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Original Research

Inadequate Iodine Intake in Mothers of Young Children in Innlandet County, Norway

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ABSTRACT

Background: Iodine has an essential role in child growth and brain development. Thus, sufficient iodine intake is particularly important in women of childbearing age and lactating women.
Objectives: This cross-sectional study aimed to describe iodine intake in a large random sample of mothers of young children (aged ≤2 y) living in Innlandet County, Norway.
Methods: From November 2020 to October 2021, 355 mother–child pairs were recruited from public health care centers. Dietary data were obtained using two 24-h dietary recalls (24-HRs) per woman and an electronic FFQ. The Multiple Source Method was used to estimate the usual iodine intake from the 24-HR assessment.
Results: Based on the 24-HRs, the median (P25, P75) usual iodine intake from food was 117 μg/d (88, 153) in nonlactating women and 129 μg/d (95, 176) in lactating women. The median (P25, P75) total usual iodine intake (from food combined with supplements) was 141 μg/d (97, 185) in nonlactating women and 153 μg/d (107, 227) in lactating women. Based on the 24-HRs, 62% of the women had a total iodine intake below the recommendations (150 μg/d in nonlactating women and 200 μg/d in lactating women), and 23% of them had an iodine intake below the average requirement (100 μg/d). The reported use of iodine-containing supplements was 21.4% in nonlactating women and 28.9% in lactating women. In regular users of iodine-containing supplements ($n = 63$), supplements contributed to an average of 172 μg/d of iodine. Among regular iodine supplement users, 81% reached the recommendations compared with 26% of nonsupplement users ($n = 237$). The iodine intake estimated by FFQ was substantially higher than that estimated by 24-HRs.
Conclusions: Maternal iodine intake in Innlandet County was inadequate. This study confirms the need for action to improve iodine intake in Norway, particularly among women of childbearing age.

Keywords: iodine intake, women of childbearing age, lactating women, 24-h dietary recall, Multiple Source Method

Introduction

In 2020, Norway was considered as one of the 21 countries with deficient iodine intake [1]. Severe iodine deficiency (ID) is no longer prevalent in Norway, but in a few, recent studies, mild-to-moderate ID was reported in specific population groups, such as pregnant and lactating women and women of childbearing age [2–7]. These groups are particularly vulnerable to ID because iodine is essential for proper growth and brain development in the fetus and infant [8].

Iodine is required to produce the thyroid hormones triiodothyronine and thyroxine [9]. Adequate iodine supply is extremely important during the first 1000 d of life [10], which is the time from conception to 2 y of age. The source of iodine for the fetus and the fully breastfed infant is maternal iodine [8,11]. Suboptimal intake of iodine reported in young women is thus of major concern. Severe ID in early life can cause irreversible brain

Abbreviations used: 24-HR, 24-h dietary recall; ID, iodine deficiency; MSM, Multiple Source Method; NNR, Nordic Nutrition Recommendations; UIC, urinary iodine concentration.

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damage, whereas the consequences of mild-to-moderate ID are not fully understood [8]. Observational studies suggest that mild-to-moderate ID during pregnancy is associated with suboptimal neurological development in the offspring [12–14]. Historically, women from inland Norway were more severely affected by ID than those from coastal areas due to the low availability of fish [15]. A study of 130 lactating women in 2018 revealed that mild-to-moderate ID was common in the inland area of Norway [7].

In Norway, dietary iodine intake is highly dependent on the consumption of lean fish and milk because these are the primary iodine sources [16]. However, dietary patterns have changed over the last decades toward lower intake of milk and fish [17]. Changes in food habits and low salt iodization may explain the low iodine intake in groups of the population. Salt iodization has been implemented in most Nordic countries [18] but is neither yet sufficient nor mandatory in Norway, despite recommendations from the WHO [19] and the National Council of Nutrition in Norway [15,20]. Although the WHO recommends fortifying salt with 15–40 μg of iodine per gram of salt, the current Norwegian legislation allows only 5 μg of iodine per gram of table salt (salt for household consumption) [21]. A benefit and risk assessment from the Norwegian Scientific Committee for Food and Environment in 2020 concluded that adding more iodine to salt can compensate for low iodine intake in adolescents and women of childbearing age but could lead to iodine excess in toddlers [22]. In 2021, the National Council of Nutrition in Norway advised that the iodine concentration in table salt and salt used in industry bread and bakery products should be increased from 5 μg/g to 20 μg/g [20].

