Sanford Medical Center

Aunt Cathy's Guide to Nutrition:

New Attention to an Old Problem:

Iodine Deficiency in Pregnancy and Lactation

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Bibliography and some abstracts 2005- Jan. 2011

2011

Hypothyroxinemia and Pregnancy. Endocr Pract. 2011 Jan 17:1-24. Objective: To evaluate the peer-reviewed literature on iodine deficiency and hypothyroxinemia in pregnancy. … An adequate amount of iodine intake has to be recommended pre-conception or starting early in pregnancy.

Neonatal Age and Point of CareTSH Testing in the Monitoring of Iodine Deficiency Disorders: Findings from Western Uganda. Thyroid. 2011 Feb;21(2):183-8. Background: Iodine deficiency is a major public health problem throughout Africa. Although salt for human consumption is said to contain adequate amounts of iodine in Uganda, iodine intake may not be optimal. … **Based on the percentage of neonates with TSH values >5 mIU/L, presumptive iodine deficiency persists in western Uganda. This finding suggests that continued monitoring of iodine nutrition in the area surrounding the Rwenzori Mountains in Uganda and Congo is needed.** …

Iodine-induced neonatal hypothyroidism secondary to maternal seaweed consumption: A common practice in some Asian cultures to promote breast milk supply. J Paediatr Child Health. 2011 Jan 31. **Mild iodine deficiency is a recognised problem in Australia and New Zealand. However, iodine excess can cause hypothyroidism in some infants**. We highlight two cases which illustrate the risks of excess dietary iodine intake during pregnancy and breastfeeding. They also describe **a cultural practice of consuming seaweed soup to promote breast milk supply.** Although most attention recently has been on the inadequacy of iodine in Australian diets, the reverse situation should not be overlooked. Neither feast nor famine is desirable.

2010

Iodine deficiency in infancy - a risk for cognitive development. Dtsch Med Wochenschr. 2010 Aug;135(31-32):1551-6. Severe iodine deficiency during pregnancy seriously influences fetal brain development and in the worst case induces cretinism. **Recent studies have shown that even a mild iodine deficiency during pregnancy and during the first years of life adversely affects brain development. The World Health**

Organisation (WHO) considers iodine deficiency as the most common preventable cause of early childhood mental deficiency. In this context, the insufficient production of the four iodine atoms containing thyroxine seems to play a causal role, i. e., due to the iodine substrate deficiency the neuronally particularly relevant free-thyroxine level falls. **Due to the very limited iodine storage capacity, the infantile thyroid is eminently dependent on an adequate and steady iodine supply. In the first month of life, when milk is the only energy- and nutrient provider, infants fed a commercial formula regularly have a sufficient iodine supply. However, breastfed infants, who depend on maternal iodine status, frequently show an inadequate iodine intake. Furthermore, iodine intake is critical when complementary food (CF) is introduced. Especially homemade CF is poor in iodine, but also commercial CFs are only partly fortified.** A simultaneous inadequate iodine supply of the breastfeeding mother and the preferential use of mostly iodine-poor organic milk cannot ensure an adequate iodine supply of the infant. **In terms of an improvement of nutrient supply, especially concerning an unhindered brain development, the corresponding German reference value for iodine intake of infants until age 4 month should be raised from currently 40 microg/d to at least 60 microg/d (WHO-reference: 90 microg/d).**

Some subgroups of reproductive age women in the United States may be at risk for iodine deficiency. J Nutr. 2010 Aug;140(8):1489-94. Consuming an adequate amount of iodine during pregnancy is critical for fetal neurologic development. Even a mild deficiency can impair cognitive ability. Important sources of iodine in the United States include dairy products and iodized salt. **Although the U.S. population has traditionally been considered iodine sufficient, median urinary iodine concentrations (UIC) have decreased 50% since the 1970s.** We analyzed 2001-2006 NHANES data from urine iodine spot tests for pregnant (n = 326), lactating (n = 53), and nonpregnant, nonlactating (n = 1437) women of reproductive age (15-44 y). **We used WHO criteria to define iodine sufficiency** (median UIC: 150-249 microg/L among pregnant women; >or=100 microg/L among lactating women; and 100-199 microg/L among nonpregnant, nonlactating women). **The iodine status of pregnant women was borderline sufficient** (median UIC = 153 microg/L; 95% CI = 105-196), **while lactating** (115 microg/L; 95% CI = 62-162) **and nonpregnant, nonlactating** (130 microg/L; 95% CI = 117-140) **women were iodine sufficient.** … **Iodine levels among U.S. women should be monitored, particularly among subgroups at risk for iodine deficiency.**

Serum thyroid hormone levels in preterm infants born before 33 weeks of gestation and association of transient hypothyroxinemia with postnatal characteristics. J Pediatr Endocrinol Metab. 2010 Sep;23(9):899-912.: Fetal thyroid function and the hypothalamopituitary-thyroid axis continue to mature throughout pregnancy. Therefore, thyroid hormone levels of premature infants differ from those of mature ones. Our primary objective was to evaluate the reference values of serum thyroid hormones in preterm infants born before 33 wk gestation. The second objective was to define a cut-off value for transient hypothyroxinemia of prematurity (THOP) according to gestational age and association of THOP with postnatal characteristics in these infants…. CONCLUSIONS: In preterm infants below 30 wk, thyroid hormones were lower and urinary iodine values were higher compared to infants with older gestational age. THOP at the first wk of life may convey important prognostic information about neonatal morbidity and length of hospitalization stay.

Iodine status of pregnant women from central Poland ten years after introduction of iodine prophylaxis programme. (Pol J Endocrinol 2010; 61 (6): 646-651).2010 Nov-Dec;61(6):646-51. Introduction: Until 1997, Poland was one of the European countries suffering from mild/moderate iodine deficiency. In 1997, a national iodine prophylaxis programme was implemented based on mandatory iodisation of household salt with 30 ± 10 mg KI/kg salt, obligatory iodisation of neonatal formula with 10 µg KI/100 mL and voluntary supplementation of pregnant and breast-feeding women with additional 100-150 µg of iodine. Our aim in this study was to evaluate the iodine status of pregnant women ten years after iodine prophylaxis was introduced. … **Conclusion: Iodine supplements with 150 µg of iodine should be prescribed for each healthy pregnant woman according to the assumptions of Polish iodine prophylaxis programme to obtain adequate iodine supply.**

Patterns of iodine intake and urinary iodine concentrations during pregnancy and blood thyroid-stimulating hormone concentrations in the newborn progeny. Thyroid. 2010 Nov;20(11):1295-9. Background: Appropriate maternal intake of iodine during pregnancy is essential for maternal thyroxine production and thyroid status of the fetus. It should be possible to enhance iodine intake during pregnancy by using iodine fortified salt or taking iodine supplements. In the present report we determined the status of iodine nutrition in pregnant women who were stratified on the basis of their history of taking or not taking iodized salt or iodine supplements. The study was performed in Toledo (Spain), a region in which prior studies have noted borderline iodine sufficiency. Iodine nutrition was assessed by measuring urinary iodine concentration (UIC) and neonatal thyrotropin (TSH).… **Conclusions: In a region with a history of borderline iodine deficiency the UICs were below 150 µg/L in a substantial percentage of pregnant women who did not take iodine supplements, regardless of whether or not they took iodized salt. Our results support the use of iodine supplements from the start of the pregnancy, or even before pregnancy in women who live in regions with a history of even small degrees of iodine deficiency.** In addition, neonate TSH screening is not the best tool to assess whether the iodine status in populations is ideal.

Iodine-induced neonatal hypothyroidism secondary to maternal seaweed consumption: A common practice in some Asian cultures to promote breast milk supply. J Paediatr Child Health. 2011 Jan 31. Mild iodine deficiency is a recognised problem in Australia and New Zealand. However, iodine excess can cause hypothyroidism in some infants. We highlight two cases which illustrate the risks of excess dietary iodine intake during pregnancy and breastfeeding. They also describe **a cultural practice of consuming seaweed soup to promote breast milk supply.** Although most attention recently has been on the inadequacy of iodine in Australian diets, the reverse situation should not be overlooked. Neither feast nor famine is desirable.

Hypothyroxinemia and Pregnancy. Endocr Pract. 2011 Jan 17:1-24. Objective: To evaluate the peer-reviewed literature on iodine deficiency and hypothyroxinemia in pregnancy. … **An adequate amount of iodine intake has to be recommended pre-conception or starting early in pregnancy.**

Neonatal Age and Point of CareTSH Testing in the Monitoring of Iodine Deficiency Disorders: Findings from Western Uganda. Thyroid. 2011 Feb;21(2):183-8. Background: Iodine deficiency is a major public health problem throughout Africa. Although salt for human consumption is said to contain adequate amounts of iodine in Uganda, iodine intake may not be optimal. … **Based on the percentage of neonates with TSH values >5 mIU/L, presumptive iodine deficiency persists in western Uganda. This finding suggests that continued monitoring of iodine nutrition in the area surrounding the Rwenzori Mountains in Uganda and Congo is needed.**

Iodine intake in Portuguese pregnant women: results of a countrywide study. Eur J Endocrinol. 2010 Oct;163(4):631-5. Iodine is the key element for thyroid hormone synthesis, and its deficiency, even moderate, is harmful in pregnancy, when needs are increased, because of its potential deleterious effects on fetal brain development. In Portugal, no recent data on iodine intake exists. The objective of this countrywide study was to analyze iodine status in pregnant Portuguese women in order to propose adequate measures to the health authorities…. women assisted in most Portuguese maternity hospitals. **Considering the potential deleterious effects of inadequate iodine supply in pregnancy, iodine supplementation is strongly recommended in this period of life.**

Poor iodine status and knowledge related to iodine on the eve of mandatory iodine fortification in Australia. Asia Pac J Clin Nutr. 2010;19(2):250-5. **Background: Mandatory fortification of bread with iodised salt is proposed to address the re-emergence of iodine deficiency in Australia and New Zealand.** … **These data add support to the need for a national approach to address iodine intake which includes an accompanying consumer education campaign.**

The Swiss iodized salt program provides adequate iodine for school children and pregnant women, but weaning infants not receiving iodine-containing complementary foods as well as their mothers are iodine deficient. J Clin Endocrinol Metab. 2010 Dec;95(12):5217-24. BACKGROUND**:** If children and pregnant women in the population are iodine sufficient, it is generally assumed infants are also sufficient. But weaning infants may be at risk of iodine deficiency because iodized salt contributes little dietary iodine during this period. To fill this gap, iodine fortification of infant formula milk (IFM) and complementary foods (CF) is likely important. OBJECTIVES: The objective of the study was to first confirm that Swiss school children and pregnant women remain iodine sufficient and then to assess iodine status in infancy and the relative contribution of breast milk and IFM/CF to their iodine intakes. … RESULTS: Median (m) UICs in pregnant women (162 μg/liter) and school children (120 μg/liter) were sufficient, and 80% of the household salt was adequately iodized (≥15 ppm). However, mUICs in infants not receiving IFM/CF were not sufficient: 1) mUIC in breast-fed infants (82 μg/liter) was lower than in non-breast-fed infants (105 μg/liter) ($P<0.001$) and 2) mUIC in breast-fed weaning infants not receiving IFM/CF (70 μg/liter) was lower than infants receiving IFM (109 μg/liter) ($P<0.01$). mUIC was low in lactating mothers (67 μg/liter) and median breast milk iodine concentration was 49 μg/kg **CONCLUSIONS**: **In countries in which iodized salt programs supply sufficient iodine to older children and pregnant women, weaning infants, particularly those not receiving iodine-containing IFM, may be at risk of inadequate iodine intakes.**

Effect of iodine deficiency and hypothyroidism on the protein expressions of CaMK II in the hippocampus of pups. Wei Sheng Yan Jiu. 2010 Mar;39(2):180-3. Objective: To observe the effect of iodine deficiency and hypothyroidism on the protein expressions of CaMK II in the hippocampus of pups. … **Conclusion:** Iodine deficiency and hypothyroidism may decrease the protein expression of CaMK II.

