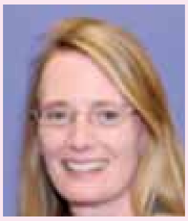

Laurie C. Dolan

Evidence that iodine supplementation should be considered during pregnancy

LAURIE C. DOLAN*, GEORGE A. BURDOCK
*Corresponding author
Burdock Group, 801 N. Orange Ave., Suite 710, Orlando, FL 32801 USA

ABSTRACT: Results of consumption surveys in the United States (US) and Europe indicate that median iodine intake in women of reproductive age has decreased to levels associated with moderate iodine deficiency. Likely reasons for this phenomenon include decreased use of iodized salt in food and/or insufficient iodization of iodized salt. Although iodine deficiency is a well known cause of birth defects, currently, over half of prenatal vitamins that are sold in the US do not contain iodine. Of the supplements that purportedly contain 150 micrograms iodine per daily serving, the actual mean concentration is 119 micrograms per daily serving. A possible reason for this discrepancy is that the majority of supplements use kelp, which is a highly variable source of iodine. Based on results of a new study that shows that infants from mothers supplemented with 300 micrograms iodine/day (as potassium iodine) during pregnancy perform better on neurocognitive tests than infants from mothers that did not take iodine supplements and an increasing body of evidence that women of reproductive age are not ingesting the recommended level of iodine in the diet, supplement makers should consider use of 300 micrograms iodine/day (as potassium iodine) in prenatal supplements and women of reproductive age should seriously consider use of such supplements.

INTRODUCTION

Iodine is an essential component of the thyroid hormones thyroxine (T_4) and 3,5,3'-triiodothyronine (T_3), which regulate cell activity and growth in virtually all tissues (1). Normal activity of these hormones is essential for normal embryonic and postnatal development (particularly of the nervous system) and maintenance of metabolic processes in adults. In pregnancy, iodine deficiency is associated with an increased risk of miscarriage, stillbirth, stunted growth, intellectual impairment, or abnormal movement, speech or hearing of offspring (2). Severe maternal iodine deficiency may result in a rare congenital disease known as "cretinism", which is characterized by dwarfed stature, mental retardation, dystrophy of the bones, and a low basal metabolism (3).

According to the Institute of Medicine (IOM), the recommended daily allowance (RDA) of iodine for adult men and women is 150 micrograms/day. Recognizing that there is an increased demand for thyroid hormone production during pregnancy and lactation, the IOM increased the RDAs for iodine in pregnant and lactating women to 220 or 290 micrograms/day, respectively (4). Because most dietary iodine absorbed in the body eventually appears in urine, urinary iodine excretion is recognized as a reliable indicator of assessing dietary iodine intake. For pregnant women, median urinary iodine concentrations of 150-249 ng/ml represent adequate iodine intake (5).

Historically, iodine consumption was adequate for those people living in coastal regions with access to crops grown in iodine rich soil and through the consumption of seafood. Those people in landlocked regions with no access to iodine-containing foods and/or were exposed to a steady diet of iodine binding foods (including cabbage, turnips, rapeseed oil and peanuts) exhibited characteristics of iodine deficiency (e.g. goiter, hypothyroidism, lethargy, and weight gain) (6). To prevent iodine deficiency, iodine has been routinely added to salt in the US since the mid-1920's. Due to this practice, it has been assumed that iodine intake is sufficient in the US. However, from the National Nutrition and Health Examination (NHANES) I Survey (1971-1974) to the 2003-2004 NHANES Survey, there was a decrease in median urinary iodine excretion of women of reproductive age from approximately 300 ng/ml to 139 ng/ml (7, 8). This indicates that in the US, the median amount of iodine intake in women of reproductive age is currently less that which is considered to be adequate for pregnant women. In Europe, recent national surveys of women of child-bearing age indicate that median iodine intakes are currently half of recommended levels (9). The decreases in iodine intake are somewhat puzzling due to increased consumption of processed foods, which contain salt.

Reasons cited for decreases in iodine intake over the past thirty years in the US include efforts by the dairy industry to reduce iodine residues in milk and a ban on erythrosine (an iodine-containing food dye) (10). However, it is likely that these uses only account for a small percentage of the decreased intake of iodine. Because iodized salt is the predominant source of iodine in the US (and other countries), the decrease in iodine consumption is most likely due to decreased use of iodized salt in food and/or insufficient iodization of iodized salt.

