

Energy and nutrients in self-reported diet before and at week 18–22 of pregnancy

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Abstract

Background: A satisfactory nutritional status, as a result of optimal food intake, before conception and during pregnancy, is important for a successful pregnancy.

Objective: To evaluate the energy and nutrient intake before conception and at mid-gestation in a group of pregnant women ($n = 50$) in relation to the Nordic Nutrition Recommendations (NNR).

Design: Pre-pregnant diet was studied by an 84-item food-frequency questionnaire and mid-gestational diet by repeated 24 h dietary recalls.

Results: Average requirements (AR) were met for all nutrients except for selenium intake before pregnancy. Absolute intakes were below recommended intake (RI) according to NNR for folate, vitamin D, selenium, vitamin E and iron both before and at mid-gestation. However, intakes were still above the lower intake levels (LI) defined by NNR for almost all women. Twenty-three women were below LI for selenium before pregnancy and five for each of vitamin D and selenium at mid-gestation. When expressed as nutrient densities (amount of nutrient per energy unit), intakes were below NNR for folate, vitamin D and selenium before pregnancy, and for folate, vitamin D and iron at mid-gestation. Intakes were adjusted for underreporting, estimated to 20% as revealed after comparing energy intake/basal metabolic rate with grouped physical activity level values.

Conclusions: The reported food intake satisfied the recommended level of intake according to AR, but when using RI for planning a diet as a reference, folate, vitamin D, selenium and iron intake were insufficient. Most striking were the low levels of folate and vitamin D intake both before pregnancy and at mid-gestation.

Keywords: *conception; dietary intake; 24 h dietary recall; folate; food-frequency questionnaire; vitamin D*

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Introduction

Nutrient intake during pregnancy and nutritional status before conception both affect pregnancy outcome (1, 2). In the industrialized countries, intake of folate, vitamin D and iron, all with a suggested impact on pregnancy outcome, has been reported to be low in pregnant women (3–5). Deficiency of folate is linked to neural tube defects (NTD), and supplementation at conception reduces the NTD risk (6, 7). Maternal vitamin D deficiency is suggested to cause poor foetal and infant skeletal growth and mineralization (8) with consequences for future bone mass (9). Iron-deficiency anaemia has been linked to preterm delivery and low neonatal birth weight (7). Guidelines on dietary intake for pregnant women in Sweden are given in the Nordic Nutrition Recommendations (NNR) (10). Recommendations differ somewhat

between European countries. For instance, in the report Dietary Reference Values for Food Energy and Nutrients for the United Kingdom recommendations for folate are lower, whereas those for iron and vitamin D are similar (11). The daily energy intake (EI) in the average pregnant women is set at 2500 kcal by NNR (10), but the intake should be individually adjusted to meet variations in basal metabolic rate (BMR), body composition before and during pregnancy, gestational weight gain, physical activity, etc. (6). The aim of the present study was to evaluate pre-pregnancy diet retrospectively using a food-frequency questionnaire (FFQ), and mid-gestational diet, using repeated 24 h dietary recalls (24-HDRs). Energy and nutrient intake was compared with average requirements (AR) and with lower limit of intakes (LI) as defined in NNR. The recommended intakes (RI) for

planning diets for groups are referred to and level of underreporting was evaluated.

Materials and methods

Subjects and study design

During 14 non-consecutive days in October 2005, 108 pregnant women attending the obstetrics office at a hospital in Västerbottens County, Northern Sweden, for a routine ultrasound examination were asked to participate in a study on food intake. (Women in Sweden are offered an ultrasound examination around gestational week 18 to establish the number of foetuses and to set a more exact date for delivery. The presence of possible defects in the foetus is also looked for during the ultrasound). A verbal introduction and written information on the study were given. Two women were not eligible because of language difficulties and one with a previous eating disorder was excluded. Fifty-two women agreed to participate. Two women could not be reached and therefore 50 women completed the whole study. All women were in the second trimester, with a mean gestational period of 18.1 ± 1.1 weeks (Table 1). Fifty-three women did not participate because of a lack of time or interest, or for no specific reason. One lacto-ovo-vegetarian woman, who had left out the indication for the portion size of meat/fish in the 84-item FFQ, was omitted from the calculations, as not enough vegetarian foods, rich in protein, are represented.

