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Iodine Supplementation for Pregnancy and Lactation—United States and Canada: Recommendations of the American Thyroid Association

The Public Health Committee of the American Thyroid Association*

The fetus is totally dependent in early pregnancy on maternal thyroxine for normal brain development. Adequate maternal dietary intake of iodine during pregnancy is essential for maternal thyroxine production and later for thyroid function in the fetus. If iodine insufficiency leads to inadequate production of thyroid hormones and hypothyroidism during pregnancy, then irreversible fetal brain damage can result. In the United States, the median urinary iodine (UI) was 168 μg/L in 2001–2002, well within the range of normal established by the World Health Organization (WHO), but whereas the UI of pregnant women (173 μg/L; 95% CI 75–229 μg/L) was within the range recommended by WHO (150–249 μg/L), the lower 95% CI was less than 150 μg/L. Therefore, until additional physiologic data are available to make a better judgment, the American Thyroid Association recommends that women receive 150 μg iodine supplements daily during pregnancy and lactation and that all prenatal vitamin/mineral preparations contain 150 μg of iodine.

Introduction

Iodine is an essential component of thyroid hormone, which is necessary for many metabolic processes as well as the maturation of the central nervous system. Because fetal thyroid gland development and hormone production are relatively 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. If iodine insufficiency leads to inadequate production of thyroid hormones and hypothyroidism during pregnancy, then irreversible fetal brain damage can result. Iodine deficiency in early infancy can lead to thyroid insufficiency, which will also interfere with the neurologic development occurring at this time. Although iodine deficiency is common throughout the developing world, it is also seen in some developed countries and is considered the world's most frequent cause of preventable mental retardation. Thus, adequate iodine nutrition during pregnancy, lactation, and infancy are important public health objectives.

The body does not produce its own iodine, and so the iodine required for thyroid hormone production, an essential nutrient, must be derived exogenously. The primary source of iodine is diet, with other sources such as vitamin/mineral preparations. In North America, dairy products constitute the major dietary source of iodine, whereas bread, seafood, meat (1), and iodized salt also provide iodine. Within any population, however, iodine content of food and therefore iodine consumption vary considerably. For example, a study from the Boston area by Pearce, Braverman, and colleagues (1) found that iodine levels in cows' milk ranged from 91.3 ± 16.6 μg I /250 mL (352 ± 66.4 μg/L) in summer months to 116 ± 23.1 μg I per 250 mL (464 ± 92 μg/L) in the winter. Also observed by these investigators was wide variation in infant formulas, with an average of 23.5 μg I per 5 oz, which is adequate for infant iodine nu-

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trition. Brands of bread varied from most containing little iodine to a few containing more than 300 μg per slice.

Iodized salt in the United States and Canada contains 77 μg I per gram as KI, which approaches some of the highest levels worldwide; however, only about 70% of consumers actually choose iodized salt for home use. Rather, most ingested salt comes from processed food (about 70%), which is typically not iodized in the United States and Canada, and only 15% comes from the natural content of foods. Because the salt for home use represents only about 15% of the daily intake (2), and if the total intake is 5 g NaCl, the amount consumed from iodized salt would be about 50 μg I daily. Vitamin/mineral supplements are also found to vary widely. Among 19 supplements listed specifically for prenatal use in the 2006 Physician's Desk Reference (PDR), only one contained 150 μg iodine; the others so listed contained none. Several other vitamin/mineral preparations not listed for prenatal use contained from 75 to 200 μg iodine per tablet.

The Food and Nutrition Board (FNB) of the Institute of Medicine recommends a daily iodine intake (RDA) of 150 μg for nonpregnant nonlactating adults (3), 110 μg per day for 0–6-month-olds, and 130 μg for 7–12-month-olds (these are "Adequate Intakes," a slightly different methodology than that for RDAs). Regarding breast milk, Semba and Delange concluded that breast milk should contain 100–200 μg I/L (4) to meet the FNB recommendations. Although recent data from Pearce, Braverman, and colleagues (personal communication, 2003) showed that the median value for breast milk in Boston was 157 μg I/L (mean value of 208 μg/L), they estimated that 44% of samples [assuming continued concentrations at that level for the duration of breast feeding] had insufficient iodine to meet the infant's calculated needs. Another recent U.S. study of 23 women (5) observed a far lower median breast milk iodide value of 33.5 μg I/L (mean value 63.3 μg/L). Although the reason for this difference between studies is not clear, these authors also point to the possibility of inadequate iodine intake in breast-fed infants.

The recommended iodine intake for pregnancy and lactation has changed over the past several decades. Although the early recommendations suggested 200 μg/day (6), more recently the FNB has recommended an intake of 220 μg/day for pregnant women and still more, 290 μg/day, for lactating women (3). These values are expressed as individual requirements, rather than the population's nutritional intake, which is measured as the median urinary iodine (UI) concentration. Because a urinary iodine concentration of 100 μg/L is thought to represent an iodine daily intake of 150 μg, the World Health Organization (WHO)/International Council for Control of Iodine Deficiency Disorders (ICCIDD)/United Nations International Children's Emergency Fund (UNICEF) proposed as the desirable median UI for nonpregnant populations, a range of 100–200 μg I/L (or 150–300 μg intake) (6). Because of the increased daily requirement during pregnancy and the increased renal excretion of iodine during pregnancy, the UI concentration should be higher for pregnant than nonpregnant adults. A recent WHO Technical Consultant Group recommended that the median UI during pregnancy should range between 150 and 249 μg iodine/L, whereas median UI concentrations greater than 250 μg/L are more than adequate and above 500 μg/L, excessive (7). The corresponding optimal iodine intake for pregnancy and lactation, therefore, should be between 225 and 375 μg per day.