In the Nordic countries, a daily iodine intake of 150 μg/d is recommended for nonpregnant adults and adolescents. For lactating women, an additional 50 μg/d of iodine is recommended to maintain maternal thyroid gland function and provide sufficient iodine in breastmilk [23]. Practically, the recommendations can be met by consuming one portion of lean fish weekly and 5 dL of milk/yogurt daily (8 dL for lactating women). With little or no lean fish in the diet, a large daily intake of dairy products is required (1–1.4 L of milk/yogurt), and thus, supplements may be needed. The Norwegian Directorate of Health recommends iodine-containing supplements to individuals who do not meet their iodine needs through food sources [24]. Some studies indicate that a sudden increase in iodine intake may lead to a transient "stunning effect" with temporary inhibition of maternal thyroid hormone synthesis, particularly in individuals with poor iodine status [22]. Therefore, iodine nutrition should be optimized before entering pregnancy.

The WHO recommends UIC to assess iodine status in a population [9]. However, because there are few dietary iodine sources in Norway and low iodine concentration in salt, iodine intake can easily be estimated by assessing the diet. In the estimation of the usual or long-term average dietary intake, the use of repeated short-term measures such as 24-h dietary recalls (24-HRs) is the preferred method [25]. Based on the above information, this study aimed to describe iodine intake in a large random sample of mothers of young children in Innlandet County, Norway.

Methods

Study design and study population

In this cross-sectional multicenter study, we aimed to include 500 mother–child pairs, of which 130 were recruited in a pilot phase in 2018 and are not part of this article. Data from the pilot are described elsewhere [7,26]. From November 2020 to October 2021, 355 mother–child pairs (2 y of age or younger at the time of recruitment) were recruited from 29 municipalities in Innlandet County, Norway. First, municipalities were selected at random from a list of all municipalities in the county. In this list, we included each municipality 1–10 times according to the birth rate in 2019, meaning that a municipality with a high birth rate was listed more often than that with a low birth rate. For each time a municipality was listed, we attempted to recruit four mother–child pairs from the corresponding health care center. Second, the participating health care centers were provided with necessary study material (participant consent forms and participant information sheets), and the nurses at the health care centers were instructed on how to approach the mothers for recruitment. Mothers who could read and write in Norwegian and had a healthy child aged ≤2 y at the time of recruitment were invited to participate.

Collection of dietary data and estimation of iodine intake from food and supplements

The main method for the collection of dietary data was two 24-HRs per woman. Dietary data were also obtained using a self-administered electronic FFQ.

The 24-HRs were performed as telephone interviews by three certified dietitians. For each mother–child pair, we aimed for two interviews with varying time intervals (3 d–2 wk) and on various days of the week. The women were reminded a maximum of three times for each of the two 24-HRs. For each unanswered call, a text message was sent with a request to return the call or reply with what time would be best for a conversation. Women who did not respond to our request to participate in the first 24-HR were not contacted later. In short, the 24-HR was conducted as a three-step sequence. First, the participants described as freely as possible what they consumed the day before the call, that is, from the time when they woke up and the following 24 h. Second, the interviewer repeated all items that were reported and asked detailed questions about portion sizes, preparation methods, and ingredients. Finally, the interviewer asked for commonly forgotten items (such as snacks, in-between meals, milk or cream in the coffee/tea, and nighttime snacks) and dietary supplements. Furthermore, the iodine intake (μg/d) was estimated using the Norwegian dietary estimation tool "Kostholdsplanleggeren" [27], which multiplies the consumption amount of each food item with its iodine concentration registered in the Norwegian Food Composition Table [28]. For items not registered in this system, similar items were chosen when appropriate, or nutritional values were obtained from the producers of the food items. The total energy intake was estimated, and women with a mean energy intake based on two 24-HRs outside the range of 500–3500 kcal/d (regarded as implausible intake) were excluded from further analyses.

