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Changes in dietary intake from the first to the second trimester of pregnancy

Sheryl L. Rifas-Shiman^a, Janet W. Rich-Edwards^{a,b}, Walter C. Willett^c, Ken P. Kleinman^a, Emily Oken^a, and Matthew W. Gillman^c

^aDepartment of Ambulatory Care and Prevention, Harvard Medical School and Harvard Pilgrim Health Care,

^bDepartment of Epidemiology and

^cNutrition, Harvard School of Public Health, Boston, MA, USA

Summary

Rifas-Shiman SL, Rich-Edwards JW, Willett WC, Kleinman KP, Oken E, Gillman MW. Changes in dietary intake from the first to the second trimester of pregnancy.

Maternal diet may influence outcomes of pregnancy and childhood. Diet in the first trimester may be more important to development and differentiation of various organs, whereas diet later in pregnancy may be important for overall fetal growth as well as for brain development. To our knowledge, no studies have examined individual-level changes in food and nutrient intake from the 1st to 2nd trimester of pregnancy. The objective of this study was to examine changes in dietary intake from the 1st to 2nd trimester of pregnancy. As part of the ongoing US prospective cohort study, Project Viva, we studied 1543 women who completed food-frequency questionnaires that assessed dietary intakes during the 1st and 2nd trimester of pregnancy. For both foods and energy-adjusted nutrients, we examined changes in dietary intake from 1st to 2nd trimester.

Reported mean energy intake was similar for the 1st (2046 kcal) and 2nd (2137 kcal) trimesters. Foods and energy-adjusted nutrients from foods whose overall mean intakes increased more than 5% from 1st to 2nd trimester were skim or 1% dairy foods (22%), whole-fat dairy foods (15%), red and processed meat (11%), saturated fat (6%) and vitamin D (7%). Intake of caffeinated beverages (−30%) and alcoholic beverages (−88%) decreased more than 5%. Because mean multivitamin intake increased by 35% from the 1st to 2nd trimester, total micronutrient intake increased appreciably more than micronutrient intake from foods only. Correlations across trimesters ranged from 0.32 for vitamin B12 to 0.68 for fruit and vegetables.

In conclusion, for many outcomes of pregnancy and childhood, the incremental information obtained from assessing complete diet in both early and late pregnancy may not outweigh the burden to participants and investigators. However, investigators should assess caffeine, alcohol, and vitamin and supplement use in both the 1st and 2nd trimester, and consider doing so for foods and nutrients for which trimester-specific hypotheses are well substantiated.

Keywords

pregnancy; maternal diet; nutrients; dietary supplements; changes in pregnancy

Introduction

Maternal dietary factors may influence outcomes of pregnancy, such as length of gestation, fetal growth, birth defects, pre-eclampsia, and of childhood such as cognitive development, blood pressure, adiposity and atopic disease.^{1–11}

Diet in the 1st trimester may be more important to development and differentiation of various organs, whereas diet later in pregnancy may be important for overall fetal growth as well as for brain development.¹¹ Women might change their dietary intake patterns during pregnancy after they learn that they are pregnant, after they receive counselling at their initial prenatal visit, or because nausea or vomiting tend to resolve after the 1st trimester. To our knowledge, however, no studies have examined changes in diet from the 1st to 2nd trimester of pregnancy.

Knowing how diet changes during pregnancy may help investigators decide when to assess dietary intake and whether multiple dietary assessments are needed. If a specific dietary exposure changes appreciably throughout pregnancy, investigators may need to target a critical or sensitive period during gestation. But for large epidemiological studies with multiple dietary exposures and outcomes of interest, diet assessments at more than one period during pregnancy can be burdensome and expensive. Thus, it is of interest to assess how much pregnant women change their diets from early to later pregnancy.

The purpose of this analysis was to examine overall and individual changes in food and nutrient intake from the 1st to 2nd trimester of pregnancy.

Methods

Study design and participants

We recruited participants into Project Viva at eight offices of Harvard Vanguard Medical Associates, a large multi-specialty urban/suburban group practice in eastern Massachusetts, USA. At the first study visit, which immediately followed the woman's initial clinical prenatal visit, we obtained informed consent, administered a brief interview, and provided a take-home self-administered questionnaire, including a validated 166-item semi-quantitative food-frequency questionnaire (FFQ) assessing the woman's diet since her last menstrual period.¹² At the second study visit, which occurred at 26–28 weeks' gestation, we again administered a brief interview and provided a questionnaire that included a similar FFQ querying dietary intakes during the preceding 3 months.

Exclusion criteria included multiple gestation, inability to answer questions in English, plans to move out of the area before delivery, and gestational age > 22 completed weeks at initial prenatal clinical appointment. Additional details of recruitment and follow-up have been presented elsewhere.¹³ Among 2128 participants who delivered infants in Project Viva, 1777 (84%) completed the 1st trimester FFQ and 1666 (78%) completed the 2nd trimester FFQ. For this analysis, we included the 1543 (73%) participants who completed both 1st and 2nd trimester diet assessments. Internal review boards of Harvard Pilgrim Health Care, Brigham and Women's Hospital, and Beth Israel Deaconess Medical Center approved the study protocols.