Dietary iodine: why are so many mothers not getting enough? Environ Health Perspect. 2010 Oct;118(10):A438-42.

Iodine deficiency in Australia: is iodine supplementation for pregnant and lactating women warranted? Med J Aust. 2010 Apr 19;192(8):461-3. Recent research has confirmed that Australian children and pregnant women are mildly iodine deficient. **A considerable proportion of the pregnant population is moderately to severely iodine deficient. Even subclinical hypothyroidism in the mother, occurring as a consequence of iodine deficiency, can cause irreversible brain damage in the fetus, making it essential to avoid iodine deficiency in pregnancy.** The proposal of Food Standards Australia and New Zealand (FSANZ) - Mandatory Iodine **Fortification for Australia (P1003) - has been implemented. FSANZ openly admits P1003 is inadequate for covering the needs of pregnant women.** Therefore, health professionals and the public must be properly informed about the limitations of this proposal. Views differ about the most effective measures to prevent iodine deficiency in Australia. **We propose that women planning a pregnancy, and pregnant and lactating women should be advised to take an iodine supplement.** Women with pre-existing thyroid disease should exercise caution and seek medical advice before taking a supplement.

Micronutrients and women of reproductive potential: required dietary intake and consequences of dietary deficienty or excess. Part II - Vitamin D, Vitamin A, Iron, Zinc, Iodine, Essential Fatty Acids. J Matern Fetal Neonatal Med. 2010 Apr 14. Part II of this review considers additional micronutrients. … **To assure adequate iodine, food is fortified worldwide with iodated salt. If urinary iodine levels are low, supplementation is needed.** Essential fatty acids requirements can be met by one to two portions of fish per week.

CB Note: The iodine-related section of the above report says that "To assure adequate iodine, food is fortified worldwide with iodated salt. If urinary iodine levels are low, supplementation is needed." It sounds a bit like things are OK because "food is fortified worldwide with iodated salt." As described elsewhere in this paper, many places that have low iodine in the soil still **do not have access to iodized salt.** Additionally, the newest evaluations are showing that **the amount added to salt is insufficient** for many women and especially for pregnant and lactating women. **And the likelihood is quite low that women around the world (and here) normally get their urinary iodine level evaluated in order to determine whether "supplementation is needed."**

Iodine intake in Portuguese pregnant women: results of a countrywide study. Eur J Endocrinol. 2010 Oct;163(4):631-5. …urine iodine concentration (UIC) was evaluated 3631 pregnant women followed in 17 maternity hospitals from hinterland and coastal areas in Continental Portugal and the Portuguese islands of Açores and Madeira. Results: Median UIC value was 84.9 μg/l (range 67.6-124.1) in Continental Portugal, 69.5 μg/l in Madeira, and 50.0 μg/l in Açores. The percentage of satisfactory values (>150 μg/l) was 16.8, ranging from 8.8 to 34.1 in the Continent, and being 8.2 in Madeira and 2.3 in Açores. The percentage of values below 50 μg/l was 23.7, ranging from 14.0 to 37.4 in the Continent, 33.7 in Madeira, and 50.0 in Açores**.** Conclusions: **Our results point to an inadequate iodine intake in pregnant women assisted in most Portuguese maternity hospitals. Considering the potential deleterious effects of inadequate iodine supply in pregnancy, iodine supplementation is strongly recommended in this period of life.**

Iodine intake and maternal thyroid function during pregnancy. Epidemiology. 2010 Jan;21(1):62-9. Background: An adequate iodine intake during pregnancy is essential for the synthesis of maternal thyroid hormones and normal brain development in the fetus. Scant evidence is available on the effects and safety of iodine supplementation during pregnancy in areas with adequate or mildly deficient iodine intake. We examined the association of maternal iodine intake and supplementation with thyroid function before 24 weeks of gestation in population-based samples from 3 different areas in Spain. Methods: A cross-sectional study of 1844 pregnant women (gestational age range 8-23 weeks) was carried out in 3 areas in Spain (Guipúzcoa, Sabadell, Valencia), during the period 2004-2008. We measured levels of free thyroxine and thyroid-stimulating hormone (TSH) in serum, iodine in a spot urine sample, and questionnaire estimates of iodine intake from diet, iodized salt and supplements. Adjusted associations were assessed by multiple linear regression and logistic regression analyses. **Results:** There was an increased risk of TSH above 3 muU/mL in women who consumed **200 microg or more of iodine supplements daily compared with those who consumed less than 100 microg/day** (adjusted odds ratio = 2.5 [95% confidence interval = 1.2 to 5.4]). **We observed no association between urinary iodine and TSH levels. Pregnant women from the area with the highest median urinary iodine (168 microg/L) and highest supplement coverage (93%) showed the lowest values of serum free thyroxine.** (geometric mean = 10.09 pmol/L [9.98 to 10.19]). **CONCLUSIONS: Iodine supplement intake in the first half of pregnancy may lead to maternal thyroid dysfunction in iodine-sufficient or mildly iodine-deficient populations.**

Thyroid disorders and pregnancy. Internist (Berl). 2010 May;51(5):620-4. Disorders of the thyroid in women are common during the reproductive years. Incorrect or delayed treatment during pregnancy can adversely affect the health of mother and child. Knowledge of the physiological changes during this time is essential. … [CB note: **This paper is looking at women who have medical conditions involving the thyroid gland, and not at public health iodine-in-pregnancy issues.]**.

Lifestyle factors in people seeking infertility treatment - A review. Aust N Z J Obstet Gynaecol. 2010 Feb;50(1):8-20. Background: Clinical infertility is a prevalent problem with significant financial and psychosocial costs. Modifiable lifestyle factors exist that may affect a person's time to conception and their chance of having a healthy, live birth. … **Results: A person's time to pregnancy and their chance of having a healthy, live birth may be affected by factors such as weight, vitamin and iodine intake** … Conclusion**:** Advice on modifiable lifestyle factors should be given to people presenting for infertility treatment to help them make positive changes that may improve their chances of pregnancy and delivering a healthy, live baby. Developing a guideline for this would be a prudent step towards helping clinicians to implement this aspect of preconception care.

The challenges of iodine supplementation: a public health programme perspective. Best Pract Res Clin Endocrinol Metab. 2010 Feb;24(1):89-99. An adequate iodine intake during pregnancy, lactation and early childhood is particularly critical for optimal brain development of the foetus and of children 7-24 months of age. **While the primary strategy for sustainable elimination of iodine deficiency remains universal salt iodisation, the World Health Organization and the United Nations Children's Fund recommend a complementary strategy of iodine supplements as a temporary measure when salt iodisation could not be implemented.** This article aims to review current evidence on efficacy and implications of implementing iodine supplementation as a public health measure to address iodine deficiency. Iodine supplementation seems unlikely to reach high coverage in a rapid,

equitable and sustained way. Implementing the programme requires political commitment, effective and efficient supply, distribution and targeting, continuous education and communication and a robust monitoring system. Thus, universal salt iodisation should remain the primary strategy to eliminate iodine deficiency.

Cretinism revisited. Best Pract Res Clin Endocrinol Metab. 2010 Feb;24(1):39-50. **Endemic cretinism includes two syndromes: a more common neurological disorder with brain damage, deaf mutism, squint and spastic paresis of the legs and a less common syndrome of severe hypothyroidism, growth retardation and less severe mental defect. Both conditions are due to dietary iodine deficiency and can be prevented by correction of iodine deficiency before pregnancy.** Endemic cretinism is now included in the spectrum of the effects of iodine deficiency in a population termed the 'iodine deficiency disorders (IDDs)', which also includes a wide range of lesser degrees of cognitive defect that can be prevented by the correction of iodine deficiency. **Iodine deficiency is now recognised by the World Health Organization (WHO) as the most common preventable cause of brain damage with in excess of 2 billion at risk from 130 countries. A global United Nations (UN) programme of prevention has achieved 68% household usage of iodised salt by the year 2000 compared with less than 20% prior to 1990.**

Iodine intake as a determinant of thyroid disorders in populations. Best Pract Res Clin Endocrinol Metab. 2010 Feb;24(1):13-27. Depending on the availability of iodine, the thyroid gland is able to enhance or limit the use of iodine for thyroid hormone production. When compensation fails, as in severely iodine-deficient populations, hypothyroidism and developmental brain damage will be the dominating disorders. This is, out of all comparison, the most serious association between disease and the level of iodine intake in a population. In less severe iodine deficiency, the normal thyroid gland is able to adapt and keep thyroid hormone production within the normal range. However, the prolonged thyroid hyperactivity associated with such adaptation leads to thyroid growth, and during follicular cell proliferation there is a tendency to mutations leading to multifocal autonomous growth and function. … Monitoring and adjusting of iodine intake in a population is an important part of preventive medicine.

Epidemiology of iodine deficiency: Salt iodisation and iodine status. Best Pract Res Clin Endocrinol Metab. 2010 Feb;24(1):1-11. Universal salt iodisation (USI) and iodine supplementation are highly effective strategies for preventing and controlling iodine deficiency. USI is now implemented in nearly all countries worldwide, and two-thirds of the world's population is covered by iodised salt. **The number of countries with iodine deficiency as a national public health problem has decreased from 110 in 1993 to 47 in 2007. Still one-third of households lack access to adequately iodised salt. Iodine deficiency remains a major threat to the health and development of populations around the world, particularly in children and pregnant women in low-income countries**. Data on iodine status are available from 130 countries and approximately one-third of the global population is estimated to have a low iodine intake based on urinary iodine (UI) concentrations. Insufficient control of iodine fortification levels has led to excessive iodine intakes in 34 countries. The challenges ahead lie in ensuring higher coverage of adequately iodised salt, strengthening regular monitoring of salt iodisation and iodine status in the population, together with targeted interventions for vulnerable population groups.