The electronic FFQ was developed at the University of Oslo [29] and included questions on 279 different foods and beverages. The women were asked to answer the questions based on their food habits over the past 6 mo or after pregnancy if they had given birth <6 mo ago. Frequencies of intake varied with the food item in question and ranged from never, seldom, per week, and per month to several times a day. Portion sizes were estimated from pictures of common food items and/or from general household measures. The food composition database and calculation system "Kostberegningssystem" (KBS, version AE-18) from the University of Oslo was used to calculate energy and nutrient intake. Each participant received a maximum of three written reminders (text messages or emails) to answer the FFQ.

Definitions of iodine intake and supplement use

Iodine intake from food alone and the total iodine intake (from food combined with supplements) were estimated. In this article, adequate iodine intake was defined as an iodine intake of 150 μg/d in nonlactating women and 200 μg/d in lactating women, which is in accordance with the Nordic Nutrition Recommendations (NNR) 2012. Intakes above the upper intake level of 600 μg/d were defined as excessive [23].

Women were classified as regular supplement users if they reported taking iodine-containing supplements in two 24-HRs or reported taking iodine-containing supplements in one 24-HR plus minimum two to three times weekly in the FFQ.

Statistics

Descriptive results are reported as *n* (%) for categorical variables and mean (SD) for continuous variables. Data processing and analysis were performed using STATA/SE 16.1 (StataCorp). Intake distributions from the 24-HRs were estimated using the statistical package in the Multiple Source Program. The Multiple Source Method (MSM) is a statistical method for estimating the usual dietary intake from repeated short-term dietary instruments. FFQ information does not appear to substantially alter estimates of usual intakes from 24-HRs [25], and was not used in the MSM analysis. Estimated iodine intakes were expressed as medians with 25th and 75th percentiles because the distribution of the data was skewed. Spearman correlation coefficients were calculated to compare the estimated iodine intakes from the 24-HRs and the FFQ.

