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Request: Research on Iodine + Cognitive Development
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Date: April 5, 2019

Research on Iodine and Cognitive Development

DCC RESEARCH SUMMARY & KEY FINDINGS

Iodine as Essential Nutrient during the first 1000 Days of Life
Iodine is an essential nutrient, particularly crucial for neurodevelopment. Iodine deficiency during pregnancy and maternal hypothyroxinemia can negatively impact brain development and neuro-behavioral performance postnatally.
Source: Velasco et al. *Nutrients,* 2018. https://www.mdpi.com/2072-6643/10/3/290/htm

Key findings:
- Iodine is an essential nutrient, particularly crucial for neurodevelopment.
- The first 1000 days of life have been established as a “window of opportunity” for potential interventions able to determine crucial pathways of human growth and development.

Cow Milk Consumption Increases Iodine Status in Women of Childbearing Age in Randomized Controlled Trial
A randomized controlled trial found that the consumption of additional cow’s milk can significantly increase urinary iodine concentration in women of childbearing age. These results suggest that cows milk is a potentially important dietary source of iodine in this population group. Cow milk contributes the greatest amount to iodine intakes in several countries.
Source: O’Kane et al. *J Nutr,* 2018. https://doi.org/10.1093/jn/nxx043

Key findings:
- Cow’s milk is a potentially important dietary source of iodine for women of childbearing age. Cow’s milk contributes the greatest amount to iodine intakes in several countries.
- Within the context of a public health strategy designed to reduce the prevalence of iodine deficiency, an increase in milk consumption could represent an important contribution.

The Lancet
Study analyzed mother–child pairs from the Avon Longitudinal Study of Parents and Children (ALSPAC) cohort by measuring urinary iodine concentration (and creatinine to correct for urine volume) in stored samples from 1040 first-trimester pregnant women. After adjustment for confounders, children of women with an iodine-to-creatinine ratio of less than 150 μg/g were more likely to have scores in the lowest quartile for verbal IQ, reading accuracy, and reading comprehension than were those of mothers with ratios of 150 μg/g or more. Our results show the importance of adequate iodine status during early gestation and emphasize the risk that iodine deficiency can pose to the developing infant, even in a country classified as only mildly

iodine deficient. Iodine deficiency in pregnant women in the UK should be treated as an important public health issue that needs attention.
Source: Bath SC et al. *Lancet,* 2013. https://doi.org/10.1016/S0140-6736(13)60436-5

Key findings:

- Research supports the importance of adequate iodine status during early gestation and emphasize the risk that iodine deficiency can pose to the developing infant, even in a population classified as only mildly iodine deficient.

Mild Iodine Deficiency During Pregnancy is Associated with Reduced Educational Outcomes in the Offspring: 9-Year Follow-Up of the Gestational Iodine Cohort
A longitudinal follow-up (at 9 years old) of the Gestational Iodine Cohort found that children whose mothers had UIC <150 µg/L had reductions of 10.0% in spelling, 7.6% in grammar, and 5.7% in English-literacy performance compared with children whose mothers' UICs were ≥150 µg/L. These associations remained significant after adjustment for a range of biological factors. Differences in spelling remained significant after further adjustment for socioeconomic factors.
Source: Hynes KL et al. *J Clin Endocrinol Metab*, 2013. https://doi.org/10.1210/jc.2012-4249

Key findings:

- Emerging evidence shows that even mild iodine deficiency during pregnancy can have long-term adverse impacts on fetal neurocognition that are not ameliorated by iodine sufficiency during childhood.

KEY FINDINGS FROM PROVIDED RESOURCES

Iodine intake amongst women of childbearing age in the UK
Source: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4340577/

Key findings:
- Women entering pregnancy need to have adequate iodine status to ensure optimal fetal neurological development and pregnancy outcome.