Iodine deficiency in the prenatal period may form learning ability deficiency in the postnatal period. Georgian Med News. 2010 Jan;(178):65-8. The present study analysis the changes in learning ability of the progeny of rats suffered from iodine deficiency. … **We can conclude that the diet with very low iodine content results in a low level of thyroxin in maternal serum and neurological deficiency in progeny manifested by learning disability during maze testing. Addition of the iodine to the diet prevents development of mentioned neurological deficiency.**

Suboptimal iodine status of Australian pregnant women reflects poor knowledge and practices related to iodine nutrition. Nutrition. 2010 Oct;26(10):963-8. OBJECTIVE: To assess the iodine status and knowledge and practices related to iodine nutrition of Australian women during pregnancy. …**CONCLUSION: Public health strategies, including nutritional education and supplementation, are urgently required to improve the iodine status of pregnant women. Currently, no readily accessible information on iodine is available to women attending antenatal clinics in Australia.**

The influence of dietary status on the cognitive performance of children. . Mol Nutr Food Res. 2010 Apr;54(4):457-70. **The rapid rate of growth of the brain during the last third of gestation and the early postnatal stage makes it vulnerable to an inadequate diet, although brain development continues into adulthood and micronutrient status can influence functioning beyond infancy. Certain dietary deficiencies during the first 2 years of life, for example iodine and iron, create problems that are not reversed by a later adequate diet**. …. In particular, attention has been directed to protein-calorie malnutrition and more **specifically the intake of iron, iodine and vitamin A** …

Iodine intake is still inadequate among pregnant women eight years after mandatory iodination of salt in Turkey. J Endocrinol Invest. 2010 Jul-Aug;33(7):461-4. … Conclusion: Our study revealed that **iodine deficiency still remains a serious problem for pregnant women**. Based on our results, antenatal follow-up protocols in the primary care setting in Turkey must include iodine supplementation.

Iodine deficiency in pregnancy, infancy and childhood and its consequences for brain development. Best Pract Res Clin Endocrinol Metab. 2010 Feb;24(1):29-38. Iodine deficiency during foetal development and early childhood is associated with cognitive impairment. Randomised clinical studies in school-aged children encountered in the literature indicate that cognitive performance can be improved by iodine supplementation, but most studies suffer from methodological constraints. Tests to assess cognitive performance in the domains that are potentially affected by iodine deficiency need to be refined. Maternal iodine supplementation in areas of mild-to-moderate iodine deficiency may improve cognitive performance of the offspring, but randomised controlled studies with long-term outcomes are lacking. Studies in infants or young children have not been conducted. The best indicators for iodine deficiency in children are thyroid-stimulating hormone (TSH) in newborns and thyroglobulin (Tg) in older children. Urinary iodine may also be useful but only at the population level. Adequate salt iodization will cover the requirements of infants and children as well as pregnant women. However, close monitoring remains essential.

[CB note: This particular discussion is about research design and the need for more research. Of course more research is always needed. However, as most of the people who read my materials are not epidemiologists (nor am I) some fine points of interpretation of this report may be helpful.

First, the type of research designs described here as "lacking" are "randomized controlled studies with long-term outcomes" including "studies in infants or young children." **Although desirable from a statistical confidence level sense, obtaining the results of this kind of study design with infants, children, or ANYBODY would most likely be unethical** and therefore not likely to ever become available. **(If we are pretty darn sure that iodine deficiency is not good for people, we can never do the kind of study where some folks are randomly assigned to not receive the supplemental amount presumed to provide adequacy … especially for "long-term" outcome measures**.)

I think it is important to realize that although we will likely never have this kind of definitive data, there is a ton of other kinds of research evidence that the problem of Iodine Deficiency Disorders (IDD) is huge and that correcting it to the best of our ability is worthwhile.

Second is a comment about the interpretation of the second to the last statement: "Adequate salt iodization will cover the requirements of infants and children as well as pregnant women." My reaction is, well, of course "ADEQUATE" salt iodization will cover everyone's requirements. That's like saying "taking in enough food prevents starvation." It sounds like there is no problem. Here's the problem:

1) **Many people who need additional iodine do not get it for many reasons even if local iodization levels in salt are "adequate."** The reasons for this are discussed in detail in several of my other papers.
2) It is apparent by the recent upward adjustment in the amount of iodine now recommended by the WHO that the previous (recent**) iodization level has in fact been "INadequate" for pregnant women in particular.**

3) **About 1/3 of the world's population still does not have access to iodized salt. "**Epidemiology of iodine deficiency: Salt iodisation and iodine status." Best Pract Res Clin Endocrinol Metab. 2010 Feb;24(1):1-11.

Neonatal TSH screening: is it a sensitive and reliable tool for monitoring iodine status in populations? Best Pract Res Clin Endocrinol Metab. 2010 Feb;24(1):63-75. Conclusion … these researchers do not think it is very useful and they explain why they think this.

Thyroid function at the third trimester of pregnancy in a Northern French population. Ann Endocrinol (Paris). 2010 Sep 29. … Conclusion: The hypothyroxinemia at the third trimester of pregnancy was more prominent in the Parisian population and insufficient iodine intake could be responsible for the deficient increase in TT4. **It is therefore concluded that the inability of the thyroid to establish the required equilibrium could be corrected by systematic iodine supplementation before pregnancy.** Finally, the strong correlation between FT4 and FTI suggests that the quality of FT4 test immunoassay is appropriate for estimating FT4 serum levels during pregnancy.

Inadequacy of nutrients intake among pregnant women in the Deep South of Thailand. BMC Public Health. 2010 Sep 24;10(1):572.

Universal screening detects two-times more thyroid disorders in early pregnancy than targeted high-risk case finding. Eur J Endocrinol. 2010 Oct;163(4):645-50. … CONCLUSIONS: Over half (55%) of pregnant women with abnormalities suggestive of autoimmune thyroiditis and/or hypothyroidism would be missed if only those with high-risk criteria were examined. A more extensive screening of thyroid autoimmunity and dysfunction seems warranted.

An approach to a sanitary and social problem: urinary iodine excretion in pregnant women from a iodine deficient region. Arch Latinoam Nutr. 2009 Dec;59(4):378-82. The urinary iodine excretion (UIE) assay is an effective method to detect reduced iodine intake. … 45% of pregnant women with UIE < 100 ug/l showed impaired thyroid function. …

Post-production losses in iodine concentration of salt hamper the control of iodine deficiency disorders: a case study in northern Ethiopia. J Health Popul Nutr. 2010 Jun;28(3):238-44.

Parameters of thyroid function throughout and after pregnancy in an iodine-deficient population. Thyroid. 2010 Sep;20(9):995-1001. Background: The thyroid hormone milieu is of crucial importance for the developing fetus. Pregnancy induces physiological changes in thyroid homeostasis that are influenced by the iodine status. However, longitudinal studies addressing thyroid function during pregnancy and after delivery are still lacking in mild-to-moderate iodine-deficient populations. Here we characterize the serum parameters of thyroid function throughout pregnancy, and until 1 year after delivery, in a population of pregnant women whom we have previously reported to be iodine deficient (median urinary iodine levels below 75 microg/L). … **Conclusion:** The pregnant women in this study had an absence of the usual free T(4) spike and a smaller than expected increment in total T(4), described during pregnancy in iodine-sufficient populations. A greater number of women had subclinical hypothyroidism compared with iodine-sufficient populations. **This hormonal profile, most likely due to iodine insufficiency, may result in inadequate thyroid hormone supply to the developing fetus. We conclude that care should be taken when reviewing the results of thyroid hormone tests in iodine-insufficient populations and when no gestation-specific reference values have been established. In addition, we recommend iodine supplementation in our population and populations with similar iodine status, particularly during pregnancy and lactation.**

Perinatal iron and copper deficiencies alter neonatal rat circulating and brain thyroid hormone concentrations. Endocrinology. 2010 Aug;151(8):4055-65. Copper (Cu), iron (Fe), and iodine/thyroid hormone (TH) deficiencies lead to similar defects in late brain development, suggesting that these micronutrient deficiencies share a common mechanism contributing to the observed derangements. … These results indicate that at least some of the brain defects associated with neonatal Fe and Cu deficiencies are mediated through reductions in circulating and brain TH levels.

Effect of selenium on hypothyroidism induced by methimazole (MMI) in lactating rats and their pups. Acta Biol Hung. 2010 Jun;61(2):145-57. The present study was undertaken to assess the effect of selenium (Se) on hypothyroidism induced by methimazole (MMI) in lactating rats and their pups. … In the MMI-treated group, thyroid iodine contents and plasma thyroid hormone levels significantly decreased, while plasma TSH levels increased in pups and their mothers. These biochemical modifications corresponded histologically to closed follicles, increased vascularity and a reduction in colloid volume. **Co-treatment with Se ameliorated these parameters. We concluded that the supplementation of Se in diet had beneficial effects on hypothyroidism during a critical period of life.**

CB Note: Both Selenium and iodine are required for production of thyroxine, and both are quite variable in foods depending on the content in the soil in which the foods are grown. In some areas of the world, particularly mountainous areas, selenium deficiency is common. Examples of areas that automatically supplement selenium include New Zealand and the Alpine region of Europe. It is likely that people with a combination of iodine AND selenium deficiency would experience much greater thyroid –related problems.

[Selenium status, thyroid volume and multiple nodule formation in an area with mild iodine deficiency. Eur J Endocrinol. 2011 Jan 17. Trace elements status in multinodular goiter. J Trace Elem Med Biol. 2010 Apr;24 (2):106-10. The impact of common micronutrient deficiencies on iodine and thyroid metabolism: the evidence from human studies. Best Pract Res Clin Endocrinol Metab. 2010 Feb;24(1):117-32. Selenium and thyroid. Best Pract Res Clin Endocrinol Metab. 2009 Dec;23(6):815-27. Selenium and the thyroid: a close-knit connection. J Clin Endocrinol Metab. 2010 Dec;95(12):5180-8. Fenvalerate exposure alters thyroid hormone status in selenium- and/or iodine-deficient rats. Biol Trace Elem Res. 2010 Jun;135(1-3):233-41.Selenium & iodine supplementation: effect on thyroid function of older New Zealanders. Am J Clin Nutr. 2009 Oct;90(4):1038-46. Role of iodine, selenium and other micronutrients in thyroid function and disorders. Endocr Metab Immune Disord Drug Targets. 2009 Sep;9(3):277-94. Selenium levels in first-degree relatives of diabetic patients. Biol Trace Elem Res. 2009 May;128(2):144-51. Effect of trace elements on thyroid structural and functional state (a review). Gig Sanit. 2008 Sep-Oct;(5):79-81.On the importance of selenium and iodine metabolism for thyroid hormone biosynthesis and human health. Mol Nutr Food Res. 2008 Nov;52(11):1235-46.Environmental factors and autoimmune thyroiditis. Nat Clin Pract Endocrinol Metab. 2008 Aug;4(8):454-60. Environmental triggers of autoimmune thyroiditis. J Autoimmun. 2009 Nov-Dec;33(3-4):183-9. Trace element levels in hashimoto thyroiditis patients with subclinical hypothyroidism. . Biol Trace Elem Res. 2008 Summer;123(1-3):1-7. Trace elements in growth: iodine and selenium status of Turkish children. . J Trace Elem Med Biol. 2007;21 Suppl 1:40-3.]

The impact of transient hypothyroidism on the increasing rate of congenital hypothyroidism in the United States. Pediatrics. 2010 May;125 Suppl 2:S54-63.

Therapeutic drug monitoring during pregnancy and lactation: thyroid function assessment in pregnancy-challenges and solutions. Ther Drug Monit. 2010 Jun;32(3):265-8.

