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Short Communication

Iodine status of pregnant women in a population changing from high to lower fish and milk consumption

Ingibjorg Gunnarsdottir[1,2,*], Anita G Gustavsdottir[1], Laufey Steingrimsdottir[1,2], Amund Maage[3], Ari J Johannesson[4] and Inga Thorsdottir[1,2]

[1]Unit for Nutrition Research, University of Iceland and Landspitali-University Hospital, Reykjavik, Iceland: [2]Faculty of Food Science and Nutrition, University of Iceland, Eiriksgata 29, 101 Reykjavik, Iceland: [3]National Institute of Nutrition and Seafood Reasearch (NIFES), Bergen, Norway: [4]Department of Endocrinology and Metabolism, Landspitali-University Hospital, Reykjavik, Iceland

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Abstract

Objectives: Pregnancy is one of the most critical periods for iodine deficiency. The aim of the present study was to assess the iodine status and dietary intake of pregnant women in a population changing from high to lower consumption of milk and fish.

Design: Cross-sectional observational study. Urine samples were collected for measuring urinary iodine concentration (UIC) and creatinine, and blood samples for measuring serum thyroid-stimulating hormone (TSH). Frequency of consumption of selected food and beverages was obtained through a semi-quantitative validated FFQ. The difference in the distribution of UIC, ratio of iodine to creatinine (I:Cr) and TSH between groups following recommendations on fish and dairy product intake or not (fish ≥2 times/week as a main meal, diary products ≥2 portions/d) was assessed.

Setting: Primary Health Care of the Capital Area, Reykjavik, Iceland.

Subjects: Randomly selected pregnant women (19–43 years old, *n* 162).

Results: The median UIC was 180 μg/l, I:Cr 173 μg/g and TSH 1·5 mmol/l. Women who did not consume fish ≥2 times/week and also did not consume dairy products in line with the recommended intake level of ≥2 portions/d had median UIC of 160 μg/l (I:Cr 149 μg/g) compared with 220 μg/l (I:Cr 190 μg/g) in the group following both the recommendations for fish and those for dairy products. Use of dietary supplements in the two groups was similar.

Conclusions: Iodine status in the population studied was within the optimal range (150–249 μg/d) defined by the WHO.

Keywords
Iodine
Pregnancy
Fish
Dairy
Recommendations

Iodine deficiency is considered one of the most common nutritional disorders in the world and the world's largest single cause of preventable brain damage(1–3). All European countries except Iceland have experienced this health and socio-economic threat to a greater or lesser extent(4). The Icelandic population has in the past been known for its high iodine status, based on studies from 1939, 1988 and 1998(5–7). The good iodine status observed in these studies was suggested to be due to high fish consumption and abundant milk, both important dietary sources of iodine(8–10). Dietary surveys in Iceland have shown that fish and milk consumption has decreased considerably during recent decades, with possible consequences for the iodine status of the population(11,12). Furthermore, the iodine content of milk and dairy products has decreased during the last decades(6,8,13,14). Iodized table salt is widely available in Europe, but not in Iceland.

The aim of the present study was to assess the iodine status and dietary intake of pregnant women in a population changing from high to lower consumption of milk and fish. Iodine status has not been assessed previously among pregnant women in Iceland but WHO urges governments to monitor the iodine status of vulnerable groups, including pregnant women(15).

Materials and methods

Sample

The data were collected between November 2007 and February 2009 at the Primary Health Care of the Capital

*Corresponding author: Email ingigun@landspitali.is

Area, at four different clinics in the capital area providing prenatal care. All pregnant women who met the inclusion criteria were invited to participate in the study. The inclusion criteria were that the woman was able to understand Icelandic, lived in the capital area and was in her second or third trimester of pregnancy. The health-care clinics were selected based on location, aimed to represent the population of pregnant women in the capital area. Five per cent of the original sample (*n* 320) did not fulfil the participation criteria, 15 % could not be reached by telephone and 3 % had already given birth when contacted, had a miscarriage or had moved abroad, leaving 245 women. Of these 245 women, fifty-three declined participation and thirty did not show up at the clinic, leaving 162 women. The main reason for not participating was lack of time or lack of interest. The study was approved by The National Bioethics Committee (VSNb2007040006) and The Icelandic Data Protection Commission (2007040320). Written consent was obtained from the participants.