One concern is that if iodine intake in a population is increased substantially, the incidence of thyroid diseases such as autoimmune thyroid disease, hyperthyroidism, and possibly of papillary thyroid cancer, may increase (8). However, the FNB set 1100 μg I as the upper tolerable level for individual intake (3). Generally, the opinion of experts is that the benefits of correcting iodine deficiency far outweigh the risks from iodine supplementation in the world community (8,9).

In the United States, National Health and Nutrition Examination Survey (NHANES) I for the period from 1971 to 1974 measured median UI concentrations of 321 μg/L (10), which corresponds to an iodine intake of about 500 μg/day. Additional dietary surveys during that period also reported correspondingly high daily iodine intakes (11). Later data from NHANES III collected from 1988 to 1994 (10) showed that the median UI was 145 μg/L, less than half of the 1971–1974 value. Since that time, the median UI has stabilized or increased slightly to 161 μg/L in 2000 (12) and 168 μg/L in 2001–2002 (13). For women of reproductive age, the changes over that period of time paralleled those of the entire population (Table 1).

The only immediately available United States data on UI during lactation show 172 (±115) μg/L in 27 women (Pearce, Braverman, and colleagues, personal communication, 2003). As also can be seen in Table 1, median UI levels of pregnant women were lower than recommended from 1988 to 1994 and within the recommended range from 2000 to 2002, but with 95% confidence intervals (CI) in 2001–2002 extending from 75 to 229 μg/L (13).

America's diet appears to be generally sufficient in overall iodine, but highly variable from food to food, and even among foods within the same category. There are likely to be some outliers where iodine intake may be insufficient for some people and excessive for others. Vegans, for example, are likely to have a diet that is deficient in iodine whereas frequent kelp

TABLE 1. MEDIAN URINE IODINE VALUES FOR POPULATION OF UNITED STATES—PAST 30 YEARS

	NHANES years of sample collection			
	1971–1974 (10)	*1988–1994 (10)*	*2000 (12)*	*2001–2002 (13)*
Total population (age 6–74 years)	321 (±6)[a]	145 (±3)	161 (±6)	168 (±7)
Women of reproductive age (age 15–44 years)				
Pregnant	373 (±35)	141 (±14)	Not available	173 (±38)
Nonpregnant	293 (±10)	127 (±4)		132 (±9)

NHANES, National Health and Nutrition Examination Survey.
[a]Urine iodine in μg/L (±SE).

consumers may ingest excessive iodine. Although the current data do not lead to a recommendation of fortification or supplementation with iodine for the U.S. population as a whole, this may not be the case to meet the increased needs of pregnancy and lactation. However, the evidence to date is not clear on what exactly these increased requirements should be because the number of pregnant women sampled in these studies was small. For example, in the 1988–1994 NHANES survey, the median UI was 141 μg/L for 234 pregnant women not taking iodine supplements and 169 μg/L for 100 pregnant women taking daily supplements containing 150 μg iodine. In 1988–1994, the UI concentration was less than that recommended recently by the WHO technical group. Even with supplementation, the UI was in the lower portion of the recommended range of 150 to 250 μg/L. The fraction of women excreting excessive amounts of iodine, i.e., 500 μg/L, was not appreciably higher than in those not taking than taking supplements (14). Without specific physiologic evidence of iodine deficiency in the United States at this time, and with the most recent U.S. survey reporting a median value of 173 μg/L, which is within that currently recommended for pregnancy, the rationale for iodine supplementation during pregnancy is tenuous. However, in the 126 pregnant women sampled in the 2001–2002 survey, the 95% CI of the median UI overlapped the lower limit of the normal median. We conclude that until additional physiologic outcome data are available, supplementation with 150 µg iodine per day during pregnancy is in keeping with the current recommendations of national and international groups for increased iodine intake in pregnancy and lactation, and appears to be safe.

Recommendations for the United States and Canada

The American Thyroid Association (ATA) recommends the following:

1. Iodine supplementation during pregnancy and lactation
   a. Include 150 μg iodine in daily prenatal vitamin/mineral supplements during pregnancy and lactation.
   b. Discuss this need for iodine with manufacturers of vitamin/mineral preparations, obstetricians, pediatricians, and the public.
   c. Encourage manufacturers to include 150 μg iodine in all vitamin/mineral preparations labeled for use during pregnancy and lactation.
2. Monitoring iodine nutrition
   a. Urge Centers for Disease Control and Prevention to continue regular and adequate monitoring of iodine nutrition of the U.S. population by measuring UI, and to make results available promptly.
   b. This monitoring should include:
      i. Oversampling of pregnant women in order to have sample numbers large enough for adequate analysis.
      ii. One or more additional outcome indicators of iodine nutrition in the population, such as measurements in serum of thyrotropin, free thyroxine, and thyroglobulin, and thyroid volume by ultrasound.
      iii. Longitudinal studies of UI and outcome indicators in a number of individuals, especially in those with low UI, to determine the variability of iodine concentration over time.
   c. ATA should routinely review these data and any other available information, interpret results, and report to ATA members and the public.
   d. Canada should update its information on monitoring of iodine and on iodine nutrition.
   e. For the general nonpregnant, nonlactating U.S. population, data do not support a recommendation to change iodine fortification of salt or other foods at this time.
3. Sources of iodine
   a. Encourage continuing studies of nutritional sources of iodine for the U.S. population by the U.S. Food and Drug Administration (FDA) and the U.S. Department of Agriculture (USDA).

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