Iodine intake in a population of pregnant women: INMA mother and child cohort study, Spain. J Epidemiol Community Health. 2010 Aug 15. Background Monitoring iodine status during pregnancy is essential to prevent iodine-related disorders. The objectives of this study are to estimate iodine intake and excretion, to assess their association and to evaluate the compliance of the recommendations in a multicentre cohort of pregnant women. …. Results 1522 women were included in the study. Median UIC was 134 (IQR 80-218) mug/l in Valencia, 168 (IQR 108-272) mug/l in Gipuzkoa and 94 (IQR 57-151) mug/l in Sabadell. 48.9% of Valencian women consumed iodine supplements, 93.3% in Gipuzkoa and 11.0% in Sabadell. Prevalence of iodised salt consumption was 50.5% in the whole sample. UIC was associated with intake of supplements, iodised salt, dietary iodine and water. UIC levels were lower than expected according to the estimated iodine intake. **Conclusion Median UIC reflected iodine deficiency according to WHO reference levels, except in Gipuzkoa where supplements are widely consumed. It is necessary to strengthen iodised salt consumption since it is already far from the objective proposed of coverage of 90% of households. More data would be valuable to assess the correspondence between iodine intake and excretion during pregnancy.**

Iodine intake and maternal thyroid function during pregnancy. Epidemiology. 2010 Jan;21(1):62-9. [Data from same study in Spain as above.]Background: An adequate iodine intake during pregnancy is essential for the synthesis of maternal thyroid hormones and normal brain development in the fetus. Scant evidence is available on the effects and safety of iodine supplementation during pregnancy in areas with adequate or mildly deficient iodine intake. We examined the association of maternal iodine intake and supplementation with thyroid function before 24

weeks of gestation in population-based samples from 3 different areas in Spain. Methods: A cross-sectional study of 1844 pregnant women (gestational age range 8-23 weeks) was carried out in 3 areas in Spain (Guipúzcoa, Sabadell, Valencia), during the period 2004-2008. We measured levels of free thyroxine and thyroid-stimulating hormone (TSH) in serum, iodine in a spot urine sample, and questionnaire estimates of iodine intake from diet, iodized salt and supplements. Adjusted associations were assessed by multiple linear regression and logistic regression analyses. **Results:** There was an increased risk of TSH above 3 muU/mL in women who consumed **200 microg or more of iodine supplements daily compared with those who consumed less than 100 microg/day** (adjusted odds ratio = 2.5 [95% confidence interval = 1.2 to 5.4]). **We observed no association between urinary iodine and TSH levels. Pregnant women from the area with the highest median urinary iodine (168 microg/L) and highest supplement coverage (93%) showed the lowest values of serum free thyroxine.** (geometric mean = 10.09 pmol/L [9.98 to 10.19]). **CONCLUSIONS: Iodine supplement intake in the first half of pregnancy may lead to maternal thyroid dysfunction in iodine-sufficient or mildly iodine-deficient populations.**

Plenary Lecture 3: Food and the planet: nutritional dilemmas of greenhouse gas emission reductions through reduced intakes of meat and dairy foods. Proc Nutr Soc. 2010 Feb;69(1):103-18. Legally-binding legislation is now in place to ensure major reductions in greenhouse gas emissions in the UK. Reductions in intakes of meat and dairy products, which account for approximately 40% of food-related emissions, are an inevitable policy option. The present paper assesses, as far as is possible, the risk to nutritional status of such a policy in the context of the part played by these foods in overall health and well-being and their contribution to nutritional status for the major nutrients that they supply. … However, overall protein intakes would probably fall, with the potential for intakes to be less than current requirements for the elderly. Whether it is detrimental to health is uncertain and controversial. Zn intakes are also likely to fall, raising questions about child growth that are currently unanswerable. Milk and dairy products, currently specifically recommended for young children and pregnant women, provide 30-40% of dietary Ca, **iodine**, vitamin B12 and riboflavin. Population groups with low milk intakes generally show low intakes and poor status for each of these nutrients. **Taken together it would appear that the reductions in meat and dairy foods, which are necessary to limit environmental damage, do pose serious nutritional challenges for some key nutrients. These challenges can be met, however, by improved public health advice on alternative dietary sources and by increasing food fortification.**

Symposium on 'Geographical and geological influences on nutrition': Iodine deficiency in industrialised countries. Proc Nutr Soc. 2010 Feb;69(1):133-43**. Iodine deficiency is not only a problem in developing regions; it also affects many industrialised countries. Globally, two billion individuals have an insufficient iodine intake, and approximately 50% of continental Europe remains mildly iodine deficient. Iodine intakes in other industrialised countries, including the USA and Australia, have fallen in recent years.** Iodine deficiency has reappeared in Australia, as a result of declining iodine residues in milk products because of decreased iodophor use by the dairy industry. In the USA, although the general population is iodine sufficient, it is uncertain whether iodine intakes are adequate in pregnancy, which has led to calls for iodine supplementation. The few available data suggest that pregnant women in the Republic of Ireland and the UK are now mildly iodine deficient, possibly as a result of reduced use of iodophors by the dairy industry, as observed in Australia. Representative data on iodine status in children and pregnant women in the UK are urgently needed to inform health policy. In most industrialised countries the best strategy to control iodine deficiency is carefully-monitored salt iodisation. **However, because approximately 90% of salt consumption in industrialised countries is from purchased processed foods, the iodisation of household salt only will not supply adequate iodine. Thus, in order to successfully control iodine deficiency in industrialised countries it is critical that the food industry use iodised salt. The current push to reduce salt consumption to prevent chronic diseases and the policy of salt iodisation to eliminate iodine deficiency do not conflict; iodisation methods can fortify salt to provide recommended iodine intakes even if per capita salt intakes are reduced to <5 g/d.**

The current salt iodization strategy in Kyrgyzstan ensures sufficient iodine nutrition among school-age children but not pregnant women. Public Health Nutr. 2010 May;13(5):623-30. Although goitre and cretinism were brought under control in Kyrgyzstan during the 1960s by centrally directed iodized salt supplies, iodine-deficiency disorders (IDD) had made a comeback when the USSR broke up in 1991. Upon independence, Kyrgyzstan started developing its own salt processing industry and by 2001 the Government enacted a law on IDD elimination, mandating

universal salt iodization (USI) at 25-55 mg/kg. The present study [in 2007] aimed to evaluate the effectiveness of the USI strategy on the iodine consumption, iodine status and burden of IDD in the population of Kyrgyzstan. …
CONCLUSIONS: The iodine nutrition status of the Kyrgyz population is highly responsive to household salt iodization. Although the results in children suggest adequate iodine nutrition, the iodine consumption among pregnant women did not assure their dietary requirements. In-depth analysis of the survey data suggest that excess iodine intake is not likely to become a public health concern in Kyrgyzstan when the salt supply meets agreed standards.

Iodine: it's important in patients that require parenteral nutrition. Gastroenterology. 2009 Nov;137(5 Suppl):S36-46. Iodine deficiency has multiple adverse effects on growth and development because of inadequate thyroid hormone production. Four methods are generally recommended for assessment of iodine nutrition: urinary iodine concentration, thyroid size, and blood concentrations of thyroid-stimulating hormone and thyroglobulin. Iodine intakes < or = 1 mg/d are well tolerated by most adults, because the thyroid is able to adjust to a wide range of intakes. **A daily dose of 1 microg iodine/kg body weight is recommended for infants and children receiving parenteral nutrition (PN), but this is far below their requirement**. **Daily iodine requirements in adults receiving enteral nutrition or PN are estimated to be 70-150 microg, but most PN formulations do not contain iodine.** Despite this, deficiency is unlikely because absorption from iodine-containing skin disinfectants and other adventitious sources can provide sufficient iodine**. However, if chlorhexidine replaces iodine-containing disinfectants for catheter care, iodine deficiency may occur during long-term PN, and periodic testing of thyroid functions may be prudent. Infants may be particularly vulnerable because of their small thyroidal iodine store, but available data do not yet support routine supplementation of preterm infants with iodine**. Adults may be less vulnerable because thyroidal iodine stores may be able to support thyroid hormone production for several months. More studies to clarify this issue would be valuable.

Fetal and neonatal thyroid function: review and summary of significant new findings. Curr Opin Endocrinol Diabetes Obes. 2010 Feb;17(1):1-7. The purpose of this review is to briefly summarize current knowledge of fetal and neonatal thyroid function, and then to summarize the most significant new findings over the last year that add to our knowledge of the cause, diagnosis, and management of fetal and neonatal thyroid disorders…. [CB note: This is about managing certain types of thyroid disorders in newborns, and not generally about iodine intake issues in pregnancy.]

Impact of pregnancy on prevalence of goitre and nodular thyroid disease in women living in a region of borderline sufficient iodine supply. Horm Metab Res. 2010 Feb;42(2):137-42. An interplay of genetic, epigenetic, and environmental factors contributes to thyroid disease. In a cross-sectional study, we aimed to determine the influence of parity in combination with other risk factors on the prevalence of goitre and nodular thyroid disease (NTD) in women living in a region of previous overt iodine deficiency, which experienced a continuous improvement in alimentary iodine supply in the last two decades. Thyroid ultrasonography (7.5 MHz; Merck Thyromobil) was performed by the same investigator in 736 women living in Thuringia and Saxony [Germany].. **Goitre prevalence was 19.1%.** Solitary thyroid nodules were detected in 21.5%, and multiple nodules in 23.8% of women. In a multivariate analysis, neither age nor parity was positively correlated with goitre prevalence and NTD. A significant correlation was detected between BMI and goitre and multinodular disease. **Goitre was found in 25.3% of women with a positive family history for thyroid disease, as opposed to 16.1% goitre in women with a negative family history. Neither goitre nor NTD were associated with a history of smoking in the whole study population. Thyroid nodules and/or goitre are present in up to 45% of women in an area of previous overt iodine deficiency**. Whereas BMI and family history are positively correlated with the presence of NTD and goitre, no such correlation could be detected for pregnancy and smoking after processing our data with multivariate analyses.

