lower than that of neonates whose mothers were iodine sufficient (17.34 ± 7.83 μg/dL versus 22.21 ± 7.57 μg/dL; *P*<0.01). A direct significant correlation was noted between the urinary iodine excretion of neonates and that of their mothers ($r = 0.37$; $P<0.01$).

Conclusion: The urinary iodine excretion in mothers paralleled the urinary iodine concentration of their neonates. If urinary iodine concentration is considered an index of total body iodine content, this study demonstrated that prolonged iodized salt intake has minimized the occurrence of iodine deficiency in Isfahan. **(Endocr Pract. 2002;8:347-350)**

Submitted for publication February 1, 2001
Accepted for publication July 11, 2001
From the [1]Department of Pediatrics and [2]Department of Internal Medicine, Endocrine Research Center, Isfahan University of Medical Sciences, Isfahan, Iran.
Address correspondence and reprint requests to Dr. Mahin Hashemipoor, Endocrine Research Center, Isfahan University of Medical Sciences, Isfahan, Iran.
© 2002 AACE.

Abbreviations:
T_3 = triiodothyronine; **T_4** = thyroxine; **TSH** = thyroid-stimulating hormone

INTRODUCTION

Iodine is involved in hormonogenesis in the thyroid gland. Iodine deficiency leads to several disorders such as endemic goiter, cretinism, prenatal mortality, cerebral damage, mental retardation, and hearing loss (1). A study in Paris showed that high hearing thresholds were commonly associated with low urinary iodine excretion; thus, this laboratory finding was thought to suggest a mild hearing defect (2). One investigation in India indicated that the mean urinary iodine concentrations of children in severe iodine-deficient areas were substantially less than those of children who lived in mild iodine-deficient areas (3).

Goiter has been hyperendemic in many parts of Iran. Iodine deficiency had been considered an important contributing factor—but probably not the exclusive one—for the high prevalence of goiter in Iran (4-6). In addition to goiter, other iodine-deficiency disorders, such as impaired physical and intellectual growth, hearing deficit, and hypothyroidism, have been reported in Iran (7,8). Studies have revealed that total body iodine content corresponds to environmentally available iodine, and because the intestinal excretion can be negligible (5 μg/day), the urinary iodine concentration can be used as an index of the daily iodine intake (2). In iodine-sufficient areas, the urinary excretion rate of iodine is 100 μg/day; in iodine-deficient areas with endemic goiter, the excretion rate is 3 to 45 μg/day (9). Because of the difficulty of daily determinations of urinary iodine in field investigations, random urinary concentrations have been measured (10). Several studies have indicated that, if the iodine content of maternal milk is sufficient, newborn infants will receive adequate iodine (11). Studies performed in seven British towns demonstrated a positive correlation between the iodine content of breast milk in mothers and their urinary iodine excretion (12). Differences in the iodine intake of mothers in several areas have been shown to be parallel with the differences in iodine content of breast milk and urinary iodine excreted by their neonates (13,14).

In 1989, iodized salt distribution was initiated in Iran (4). After 8 years of this program (in 1997), we decided to determine the urinary iodine excretion of neonates (28 days of age or younger) and their mothers in Isfahan, a centrally located city in Iran.

METHODS

An initial pilot study was undertaken with 40 mother-neonate paired samples. Then in a cross-sectional study, paired subjects (newborns and their mothers) were selected from the Shahid Sadoughi Hospital of Isfahan, and urine samples were obtained from the neonates and their mothers. In order to eliminate the effect of antiseptic iodine on the urinary iodine concentration, Savlon antiseptic solution was used instead of povidone-iodine for vaginal delivery and on the umbilical cord. In those cases in which iodine-containing antiseptic was used, urine collection was delayed for 5 days, the interval required for eliminating external iodine from urine (15,16). Mothers who were dismissed from the hospital before a urine sample was obtained were invited by telephone or letter to participate in the study. Those mothers who did not respond to the invitation or were reluctant to take part in the research were excluded from the study (as were their neonates).

Urine samples were sent to the Isfahan reference laboratory, and the iodine concentrations were measured with use of the digestion method by only one technician. Normal values for the urinary iodine concentration were established at ≥10.0 μg/dL for the mothers and at >5.0 μg/dL for their neonates (17). The urinary iodine excretions of mothers with mild, moderate, and severe iodine deficiency were 5.0 to 9.9, 2.0 to 4.9, and <2.0 μg/dL, respectively, and the corresponding ranges in their neonates were 3.5 to 5.0, 1.5 to 3.4, and <1.5 μg/dL, respectively (1). The data were recorded as mean ± standard deviation. Statistical analysis was done by using the Student *t* test and Pearson correlation coefficient in SPSS software. *P* values <0.05 were considered statistically significant.

