Dietary recommendations of Iodine

Introduction

Iodine is essential for the synthesis of the thyroid hormones L-triiodothyronine and L-tetraiodothyronine or thyroxine. Iodine deficiency (ID), through impairment of synthesis, can lead to a range of adverse effects, defined as iodine deficiency disorders (IDD). IDD can affect different lifecycle stages with a variety of symptoms, including hypothyroidism, stillbirth, impaired mental function, congenital anomalies and iodine-induced hyperthyroidism or hypothyroidism. The consequences of ID range from loss of intelligence quotient (IQ) to cretinism. The main visible sign of severe ID is goitre.

More than 120 countries, including Sri Lanka, have implemented salt iodisation and food fortification, strategies that have been partially successful. Supplementation during pregnancy is recommended in some countries and supported by the WHO when mandatory salt iodisation is not present. The proposed iodisation of salt is 20–40 mg/kg and is based on an average salt intake of 10 g daily.

In 1995, the government of Sri Lanka launched "Universal Salt Iodisation" as the mainstay of iodine deficiency control. The regulations on level of iodine at the household level were changed from 25ppm in 1995 to 15ppm in 2005. When the programme was evaluated in 2010, the overall goitre rate among children aged 6-10 years in Sri Lanka was 4.4%. Inadequate level of iodine intake in pregnant women was also found in 2010 (1).

Iodine recommendations

The WHO/UNICEF/International Council for the Control of IDD recommended the daily intake for adults is 150 µg/d, increasing to 250 µg/d for pregnant women (2).

The European Food Safety Authority proposed in 2014 a new reference value of adequate intake for pregnant women of 200 µg/d (3).

The US Institute of Medicine and the Food Standards Australia New Zealand also propose an increase in iodine intake for pregnancy and lactation.

in the UK, the Department of Health reference nutrient intake is for adults 140 µg/d, with no proposed increment for pregnancy and lactation.

Table 1: Existing iodine recommendations (µg/d)

	FAO/WHO (2004)	EFSA (2014)	US IoM (2001)	FSANZ (2006)	UK DoH (1991)
Preschool children (0–59 months)	90	70–90	90	90	60–70
School children (6–12 years)	120	90–120	90–120	90–120	100–130
Adolescents (>12 years)/adults	150	150	150	150	140
Pregnancy	250	200	220	220	140
Lactation	250	200	290	270	140

DoH, Department of Health; EFSA, European Food Safety Authority; FSANZ, Food Standards Australia New Zealand; IoM, Institute of Medicine.

Iodine requirements vary with age (Table 1), with no sex differentiations in the recommendation, besides from pregnancy and lactation.

Health risks from excessive Iodine and Tolerable Upper Limits

Adverse effects of supplementation are generally minor and transient. High intakes of iodine can cause some of the same symptoms as iodine deficiency—including goiter, elevated TSH levels, and hypothyroidism—because excess iodine in susceptible individuals inhibits thyroid hormone synthesis and thereby increases TSH stimulation, which can produce goiter (4,5). Iodine-induced hyperthyroidism can also result from high iodine intakes, usually when iodine is administered to treat iodine deficiency. Studies have also shown that excessive iodine intakes cause thyroiditis and thyroid papillary cancer (4,5). Cases of acute iodine poisoning are rare and are usually caused by doses of many grams. Acute poisoning symptoms include burning of the mouth, throat, and stomach; fever; abdominal pain; nausea; vomiting; diarrhea; weak pulse; and coma (4).

There is an ongoing debate regarding the thresholds of sufficiency in pregnancy and the different existing recommendations for **tolerable upper limit (UL)** of intake, which ranges from **600 µg/d** (6) in Europe (Scientific Committee on Food) to **1100 µg/d** (4) in the USA (Institute of Medicine). Lee and Pearce (7) proposed that the upper level of sufficiency in pregnancy should be an intake of **250 µg/d**.

Ingestion of greater than UL for iodine) is not recommended and may cause thyroid dysfunction. During pregnancy and lactation, the recommendations for the upper limit vary and range from 500-1,100 mcg of iodine daily (7). Lee and Pearce (8) proposed that the upper level of sufficiency in pregnancy should be an intake of 250 µg/d.

In particular, infants, the elderly, pregnant and lactating women, and individuals with preexisting thyroid disease are susceptible to adverse effects of excess iodine intake and exposure (9). The public is advised that many iodine, potassium iodide, and kelp supplements contain iodine in amounts that are up to several thousand times higher than the daily UL for iodine. The American Thyroid Association (ATA) advises against the ingestion of iodine and kelp supplements containing in excess of 500 µg iodine daily for children and adults and during pregnancy and lactation. Chronic iodine intake in amounts greater than the UL should be closely monitored by a physician. There is only equivocal data supporting the benefit of iodine at higher doses than these, including a possible benefit for patients with fibrocystic breast disease (10). There is no known thyroid benefit of routine daily iodine doses in excess of the RDA.

Studies suggested a potentially narrow margin of sufficient intake, which would be difficult to control around the world, due to the different iodine content of foods, salt and lack of labelling (11).

The Food and Nutrition Board (FNB) at the Institute of Medicine of the National Academies has established iodine ULs for food and supplement intakes (Table 2). In most people, iodine intakes from foods and supplements are unlikely to exceed the UL (4). Long-term intakes above the UL increase the risk of adverse health effects. The ULs do not apply to individuals receiving iodine for medical treatment, but such individuals should be under the care of a physician (4).

Table 2: Tolerable Upper Intake Levels (ULs) for Iodine (4)

Age	Male	Female	Pregnancy	Lactation
Birth to 6 months	Not possible to establish*			
7–12 months	Not possible to establish*			
1–3 years	200 µg	200 µg		

4–8 years	300 µg	300 µg		
9–13 years	600 µg	600 µg		
14–18 years	900 µg	900 µg	900 µg	900 µg
19+ years	1,100 µg	1,100 µg	1,100 µg	1,100 µg

** Formula and food should be the only sources of iodine for infants.*

Since 15–20 mg of iodine is stored in the body of a healthy adult (70–80 % in the thyroid), intermittent consumption is acceptable, with thyroid hormone synthesis requiring approximately 60–95 µg iodine daily based on iodine turnover, which is close to the lower reference nutrient intake of 70 µg/d (12). The recommended WHO intake of 250 µg/d for pregnant women could be met by consuming two portions of fish per week, and dairy to the equivalent of two glasses of milk (drinks, in cereals), plus one yoghurt and a cheese serving daily. However, the consumption of these foods is relatively low in Sri Lanka.

Supplementation is an alternative strategy to address iodine insufficiency in pregnant and lactating women. WHO recommends iodine supplementation in pregnancy and lactation in all countries where iodised salt is available in <20 % of the households (2). However, 68.3% of households in Sri Lanka were using adequately iodised salt in 2010 (1). Many multivitamin/mineral supplements contain iodine in the forms of potassium iodide or sodium iodide. Dietary supplements of iodine or iodine-containing kelp (a seaweed) are also available. A small study found that potassium iodide is almost completely (96.4%) absorbed in humans (13).

Iodine supplements

Iodine in supplements should be in the form of “potassium iodide” or “potassium iodate” and should not exceed the daily adult requirement of 150 µg.