One semi-quantitative FFQ and one basic questionnaire on occupation, living conditions, tobacco, snuff and alcohol use, physical activity, age, body weight and height were completed (Tables 1–3). The women were also informed about forthcoming 24-HDRs by telephone, and received a booklet for portion size estimations.

Table 1. Self-reported age, weeks of gestation, height and weight

	Mean \pm SD	Range
Age (years)	30.0 \pm 4.6	18.0 to 40.0
Weeks of gestation	18.1 \pm 1.1	15.0 to 21.0
Height (cm)	167 \pm 1	150 to 177
Pre-pregnant weight (kg)	65.1 \pm 10.5	46.0 to 89.1
Pre-pregnant BMI (kg m^{-2})	23.2 \pm 3.1	17.1 to 32.4
Mid-gestational weight (kg)	69.5 \pm 11.0	48.0 to 92.1
Weight change (kg)	4.5 \pm 2.9	-4.0 to 11.0

BMI: body mass index.

Table 2. Social characteristics

	Proportion	
	n	%
Ethnicity		
Swedish	46	92
Asian	3	6
Persian	1	2
Civil status		
Married	16	32
Cohabiting	34	68
Occupation before pregnancy		
Full-time worker	26	52
Student	10	20
Part-time worker (50–80%)	8	16
Sick-listed or unemployed	2	4
Other	4	8
Occupation at gestational week 18		
Full-time worker	25	50
Student	9	18
Part-time worker (50–80%)	6	12
Sick-listed or unemployed	3	6
Other	7	14
Children		
None	31	62
One or more	19	38

Table 3. Use of tobacco and alcohol before and during pregnancy

	Before pregnancy		During pregnancy	
	n	%	n	%
Smoking				
No	38	76	47	94
Yes	8	16	3	6
Quit >6 months ago	4	8		
Use of smokeless tobacco				
No	39	78	48	96
Yes	10	20	2	4
Quit >6 months ago	1	2		
Alcohol				
Never	5	10	49	98
A couple of times a year	11	22	0	0
Once or twice a month	22	44	0	0
Once a week	11	22	1	2
More than once a week	1	2	0	0

Recording of diet intake

A self-administered, validated FFQ (84-item) was used retrospectively to capture food intake in the year before pregnancy. The FFQ contained frequencies for food items on a nine-level scale (never

to four or more times a day). Portion sizes are illustrated by four photos, showing amounts of food. For each component on the plate (potatoes/rice/pasta, meat/fish and vegetables), an additional four-level scale was given to register the individual intake of these components. The population used for validation of the FFQ was randomly selected from 30–60-year-old women and men participating in a population intervention project (12). For example, for the women, the Pearson correlation coefficient for vitamin C was 0.51 (0.35–0.64), for vitamin E 0.45 (0.28–0.60), for calcium 0.47 (0.30–0.61) and for iron 0.43 (0.24–0.57) (13).

To capture food intake at mid-gestation, two 24-HDRs per participant were performed by telephone. The time span between recruitment at the obstetrics clinic and completion of the second 24-HDR was on average 4.2 weeks, i.e. food intake was recorded at gestational weeks 18–22.2. The women were called without prior notification and asked to describe what they had eaten and drunk during the preceding 24 h. Each telephone interview took about 20 min. Seventy per cent of the interviews took place on weekdays and 30% on Saturdays or Sundays. Matmallen (“food template”), a booklet with photographs and drawings of various foods and dishes, was used to describe portion sizes, and standard household measures or package sizes were used for food items that were not included (National Food Administration, Uppsala, Sweden) (14). Energy and nutrient intake was calculated using the software Dietist XP (Kost och näringsdata, Stockholm, Sweden), which uses the National Food Administration’s food database 04.1.1 (Uppsala, Sweden).

