Report

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Iodine intake and status in Iceland through a period of 60 years

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Abstract

Iodine deficiency is considered to be one of the most common nutrition disorders in the world and the world's greatest single cause of preventable brain damage. Despite a worldwide application of successful iodine supplementation programs over the last four decades, iodine deficiency remains a major public health problem throughout the world. All European countries except Iceland have experienced this health and socioeconomic threat to a greater or lesser extent. The fact that mild to severe iodine deficiency persists in many European countries may have important public health consequences, including impaired intellectual development of infants and children. Iceland has in the past been known for its high iodine status, based on results from studies of iodine status from 1939, 1988, and 1998, suggested to be due to high fish consumption. Fish together with milk and other dairy products are the main sources of iodine in the Icelandic diet, but iodized salt is not commonly used. In recent years fish and dairy intake has decreased, especially among young people. In this paper, historical data on iodine status and iodine intake in Iceland is reviewed and the need for further studies as well as possible need for public health actions evaluated.

Keywords: *iodine*; *nutritional status*; *nutrition*; *fish*; *food intake*; *dairy products*

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Iodine is a trace element present almost exclusively in the thyroid gland and an essential component of the thyroid hormones. When the physiological requirements for iodine are not met, a series of functional and developmental abnormalities occur, including thyroid function abnormalities. When iodine deficiency is severe, hypothyroidism, endemic goiter and cretinism, endemic mental retardation, decreased fertility, increased prenatal death, and infant mortality may occur (1). According to the Nordic Nutrition recommendations, the average requirement is estimated to be 100 µg iodine per day for both adult women and men. The recommended intake (RDI) of iodine is 150 µg/day for adults and adolescents. An extra 25 µg/day is recommended during pregnancy and extra 50 µg/day during lactation to provide sufficient iodine in the breast milk (2).

Fish has the highest natural concentration of iodine (3–5). Analysis on various Icelandic fish species showed iodine content in haddock of 191 µg/100 g, in cod 170 µg/100 g, wild salmon 36 µg/100 g, and in farmed salmon 30 µg/100 g (6). Marine fish species, low in fat have the highest iodine contents (6). Cod and haddock (marine fish low in fat) are the most common species consumed in Iceland (7, 8). Kelp is also a good natural source of iodine, but is not commonly consumed by Icelanders. Iodized salt is in many countries the main dietary source of iodine, particularly in countries where the consumption of seafood is rather poor. Iodized salt is not commonly used in Iceland.

Another important sources of iodine are milk, other dairy products, and eggs (3–5). Iodine content of milk and dairy products varies considerably depending on feed and use of disinfectants containing iodine in connection with milking (5). In Iceland, fish products have traditionally been used for animal feeding causing high iodine content in milk and dairy products (3). The first measurements of iodine concentration in Icelandic milk, performed in 1962 (9), found 21.6 µg/100 g which was higher than in Scottish milk analyzed for comparison. Analyses from 1997 showed an average concentration of 11.2 µg/100 g (6). The reduction of iodine content of milk from 1962 could be explained by the reduction in the use

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of fishmeal as cow fodder. However, it should be noted that estimates of iodine content of food in the Icelandic nutrition database are often based on very few samples. Additionally, seasonal variations in iodine content of food can be significant (10) and in the analysis of milk from 1997 all samples were collected in November (6). For this reason, measurements of iodine excretion in urine should be conducted regularly to estimate iodine status rather than to depend solely on dietary surveys.

Iodine status and dietary intake of Icelanders in 1939

In 1939, Sigurjonsson reported that the thyroid gland in the Icelandic population appeared to be very small compared to the commonly accepted normal size in other countries (11). The first study on nutrition and diet of Icelanders showed that fish as well as dairy products were the main iodine sources (12). The high consumption of fish, 200 g/day on average, was considered unique compared to other countries (Table 1). Milk and dairy product consumption was also high, on an average 1,000 ml/day. Considering that 100 g of fish provides on an average 180 μg/day (6) and 100 ml of milk around 21 μg/day in this period (9), approximately 570 μg of iodine was provided daily through consumption of these products (Table 1). This level of consumption is close to the upper safe limit of iodine intake (600 μg/day) proposed by the Scientific Committee on Food (13). However, persons with normal thyroid function can in general tolerate a prolonged consumption of iodine up to 1 mg/day (14), suggesting that the high iodine consumption of the Icelandic population probably did not cause any harm.