Determination of iodine status

Urine spot samples were collected for determination of iodine and creatinine. Samples were collected in vials between 09.00 and 15.00 hours. The samples used for measurement of urinary iodine concentration (UIC) were kept frozen at −80°C at Landspitali-University Hospital in Reykjavik, Iceland, until all samples had been collected. The samples were then sent by courier in dry ice packages to the National Institute of Nutrition and Seafood Research (NIFES) in Bergen, Norway. An Agilent quadrupole inductively coupled plasma–mass spectrometer ICP-MS 7500c (Yokogawa Analytical System Inc., Tokyo, Japan) was used as an iodine-specific detector for urinary determination. Optimization and operating conditions of the instrument are described elsewhere[9,16,17]. The uncertainty in the method is based on both use of a control chart (reproducibility) and by participation in round robins (correctness) and set at ±15 %. Data were collected using the Agilent Chemstation ICP-MS chromatographic software[9,16,17]. Certified reference material (Seronorm™ Trace Elements; Nycomed, Oslo, Norway) of iodine in human urine was included in each analytical series of twenty-five samples in order to control for the systematic errors of the analytical method.

Creatinine was measured with the VITROS CREA Slide method, using the VITROS CREA Slides and the VITROS Chemistry Products Calibrator Kit 1 (National Institute of Standards and Technology, Gaithersburg, MD, USA) on a VITROS Chemistry System. The VITROS CREA Slide is a multilayered analytical element, coated on a polyester support. Measurements were carried out at the Department of Clinical Biochemistry, Landspitali-University Hospital in Reykjavik, Iceland.

A blood sample was collected to measure serum thyroid-stimulating hormone (TSH). TSH was measured by electrochemiluminescence immunoasssy, using the MODULAR ANALYTICS E170 platform from Roche (Indianapolis, IN, USA), at the Department of Clinical Biochemistry, Landspitali-University Hospital in Reykjavik, Iceland.

According to WHO guidelines, median UIC in pregnant women should range between 150 and 249 μg/l[18]. The use of the ratio μg iodine/g creatinine (I:Cr) is not recommended by WHO. However, it has been used in the past for adjusting dilution in spot samples. As urinary creatinine was analysed in the present study we decided to present our data as both median UIC (μg/l) and I:Cr (μg/g).

FFQ

Information on the average frequency of consumption of selected foods and beverages was obtained through a semi-quantitative validated FFQ, filled in during a personal interview by a trained research person. The participants chose from eleven possible responses that ranged from 'never' to '≥5 times per day'[19,20]. The FFQ provides information on the consumption of 130 different food items and use of dietary supplements, designed to reflect food intake over the previous 3 months. According to previous national dietary surveys in Iceland, fish, milk and cheese are found to contribute more than 75 % of the total iodine in the diet[11,12]. According to regulations from year 2007 (The Icelandic Food and Veterinary Authority), manufacturers of food and companies importing food should report use of any vitamin- and mineral-supplemented food, including iodized salt. In the case of iodized salt, no products have been reported to the authorities.

We assessed iodine status in groups according to adherence to public recommendations on fish and dairy product consumption[21,22]. Expectant mothers are advised, as are everyone else, to eat fish at least twice weekly. They are encouraged to enjoy common types of fish found in the waters surrounding Iceland, such as haddock, cod, flounder, catfish, monkfish (anglerfish), trout and salmon, as often as possible[22]. Consumption of large predatory fish and toothed whales are discouraged due to possible contamination. Two glasses, bowls or cans of milk or dairy products daily are recommended for adults.