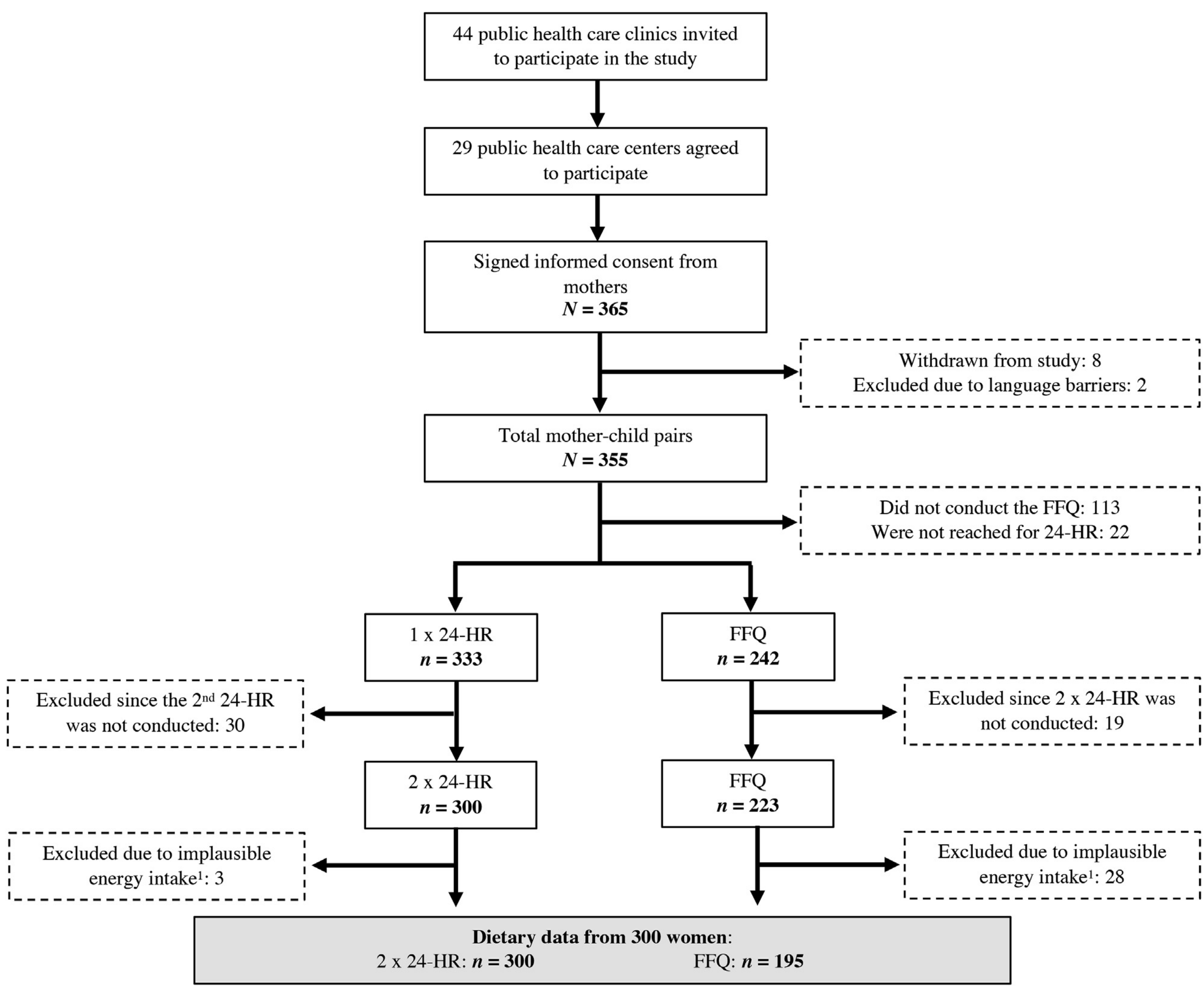

FIGURE 1. Flow chart of the study population and collection of dietary data (24-HRs and FFQ). [1]Estimated energy intake outside the range of 500–3500 kcal/d based on the mean of two 24-HRs. 24-HR, 24-h dietary recall.

Ethics

All women gave written informed consent before participation. The study was approved by the Regional Committee for Medical and Health Research Ethics (2018/1230/REC South East).

Results

Study population

An overview of the study population and the collected dietary data are given in Figure 1. Of the 46 municipalities in the county, 44 were contacted at least once, and 29 accepted the invitation. Written informed consent was given by 365 women, of which 300 provided dietary data and were included in the final estimations of iodine intake. In total, 66% (197/300) of the women were lactating and 34% (103/300) did not lactate/had ceased lactating. Regular use of iodine-containing supplements according to our definition was reported by 21% (63/300) of the women. More characteristics of the study population are given in Table 1.