IODINE CONCENTRATION IN SALT

In Canada and in some parts of Europe, iodization of all table salt is mandatory, although it remains voluntary in the US. Fortification of table salt with 30 mg iodine (from potassium iodide or potassium iodate) per kg of salt, is typical of many European programs (11). Currently it is estimated that iodized salt is used by approximately 50-60 percent of the US population. Although salt intake of most people in developed countries is higher than recommended levels, most ingested salt comes from processed food, which is typically not iodized. Furthermore, use of coarse sea salt (which is typically not supplemented with iodine) is increasing. Therefore, even if intake of salt is high, one should not assume that iodine intake will be sufficient.

A recent study indicates that commercially available iodized table salt in the US may not contain the amount of iodine listed on the label (12). The median and mean (± one standard deviation) iodine content in 88 freshly opened, top-of the can salt samples was 44.1 and 47.5 ± 18.5 mg/kg. The range was 12.7-129 mg iodine/kg. Forty-seven of the 88 samples (53.4 percent) fell below the lower limit of US FDA recommended iodine content of 46-76 mg iodine/kg salt, and 6 exceeded it. The homogeneity of iodine content was highly variable within each container (49.3 percent coefficient of variance), indicating that current quality control methods are not sufficient to produce a standard product. Furthermore, the authors demonstrated that iodine is lost upon high humidity storage. Therefore, iodized salt that remains in a kitchen for a long period of time may not contain enough iodine to meet the body's requirements (particularly if it contained a low amount of iodine to begin with). Altogether, this suggests that the assumption that ingestion of one teaspoon of table salt (approximately 6 g) per day provides an adequate amount of iodine for pregnant or lactating women may no longer be valid.

IODINE SUPPLEMENTS

In a public heath statement issued on April 26, 2004 the American Thyroid Association (ATA) concluded that although iodine supplies in most of the developed world were sufficient to prevent cretinism and severe mental retardation from iodine deficiency, some women of reproductive age were possibly at risk for slightly deficient intake (13). Therefore, the agency recommended that all prenatal vitamin and mineral supplements for use during pregnancy contain at least 150 micrograms/day iodine.

A new study reported in the New England Journal of Medicine indicates that many manufacturers of prenatal multivitamins have not heeded the ATA's recommendation (14). Out of 223 prenatal vitamins sold in the US, only 51 percent contained iodine. Although the labels of 89 percent of the 114 products containing iodine indicated that each daily serving contained 150 micrograms iodine, the mean concentration in 60 randomly selected products was 119 micrograms iodine/serving. The iodine values ranged widely, particularly if the source of the iodine was kelp (from 33-610 micrograms/serving). Although it is recognized that kelp can be a highly variable source of iodine (compared to synthetically produced potassium iodine, which yields a fixed ratio of one atom of each at a very high level of purity), kelp as a source of iodine is preferred for use by supplement manufacturers. Potassium iodine is reportedly difficult to follow and analyze through the manufacturing process and requires sophisticated analytical methods for detection. Finished product content uniformity for potassium iodine is also difficult to achieve because of the very small amounts added to supplements. By contrast, kelp iodine is easy to monitor and can be readily standardized to the iodine content. Kelp also is a natural and economical source of several other nutrients as well, including calcium, iron, magnesium, potassium, zinc, folate, vitamins A and K, protein and carbohydrate (15). Therefore, use of kelp as an iodine source has several advantages over potassium iodine. A possible reason for the omission of iodine from many prenatal multivitamins is the assumption that adequate amounts of iodine are obtained by the use of salt. However, there is an increasing body of evidence that this is not the case.

EVIDENCE SUPPORTING BENEFICIAL EFFECTS OF IODINE SUPPLEMENTATION

The link between iodine deficiency and impaired school performance and IQ in children and adolescents is well established. Although several randomized clinical trials examining the use of iodine containing dietary supplements on thyroid hormone status of pregnant women have been conducted, relatively few have examined the effect of iodine supplementation on pregnancy outcome and early childhood development. A recent study performed in 133 pregnant, Spanish women receiving 300 micrograms/day iodine (in the form of potassium iodine) from the first trimester to delivery versus 61 controls that did not receive supplemental iodine, revealed that although iodine supplementation during pregnancy had no effect on birth weight, incidence of premature delivery or duration of pregnancy, it had a beneficial effect on neurocognitive development of infants (16). Babies from supplemented mothers had higher scores on psychomotor development index and behaviour rating scales from ages 3-18 months. No parameters measured in infants were adversely affected by iodine supplementation of mothers. With supplementation, urinary iodine in the third trimester was 263.04 ± 120.75 ng/ml and without supplementation, it was 87.61 ± 62.06 ng/ml. These data indicate that women in the control population were moderately iodine deficient during pregnancy and that supplementation with 300 micrograms/day iodine was required for maintenance of recommended levels of iodine during pregnancy (150-249 ng/ml). Although this study was not a randomized controlled trial and the control group was not included from the first trimester, the study indicates that use of 300 micrograms/day iodine (in the form of potassium iodide) should be considered during pregnancy.