Clin Endocrinol (Oxf). 2010 Jan;72(1):81-6. **Iodine sources and iodine levels in pregnant women from an area without known iodine deficiency.** An adequate iodine intake during pregnancy is essential for normal development of the foetus. **The World Health Organization (WHO) recommends that the median urinary iodine concentration (UIC) in a population of pregnant women should range between 150 and 249 microg/l.** The aim of this study was to evaluate iodine status and to examine the main sources of iodine in pregnant women from an apparently iodine-sufficient area. Methods: Six hundred pregnant women in the third trimester completed a food

frequency questionnaire, and iodine was measured in urine samples. Urinary iodine concentrations were described in the whole population and in subgroups according to their frequency of intake of milk, fish, eggs, bread and iodized salt, as iodine supplements. Results: The median UIC was 104 microg/l (n = 600), however, the median was higher among women who had a high milk intake (117 microg/l), used iodized salt (117 microg/l) or who were supplemented with iodine (141 microg/l). Women receiving iodine supplementation who also consumed more than one cup of milk per day had median UIC higher than 150 microg/l. In multivariate models, women with moderate and high milk intake had lower risk of having UIC below 150 microg/l [OR (95% CI): 0.42 (0.22-0.82) and 0.29 (0.15-0.55) respectively], after adjustment for potential confounders. **Conclusions: On the basis of WHO criteria, the iodine status of pregnant women was inadequate in this area. Milk was the most important dietary source of iodine, and iodine supplementation was also an important source of iodine, although not enough to reach the current recommendations.**

2009

Prevalence of iodine deficiency in pregnant women in the health area of Palencia (Spain). Endocrinol Nutr. 2009 Dec;56(10):452-7. BACKGROUND: **Iodine deficiency in pregnant women may result in substantial and irreversible impairment in fetal brain development, even from the first few weeks of pregnancy.** OBJECTIVE: To assess the nutritional iodine status of pregnant women in our health area and its **relationship with dietary factors and thyroid function and to suggest treatment guidelines.** … CONCLUSIONS: **Seventy-eight percent of pregnant women in our health area were iodine deficient. Iodized salt intake is related to iodine sufficiency and to increased urinary iodine concentrations. Measures to increase intake of iodized salt among the population should be implemented. Iodized salt supplements should be systematically prescribed in women from the beginning of pregnancy.**

A framework to explore micronutrient deficiency in maternal and child health in Malawi, Southern Africa. Environ Health. 2009 Dec 21;8 Suppl 1:S13. Global food insecurity is associated with micronutrient deficiencies and it has been suggested that 4.5 billion people world-wide are affected by deficiencies in iron, vitamin A and iodine. Zinc has also been identified to be of increasing concern. The most vulnerable are young children and women of childbearing age. …

Perinatal goiter with increased iodine uptake and hypothyroidism due to excess maternal iodine ingestion. Horm Res. 2009;72(6):344-7. AIMS: To review cases of fetal/newborn goiter due to excess maternal iodine ingestion. **…** We reviewed the medical records of all patients that presented with congenital goiter in 2003. We used the PubMed search engine to conduct a review of publications addressing congenital goiter and excessive iodine intake. **…Maternal ingestion of large amounts of iodine due to an error in the manufacturing of a prenatal vitamin** caused a goiter in her fetus. Seven other women who received the same prenatal vitamin had newborn children with goiters. Three of these children were hypothyroid at the time of initial examination. Three patients (2 hypothyroid and 1 euthyroid) had thyroid scans with radioactive iodine; iodine uptake was elevated (>80%) in all 3, and in 1 the perchlorate washout test was positive. **…**The finding of congenital goiter and increased iodine uptake in a newborn is considered diagnostic of dyshormonogenesis, a permanent form of hypothyroidism. Our description is important because it demonstrates **that iodine excess during pregnancy may mimic some forms of dyshormonogenesis.** The differentiation between the two causes of newborn goiter may prevent the lifelong use of supplemental levothyroxine in patients with a transient abnormality.

Breastfeeding and maternal and infant iodine nutrition. Clinical Endocrinology. 70(5):803-9, 2009 May. Adequate concentration of iodine in breast milk is essential to provide for optimal neonatal thyroid hormone stores and to prevent impaired neurological development in breast-fed neonates. In many countries of the world, low iodine content of the breast milk indicates less than optimum maternal and infant iodine nutrition. The current WHO/ICCIDD/UNICEF recommendation for daily iodine intake (250 microg for lactating mothers) has been selected to ensure that iodine deficiency dose not occur in the postpartum period and that the iodine content of the milk is sufficient for the infant's iodine requirement

Iodine status and thyroid function of pregnant, lactating women and infants (0-1 yr) residing in areas with an effective Universal Salt Iodization program. Asia Pacific Journal of Clinical Nutrition. 18(1):34-40, 2009. Pregnant women, lactating women and infants were selected randomly in the regions where iodized salt coverage rate is more than 90% since 2000. Median Urinary Iodine (MUI) of infants, three groups of pregnant women (first, second and third trimester) and two groups lactating women (breastfeeding less than or more than six months) were 233, 174, 180, 147, 126 and 145 microg/L, respectively. Median milk iodine of lactating women was 163 microg/L. **Percentage of milk iodine < 150 microg/L of early lactating women was 40% less than that of late lactating women** ($p < 0.01$). **There was a positive correlation between urine iodine of infants and milk iodine of lactating women** ($r = 0.526$, $p = 0.000$)…. **Total 15.4% women's TSH were abnormal. Most of these women's urinary iodine were lower than 150 microg/L**.

Iodine Content of prenatal multivitamins in the United States. NEJM. 2009;360:939-940. The amount of iodine on the label was found not to be a good indicator of the amount in the product; in most cases it was less than stated and in some cases more. Kelp-based products were less reliable than products using potassium iodide. 127 non-prescription and 96 prescription prenatal vitamins were identified. 69% of non-prescription but only 28% of prescription products contained iodine at all, according to the label. 13 brands contained levels that were discordant by 50% or more with the amount on the label.

Iodine levels and thyroid hormones in healthy pregnant women and birth weight of their offspring. Eur J Endocrinol. 2009 Mar;160(3):423-9. Studied 239 women who had thyroid function and UIC at the first and third trimesters available. Conclusions: The present study suggests that iodine status during pregnancy may be related to prenatal growth in healthy women.

A study for maternal thyroid hormone deficiency during the first half of pregnancy in China. Eur J Clin Invest. 2009 Jan;39(1):37-42.

Prenatal induced chronic dietary hypothyroidism delays but does not block adult-type Leydig cell development. Am J Physiol Endocrinol Metab. 2009 Feb;296(2):E305-14.

Iodine deficiency in pregnancy and the effects of maternal iodine supplementation on the offspring: a review. Am J Clin Nutr. 2009 Feb;89(2):668S-72S**. The World Health Organization (WHO) recently increased their recommended iodine intake during pregnancy from 200 to 250 microg/d and suggested that a median urinary iodine (UI) concentration of 150-249 microg/L indicates adequate iodine intake in pregnant women.** Thyrotropin concentrations in blood collected from newborns 3-4 d after birth may be a sensitive indicator of even mild iodine deficiency during late pregnancy; a <3% frequency of thyrotropin values >5 mU/L indicates iodine sufficiency. New reference data & a simple collection system may facilitate use of the median UI concentration as an indicator of iodine status in newborns. In areas of severe iodine deficiency, maternal & fetal hypothyroxinemia can cause cretinism and adversely affect cognitive development in children; to prevent fetal damage, iodine should be given before or early in pregnancy. Whether mild-to-moderate maternal iodine deficiency produces more subtle changes in cognitive function in offspring is unclear; no controlled intervention studies have measured long-term clinical outcomes. Cross-sectional studies have, with few exceptions, reported impaired intellectual function & motor skills in children from iodine-deficient areas, but many of these studies were likely confounded by other factors that affect child development. In countries or regions where <90% of households are using iodized salt & the median UI concentration in school-age children is <100 microg/L, the WHO recommends iodine supplementation in pregnancy and infancy.

Iodine status of pregnant women and their progeny in the Minho Region of Portugal. Thyroid. 2009 Feb;19(2):157-63. … in Portugal, a country that the International Council for Control of Iodine Deficiency Disorders considered, in 2004, to have probably reached iodine sufficiency. … [Results of this study] suggest that iodine supplementation should be implemented throughout pregnancy and lactation in Portugal.

Gestational thyroid function abnormalities in conditions of mild iodine deficiency: early screening versus continuous monitoring of maternal thyroid status Eur J Endocrinol. 2009 Jan 29. Conclusions: In mildly ID areas thyroid function testing early in gestation seems to be only partly effective in identifying thyroid underfunction in pregnant women. Indeed, in our series more than 40% hypothyroid women would not have been diagnosed had we limited our observation to early thyroid function tests alone. Although thyroid

autoimmunity carried a 5-fold increased risk of hypothyroidism, iodine deficiency seems to be a major determinant in the occurrence of thyroid underfunction. Adequate iodine supplementation should be strongly recommended to meet the increased hormone demand over gestation.

Colostrum iodine and perchlorate concentrations in Boston-area women: a cross-sectional study. Clin Endocrol (Oxf). 2009 Feb;70(2):326-30 OBJECTIVE: To measure levels of colostrum iodine, which has not been previously measured… RESULTS: Sufficient colostrum was obtained to measure iodine in 61 samples … . Median colostrum iodine content was 51.4 micromol/l (range 21.3-304.2 microg/l)., CONCLUSIONS: Iodine is present in human colostrum and thus available for breastfeeding infants immediately after birth.

CB Note:

These researchers report that the **median colostrum iodine content was 51.4** micromol/l, with a very wide range (21.3-304.2). As described earlier (Breastfeeding and maternal and infant iodine nutrition. Clin Endocrinol (Oxf). 2008 Oct 6.) in areas of iodine sufficiency **breast milk iodine concentration should be in the range of 100-150 mug/dL**. That means that we must interpret this research as indicating that colostrum can and does contain iodine, but the amount is generally often well below the level found in the milk of women who are iodine sufficient. It would be interesting to evaluate the colostrum iodine content among women who have biochemical evidence of being iodine sufficient versus those who are not. In any case, it appears that like milk, the iodine content of colostrums varies significantly, most likely depending on the mother's state of adequacy or inadequacy. **Iodine is clearly one more nutrient for which we must not assume that mother's milk or colostrum will automatically deliver the necessary level to the baby if mother's own iodine status is poor. At the same time, it is also now clear that we must not assume that her iodine status is adequate. This will require some serious re-thinking of our current maternal-child nutrition recommendations in order to assure iodine adequacy for all.**

Thyroid disorders during pregnancy .Dtsch Med Wochenschr. 2009 Jan;134(3):83-6.

Is maternal diet supplementation beneficial? Optimal development of infant depends on mother's diet. Am J Clin Nutr. 2009 Feb;89(2):685S-7S . **…** Whatever the limitations of our current state of knowledge, it is apparent that pregnancy and lactation are periods during which good nutrition is exceptionally important. The infant is not protected from the inadequate diet of the mother.

Maternal milk concentration of zinc, iron, selenium, and iodine and its relationship to dietary intakes. Biol Trace Elem Res. 2009 Jan;127(1):6-15. … Rio Grande WIC: The lactating mothers consumed significantly less Zn, Se, and I when compared to the Recommended Dietary Allowances (RDA) even though Fe intake was higher than the RDA value. Breast milk concentration of Zn, Fe, and Se were in agreement within the range of representative values for Constituents of Human Milk but Iodine was at significantly lower concentration than the representative value.

2008

Iodine status of the U.S. population, National Health and Nutrition Examination Survey 2003-2004. Thyroid. 2008 Nov;18(11):1207-14. BACKGROUND: Since 1971, the general U.S. population has been monitored for dietary iodine sufficiency by urinary iodine (UI) measurements through the National Health and Nutrition Examination Survey (NHANES). This report presents the UI levels for the population participating in NHANES 2003-2004. It is the third assessment of the U.S. population since NHANES III (1988-1994), when the median UI level was observed to decrease from NHANES I (1971-1974). METHODS: In 2003-2004, a stratified, multistage, probability sample of approximately 5000 participants per year were selected to participate in NHANES Household interviews, and specimen collection were performed. UI level was measured by inductively coupled plasma mass spectrometry on a random subsample of 2526 participants aged 6 years and older. RESULTS: The **median UI level** for the general U.S. population in 2003-2004 **was 160 microg/L** (95% confidence interval [CI] 146-172), and 11.3 +/- 1.8% of the population had a UI level below 50 microg/L. Children had a higher UI level than adolescents and adults. **Among all (pregnant and nonpregnant) women of reproductive age, the median UI level was 139 microg/L** (95% CI

117-156), **15.1 +/- 3.2% women had a UI level <50 microg/L**, and Non-Hispanic blacks in this group had a lower UI level than other racial/ethnic groups. **CONCLUSIONS: These findings affirm the stabilization of the UI level and the adequate iodine nutrition in the GENERAL U.S. population since 2000. Future surveys designed to achieve UI levels representative of pregnant women can improve the estimate of iodine sufficiency in this population subgroup. Continued monitoring of the population for iodine sufficiency is warranted because of groups at risk for iodine deficiency disorders.**

CB note:

Some key points from the above report that I don't want to get lost: Although the average UI in this large US study (160 mcg/L) was interpreted as reflecting adequacy of iodine, **the median UI level for <u>women</u> was 139; in several studies a UI of <150 is described as indicating iodine deficiency.** There are many issues about how iodine sufficiency is assessed, but it looks like an important observation to mark that even if the "general" US population is fine, women (pregnant or not) are much less likely to achieve the value the NHANES researchers describe as adequate iodine status. Additionally, note that they also report that about 15% of women had a UI of <50! Fifteen percent of the women is a lot of people (some at reproductive age) with seriously poor iodine status.

