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Iodine in dairy milk: Sources, concentrations and importance to human health

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Milk and dairy products are major iodine sources in industrialized countries. However, consumption of milk and dairy, as well as their iodine concentrations, vary widely, making them an unpredictable iodine source. Milk iodine concentrations in industrialized countries range from 33 to 534 μg/L and are influenced by the iodine intake of dairy cows, goitrogen intake, milk yield, season, teat dipping with iodine-containing disinfectants, type of farming and processing. We estimate milk and dairy contribute ≈13–64% of the recommended daily iodine intake based on country-specific food intake data. To ensure adequate iodine levels but avoid the risk of iodine excess through milk and dairy, it is crucial to reduce the wide variations in milk iodine. If iodine intakes from iodized salt fall because of public health efforts to reduce salt intake, milk and dairy products may become increasingly important sources of dietary iodine in the future.

Introduction

Milk and dairy products are becoming an increasingly important source of iodine in the diet of humans in industrialized countries. Their contribution to dietary iodine has been estimated at ≈25–70% of total daily iodine intake [1–6], but may vary widely depending on the amount of milk and dairy consumed and their iodine content. Iodine concentrations in milk and dairy are influenced by a

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variety of factors that span from geographical and seasonal variations to animal feeding and milking practices through milk treatment and processing [7].

Iodine is an essential trace element in human nutrition. Dietary iodine intakes need to cover the requirements of all vulnerable groups but excessive intakes need to be avoided because they can increase risk for thyroid disorders. Thus, understanding sources of variation in iodine concentration in these important dietary sources and their rate of consumption among populations in industrialized countries is critical in order to estimate their contribution to dietary iodine.

The aim of this review is to review factors that influence iodine content in milk and dairy products, summarize current estimates on milk and dairy consumption in industrialized countries, and revise contribution estimates of these sources to the recommended daily iodine intake.

Iodine in human nutrition

Iodine is essential for the production of the thyroid hormones thyroxine (T_4) and triiodothyronine (T_3), which play an important role in growth and metabolism in humans [8]. Iodine in form of iodide (I^-) is almost completely absorbed (>90%) in the stomach and duodenum of healthy adults [9]. Other forms of iodine, such as iodate or organically bound iodine, are converted into iodide prior to absorption. Iodide is transported from the blood into the thyrocyte by the sodium/iodide symporter (NIS). In the thyrocyte, iodide is oxidized and bound to thyroglobulin to produce iodotyrosine and diiodotyrosine, which are coupled to form T_3 and T_4 [8]. Thus, dietary intakes of iodine need to be adequate in order to provide sufficient iodine for thyroid hormone production. Recommended intake varies depending on age and life-stage (Table 1), and intake recommendations have been proposed by WHO and the U.S. Institute of Medicine [9,10].

Insufficient iodine intakes adversely affect growth and development as a consequence of impaired thyroid hormone production. These adverse effects are referred to as iodine-deficiency (ID) disorders [10]. The most common clinical sign of ID is the enlargement of the thyroid (goiter), but ID also increases risk for hypo- and hyperthyroidism [8,10]. The most susceptible population groups to ID are pregnant women (and their fetus), infants and lactating women. ID in early life increases risk of spontaneous abortions, stillbirths, congenital anomalies, infant mortality, cretinism and impaired mental and physical development [10]. However, excessive iodine intake also has adverse health consequences and upper levels of intake are 3–7-fold the recommended intake, depending on age and life-stage [9,11,12].

As the strategy of choice to ensure an adequate iodine supply and thereby improve the health and development of deficient populations, WHO/UNICEF/Iodine Global Network recommend universal salt iodization at a fortification level of 20–40 mg iodine per kg salt [10]. Despite a remarkable decrease in the number of iodine-deficient countries worldwide (from 54 in 2003 to 32 in 2011 to 20 in 2017), ID remains a health concern in both developing and industrialized countries, with 13.7–44.2% of the general population at risk of insufficient iodine intakes (urinary iodine concentration <100 μg/L)

Table 1
WHO and U.S. Institute of Medicine recommendations for iodine intake (μg/day) by age or life-stage [9,10].

Age or population group	WHO[a]	U.S. Institute of Medicine[b]
0–12 months[c]	–	110–130
0–5 years	90	–
1–8 years	–	90
6–12 years	120	–
9–13 years	–	120
≥13 years	150	–
≥14 years	–	150
Pregnancy	250	220
Lactation	250	290

[a] Recommended nutrient intake.
[b] Recommended daily allowance.
[c] Adequate intake.

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