Some subgroups of reproductive age women in the United States may be at risk for iodine deficiency
Source: https://www.ncbi.nlm.nih.gov/pubmed/20554903

Key findings:
- 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.
- Dairy product consumption may be an important contributor to iodine status among both pregnant and nonpregnant, nonlactating women. Those who do not consume dairy products may be at risk for iodine deficiency. Although larger samples are needed to confirm these findings, these results raise concerns about the iodine status of pregnant women and women of reproductive age who are not consuming dairy products.

Mild to moderate iodine deficiency affect thyroid function in pregnancy
Source**:** https://www.ncbi.nlm.nih.gov/pubmed/30132420

Key findings:
- Studies indicate that mild to moderate iodine deficiency in pregnancy may have a long-term negative impact on child neurodevelopment.
- Results of this study indicate that mild to moderate iodine deficiency affect thyroid function in pregnancy

Overview of the disorders caused by iodine deficiency. It emphasizes the role of iodine deficiency in the development of brain damage and neurocognitive impairment
Source: https://www.ncbi.nlm.nih.gov/books/NBK285556/

Key findings:
- Major dietary sources of iodine in the USA, Europe and Australia are bread, milk and to a lesser extent seafood.
- The consequence of iodine deficiency during pregnancy is impaired synthesis of thyroid hormones by the mother and the fetus. An insufficient supply of thyroid hormones to the developing brain may result in neurocognitive impairment

Disorders of the Thyroid Gland in Infancy, Childhood and Adolescence
Source: https://www.ncbi.nlm.nih.gov/books/NBK279032/

Key findings: n/a

ADDITIONAL RESEARCH, KEY FINDINGS & RESOURCES

Iodine facts for health professionals, from the National Institutes of Health
Source: https://ods.od.nih.gov/factsheets/Iodine-HealthProfessional/

Key findings:

- Iodine is a trace element that is naturally present in some foods, added to others, and available as a dietary supplement. Iodine is an essential component of the thyroid hormones thyroxine (T4) and triiodothyronine (T3). Thyroid hormones regulate many important biochemical reactions, including protein synthesis and enzymatic activity, and are critical determinants of metabolic activity [1,2]. They are also required for proper skeletal and central nervous system development in fetuses and infants [1].
- Iodine may have other physiological functions in the body as well. For example, it appears to play a role in immune response and might have a beneficial effect on mammary dysplasia and fibrocystic breast disease [2].
- According to the WHO, a median urinary iodine concentration of 150–249 mcg/L indicates adequate iodine nutrition during pregnancy, while values less than 150 mcg/L are considered insufficient [3,7]. Analyses of NHANES datasets covering time periods from 2001 to 2008 indicate that a substantial portion of pregnant women in the United States are iodine insufficient.
- Pregnant women who do not consume dairy products may be particularly at risk of iodine insufficiency. According to NHANES 2001–2006 data, pregnant women who consumed no dairy products in the previous 24 hours had a median urinary iodine concentration of only 100 mcg/L, compared with 163 mcg/L among consumers of dairy [27]. Women who restrict their dietary salt intake also have lower urinary iodine concentrations and might be more likely to be iodine deficient than women who don't restrict salt intake [30].
- Due to its important role in fetal and infant development and thyroid hormone production, iodine is a critical nutrient for proper health at all life stages.
- Iodine sufficiency during pregnancy is extremely important for proper fetal development. During early pregnancy, when fetal thyroid gland development is incomplete, the fetus depends entirely on maternal T4 and therefore, on maternal iodine intake [39]. Sufficient iodine intake after birth is also important for proper physical and neurological growth and maturation.
- Intake recommendations for iodine and other nutrients are provided in the Dietary Reference Intakes (DRIs) developed by the Food and Nutrition Board (FNB) at the Institute of Medicine of the National Academies (formerly National Academy of Sciences) [2]. DRI is the general term for a set of reference values used for planning and assessing nutrient intakes of healthy people. These values, which vary by age and gender [2], include:
- Recommended Dietary Allowance (RDA): Average daily level of intake sufficient to meet the nutrient requirements of nearly all (97%–98%) healthy individuals; often used to plan nutritionally adequate diets for individuals.
- Adequate Intake (AI): Intake at this level is assumed to ensure nutritional adequacy; established when evidence is insufficient to develop an RDA.