Considering reported intake

Nutrient intake was studied by comparing the results with AR and LI (the lower intake levels used for evaluation of a dietary survey) as well as RI for planning diets (10). Possible underreporting of EI in the pregestational diet was evaluated by comparing the EI/BMR to the estimated physical activity level (PAL). The women reported activity in their spare time on a five-level scale. These five levels were transformed into two categories: sedentary or light active lifestyle, and active or moderately active lifestyle. The mean PALs for these two groups were used (1.55 and 1.85) for comparison with EI/BMR (10). These calculations can only be

used in non-pregnant women since there is a lack of BMR equations for pregnant women.

Statistical analysis

SPSS version 13.0 (Statistical Package for Social Sciences; SPSS, Chicago, IL, USA) was used for statistical analyses. Data are presented as means and standard deviations (SD). The study was approved by the Regional ethical review board in Umeå, Sweden.

Results

Energy and nutrient intake before and at mid-gestation

The reported EI, as well as energy percentage ($E\%$) from carbohydrates, protein and fat, before pregnancy ($n=49$) and at mid-gestation ($n=50$) are presented as means in Table 4. The EI corresponded to 84% of NNR both before and at mid-gestation. Underreporting was assessed by comparing EI/BMR with PAL, and the ratio of 0.79 confirmed that underreporting most probably existed. Intake figures were therefore corrected, assuming 20% underreporting.

Nutrient level, except for selenium, was sufficient when referring to AR, and only a few participants fell below LI (Table 4).

Relative to the recommendations for planning a diet (% of RI), the studied women had low intakes of folate, vitamin D, selenium, vitamin E and iron both before and at 18–22 weeks of pregnancy (Table 4). When assuming a 20% underreporting before pregnancy, the recommendation for vitamin E and iron intake was met, but intake of folate, selenium and vitamin D remained below RI for non-pregnant women. When recalculating for the assumed 20% underreporting during pregnancy, mean intakes of folate, vitamin D, selenium, vitamin E and iron were still below RI.

Intakes were also expressed as nutrient densities (amount per MJ) and were shown to be lower than RI for folate, vitamin D and selenium in the pregestational diet, and for folate, vitamin D and iron at mid-gestation (Table 5).

Diet supplements

Eighteen of the women (36%) took some kind of supplement (vitamins and/or minerals) before conception, which increased to 33 (66%) at mid-gestation. None of the women took folate supplementation before, and only six (12%) during

Table 4. Dietary intake before pregnancy (84-item food-frequency questionnaire) and at mid-gestation (repeated 24 h dietary recall) presented as mean intakes per day corrected for 20% underreporting and as a percentage of average requirement (AR) and recommended intake (RI) according to Nordic Nutrition Recommendations (NNR, 10); number of subjects falling below the lower intake (LI) is also given