RESULTS

During the study period, 146 mothers and 146 of their neonates were selected for analysis. Among this overall group, 21 mothers (14%) and 4 neonates (3%) were iodine deficient. The mean urinary iodine concentrations of the mothers and of their neonates were 18.97 ± 8.29 μg/dL and 21.53 ± 7.50 μg/dL, respectively. The mean urinary iodine concentration of neonates whose mothers were iodine deficient was significantly lower than that of the others (17.34 ± 7.83 μg/dL versus 22.21 ± 7.57 μg/dL; $P<0.01$). A moderate correlation was found between urinary iodine excretion of the neonates and of their mothers ($r = 0.37$; $P<0.01$). No study subjects had severe iodine deficiency. The distribution of urinary iodine concentrations in the neonates and their mothers is shown in Tables 1 and 2, respectively.

DISCUSSION

Goiter has been present in most parts of Iran (4-6,18). In a study reported in 1967, the prevalence of goiter was 1.2 to 44.3% in different areas of Iran, and the incidence of goiter exceeded 10% in 4 of the 13 localities studied (18). A strong correlation was noted between the iodine content in drinking water and the incidence of goiter in these 13 regions. The percentage of radioiodine uptake by the thyroid was increased and the percentage of urinary excretion of ^{131}I was decreased in persons with goiter in comparison with normal subjects.

In a 1983 survey conducted in Shahriar, a town near Tehran (the capital of Iran), 54% of male members and 66% of female members of 368 examined families had goiter, as did 74% of the girls and 73% of the boys in primary school and high school. The urinary iodine excretion was less than 50 μg/g creatinine in many subjects. Results of thyroid function tests and serum thyroid-stimulating hormone (TSH) concentrations were similar in goitrous and nongoitrous subjects (4).

In 1984, a similar study in students of East Tehran showed the same goiter prevalence. Again, results of

Table 1
Urinary Iodine Concentrations in Isfahani Neonatal Study Subjects*

Urinary iodine (μg/dL)	Deficiency	Neonates	
		No.	%
>5.0	…	142	97
3.5-5.0	Mild	3	2
1.5-3.4	Moderate	1	~1
<1.5	Severe	0	0

*Age = 28 days or younger.

Table 2
Urinary Iodine Concentrations in Isfahani Maternal Study Subjects

Urinary iodine (μg/dL)	Deficiency	Mothers	
		No.	%
≥10.0	…	125	86
5.0-9.9	Mild	3	2
2.0-4.9	Moderate	18	12
<2.0	Severe	0	0

thyroid function tests and serum TSH concentrations were normal, despite low levels of urinary iodine excretion (21 ± 12 μg/g creatinine). Other surveys performed in different provinces in Iran demonstrated similar results (4). In Keega, 40 km northwest of Tehran, visible goiter was present in 94% and 93% of the schoolgirls and schoolboys, respectively. In addition, 54% of the girls and 33% of the boys had an increased serum TSH concentration. On assessment of height, 70% of the girls and 54% of the boys were below the third percentile for their age. Pyramidal signs were present in 48% of the girls and 50% of the boys, an indication of moderately severe growth retardation and neurologic dysfunction in this area. In 59% of the subjects, urinary excretion of iodine was below 25 μg/g creatinine (4). Another study of iodine deficiency performed in three areas of Iran demonstrated mild to moderate growth retardation and neurologic, auditory, and psychomotor impairments in apparently normal subjects (7).

In 1989, the prevalence of goiter had been estimated at more than 70% in Isfahan Province, and in its capital (Isfahan City), 92% of girls and 85% of boys had goiter. During that year, distribution of iodized salt was initiated throughout Iran, and in some parts of the country, iodized oil injections were administered (4). Seven years later, a study assessed the iodine status in randomly selected subjects in all age-groups in Tehran. The mean urinary iodine excretion was 17.5 μg/dL, and the mean serum thyroxine (T_4), triiodothyronine (T_3), and TSH were in the normal ranges. Nevertheless, 33 to 49% of male and female study subjects had goiter (5). In 1997, the goiter prevalence among children 6 to 18 years old in Isfahan was 62%, and the urinary iodine concentration was 10 μg/dL or more in 94% of them (6).