POSSIBLE CONSEQUENCES OF OVER SUPPLEMENTATION OF IODINE

The tolerable upper limit (UL) for iodine in all groups of adults (including pregnant and lactating women) is 1,100 micrograms/day (4). Intakes higher than this amount may be associated with goiter or hypothyroidism (which paradoxically, may also occur with iodine deficiency), hyperthyroidism, thyroiditis, sensitivity reactions, thyroid papillary cancer, or rare dermatological reactions (4). Individuals with autoimmune thyroid disease may exhibit signs of toxicity at concentrations substantially lower than the UL. Therefore, iodine supplementation should be avoided in women with this condition.

In women in the US, 90th percentile consumption of iodine in the diet is approximately 500 micrograms/day (based on an upper limit of 507 ng/ml iodine in urine of 90th percentile consumers) (6). A risk assessment performed by an expert group on vitamins and minerals in the United Kingdom indicates that "a supplemental intake of 500 micrograms/day in addition to the iodine present in the diet would not be expected to have any significant effects in adults" (1). Therefore, consumption of a prenatal supplement containing 300 micrograms/day iodine would not be expected to produce toxicity in women. However, use of supplements in women who customarily ingest large amounts of marine fish or seaweed may be ill conceived due to the fact that their iodine intake is likely to be sufficient without supplementation and may approach toxic levels with supplementation.

CONCLUSION

In light of the beneficial effects of iodine supplementation during pregnancy on neurocognitive development of infants, the increasing amount of evidence that iodine consumption in the diet is decreasing, and the margin of safety between normal consumption and concentrations producing toxicity is large enough to include supplementation with 300 micrograms/day iodine, supplementation with 300 micrograms/day iodine (in the form of potassium iodine) should be considered in prenatal vitamins, particularly in areas of the world that are iodine deficient.

REFERENCES AND NOTES

1. http://www.food.gov.uk/multimedia/pdfs/vitmin2003.pdf; site visited September 15, 2009.
2. http://jn.nutrition.org/nutinfo/content/iodi.shtml; site visited September 15, 2009.
3. http://medical-dictionary.thefreedictionary.com/cretinism; site visited September 15, 2009.
4. IOM, "Zinc", *Dietary Reference Intakes for Vitamin A, Vitamin K, Arsenic, Boron, Chromium, Copper, Iodine, Iron, Manganese, Molybdenum, Nickel, Silicon, Vanadium, and Zinc*. National Academy Press, Washington, DC. pp. 258-289 (2001).
5. World Health Organization, *Assessment of iodine deficiency disorders and monitoring their elimination: a guide for programme managers*, 3rd ed. Geneva (Switzerland). Available from http://whqlibdoc.who.int/publications/2007/9789241595827_eng.pdf; site visited September 15, 2009.
6. http://www.feinberg.northwestern.edu/nutrition/factsheets/iodine.html; site visited September 20, 2009.
7. www.cdc.gov/nutritionreport/part_4a.html; site visited September 15, 2009.
8. K.L. Caldwell, G.A. Miller et al., "Iodine status of the U. S. Population, National Health and Nutrition Examination Survey 2003-2004", *Thyroid*, **18**, pp. 1207-1214 (2008).
9. http://www.nature.com/ejcn/journal/v58/n7/full/1601933a.html; site visited September 15, 2009.
10. J.A.T. Pennington, S.A. Schoen, "Total diet study: estimated dietary intakes of nutritional elements, 1982-1991", *Int. J. Vit Nutr Res*, **66**, pp.350-362 (1995), as referenced in www.cdc.gov/nutritionreport/part_4a.html; site visited September 15, 2009.
11. http://www.pubmedcentral.nih.gov/articlerender.fcgi?artid=2453047; site visited September 16, 2009.
12. P.K. Dasgupta, Y. Liu et al., "Iodine nutrition: Iodine content of iodized salt in the United States", *Environ Sci Technol*., **42**, p. 1315-1323 (2008).
13. http://www.thyroid.org/professionals/publications/statements/04_04_26_maternalthyroidal.html; site visited September 15, 2009.
14. http://www.thyroid.org/professionals/publications/news/09_02_25_pearce.html; site visited September 15, 2009.
15. http://www.nal.usda.gov/fnic/foodcomp/cgi-bin/list_nut_edit.pl; search initiated for seaweed, kelp, raw. site visited September 17, 2009.
16. M. Velasco, P. Carreira et al., "Effect of iodine prophylaxis during pregnancy on neurocognitive development of children during the first two years of life", *J Clin Endocrinol Metab*., dor: 10.1210/jc.2008-2652.