	Intake before pregnancy				Intake at mid-gestation				NNR		
	Mean \pm SD (range)	% of AR	% of RI	No. below LI/total	Mean \pm SD (range)	% of AR	% of RI	No. below LI/total	AR	LI	RI non-pregnant/pregnant
Energy (kcal)	1852 \pm 751 (1116–6087)				2104 \pm 583 (945–3627)						
Energy (MJ)	7.75 \pm 3.14 (4.67–25.49)				8.81 \pm 2.44 (3.96–15.19)						
Carbohydrates (E%)	48.1 \pm 5.3				51.1 \pm 6.6						
Protein (E%)	14.6 \pm 2.1				16.8 \pm 2.4						
Fat (E%)	35.9 \pm 5.4				32.1 \pm 6.4						
Folate (μ g)	225 \pm 91 (106–628)	113	56	0/49	260 \pm 80 (121–472)	130	52	0/50	200	100	400 ^a /500
Selenium (μ g)	25 \pm 16 (9–117)	83	63	23/49	40 \pm 20 (14–116)	133	73	5/50	30	20	40/55
Vitamin D (μ g)	5.5 \pm 2.2 (2.5–14.7)	–	73	0/49	5.6 \pm 4.5 (1.6–27.6)	–	56	5/50	NA	2.5 ^b	7.5/10
Vitamin E (μ g) ^c	7 \pm 3 (4–26)	140	86	0/49	8 \pm 4 (4–25)	160	82	0/50	5	3	8/10
Iron (mg)	15 \pm 7 (8–57)	150	98	0/49	12 \pm 8 (3–38)	120	80	3/50	10	5 ^d	15/15 ^e
Calcium (mg)	883 \pm 343 (326–1746)	–	110	2/49	1203 \pm 600 (506–3932)	–	134	0/50	NA	400	800/900
Vitamin C (mg)	86 \pm 39 (14–198)	172	114	0/49	126 \pm 63 (23–278)	252	148	0/50	50	10	75/85
Riboflavin (μ g)	1.6 \pm 0.7 (0.8–4.3)	145	123	1/49	–	–	–	–	1.1	0.8	1.3/1.6
Vitamin B ₆ (mg)	2.0 \pm 1.0 (1.1–7.5)	200	156	0/49	2.0 \pm 0.7 (0.9–3.8)	200	135	0/50	1.0	0.8	1.3/1.5
Vitamin B ₁₂ (μ g)	4.4 \pm 2.2 (1.1–13.7)	314	220	0/49	5.9 \pm 3.4 (2.0–19.0)	421	298	0/50	1.4	1	2.0/2.0
Zinc (mg)	–	–	–	–	11 \pm 4 (5–24)	275	127	0/50	4	5	7/9
Magnesium (mg)	–	–	–	–	324 \pm 104 (172–608)	–	117	–	NA	NA	280/280
Phosphorus (mg)	–	–	–	–	1527 \pm 565 (718–3654)	339	220	0/50	450	300	600/700

^a Women of reproductive age.

^b Primarily for individuals >60 years of age.

^c α -Tocopherol equivalents; 1 α -tocopherol equivalent (α -TE) = 1 mg RRR- α -tocopherol.

^d A lower limit cannot be given for women of fertile age without considering the woman's iron status.

^e Iron balance during pregnancy requires iron stores of approximately 500 mg at the start of pregnancy. The physiological need of some women for iron cannot be satisfied during the last two-thirds of pregnancy with food only, and supplemental iron is therefore needed (NNR, 10).

NA: information not available.

Table 5. Intake of micronutrients (amount per MJ) before pregnancy and at mid-gestation

	Intake before pregnancy		Intake at mid-gestation	
	Mean (95% CI)	% of NNR	Mean (95% CI)	% of NNR
Folate (μg)	29 (27–32)	64 ^a	30 (27–33)	68 ^a
Selenium (μg)	3.1 (2.9–3.3)	78 ^a	4.5 (4.0–4.9)	125
Vitamin D (μg)	0.71 (0.66–0.76)	70 ^a	0.6 (0.5–0.7)	60 ^a
Vitamin E (μg)	0.88 (0.84–0.92)	100	0.9 (0.8–1.0)	100
Iron (mg)	1.86 (1.79–1.94)	119	1.4 (1.2–1.6)	81 ^a
Calcium (mg)	116 (106–125)	116	133 (122–144)	134
Vitamin C (mg)	11 (10–13)	138	15 (12–18)	200
Riboflavin (μg)	0.21 (0.19–0.22)	100	–	–
Vitamin B ₆ (mg)	0.25 (0.24–0.26)	192	0.24 (0.21–0.26)	177
Vitamin B ₁₂ (μg)	0.57 (0.52–0.62)	300	0.7 (0.6–0.8)	335
Zinc (mg)	–	–	1.3 (1.2–1.4)	116
Magnesium (mg)	–	–	37 (35–40)	106
Phosphorus (mg)	–	–	172 (163–181)	215

^a Levels below NNR (10).

–: No information from data program used.

pregnancy. Iron was taken by 16% before and 30% during pregnancy and multivitamins by 34% before and 54% during pregnancy. Supplements were not considered in the calculations of nutrient intakes.

Discussion

This study on a small group of women indicates that the nutrient intake is sufficient when referring to AR. As deficiencies may affect the outcome of the pregnancy, however, it seems appropriate to evaluate the intakes in relation to RI, set to meet the requirement of “practically all healthy people”, to be used for planning of diets (10). From this perspective, the most striking result from this study was the considerably lower than recommended intakes of folate and vitamin D, both before and during pregnancy, even when probable underreporting was taken into account. This was true regarding both total amounts and nutrient densities. Both folate and vitamin D are considered to have profound effects on pregnancy outcome, as well as on maternal health. (6, 7).