Another investigation in Iran evaluated thyroid function in 54 euthyroid and hypothyroid iodine-deficient girls before and at 4, 7, and 12 months after intramuscular injection of 480 mg of iodine. Of 54 girls with hypothyroidism, 45 responded well to administration of iodized oil, and none of them had increased levels of TSH at 7 and 12 months of follow-up. Serum T_3 was above the normal limit in 16 of 54 subjects but returned to pretreatment values by 7 and 12 months. The TSH response to thyrotropin-releasing hormone was subnormal in five girls, who had an increase in either T_3 or T_4 (or both) at the end of 1 year. Thus, transient elevation in serum levels of T_3, T_4, or both occurred in many girls and persisted in some for at least 1 year after injection of iodized oil (19). In another study performed in 3,420 Iranians with simple goiter, 480 mg of iodized oil was injected, and clinical and laboratory evaluations were performed every 3 months for 1 year and then every 6 months for the next 4 years. The occurrence of iodine-induced hyperthyroidism after administration of iodized oil approximated the ratio observed in spontaneous thyrotoxicosis. Overall, the frequency of iodine-induced hyperthyroidism in Iran is still variable and must be determined in the future (20).

In the current study, iodine deficiency was more pronounced in mothers than in their neonates (Tables 1 and 2). The exact cause of this difference could not be determined. Because of an accelerated intrathyroidal iodine turnover rate in iodine-deficient neonates and neonatal thyroidal iodine storage, the definition of iodine deficiency in mothers differs from that in neonates—that is, urinary iodine concentration ≤5.0 μg/dL and <10.0 μg/dL in neonates and mothers, respectively (17,21). Studies have shown that, in mothers with inadequate iodine intake, the iodine concentrations in their breast milk and in their infants' urine were lower than normal (22,23). The urinary iodine excretion, determined with use of the same method, in newborns in Hungary was 17.1 ± 3.4 μg/dL in an area with no endemic goiter (N = 39), 2.7 ± 0.3 μg/dL in an area of endemic goiter without iodine prophylaxis (N = 28), and 18.8 ± 3.2 μg/dL in an area previously affected by endemic goiter but currently using iodine prophylaxis (N = 15) (21).

In our study, because of consumption of iodized salt in Iran, the results are similar to those in other repleted iodine areas. A correlation was noted between the urinary iodine excretion of neonates and that of their mothers (r = 0.37; P<0.01). Because a relationship exists between urinary and breast milk iodine concentrations, we conclude that neonates' urinary iodine concentration is a reflection of maternal milk iodine content. Studies performed in Europe and India also support this finding (3,12). In Italy, the mean urinary iodine concentrations among mothers in an endemic iodine-deficient area and a nonendemic

iodine-sufficient area were 1.28 ± 0.13 μg/dL and 3.77 ± 0.57 μg/dL ($P<0.05$), respectively—values that are obviously less than those in the current study (24).

CONCLUSION

In our current study, iodine deficiency was more frequently found in the mothers than in their neonates. The cause of this difference could not be definitively explained, but it may be due to relative iodine-concentrating capacity of the mammary glands (24). The distribution of the urinary iodine concentrations in the mothers revealed that 86% had normal urinary iodine excretion. No study subjects among the mothers or their neonates, however, had severe iodine deficiency. Moreover, most of the neonates had normal urinary iodine concentrations. The small proportion of neonates who had mild to moderate iodine deficiency should undergo follow-up for the possible appearance of iodine-deficiency disorders. On the basis of these data, iodine deficiency currently seems uncommon in Isfahan, which is now a repleted iodine area.

ACKNOWLEDGMENT

We thank all nurses of the neonatal ward of Shahid Sadoughi Hospital and especially Ms. Khan Ahmadi for collection of urine samples and follow-up of study subjects.