TABLE 1
Characteristics of mother–child pairs enrolled in the study

Characteristic	*n*	*n* (%) or mean (SD)
Maternal age, mean (SD)	295	31.0 (4.4)
Maternal BMI (kg/m^2), *n* (%)	288	
<18.5 (underweight)		1 (0.3)
18.5–24.9 (normal weight)		151 (52.4)
25–29.9 (overweight)		81 (28.1)
>30 (obese)		55 (19.1)
Prepregnancy BMI (kg/m^2), *n* (%)	290	
<18.5 (underweight)		3 (1.0)
18.5–24.9 (normal weight)		171 (59.0)
25–29.9 (overweight)		74 (25.5)
>30 (obese)		42 (14.5)
Lactation status, *n* (%)	300	
Yes		197 (65.7)
No		103 (34.3)
Marital status, *n* (%)	295	
Single		9 (3.1)
Cohabitant		195 (66.1)
Married		90 (30.5)
Other		1 (0.3)
Maternal education level, *n* (%)	295	
<12 y		3 (1.0)
12 y		71 (24.1)
1–4 y college/university		161 (54.6)
>4 y college/university		60 (20.3)
Country of birth, Norway, *n* (%)	295	261 (88.5)
Smoking status, *n* (%)	295	
Daily		7 (2.4)
No		263 (89.2)
Previous smoker		25 (8.5)
Use of snuff, *n* (%)	295	
Daily		22 (7.5)
Sometimes		4 (1.4)
No		248 (84.1)
Previous		21 (7.1)
Previous or current thyroid disease, *n* (%)	295	15 (4.6)
Hyperthyroidism		6 (2.0)
Hypothyroidism		9 (3.1)
Current use of thyroid medication		8 (2.7)
Child characteristics		
Age (wk), mean (SD)	296	39.8 (27.1)
Sex, boy, *n* (%)	295	142 (48.1)

Iodine intake from food and supplements

Estimated iodine intakes by the 24-HRs and the FFQ, stratified by lactation status, are shown in Tables 2 and 3, respectively. The correlation between the usual iodine intakes estimated by the two methods was moderate (Spearman rank correlation coefficient $r = 0.49$, $P < 0.001$, $n = 195$).

The iodine contribution from different food groups was calculated based on the 24-HRs because these generated more detailed data on specific food items than the FFQ. The main sources of iodine in this population were dairy products, iodine-containing supplements, and fish, contributing ~70% to the total iodine intake. The iodine content of the supplements was 75–225 µg. The mean daily intake of different food groups and their contribution to the iodine intake from food are given in Table 4. Supplemental Table 1shows the iodine contribution from different food groups when iodine intakes from supplements were also included.

Estimated intake based on 24-HRs using the MSM

The median usual iodine intake based on the 24-HRs was below the NNR in both lactating and nonlactating women, with and without the inclusion of iodine-containing supplements (Table 2). The median (P25, P75) usual iodine intake from food was 117 µg/d (88, 153) in nonlactating women and 129 µg/d (95, 176) in lactating women. The median (P25, P75) usual total iodine intake (from food combined with supplements) was 141 µg/d (97, 185) in nonlactating women and 153 µg/d (107, 227) in lactating women. Among women who reported regular use of iodine-containing supplements ($n = 63$), 81% reached their daily iodine recommendations compared with 26% of nonsupplement users ($n = 237$, Supplemental Table 2). None of the women had a usual total iodine intake above the safe upper level of 600 ug/d (excessive intake).

Estimated intake based on FFQ

The total iodine intake estimated by FFQ was substantially higher than that estimated by 24-HRs, with a mean absolute difference of 53 µg/d (data not shown). The median iodine intake estimated by FFQ was within the adequate range when iodine from supplements was included, but not from food alone. The median (P25, P75) iodine intake from food was 133 µg/d (106, 210) in nonlactating women and 188 µg/d (122, 247) in lactating women. The median (P25, P75) total iodine intake was 193 µg/d (114, 272) in nonlactating women and 227 µg/d (161, 326) in lactating women. Four percent of the women had excessive total iodine intake.