Besides this, not all women were safe according to LI levels defined in NNR. Surprisingly, more than half of the women before pregnancy were below LI for selenium. At mid-gestation five women were below LI for vitamin D and selenium. This indicates that evaluation of diet during pregnancy is difficult and should include many aspects.

The level of intake before and during pregnancy needs to be secured. Is the level of recommended

intake realistically achievable solely by improving dietary patterns, or should supplementation be recommended? Poor compliance in taking pills may limit the improvement in nutritional status and highlights the need for fortification. Something to consider regarding nutrient intake recommendations, however, is that they can differ considerably between countries. There is, for example, a two-fold difference in recommended folate intake between Sweden and the UK (11). With regard to vitamin D recommendations, this vitamin is not only obtained from the diet, but also produced in the skin by sun exposure (6). Since the winter, with less light, in Sweden is quite long, relatively more vitamin D is needed from food. Almost all milk with up to 1.5% fat content is fortified with vitamin D in Sweden (15), and included in the intake data.

Absolute intakes (mg day^{-1}) and nutrient density (mg MJ^{-1}) of iron were low at mid-gestation. Considering AR, the level of iron intake was sufficient. A concern may be that the two 24-HDRs in the present study may be insufficient to capture the true intake for some of the nutrients (e.g. iron and vitamin D). A pregnant woman is claimed to need a preconception iron depot of about 500 mg and a satisfactory intake during the entire pregnancy to maintain what is considered an optimal iron status (10, 16). This has been found difficult to obtain through the diet, and most women in Sweden are recommended to take iron supplements during the later part of pregnancy.

A certain degree of selection bias cannot be excluded as the proportion that did not consent to participate was rather high (50%). Compared with the most recent statistics from 2004, women who participated coincided in age with pregnant women in the studied area (on average 30.0 years old). The percentage of smokers during pregnancy was 5.9% in the studied group compared with 5.6% among pregnant women in Västerbottens County in 2004 (17).

The FFQ used has a good reproducibility when used twice, 1 year apart, indicating a power to monitor intake retrospectively for at least a year and an estimated validity similar to that of FFQs in most cohort studies (13). The weaknesses of using a FFQ are that the list of foods or food aggregates must be limited, and that there is a risk of not remembering the average intake for the last year (18). In addition, recent intake can also influence the reporting (19). To monitor present diet at mid-gestation repeated 24-HDRs were used. These two methods were selected since they require comparatively little effort from the participant and thereby favour recruitment of participants who complete the study.

The present finding, that reported energy intakes were approximately 20% below estimated average energy requirements, regardless of method used and regardless of pregnancy status, is in agreement with previous reports (18). In addition, the ratio between EI/BMR and PAL before pregnancy indicates an underreporting of 20%. The underreporting may affect most food consumed and not only single food items. The omission of sugar and fat-rich food in the reported diet in this group of women is, in the authors' view, not the main reason for underreporting.

Out of concern for the foetus, as well as the mother, energy and nutrient intake should be balanced during pregnancy. However, a positive energy balance and increasing body weight do not per se guarantee a proper nutritional status. At present, dietary advice given to pregnant women in Sweden focuses on "not overeating energy" and how to meet the need for iron and calcium. According to the present study there is a need to expand this focus and include selenium, folate and vitamin D too. Folate fortification has been introduced in several countries (20, 21). Recently, the Swedish Council on Technology Assessment in Health Care presented an evaluation report concerning whether to fortify flour with

folate in Sweden. Their conclusion was that they could not recommend fortification based on their basic scientific data for decision making (22). In the present study selenium, calcium and vitamin C density were higher, and iron was lower at mid-gestation compared with the densities of these nutrients before gestation. This indicates that food selection can be improved to meet requirements, i.e. by increasing intake of foods with high densities of, for example, folate and vitamin D, rather than increasing energy intake in general.

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