The FFQ was not designed to provide detailed information on iodine content of dietary supplements, and the participants were unable to provide us with brand names of the supplements. Two out of eleven dietary supplements listed in the FFQ might contain iodine (multivitamin and mineral supplements). Out of sixty-two multivitamin and mineral supplements on the Icelandic market, twenty-three contain iodine (information from The Icelandic Food and Veterinary Authority). The average iodine content per tablet/portion is 119 μg. The number of participants using supplements that might contain iodine is reported.

Anthropometric measures and lifestyle questioning

Participants' weight was measured using a digital weighing scale (model 708; Seca, Hamburg, Germany) to

Table 1 Characteristics of the participants: pregnant women aged 19–43 years (n 162), Reykjavik, Iceland, November 2007 to February 2009

	Mean	SD
Age (years)	30·5	5·5
Height (cm)	167·6	6·4
Weight, pre-pregnancy (kg)	71·5	13·6
BMI, pre-pregnancy (kg/m^2)	25·5	4·7
	n	%
Ever smoked	66	40·7
Currently smoke	10	6·2
Underweight, pre-pregnancy	1	0·6
Normal weight, pre-pregnancy	93	57·4
Overweight/obese, pre-pregnancy	68	41·9
Nullipara	56	34·6
Primipara	55	34·0
Multipara	51	31·5

the nearest 100 g with light clothing and without shoes. Standing height was measured using a stadiometer (model 708; Seca) to the nearest 1 mm. Participants were asked for their pre-pregnancy weight which was used to calculate BMI (kg/m^2). Pre-pregnancy underweight was defined as BMI < 18·50 kg/m^2, normal weight as BMI = 18·50–24·99 kg/m^2, overweight as BMI ≥ 25·00–29·99 kg/m^2 and obesity as BMI ≥ 30·00 kg/m^2. Participants were also asked about their smoking habits and parity. Participants' characteristics are given in Table 1.

Data analysis

Analysis was carried out using the IBM SPSS Statistics 20·0 statistical software package (IBM, Armonk, NY, USA). The results are presented as mean, standard deviation, median, 20th and 80th percentile. The difference in the distribution of UIC, I:Cr and serum TSH between groups following recommendations on fish and dairy product intake or not (fish ≥2 times/week as a main meal; milk and cheese ≥2 portions/d) was assessed using the non-parametric Mann–Whitney U test. The level of significance was taken as $P < 0·05$.

Results

Table 2 shows the iodine status of the population studied. Iodine status was not associated with smoking, parity or pre-pregnancy weight.

The average frequency of fish consumption was 1·6 times/week. Fish was consumed at least twice weekly by 54 % of the participants, while 25 % recorded consumption as less than once weekly. Haddock was recorded as the most commonly consumed fish species by 83 % of the participants. The average frequency of milk and dairy product consumption (including cheese) was 2·3 portions/d. About 60 % of participants reached the recommended intake of two portions daily. Use of dietary supplements that might have contained iodine was recorded by 66 % of the participants, of whom 52 % recorded daily use.

Table 2 Mean (SD), median, 20th and 80th percentiles of urinary iodine concentration (UIC), ratio of iodine to creatinine (I:Cr) and serum thyroid-stimulating hormone (TSH)* among the study participants: pregnant women aged 19–43 years (n 162), Reykjavik, Iceland, November 2007 to February 2009

	n	Mean	SD	Median	20th	80th
UIC (μg/l)	162	228	190	180	79	340
I:Cr (μg/g)	158	231	174	173	106	319
TSH (mmol/l)	132	1·7	0·9	1·5	1·1	2·0

*Analysis of urinary creatinine was missing for four women and thirty refused to have their blood drawn for analysis of TSH.