Discussion

The present study assessed maternal iodine intake in a large random sample of mothers of young children in Innlandet County. Our results suggest that inadequate iodine intake was prevalent among the women. Based on the repeated 24-HRs, which was the main dietary assessment method chosen for this study, the majority (62%) of the women had a usual total iodine intake below the NNR and 23% had an iodine intake of below the average requirement of 100 µg/d. The proportion of women with inadequate iodine intake was particularly high among women who did not report regular use of iodine-containing supplements (Supplemental Table 2**)**. The iodine intake estimated by FFQ

TABLE 2
Maternal intakes of iodine (μg/d) estimated using two 24-HRs per woman ($N = 300$). Presented for all women and for two categories of lactation

Study population	n	P50[1]	P25, P75[1]	% below NNR[2] (95% CI)	% below AR[3] (95% CI)	% above UL[4] (95% CI)
All women, food only	300	124	93, 167	82 (77–86)	33 (27–38)	0 (0–1)
All women, total intake	300	151	103, 216	62 (57–68)	23 (18–28)	0 (0–1)
Lactating, food only	197	129	95, 176	86 (81–91)	29 (23–36)	0 (0–2)
Lactating, total intake	197	153	107, 227	67 (60–74)	20 (15–26)	0 (0–2)
Nonlactating, food only	103	117	88, 153	73 (63–81)	40 (30–50)	0 (0–4)
Nonlactating and total intake	103	141	97, 185	53 (43–63)	29 (21–39)	0 (0–4)

24-HR, 24-h dietary recall; AR, average requirement; NNR, Nordic Nutrition Recommendations; UL, upper intake level.
[1] Estimated usual intakes were calculated using the Multiple Source Method [25].
[2] Recommended intakes from the NNR from 2012 (200 μg/d in lactating women and 150 μg/d in nonlactating women).
[3] Average requirement from the Nordic Nutrition Recommendations from 2012 (100 μg/d).
[4] Upper intake level from the Nordic Nutrition Recommendations from 2012 (600 μg/d).

TABLE 3
Maternal intakes of iodine (μg/d) estimated using FFQ ($N = 300$). Presented for all women and for two categories of lactation

Study population	n	P50[1]	P25, P75[1]	% below NNR[2] (95% CI)	% below AR[3] (95% CI)	% above UL[4] (95% CI)
All women, food only	195	174	115, 244	57 (50–64)	16 (11–22)	0 (0–2)
All women, total intake	195	211	131, 314	42 (34–49)	12 (1–18)	4 (2–8)
Lactating, food only	129	188	122, 247	56 (47–65)	13 (1–20)	0 (0–3)
Lactating, total intake	129	227	161, 326	42 (33–51)	11 (1–17)	5 (2–11)
Nonlactating, food only	66	133	106, 210	59 (46–71)	21 (12–33)	0 (0–5)
Nonlactating and total intake	66	193	114, 272	41 (29–54)	15 (1–26)	2 (0–8)

AR, average requirement; NNR, Nordic Nutrition Recommendations; UL, upper intake level.
[1] Estimated using the food composition database and calculation system "Kostberegningssystem" (KBS, version Ae-18) from the University of Oslo.
[2] Recommended intakes from the NNR from 2012 (200 μg/d in lactating women and 150 μg/d in nonlactating women).
[3] Average requirement from the Nordic Nutrition Recommendations from 2012 (100 μg/d).
[4] Upper intake level from the Nordic Nutrition Recommendations from 2012 (600 μg/d).

showed inadequate iodine intake from food alone, but not from food combined with supplements. Excessive iodine intake was indicated only by the FFQ.

The total iodine intake estimated by FFQ was much higher than that estimated by 24HRs. Although FFQ is a feasible method for assessing dietary intake in large groups, it often tends to overestimate food and nutrient intakes compared to 24-HR [30–32]. To account for this, FFQ answers from 28 women were excluded due to energy intakes of >3500 kcal/d. These women had a median 24-h energy intake of 3958 kcal/d (range: 3515–6856) and a median total 24-h iodine intake of 405 μg/d (range: 191–992). Certain foods may contribute to excessive amounts of iodine, such as seaweed or seaweed products, but none of the women in this study reported the use of such products. Both the FFQ and the 24-HR method pose challenges related to the estimation of portion sizes, misreporting of food intake, and the bias caused by poor memory and social desirability [32]. However, repeated short-term instruments, such as 24-HR, tend to provide more accurate estimates of dietary intake than tools that examine usual intake directly, such as FFQs [25].