Iodine status and thyroid volume changes during pregnancy: results of a survey in Aran Valley (Catalan Pyrenees, Spain.) J Endocrinol Invest. 2008 Oct;31(10):851-5 The Aran Valley has a long-standing history of iodine deficiency. … As of 2000, iodine deficiency among pregnant women in the Aran Valley was still very high… preconceptional supplements with iodine are required for its prevention.

Perinatal and chronic hypothyroidism impair behavioural development in male and female rats. Exp Physiol. 2008 Nov;93(11):1199-209.

Perinatal iodine deficiency in the Far East. Vopr Pitan. 2008;77(5):65-8.

Maternal and infant thyroid disorders and cerebral palsy. Semin Perinatol. 2008 Dec;32(6):438-4. … A major research priority should be to assess the effects on CP risk of thyroid supplementation in transient hypothyroxinemia of prematurity. Iodine deficiency can be addressed by inexpensive and well-established public health measures, and thyroid hormone deficiency can be addressed by inexpensive and well-established clinical measures. If a causal chain can be established that links iodine and thyroid hormone to risk of CP, the potential for introducing very cost-effective ways of reducing the burden of CP will be considerable.

Iodine balance, iatrogenic excess, and thyroid dysfunction in premature newborns. Semin Perinatol. 2008 Dec;32(6): 407-12 … The iodine intake of newborns is entirely dependent on the iodine content of breast milk and the formula preparations used to feed them. An inadequate iodine supply (deficiency and excess) might be especially dangerous in the case of premature babies. The minimum recommended dietary allowance is different depending on age groups. **The iodine intake required is at least 15 microg/kg/d in full-term infants and 30 microg/kg/d in preterms.** Premature infants are in a situation of iodine deficiency, precisely at a stage of psychomotor and neural development that is extremely sensitive to alterations of thyroid function.

Iodine deficiency in 2007: global progress since 2003. Food Nutr Bull. 2008 Sep;29(3):195-202 Conclusions: Global progress in controlling iodine deficiency has been made since 2003, but efforts need to be accelerated in order to eliminate this debilitating health issue that affects almost one in three individuals globally. Surveillance systems need to be strengthened to monitor both low and excessive intakes of iodine.

Micronutrient status, cognition and behavioral problems in childhood. Eur J Nutr. 2008;47 Suppl 3:38-50.

Reference values for neonatal thyroid volumes in a moderately iodine-deficient area. J Endocrinol Invest. 2008 Jul;31(7):642-6. The reference ranges of thyroid volumes in neonates vary according to the iodine status of a specific region. In different studies, it ranged between 0.47 and 1.62 ml. It has been previously shown that Bursa city was a moderately iodine-deficient area. We therefore aimed at determining normal reference ranges of neonatal thyroid volumes in our moderately iodine-deficient area. … Conclusion: Normal thyroid volumes in neonates vary

between different regions. Local reference values should be used in thyroid volume assessment. Our results are in concordance with the literature and can be used as reference values for our region.

CB note:

These researchers (above) found that in their "moderately iodine -deficient area" neonates have evidence of poorer iodine status (i.e. larger thyroid volume) than elsewhere. They appear to suggest using a local regional average to assess inadequacy to better reflect their population. However, just re-labeling poor iodine status as "OK for around here" is unlikely to be helpful. **Establishing lower iodine reference values as regionally "normal" because they are commonly seen seems like a recipe for missing infants at risk.** It reminds me of the old vitamin D tables that gave significantly lower blood levels as "normal" if the measurement was done in the winter. It was "normal" only in the mathematical sense of the word because deficiency was in fact very common in the winter especially. However, as we have been learning in the vitamin D world, "averages" and "normal values" in this situation are not the same thing as "healthiest" values.

Iodine deficiency, more than cretinism and goiter. Med Hypotheses. 2008 Nov;71(5):645-8. Recent reports of the World Health Organization show iodine deficiency to be a worldwide occurring health problem. … iodine deficiency may give rise to clinical symptoms of hypothyroidism without abnormality of thyroid hormone values. [Hypothesis discussed here that there may be a relationship] between iodine deficiency and obesity, attention deficit hyperactivity disorder (ADHD), psychiatric disorders, fibromyalgia, and malignancies.

Iodine prophylaxis using iodized salt and risk of maternal thyroid failure in conditions of mild iodine deficiency. J Clin Endocrinol Metab. 2008 Jul;93(7):2616-21.

Inadequate iodine nutrition of pregnant women from Extremadura [Spain] Eur J Endocrinol. 2008 Oct;159(4):439-45.

Iodine deficiency disorders and their prevention in India. Rev Endocr Metab Disord. 2008 Sep;9(3):237-44**.** New insights on the high prevalence of functional decompensation of the thyroid among newborn and children from several states of India as well as neighbouring countries of Nepal and Bhutan helped to prevent nutritional iodine deficiency and iodine deficiency disorders through country-wide iodized salt prophylaxis. Presently on the basis of scientific studies, salt iodization in India is saving millions of children from neonatal hypothyroidism related psycho-physical retardation.

Can neonatal TSH screening reflect trends in population iodine intake. Thyroid. 2008 Aug;18(8):883-8. The distribution of neonatal blood thyroid-stimulating hormone (TSH) concentrations has been used as an index reflecting population dietary iodine intake, with higher concentrations being indicative of lower iodine intake. We examined this distribution in neonates born in Ireland, where the pregnant population has shown a recent decline in urinary iodine (UI) excretion. … Conclusions: These data support a link between fetal thyroid function and a fall in maternal iodine intake. While the findings of the proportion of blood TSH values >5.0 mIU/L exclude severe maternal or fetal iodine deficiency, a trend toward increasing TSH may provide an early indication of impending iodine deficiency. The findings assume greater importance in the context of declining UI reported from many developed countries even where the proportion of blood TSH values >5.0 mIU/L is <3%, thus excluding severe maternal and fetal iodine deficiency.

Neurodevelopmental and neurophysiological actions of thyroid hormone. J Neuroendocrinol. 2008 Jun;20(6):784-94 For over 100 years, thyroid hormones have been known to be essential for neonatal neurodevelopment but whether they are required by the foetal brain remains a matter of controversy. For decades, the prevailing view was that thyroid hormones are not necessary until after birth because circulating levels in the foetus are very low and the placenta forms an efficient barrier to their transfer from the mother. … It is now clear that thyroid hormones are essential for both foetal and post-natal neurodevelopment and for the regulation of neuropsychological function in children and adults. …

Methods to assess iron and iodine status. Br J Nutr. 2008 Jun;99 Suppl 3:S2-9. Four methods are recommended for assessment of iodine nutrition: urinary iodine concentration, the goitre rate, and blood concentrations of thyroid stimulating hormone and thyroglobulin. These indicators are complementary, in that **urinary iodine** is a sensitive indicator of recent iodine intake (days) and **thyroglobulin** shows an intermediate response (weeks to months), whereas changes in the **goitre rate** reflect long-term iodine nutrition (months to years). **Spot urinary iodine concentrations** are highly variable from day-to-day and should not be used to classify iodine status of individuals. International reference criteria for thyroid volume in children have recently been published and can be used for identifying even small goitres using thyroid ultrasound. Recent development of a **dried blood spot thyroglobulin assay** makes sample collection practical even in remote areas. **Thyroid stimulating hormone** is a useful indicator of iodine nutrition in the newborn, but not in other age groups.

Iodine: deficiency and therapeutic considerations. Altern Med Rev. 2008 Jun;13(2):116-27. … The safety of therapeutic doses of iodine above the established safe upper limit of 1 mg is evident in the lack of toxicity in the Japanese population that consumes 25 times the median intake of iodine consumption in the United States. …

The many reasons why goiter is seen in old paintings. Thyroid. 2008 Apr;18(4):387-93.

The results of the "tiromobil" epidemiological trial of pregnant women in the Russian Federation. Ter Arkh. 2008;80(2):78-81. CONCLUSION: Most of the pregnant women in the regions studied were at risk of diseases associated with iodine deficiency. Prevention of iodine deficiency is not adequate.

Analysis of food supplements containing iodine: a survey of Italian market[in Italy]. Clin Toxicol (Phila). 2008 Apr;46(4):282-6. Aim: Compare claimed concentrations of iodine with measured ones in various iodine-supplemented products … Analytical values resembled those declared in the label in fewer than half of the examples… Labeling of iodine-rich food supplements appears to be unreliable …

Iodine in breast milk of nursing mother in normal and with premature birth. Vopr Pitan. 2008;77(6):75-8. Iodine content in breast milk depends on the consumption level of iodine. Iodine deficiency in mothers results in inadequate iodine status of neonates. Iodine supplements at any gestation stage normalized iodine content in breast milk. [Study done in Russia.]

Naturally occurring iodine in humic substances in drinking water in Denmark is bioavailable and determines population iodine intake. Br J Nutr. 2008 Feb;99(2):319-25.

Breastfeeding and maternal and infant iodine nutrition. Clin Endocrinol (Oxf). 2008 Oct 6. Thirty six MEDLINE studies between 1960 – 2007.Conclusions: Adequate concentration of iodine in breast milk is essential to provide for optimal neonatal thyroid hormone stores and to prevent impaired neurological development in breastfed neonates. In many countries of the world, low iodine content of the breast milk indicates less than optimum maternal and infant iodine nutrition. The current WHO/ICCIDD/UNICEF recommendation for daily iodine intake (250 mug for lactating mothers) has been selected to ensure that iodine deficiency does not occur in the postpartum period and that the iodine content of the milk is sufficient for the infant's iodine requirement.

Intake of iodine and perchlorate and excretion in human milk. Environ Sci Technol. 2008 Nov 1;42(21):8115-21.

Treating iodine deficiency: long-term effects of iodine repletion on growth and pubertal development in school-age children. Thyroid. 2008;18(4):449-54.[Azerbaijan] Long-term correction of severe ID leads to sustained improvement of linear growth accompanied by a normalization of the time of onset of pubertal development for both sexes.

The complex hygienic characteristics preventive iodine deficiency in population of Siberia. Vopr Pitan. 2008;77(2):59-63. … The study showed that 58.3-88.1% of examined children … suffer from iodine deficiency. …Preventable iodine deficiency … is the reason for many illnesses. It is an important and until now an unresolved problem of the Krasnoyarsk areas.