Icelandic dietary survey in 1979–1980

A second diet survey was performed in 1979–1980 by the Icelandic Nutrition Council (15). In the council's report presenting the main results of the study, food intake was reported as percentages of total energy intake. The food group 'fish, meat and eggs' provided 20% of the energy intake. The average energy intake of women was 1,970 kcal/day and for men 2,750 kcal/day, meaning that fish, meat, and eggs provided about 400–550 kcal per day. Food supply data suggest the proportional intake of meat, fish, and eggs in 1979 was very similar to that in year 2002 (7, 16). Using this assumption, about 15% of the total energy from the food group (fish, meat, and eggs) is attributable to fish, and the average fish intake could be estimated as around 70 g/day (60 g/day for women and 80 g/day for men), given that 100 g provide around 100 kcal (6) (Table 1).

In the 1979–1980 study, milk and dairy products provided 21% of the total energy. Given that most of the milk consumed was whole milk providing 68 kcal/100 g, the estimated average intake of milk and dairy products is 729 g/day. This level of intake harmonizes very well with data on food supplies in Iceland in 1979, was estimated to be 269 kg/person/year or 737 g/day (16). Interestingly, the authors of the report 1979 mentioned changes in diet habits, especially by the younger generation and a risk of nutritional deficiency due to poor diet (15). The average intake of iodine was estimated to be 336 μg/day, using the same assumptions as in the previous section (only based on intake of fish, milk, and dairy products).

Second study of iodine status and the national dietary survey in 1990

In 1988 a second study of iodine status on Icelanders was performed, including 20–59 years old individuals showing excellent iodine status with average iodine excretion of 395 μg/L for men and 270 μg/L for women (9). In 1990, the Icelandic Nutrition Council conducted a third national dietary survey (8). The average fish consumption was 73 g/day, which was a huge drop from the survey in 1939, although similar to the estimated intake in 1979–1980 (Table 1). People above 50 years had the highest fish consumption but the younger generations consumed considerably less. The average consumption of milk was 320 g/day but on an average the total consumption of dairy products was 589 g/day (Table 1). Although the intake of fish and milk had decreased, the average intake of iodine was 299 μg/day, 365 μg/day for men and 238 μg/day for women (Table 1). However, the study revealed a group of young women, consuming on an average less than 22 g fish per day, and very low amount of dairy products as well. The average intake of iodine by these young women ranged from 86 μg/day to 130 μg/day which is below the RDI of iodine. These results were the first evidences to reveal a certain group in Iceland which could be at risk for iodine deficiency (8).

Iodine status of Icelanders in 1998

In 1998 the iodine concentration was measured in the urine of 66–70 years old Danes and Icelanders (17). The results showed that the iodine status of Icelanders was still optimal, on an average 50 μg/L, ranging from 33 μg/L to 703 μg/L. However, it was lower than in the previous studies, indicating changes in dietary habits. It should be noted, however, that this study only included elderly individuals and not the group of young women suspected to be at risk of iodine deficiency in the dietary survey 1990 (8). Data collection is ongoing to study further iodine status of young women (16–20 years old) and pregnant women in Iceland, where both iodine intake and urinary iodine excretion will be estimated.

Major changes in dietary habits – national dietary survey 2002

The latest dietary survey was performed by the Icelandic Public Health Institute (formerly Nutrition Coucil) in 2002 and the results showed quite extensive changes in

Table 1. Intake of fish, milk, and dairy products in Icelandic dietary surveys, and estimated iodine intake