REFERENCES

1. **Zamrazil V.** Present status of the iodine supply and its results in the Czech Republic [article in Czech]. *Cas Lek Cesk.* 1998;137:611-618.
2. **Valeix P, Preziosi P, Rossignol C, Farnier MA, Hercberg S.** Iodine intakes assessed by urinary iodine concentrations in healthy children aged ten months, two years, and four years. *Biol Trace Elem Res.* 1992;32:259-266.
3. **Tiwari BD, Godbole MM, Chattopadhyay N, Mandal A, Mithal A.** Learning disabilities and poor motivation to achieve due to prolonged iodine deficiency. *Am J Clin Nutr.* 1996;63:782-786.
4. **Azizi F, Kimiagar M, Nafarabadi M, Yassai M.** Current status of iodine deficiency disorders in the Islamic Republic of Iran. *EMR Health Serv.* 1990;8:23-27.
5. **Salarkia N, Azizi F, Kimiagar M, Zakeri H, Soheilikhah S, Nafarabadi M.** Monitoring iodine following consumption of iodized salt in Tehrani inhabitants. *Int J Vitam Nutr Res.* 2000;70:65-69.
6. **Aminorroaya A, Amini M, Rezvanian H, et al.** Effects of iodized salt consumption on goiter prevalence in Isfahan: the possible role of goitrogens. *Endocr Pract.* 2001;7:95-98.
7. **Azizi F, Kalani H, Kimiagar M, et al.** Physical, neuromotor, and intellectual impairment in noncretinous school children with iodine deficiency. *Int J Vitam Nutr Res.* 1995;65:199-202.
8. **Azizi F, Sarshar A, Nafarabadi M, et al.** Impairment of neuromotor and cognitive development in iodine deficient schoolchildren with normal physical growth. *Acta Endocrinol (Copenh).* 1993;129:501-504.
9. **Stanbury JB, Hetzel BS.** *Endemic Goiter and Cretinism: Iodine Nutrition in Health and Disease.* New York: John Wiley & Sons, 1980: 1.
10. **Bourdoux P, Thilly C, Delange F, Ermans AM.** A new look at old concepts in laboratory evaluation of endemic goiter. In: Dunn JT, Pretell E, Daza CH, Viter FE, eds. *Towards the Eradication of Endemic Goiter, Cretinism and Iodine Deficiency.* Washington, DC: Pan American Health Organization, 1986: 115-129. PAHO publication 502.
11. **Etling N, Padovani E, Gehin-Fouque F, Tato L.** Iodine and thyroid hormone levels in serum and urine of full term newborn infants. *Helv Paediatr Acta.* 1983;38:117-122.
12. **Nelson M, Phillips DI, Morris JA, Wood TJ.** Urinary iodine excretion correlates with milk iodine content in seven British towns. *J Epidemiol Community Health.* 1988; 42:72-75.
13. **Delange F, Heidemann P, Bourdoux P, et al.** Regional variations of iodine nutrition and thyroid function during the neonatal period in Europe. *Biol Neonate.* 1986;49:322-330.
14. **Pongpaew P, Supawan V, Tungtrongchitr R, et al.** Urinary iodine excretion as a predictor of the iodine content of breast milk. *J Med Assoc Thai.* 1999;82:284-289.
15. **Gruters A, l'Allemand D, Heidemann PH, Schurnbrand P.** Incidence of iodine contamination in neonatal transient hyperthyrotropinemia. *Eur J Pediatr.* 1983;140:299-300.
16. **l'Allemand D, Gruters A, Beyer P, Weber B.** Iodine in contrast agents and skin disinfectants is the major cause for hypothyroidism in premature infants during intensive care. *Horm Res.* 1987;28:42-49.
17. **Delange F, Ermans AM.** Iodine deficiency. In: Braverman LE, Utiger RD, eds. *Werner and Ingbar's The Thyroid: A Fundamental and Clinical Text.* 7th ed. Philadelphia: Lippincott-Raven, 1996: 296-312.
18. **Emami A, Shahbazi H, Sabzevari M, et al.** Goiter in Iran. *Am J Clin Nutr.* 1967;22:1584-1588.
19. **Azizi F, Kimiagar M, Ghazi AA, Nafarabadi M.** The effects of iodized oil injection in eu- and hypothyroid iodine deficient girls. *J Endocrinol Invest.* 1997;20:18-23.
20. **Azizi F, Daftarian N.** Side-effects of iodized oil administration in patients with simple goiter. *J Endocrinol Invest.* 2001;24:72-77.
21. **Delange F, Burgi H.** Iodine deficiency disorders in Europe. *Bull World Health Organ.* 1989;67:317-325.
22. **Nohr SB, Laurberg P, Borlum KG, et al.** Iodine status in neonates in Denmark: regional variations and dependency on maternal iodine supplementation. *Acta Paediatr.* 1994; 83:578-582.
23. **Akanji AO, Mainasara AS, Akinlade KS.** Urinary iodine excretion in mothers and their breast-fed children in relation to other childhood nutritional parameters. *Eur J Clin Nutr.* 1996;50:187-191.
24. **Vermiglio F, Lo Presti VP, Finocchiaro MD, et al.** Enhanced iodine concentrating capacity by the mammary gland in iodine deficient lactating women of an endemic goiter region in Sicily. *J Endocrinol Invest.* 1992;15:137-142.

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.