Status of iodine nutrition of children until 1 year: consequences on the thyroid function. Arch Pediatr. 2008 Aug;15 (8):1276-82. Iodine status is not optimal in French population of hospitalized children in the first year. They also found no clear relationship between iodine status and thyroid function.

Intake of iodine and perchlorate and excretion in human milk. Environ Sci Technol. 2008 Nov 1;42(21):8115-21.

Iodine prophylaxis using iodized salt and risk of maternal thyroid failure in conditions of mild iodine deficiency. J Clin Endocrinol Metab. 2008 Apr 15

Transient neonatal hypothyroidism due to amiodarone administration during pregnancy--two cases report and review of literature. Arq Bras Endocrinol Metabol. 2008 Feb;52:126-30.

Iodine deficiency in pregnant women residing in an area with adequate iodine intake. Nutrition. 2008 May;24(5):458-61.Conclusion: This observational study demonstrated that, despite the adequate supplementation of iodine intake, most pregnant women appear not to be protected against iodine deficiency. If confirmed in larger case studies, this finding claims the attention of relevant professionals to monitor iodine nutrition during gestation, assuming that ordinary supplementation of iodine intake seems to be sufficient only in non-gestational conditions.

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Association of first-trimester thyroid function test values with thyroperoxidase antibody status, smoking, and multivitamin use. Endocr Pract. 2008 Jan-Feb;14(1):33-9.

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Reaching optimal iodine nutrition in pregnant and lactating women and young children: programmatic recommendations. Public Health Nutr. 2007 Dec;10(12A):1527-9.

Prevention and control of iodine deficiency in pregnant and lactating women and in children less than 2-years-old: conclusions and recommendations of the technical consultation. Public Health Nutr. 2007 Dec;10(12A):1606-11

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The impact of iodised salt or iodine supplements on iodine status during pregnancy, lactation and infancy. Public Health Nutr. 2007 Dec;10(12A):1584-95.

Reproductive age in the United States Of America. Public Health Nutr. 2007 Dec;10:1532-9; Discuss 1540-1.

The importanceof iodine nutrition during pregnancy. Public Health Nutr. 2007 Dec;10(12A):1542-6. Conclusions: Iodine prophylaxis should be given systematically to women during pregnancy. In most public health programmes dealing with the correction of iodine deficiency disorders, iodised salt has been used as the preferred means to deliver iodine to households. Iodised salt, however, is not the ideal means of delivering iodine in the specific instances of pregnancy, breast-feeding and complementary feeding because of the need to limit salt intake during these periods. In European countries, presently it is proposed that iodine is given to pregnant women and breast-

feeding mothers by systematically administering multivitamin tablets containing iodine in order to reach the recommended dietary allowance of 250 microg iodine day-1.

Iodine requirements during pregnancy, lactation and the neonatal period and indicators of optimal iodine Nutrition. Public Health Nutr. 2007;10(12A):1571-80; Discussion 1581-3.Conclusions: Pregnant women and young infants, but especially the second group, are more sensitive to the effects of an iodine deficiency (ID) than the general population because their serum thyroid-stimulating hormone (TSH) and thyroxine are increased and decreased, respectively, for degrees of ID that do not seem to affect thyroid function in the general population. Systematic neonatal thyroid screening using primary TSH could be the most sensitive indicator to monitor the process of ID control.

Iodine deficiency and brain development in the first half of pregnancy. public health nutr. 2007;10 (12A): 1554-70. An inadequate supply of iodine during gestation results in damage to the foetal brain that is irreversible by mid-gestation unless timely interventions can correct the accompanying maternal hypothyroxinemia. Even mild to moderate maternal hypothyroxinemia may result in suboptimal neurodevelopment. This review mainly focuses on iodine and thyroid hormone economy up to mid-gestation, a period during which the mother is the only source for the developing brain of the foetus. The cerebral cortex of the foetus depends on maternal thyroxine (T4) for the production of the 3',3,5-tri-iodothyronine (T3) for nuclear receptor-binding and biological effectiveness.Maternal hypothyroxinemia early in pregnancy is potentially damaging for foetal brain development. Direct evidence has been obtained from experiments on animals: even a relatively mild and transient hypothyroxinemia during corticogenesis, which takes place mostly before mid-gestation in humans, affects the migration of radial neurons, which settle permanently in heterotopic locations within the cortex and hippocampus. Behavioural defects have also been detected.The conceptus imposes important early changes on maternal thyroid hormone economy that practically doubles the amount of T4 secreted something that requires a concordant increase in the availability of iodine, from 150 to 250-300 microg I day- 1. Women who are unable to increase their production of T4 early in pregnancy constitute a population at risk for having children with neurological disabilities. As a mild to moderate iodine deficiency is still the most widespread cause of maternal hypothyroxinemia, the birth of many children with learning disabilities may be prevented by advising women to take iodine supplements as soon as pregnancy starts, or earlier if possible, in order to ensure that their requirements for iodine are met.

Iodine deficiency, iodine content of salt and knowledge of iodine supplementation in the Dominican Republic. J Trop Pediatr. 2007 Jun;53(3):214-6.

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Increase in congenital hypothyroidism in new york state and in the United States. Mol Genet Metab. 2007 Jul;91(3):268-77. Mandated screening of newborns for congenital hypothyroidism (CH) in NYS was initiated in l978. Currently, every newborn screening program in the U.S. includes CH in its panel. Between 1978 and 2005, 7.4 million newborns were screened for CH in NYS. In NYS, between 1978 and 2005, the incidence of CH has increased by 138%. Nationwide (excluding NYS data), with nearly 58 million infants screened between 1987 and 2002, the incidence has increased 73% between 1987 and 2002. These data and possible reasons for the increases are discussed, though no definitive causes are identified.

Iodine supplementation during pregnancy: a public health challenge. Trends Endocrinol Metab. 2007 Nov;18(9): 338-43. Iodine deficiency remains the most frequent cause worldwide, after starvation, of preventable mental retardation in children. It causes maternal hypothyroxinemia, which affects pregnant women even in apparently iodine-sufficient areas, and often goes unnoticed because L-thyroxine (T4) levels remain within the normal range, and thyroid-stimulating hormone (TSH) is not increased. Even a mild hypothyroxinemia during pregnancy increases the risk of neurodevelopmental abnormalities, and experimental data clearly demonstrate that it damages the cortical cytoarchitecture of the fetal brain. The American Thyroid Association (ATA) recommends a supplement of 150 microg iodine/day during pregnancy and lactation, in addition to the use of iodized salt. We discuss the importance of iodine supplementation to ensure adequate T4 levels in all women who are considering conception and throughout pregnancy and lactation.

Evaluating iodine deficiency in pregnant women and young infants-complex physiology with a risk of misinterpretation. Public Health Nutr. 2007 Dec;10(12A):1547-52; Discussion 1553.

The adverse effects of mild-to-moderate iodine deficiency during pregnancy and childhood: a review. Thyroid. 2007 Sep;17(9):829-35. Iodine is required for the production of thyroid hormones, which are essential for normal brain development, and the fetus, newborn, and young child are particularly vulnerable to iodine deficiency. The iodine requirement increases during pregnancy and recommended intakes are in the range of 220-250 microg/day. Monitoring iodine status during pregnancy is a challenge. New recommendations from World Health Organization suggest that a median urinary iodine concentration >250 microg/L and <500 microg/L indicates adequate iodine intake in pregnancy. Based on this range, it appears that many pregnant women in Western Europe have inadequate intakes. A recent Swiss study has suggested that thyroid-stimulating hormone concentration in the newborn is a sensitive indicator of mild iodine deficiency in late pregnancy. The potential adverse effects of mild iodine deficiency during pregnancy are uncertain. Controlled trials of iodine supplementation in mildly iodine-deficient pregnant women suggest beneficial effects on maternal and newborn serum thyroglobulin and thyroid volume, but no effects on maternal and newborn total or free thyroid hormone concentrations. There are no long-term data on the effect of iodine supplementation on birth outcomes or infant development. New data from well-controlled studies indicate that iodine repletion in moderately iodine-deficient school-age children has clear benefits: it improves cognitive and motor function; it also increases concentrations of insulin-like growth factor 1 and insulin-like growth factor-binding protein 3, and improves somatic growth.

National trends in iodine nutrition: is everyone getting enough? Thyroid. 2007 Sep;17(9):823-7. Iodine deficiency is an important public health problem worldwide. Until the 1920s, endemic iodine deficiency disorders were prevalent in the Great Lakes, Appalachian, and Northwestern regions of the United States. Iodized salt was responsible for eliminating endemic goiter in the United States & remains the mainstay of iodine deficiency disorder eradication efforts worldwide. Although urinary iodine values have decreased by 50% since the early 1970s, the USA remains iodine sufficient. However, U.S. iodine nutrition, particularly among women of childbearing age, may remain an area worthy of public health concern. There is a wide amount of variation in the iodine content of some common foods, & the iodine content of foods is not well reflected by package labeling. There needs to be increased awareness of the importance of adequate iodine nutrition, particularly during pregnancy & lactation, among the U.S. public.

Iodine nutrition in pregnancy and lactation in Iran. Public Health Nutr. 2007 Dec;10(12A):1596-9. The currently recommended intake of iodine through universal salt iodization may not be adequate for pregnant & lactating women, & supplementation during pregnancy & lactation should be further considered in light of the latest recommendations.

Iodine nutrition of pregnant and lactating women in Hong Kong, where intake is of borderline sufficiency. Public Health Nutr. 2007 Dec;10(12A):1600-1 The currently recommended intake of iodine through universal salt iodization may not be adequate for pregnant and lactating women, and supplementation during pregnancy and lactation should be further considered in light of the latest recommendations.

Obstetric management of thyroid disease. Obstet Gynecol Surv. 2007 Oct;62(10):680-8; Quiz 691.

Thyroid disorders in pregnancy and after delivery. Przegl Lek. 2007;64(3):159-64.

Reaching optimal iodine nutrition in pregnant and lactating women and young children: programmatic recommendations. Public Health Nutr. 2007 Dec;10(12A):1527-9.

Reflections on mental retardation and congenital hypothyroidism: effects of trace mineral deficiencies. Sante. 2007 Jan-Mar;17(1):41-50.

Assessment of intertrimester and seasonal variations of urinary iodine concentration during pregnancy in an iodine-replete area. Clin Endocrinol (Oxf). 2007 Oct;67(4):577-81.

Chronic maternal dietary iodine deficiency but not thiocyanate feeding affects maternal reproduction and postnatal performance of the rat. Indian J Exp Biol. 2007 Jul;45:603-9.

Thyroid hormones, learning and memory. Genes Brain Behav. 2007 Jun;6 Suppl 1:40-4. Thyroid hormones (THs), T3 & T4, have many physiological actions & are essential for normal behavioral, intellectual & neurological

development. THs have a broad spectrum of effects on the developing brain & mediate important effects within the CNS throughout life. Insufficient maternal iodine intake during gestation & TH deficiency during human development are associated to pathological alterations such as cretinism & mental retardation. In adulthood, thyroid dysfunction is related to neurological & behavioral abnormalities, including memory impairment. Analysis of different experimental models suggests that most of the effects on cognition as a result of thyroid dysfunction rely on hippocampal modifications. Insufficiency of THs during development thus alters hippocampal synaptic function and impairs behavioral performance of hippocampal-dependent learning and memory tasks that persist in euthyroid adult animals. In the present review, we summarize the current knowledge obtained by clinical observations & experimental models that shows the importance of THs in learning & mnemonic processes.