Table 1: Recommended Dietary Allowances (RDAs) for Iodine [2]

Age	Male	Female	Pregnancy	Lactation
Birth to 6 months	110 mcg*	110 mcg*		
7–12 months	130 mcg*	130 mcg*		
1–3 years	90 mcg	90 mcg		
4–8 years	90 mcg	90 mcg		
9–13 years	120 mcg	120 mcg		
14–18 years	150 mcg	150 mcg	220 mcg	290 mcg
19+ years	150 mcg	150 mcg	220 mcg	290 mcg

* Adequate Intake (AI)

The World Health Organization (WHO), United Nations Children's Fund (UNICEF), and the International Council for the Control of Iodine Deficiency Disorders (ICCIDD) recommend a slightly higher iodine intake for pregnant women of 250 mcg per day [3,7].

- Seaweed (such as kelp, nori, kombu, and wakame) is one of the best food sources of iodine, but it is highly variable in its content [5]. Other good sources include seafood, dairy products (partly due to the use of iodine feed supplements and iodophor sanitizing agents in the dairy industry [8]), grain products, and eggs. Dairy products, especially milk, and grain products are the major contributors of iodine to the American diet [9]. Iodine is also present in human breast milk [2,5] and infant formulas. Fruits and vegetables contain iodine, but the amount varies depending on the iodine content of the soil, fertilizer use and irrigation practices [2].
- Important to note regarding the iodine status of the general US population: Since the inception of the NHANES monitoring program, urinary iodine measurements have shown that the general U.S. population is iodine sufficient. This is despite the fact that urinary iodine levels decreased by more than 50% between 1971–1974 and 1988–1994 [2,23]. Much of this decline was a result of decreased levels of iodine in milk due to the reduced use of iodine-containing feed supplements and iodophor sanitizing agents in the dairy industry [24], as well as the reduced use of iodate dough conditioners by commercial bakers. *(Milk's content of iodine is varied based on iodine in feed and in processing practices).*

Table 2: Selected Food Sources of Iodine [10,11,12]

Food	Approximate Micrograms (mcg) per serving	Percent DV*
Seaweed, whole or sheet, 1 g	16 to 2,984	11% to 1,989%
Cod, baked, 3 ounces	99	66%
Yogurt, plain, low-fat, 1 cup	75	50%
Iodized salt, 1.5 g (approx. 1/4 teaspoon)	71	47%
Milk, reduced fat, 1 cup	56	37%
Fish sticks, 3 ounces	54	36%
Bread, white, enriched, 2 slices	45	30%
Fruit cocktail in heavy syrup, canned, 1/2 cup	42	28%
Shrimp, 3 ounces	35	23%
Ice cream, chocolate, 1/2 cup	30	20%
Macaroni, enriched, boiled, 1 cup	27	18%
Egg, 1 large	24	16%
Tuna, canned in oil, drained, 3 ounces	17	11%
Corn, cream style, canned, 1/2 cup	14	9%
Prunes, dried, 5 prunes	13	9%
Cheese, cheddar, 1 ounce	12	8%
Raisin bran cereal, 1 cup	11	7%
Lima beans, mature, boiled, 1/2 cup	8	5%
Apple juice, 1 cup	7	5%
Green peas, frozen, boiled, 1/2 cup	3	2%
Banana, 1 medium	3	2%

*DV = Daily Value. The U.S. Food and Drug Administration (FDA) developed DVs to help consumers compare the nutrient contents of products within the context of a total diet. The DV for iodine is 150 mcg for adults and children age 4 years and older [13]. FDA does not require food labels to list iodine content unless a food has been fortified with this nutrient. Foods providing 20% or more of the DV are considered to be high sources of a nutrient, but foods providing lower percentages of the DV also contribute to a healthful diet.

The U.S. Department of Agriculture's (USDA's) National Nutrient Database [14] does not list the iodine content of foods or provide lists of foods containing iodine.