Our findings support previous findings of low iodine intake in women of childbearing age and lactating women in Norway [2, 4–7]. Poor iodine nutrition in these groups, as well as in pregnant women, has also been documented in other countries where dairy products and fish are the main dietary sources of iodine, such as Finland [33], Iceland [34], UK [35–37], USA [38], and New Zealand [39]. Although fish is a rich source of iodine, our results indicate, with support from national consumption data [16,40], that fish intake among young women is low. Furthermore, in recent years, there has been a growing interest in plant-based alternatives to animal products, such as cow milk and yogurt. These are, in general, poor sources of iodine, and few are fortified with iodine on the Norwegian marked [41]. Data on the actual consumption of plant-based dairy alternatives in Norway is lacking, but in the UK, it has been suggested that young women are driving this trend and that one-third of 16–34-y olds prefer such alternatives to cow milk [42]. In a survey among adults in Norway in 2019, 40% of young women reported to never or rarely drink cow milk [43]. In the current study, 57% of the women had an estimated cow milk intake of below one glass (200 mL) daily, based on the mean value of two 24-HRs (all types of liquid cow milk, as drink or in mixed dishes, excluding yogurt). Of them, 28% did not report any intake of cow milk at all. With a few good sources of iodine in the diet, young women are poorly equipped to meet the increased demands of iodine as they enter pregnancy and lactation.

The estimated iodine intake in the current study was substantially higher than that in our pilot among lactating women from 2018 ($N = 133$, median total intake of 32 μg/d estimated by 24-HR and 42 μg/d estimated by FFQ) [7]. In the pilot study, we only had 1 d of 24-HR data per woman, which does not take into account the variability in intake from day to day for a single individual (within-subject variability). In the current study, we applied a second day of 24-HR per woman to provide an estimate of usual iodine intake. Hence, the estimated iodine intakes by 24-HR in the two studies are not fully comparable. However, we suppose that the discrepancy in iodine intake in the two studies is mainly explained by different approaches in dietary

TABLE 4
Mean intake (g/d, SD) and contribution (%) from different food groups to the iodine intake (food only) based on data from two 24-HRs per woman ($N = 300$)

Food group	Mean intake (g/d, SD), all women	Contribution of food group to the iodine intake (%)		
		All women ($n = 300$)	Nonregular supplement users[1] ($n = 63$)	Regular supplement users[2] ($n = 237$)
Dairy products	263.9 (196.3)	39.1	40.6	33.9
Milk	174.8 (179.1)	19.9	20.7	17.3
Yogurt, cottage cheese, and quark	29.4 (53.8)	2.9	3.1	2.4
White-colored cheese[3]	38.9 (45.3)	7.6	8.1	6.0
Whey cheese	6.3 (10.4)	7.6	7.6	7.4
Other dairy products[4]	14.5 (23.9)	1.0	1.0	0.9
Fish and seafood	44.4 (65.8)	20.7	19.7	24.0
Lean/semifat fish and related products	7.8 (32.5)	9.6	9.1	11.3
Fatty fish	13.3 (42.3)	0.5	0.5	0.5
Other fish products	23.2 (308.7)	10.6	10.1	12.2
Nondairy beverages	531.9 (30)	14.4	13.8	16.3
Coffee and coffee products	186.0 (75.0)	5.5	5.7	4.7
Carbonated mineral water	22.7 (75.0)	6.7	5.5	10.7
Milk alternative drinks	12.8 (48.4)	0.1	0.1	0.1
Other beverages[5]	310.4 (250.1)	2.1	2.5	0.8
Eggs	22.7 (32.7)	6.0	5.5	7.7
Bread, cereals, seeds, and nuts	233.9 (104.0)	4.0	3.9	4.2
Vegetables, fruits, and berries	221.8 (143.4)	2.7	2.7	2.9
Poultry, meat, and meat products	94.7 (75.4)	1.4	1.4	1.3
Butter, margarine, and oils	16.1 (13.5)	1.3	1.3	1.2
Mixed dishes and other products	232.6 (157.5)	10.4	11.0	8.6