Iodine and thyroid hormones during pregnancy and postpartum. Gynecol Endocrinol. 2007 Jul;23:414-28. Iodine is a trace element essential for synthesis of the thyroid hormones, triiodothyronine & thyroxine. These hormones play a vital role in the early growth & development stages of most organs, especially the brain. The World Health Organization has declared that, after famine, iodine deficiency is the most avoidable cause of cerebral lesions including different degrees of mental retardation & cerebral paralysis. The main function of iodine in vertebrates is to interact with the thyroid hormones. During pregnancy sufficient quantities of iodine are required to prevent the appearance of hypothyroidism, trophoblastic & embryonic or fetal disorders, neonatal & maternal hypothyroidism, & permanent sequelae in infants. Thyroid hormone receptors & iodothyronine deiodinases are present in placenta & central nervous tissue of the fetus. A number of environmental factors influence the epidemiology of thyroid disorders, & even relatively small abnormalities & differences in the level of iodine intake in a population have profound effects on the occurrence of thyroid abnormalities. The prevalence of disorders related to iodine deficit during pregnancy & postpartum has increased. Iodine supplementation is an effective measure in the case of pregnant & lactating women. However, it is not implemented & the problem is still present even in societies with theoretically advanced health systems. During pregnancy & postpartum, the WHO recommends iodine intake be increased to at least 200 mcg/day. Side-effects provoked by iodine supplementation are rare during pregnancy at the recommended doses.

Iron deficiency predicts poor maternal thyroid status during pregnancy. J Clin Endocrinol Metab. 2007 Sep;92 (9):3436-40. Pregnant women are often iron deficient, and iron deficiency has adverse effects on thyroid metabolism. Impaired maternal thyroid function during pregnancy may cause neurodevelopmental delays in the offspring. Our objective was to investigate whether maternal iron status is a determinant of TSH and/or total T(4) (TT4) concentrations during pregnancy. …Conclusion: Poor maternal iron status predicts both higher TSH and lower TT4 concentrations during pregnancy in an area of borderline iodine deficiency**.**

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Placental tissue iodine level and blood magnesium concentration in pre-eclamptic and normal pregnancy. Int J Gynaecol Obstet. 2007 Aug;98(2):100-4. Results: Placental tissue iodine levels were lower in women with severe pre-eclampsia than in healthy pregnant …as were blood magnesium levels ….There was a positive correlation between placental tissue iodine levels and blood magnesium levels in women with severe pre-eclampsia ($r=0.55$, $P<0.05$), but no such correlation was observed in healthy pregnant women ($r=0.23$, $P=0.41$). Conclusion: Mg assimilation is known to be defective when iodine levels are insufficient. In northeast Anatolia, where iodine deficiency is common, clinical trials of iodine supplementation should be considered for pre-eclamptic therapy.

Clinical and biological consequences of iodine deficiency during pregnancy. Endocr Dev. 2007;10:62-85. The main change in thyroid function associated with the pregnant state is the requirement of an increased production of thyroid hormone that depends directly upon the adequate availability of dietary iodine & integrity of the glandular machinery. In healthy pregnant women, physiological adaptation takes place when the iodine intake is adequate,

while this is replaced by pathological alterations when there is a deficient iodine intake. Pregnancy acts typically, therefore, as a revelator of underlying iodine restriction. Iodine deficiency has important repercussions for both the mother & the fetus, leading to hypothyroxinemia, sustained glandular stimulation & finally goitrogenesis. Furthermore, because severe iodine deficiency may be associated with an impairment in the psychoneurointellectual outcome in the progeny, because both mother & offspring are exposed to iodine deficiency during gestation (& the postnatal period), & because iodine deficiency is still prevalent today in several large regions of the world, iodine supplements should be given systematically to pregnant & breastfeeding mothers. Particular attention is required to ensure that pregnant women receive an adequate iodine supply, in order to reach the ideal recommended nutrient intake of 250 mcg iodine/day.

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Effect of environmental iodine deficiency (eid) on foetal growth in Nigeria. Indian J Med Res.2006;124(5):535-44.

Selenium and goiter prevalence in borderline iodine sufficiency. Eur J Endocrinol. 2006 Dec;155(6):807-12.

Brain MR spectroscopy findings in neonates with hypothyroidism born to mothers living in iodine-deficient areas. AJNR Am J Neuroradiol. 2006 Nov-Dec;27(10):2083-7.

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Effects of nutrients (in food) on the structure and function of the nervous system: Update on dietary requirements for brain. Part 1: Micronutrients. J Nutr Health Aging. 2006 Sep-Oct;10(5):377-85.

Iodine supplementation for pregnancy and lactation-United States and Canada: Recommendations of the American Thyroid Association. Thyroid. 2006;16(10):949-51. 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 & later for thyroid function in the fetus. If iodine insufficiency leads to inadequate production of thyroid hormones & hypothyroidism during pregnancy, then irreversible fetal brain damage can result. In the USA, the median urinary iodine (UI) was 168 mcg/L in 2001-2, well within the range of normal established by the World Health Organization (WHO), but whereas the UI of pregnant women (173 mcg/L; 95% CI 75-229 mcg/L) was within the range recommended by WHO (150-249 mcg/L), the lower 95% CI was less than 150 mcg/L. Therefore, until additional physiologic data are available to make a better judgment, the American Thyroid Association recommends that women receive 150 mcg iodine supplements daily during pregnancy and lactation and that all prenatal vitamin/mineral preparations contain 150 mcg of iodine.

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2005

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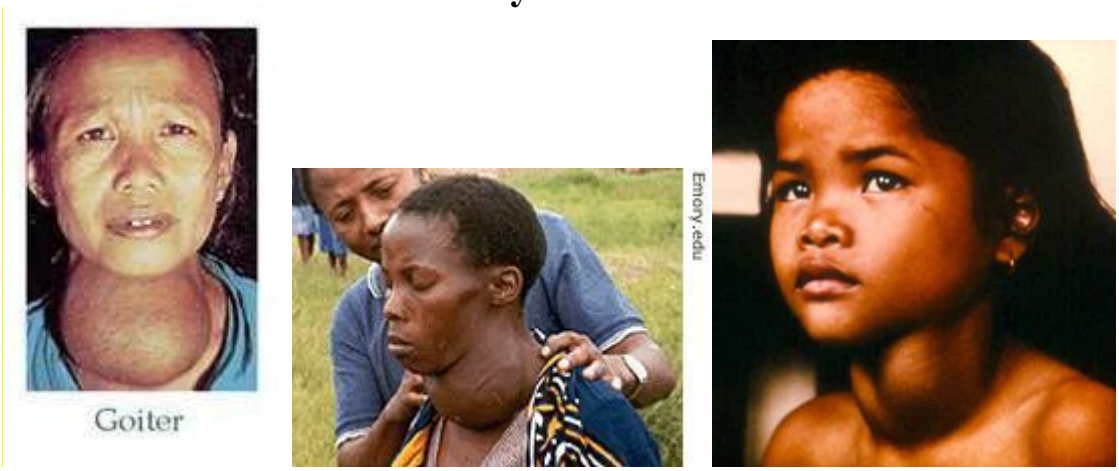
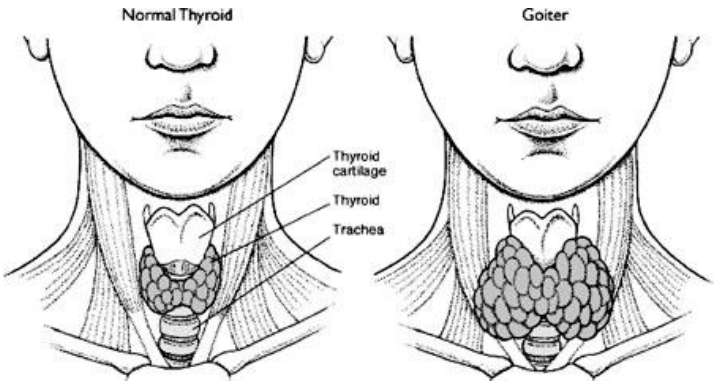
Iodine Deficiency Disorders: Goiter



http://motherchildnutrition.org/early-malnutrition-detection/images/goitre.jpg



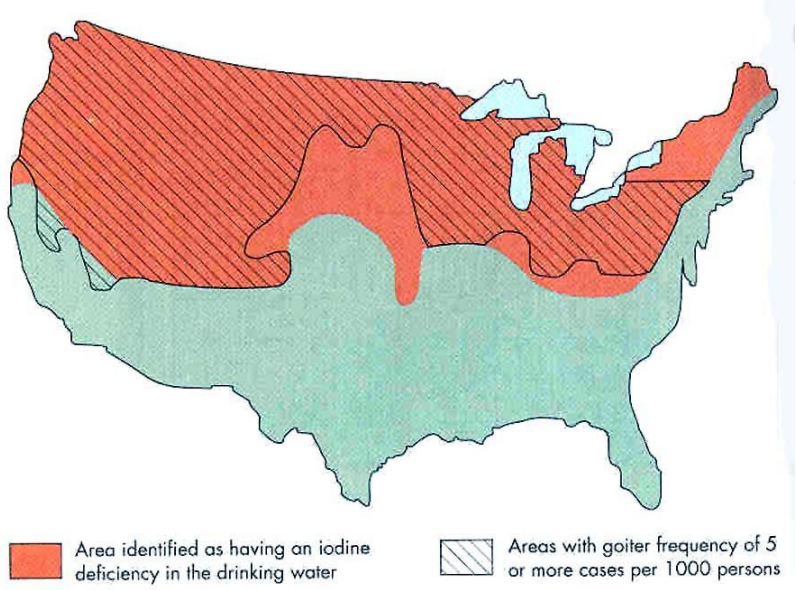
http://medicine-science.com/wp-content/uploads/2011/09/Iodine-Deficiency.jpg

Iodine Deficiency Disorders: Vulnerability to thyroid cancer from radioactive iodine exposure: "The Chernobyl Necklace" … Ukraine is a low iodine region.

<u>Iodine Deficiency Disorders</u>: The American "Goiter Belt"

Map showing spatial correlation between the former "Goiter Belt" in the northern U.S. and areas where the iodine content of drinking water is naturally low.

www.uwsp.edu/gEo/faculty/ozsvath/images/ goiter_belt.htm



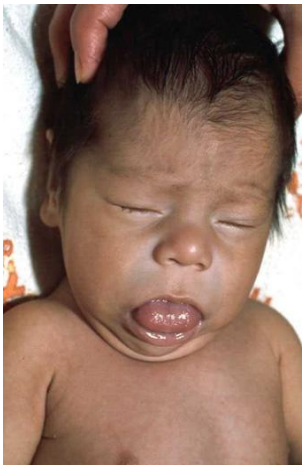
The start of the movement to iodize salt in America.

You often have to look Closely to see if salt is iodized or not.

Some sea salt is iodized but most is not.

Iodine Deficiency Disorders: Cretinism

Iodine Deficiency is the Number One Cause of Preventable Mental Retardation in the World.



Cretinism