Year	Age	Method	Fish (g/day)	Milk and dairy products (g/day)	Average iodine intake (µg/day)	Average energy intake (MJ/day)	Average iodine intake (mg/10 MJ)	Average iodine excretion (µg/L)	References
1939	0–80	Household/weighing	200[a]	1,000[a]	570[b]	13.9 ± 1.9	0.41	–	6,9,11
1979–1980	0–80	Dietary records	70[c]	729[c]	336[b]	8.8[a]	–	–	6,9,15
1988	20–59	Urinary iodine excretion	–	–	–	–	–	332 (range 72–1,650)	9
1990	15–80	Dietary history	73 ± 53	589 ± 493	299 ± 162	10.2 ± 4.4	0.29	–	8
1998	66–70	–	–	–	–	–	–	150 (range 33–703)	17
2002	15–80	24 hour recall	40 ± 76	388 ± 374	163 ± 186	10.6 ± 4.5	0.15	–	7
2002	15–19	24 hour recall	20 ± 59	395 ± 450	121 ± 110	10.3 ± 4.6	0.11	–	7
2004	9	2 × 24 hour recall	28 ± 40	570 ± 292	145 ± 93	8.2 ± 1.8	0.18	–	19
2004	15	2 × 24 hour recall	27 ± 41	514 ± 327	151 ± 111	10.3 ± 2.6	0.15	–	19

[a]Estimates of SD not available.
[b]Estimated iodine intake based in information on intake of fish (estimated iodine content of 191 µg/100 g) and milk (estimated iodine content of 21 µg/100 g).
[c]Figures are estimates as the intake was presented as percentages of total energy intake in the report presenting the data.

food consumption, compared with the survey in 1990 (7, 8). Fish consumption was only 40 g/day on average (Table 1). As in 1990 the intake of fish was split by generations, the younger people consumed three times less fish than the older people and the young women consumed the smallest serving of fish of all participants, only 15 g/day, and 23% of young women (15–19 years) consumed fish less than once a week. Milk consumption was also considerably lower than before, 185 g/day on average. However, the average consumption of other dairy products seemed to have increased resulting in an average intake of milk and dairy products corresponding to 388 g/day (Table 1). Those consuming least dairy were young women (15–19 years), where 17% consumed dairy products less than once a day.

The average iodine intake by men was 196 µg/day and by women 135 µg/day. On average, young women (15–19 years) only obtained 2/3 of RDI for iodine from the diet. Similar trends presumably due to reduction of fish intake and milk consumption have been seen in studies on children and adolescents in Iceland where up to 44% of 15-year-old adolescents were estimated to be at risk of iodine deficiency due to low intake of fish and dairy products (18). Very low fish intake has also been seen in young overweight Icelanders (19).

Is there a need for action?

Both dietary intake and composition of food is in continuous changes, and an example is Icelandic milk where the iodine concentration has decreased by 48% from 1962 to 1997 (6, 9). Milk intake has also decreased in the same period (7, 8, 12, 15). Therefore, follow-up studies are essential to evaluate dietary intake and nutrient status on regular basis, and in Iceland a study on iodine status of young women is essential.

The latest dietary survey, from 2002, showed the diet to have become more similar to the diet in other European countries and the consumption of fish and dairy products had diminished significantly. These changes were seen most clearly for young people, but previously the references for iodine status in Iceland had been considered outstanding due to the good iodine status in earlier times (18).

According to the latest diet research, intake of salt is too high in Iceland, like in other Western countries (7). Although availability of iodized salt would not necessarily result in increased salt consumption, this solution could easily be criticized. The official Icelandic recommended intake of fish is 300 g/week and two portions of milk or dairy products per day. By following these recommendations around 138 µg iodine would be provided per day, which is close to the RDI for iodine.

A group of young Icelandic women in childbearing age might be at risk of iodine deficiency. The seriousness of the matter is that in the next few years these women might get pregnant where an iodine deficiency could have some negative consequences for the future generations due to its effects on the maturation of the fetuses and neonates by irreversible derangement in the development of the brain and central nervous system (20, 21). Some but not all dietary supplements sold in Iceland contain iodine and emphasis should be made on getting vitamins and minerals from food. Fish and milk are the foods which are recommended because of the content of other important nutrients.

In conclusion, trends in dietary intake in Iceland show decreased fish and dairy intake especially by the young generation. The population cannot longer be excluded from the risk of iodine deficiency. The results from the ongoing studies on iodine status of Icelandic adolescent girls and pregnant women are important to evaluate the need for special action with regard to iodine status.

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