24-HR, 24-h dietary recall.
[1] No reported use of iodine-containing supplements or use in one 24-HR only.
[2] Reported taking iodine-containing supplements in both 24-HRs or in one recall plus minimum two to three times weekly in the FFQ.
[3] Solid and cream cheese.
[4] Cream milk, crème fraiche, sour cream, and ice cream.
[5] Juice, soda, tea, energy drink, and alcoholic beverages.

assessment. In the pilot, the 24-HR was structured around typically iodine-rich foods (iodine-specific 24-HR), and a fixed amount of iodine (15 μg) was added to each recall to account for iodine in other foods. In the current study, the 24-HR had equal focus on all nutrients and intended to capture information on all foods and beverages consumed the previous day. Thus, in the current study, we captured a wider range of foods contributing to the iodine intake compared to the pilot study. Regarding the iodine intakes estimated by FFQ, we used different FFQs in the pilot and current study. The FFQ in the pilot was relatively short (addressing 32 foods and beverages), nonquantitative, and iodine-specific, whereas the FFQ in the current study was semi-quantitative and more comprehensive (addressing 279 foods and beverages). The FFQ used in the pilot had not been validated to estimate the iodine intake. It should also be noted that in the pilot study, we used convenience sampling and the participants were accordingly not a random selection of the population.

One might also speculate that the higher iodine intake estimated in the current study may in part be related to the increased awareness about iodine in recent years among health professionals and the general public. For instance, in 2018, the Directorate of Health specifically recommended iodine supplementation to women of childbearing age and pregnant and lactating women with low intake of milk and/or lean fish [24]. In the current study, 21% of the women regularly used iodine-containing supplements according to the definition we made (use in two 24-HRs or in one recall plus minimum two to three times weekly in the FFQ). It is not clear how many of the women used iodine-containing supplements regularly in the pilot study, although 23% reported use in the past 24 h. In 2018, iodine was also implemented in antenatal care as a nutrient that should be paid special attention to, similar to nutrients such as folic acid, vitamin D, and iron [44]. Since then, health professionals providing antenatal care have been encouraged to provide women with basic information on iodine at the first consultation during pregnancy. Based on this, it is reasonable to believe that more women are aware of their iodine intake today than in 2018 when we conducted the pilot study.

Strengths and limitations

A major strength of this study was the large sample based on the random selection of health care centers in the county. Another strength was that we used the MSM to adjust for within-subject variability and provide estimates of usual iodine intake. Furthermore, it was a strength that we used a comprehensive FFQ in addition to the 24-HRs, although the correlation with estimates by 24-HRs was moderate. The discrepancy in iodine intake between the two methods underline the importance of carefully choosing the method of dietary assessment.

A limitation of this study is that we did not include any biomarkers of iodine status or thyroid function. Future studies should aim to include both dietary and biochemical data to give a more complete picture of iodine nutrition in this population group. Another limitation is that we did not calculate the participation rate due to the large number of healthcare workers involved in recruitment. Furthermore, we did not obtain detailed data on the types and producers of plant-based dairy alternatives consumed by the women, so the iodine contribution from these might be underestimated. However, most of these contain negligible amount of iodine.

In conclusion, the present study adds to the growing evidence of a low iodine intake in women of childbearing age and lactating women in Norway. The potential consequences of these findings need to be further studied. Our results highlight the need to monitor and improve iodine intake among young women, so that they are equipped to provide sufficient iodine to support child growth and neurodevelopment. Such improvement should commence before conception due to the importance of thyroid hormones in early pregnancy.

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Data Availability

Requests for data can be made to the corresponding author. To meet the ethical requirements for the use of confidential patient data, sharing of data must be approved by the Regional Committee for Medical and Health Research Ethics in Norway.

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Author disclosures

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.cdnut.2023.100047.

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