Median UIC, I:Cr and serum TSH was assessed in groups according to adherence to recommendations on fish and dairy intake (Table 3). Serum TSH was of borderline significance higher in those who consumed fish as a main meal less <2 times/week compared with those consuming fish in line with the recommendations ($P = 0·082$). In those who consumed milk or other dairy products in line with recommendations, I:Cr was significantly higher ($P = 0·001$) while UIC was of borderline significance higher ($P = 0·074$) compared with those who consumed <2 portions/d. Women who did not consume fish ≥2 times/week as a main meal and also did not consume dairy products in line with the recommended intake level of ≥2 portions/d had median UIC of 160 μg/l (I:Cr 149 μg/g) compared with 220 μg/l (I:Cr 190 μg/g) in the group following both the recommendations for fish and those for dairy products.

Discussion

The results from the present study show that the iodine status of Icelandic pregnant women is in accordance with recommendations from WHO[15,18]. For many decades Iceland has been known for its high iodine status[5–7,23]. With the sharp decreases in milk and fish intakes during past decades, worries about iodine status in the population have increased[11,12,24].

Intake of dairy products and fish has frequently been reported to be related to iodine status[25–27]. Although the scientific background for recommending consumption of fish at least twice weekly as a main meal and two portions of milk or other dairy products daily is rather related to cardiovascular risk and bone health, respectively[21], the present study suggests that adherence to these recommendations should be emphasized with iodine status in mind, at least in the population studied. Iodized salt is not available on the Icelandic market, only vitamin D and folic acid are recommended as dietary supplements during pregnancy, and iodine status has not yet received any special attention in prenatal care. It might be speculated that without dietary supplements

Table 3 Median urinary iodine concentration (UIC), ratio of iodine to creatinine (I:Cr) and serum thyroid-stimulating hormone (TSH) according to adherence to recommendations on fish and dairy intake* among the study participants: pregnant women aged 19–43 years (*n* 162), Reykjavik, Iceland, November 2007 to February 2009

	Fish ≥2 times/week as a main meal (*n* 87)	Fish <2 times/week as a main meal (*n* 75)	Dairy ≥2 portions/d (*n* 97)	Dairy <2 portions/d (*n* 65)	Both fish ≥2 times/week as a main meal and dairy ≥2 portions/d (*n* 49)	Either fish ≥2 times/week as a main meal or dairy ≥2 portions/d (*n* 74)	Neither fish ≥2 times/week as a main meal nor dairy ≥2 portions/d (*n* 39)
UIC (μg/l)	180	180	200	170	220	170	160
I:Cr (μg/g)	173	175	201	147	190	175	149
TSH (mmol/l)	1·38	1·61	1·47	1·50	1·35	1·57	1·50
Supplements†							
n	44	39	50	33	23	43	23
%	51	52	52	51	47	58	58

*According to the Icelandic food-based dietary guidelines[21] and guidelines to pregnant women[22]. Fish as a main meal is recommended at least twice weekly. Consumption of two portions of milk or other dairy products daily is recommended (one portion equals 250 ml milk or 25 g cheese).
†Number and percentage of women recording daily use of dietary supplements that might contain iodine.

the group consuming neither fish at least twice weekly nor two portions of milk or other dairy products daily might fall below the optimal range defined by WHO[15,18]. The UIC in that group was 160 μg/l (I:Cr 149 μg/g), while 58 % recorded use of dietary supplements that might have contained iodine.

The main limitation of the present study is the lack of information on the iodine content of dietary supplements. However, the percentage of women taking supplements that might contain iodine was similar between the groups assessed in the present study (Table 3). It might also be considered a limitation to the present study that UIC was measured in a spot sample and not by 24 h urine collection. The reason for choosing spot samples was mainly related to participation rate, as the greater burden of collecting 24 h urine samples might result in lower participation. Still, spot samples have been used successfully to assess iodine status in large population studies like the National Health and Nutrition Examination Survey (NHANES)[28] and the method is recommended by the WHO[18].

Conclusions

The iodine status of pregnant women in Iceland was found to be within the optimal range defined by the WHO despite sharp decreases in milk and fish intakes during past decades. Pregnant women in the population studied who consumed neither fish nor dairy products in line with recommendations, and at the same time did not use dietary supplements containing iodine, might be at risk of suboptimal iodine status.

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