Measurements

Data were obtained directly from participants and from medical records as detailed previously.¹³ Briefly, at the first visit in early pregnancy, in addition to diet assessment, we obtained information on maternal age, last menstrual period, race/ethnicity, education, marital status, gravidity, height, pre-pregnancy weight, household income, nausea status, cravings and

aversions. At the second visit in mid-pregnancy, many of these variables were updated and a second dietary assessment was performed.

Maternal diet assessment at both the first and second visits was by means of a semi-quantitative FFQ, slightly modified for use in pregnancy from the extensively validated FFQ used in the Nurses' Health Study and other large cohort studies.

Modifications for use in pregnancy included changing the time referent, beverage section, and vitamin and supplement assessment. The FFQ used at the first visit reflected intakes in the 1st trimester; the time referent was 'during this pregnancy', that is, from the date of the last menstrual period until the assessment. In addition, we collected information on beverage intake including alcoholic and caffeinated beverages, during two specified time periods: before and after the participant learned that she was pregnant. To assess vitamin and supplement intake during the 1st trimester, we administered a separate interview that queried dose, duration, and brand/type of multivitamin, prescribed prenatal vitamin, and supplements. The FFQ used at the second visit (26–28 weeks of gestation) reflected intakes during the 2nd trimester; the time referent was 'during the past 3 months'. The 2nd trimester instrument was the same as the 1st trimester except that we assessed use of vitamins/supplements as part of the self-completed FFQ and we collected beverage information during the one time period. To calculate intake of nutrients, we used the Harvard nutrient composition database used for the Nurses' Health Study and other large cohort studies.¹⁴

In a pilot study of 72 African American and 132 Caucasian pregnant women, we biochemically calibrated this FFQ, which has been extensively validated in non-pregnant adults.^{12,14} For eight categories of intake of fatty acids, carotenoids and γ -tocopherol estimated by the FFQ (energy-adjusted deciles 1, 2, 3, 4+5, 6+7, 8, 9, 10), we compared measurements of the corresponding nutrient level in pooled blood specimens from all participants in each category. We observed substantial differences in biomarker concentrations across levels of dietary intake for α -carotene, lycopene, lutein and zeaxanthin, γ -tocopherol, long-chain n-3 fatty acids and *trans*-fatty acids, but not for α linolenic acid.¹²

Data analysis

The main outcome measures included servings per day of selected foods and food groups, frequency of vitamin use, and daily intakes of selected nutrients from foods. We also examined daily intakes of selected nutrients from foods plus supplements. We used the nutrient residuals method to energy-adjust micronutrients.¹⁵

We calculated mean servings per day of foods and food groups and mean daily intakes of nutrients during each of the two trimesters. We then calculated the percentage of change in overall means (2nd FFQ – 1st FFQ/1st FFQ) as well as absolute individual changes (means and 2.5th – 97.5th percentile ranges) from the 1st to 2nd trimester. To assess individuals' 'tracking' from 1st to 2nd trimester, we also computed correlation coefficients for each food and food group and energy-adjusted nutrient. We used non-parametric correlation coefficients (Spearman) for foods and food groups because some of the distributions were not normal. For nutrients we used Pearson correlation coefficients because they were normally distributed. For each food and nutrient, we also ranked participants into quartiles at each of the two time points and calculated the proportions of participants who fell into the same quartile, or increased or decreased by one, two or three quartiles. All analyses were performed using SAS version 8.2 (SAS Institute, Cary, NC).

Results

Of the 1543 pregnant women included in this study, 25% classified themselves as belonging to racial/ethnic minorities (Table 1).

Reflective of a generally employed and insured managed care population, few participants had less than a high school education or had annual household incomes below \$20 000. Mean [standard deviation (SD)] age at enrolment was 32.4 (4.7) years and mean (SD) pre-pregnancy body mass index (BMI) was 24.5 (5.2) kg/m². Compared with participants in the entire cohort, participants in this analysis had higher educational status (72% in this analysis vs. 65% in the entire cohort completed a college degree or more) and comprised more whites (75% in this analysis vs. 66% in the entire cohort), but were similar in household income, marital status, nausea status, age and BMI. Eighty-six per cent felt nauseated during the 1st trimester. Among participants who felt nauseated, 61% felt nauseated for seven consecutive days in a row and 81% reported changing eating or drinking habits during the 1st trimester because of feeling nauseated. About half of the participants reported having new cravings (58%) or new aversions (55%) for particular foods or beverages during the 1st trimester.

First and 2nd trimester total energy intakes were 2046 kcal and 2137 kcal respectively. Overall means that increased at least 5% from the 1st to 2nd trimester included skim or 1% dairy foods (22%), whole-fat dairy foods (15%), and red and processed meat (11%), while we observed decreases in caffeinated beverages (−30%) and alcoholic beverages (−88%) (Table 2). The mean number of multi- or prenatal vitamins consumed per day increased by 35%.

While overall mean food intakes tended not to change appreciably, there was a moderate change in individuals' food intakes from the 1st to 2nd trimester. Such change over time was reflected both in the means and ranges of absolute individual change, as well as in the modest magnitude of the correlation coefficients. Spearman correlation coefficients (*r*) for the selected foods and food groups ranged from 0.39 for alcoholic beverages to 0.68 for fruits and vegetables (Table 2).

We observed similar findings for nutrient intakes from foods. Overall means that increased at least 5% from the 1st to 2nd trimester included saturated fat (6%) and vitamin D (7%). Including nutrients from vitamins and supplements in addition to foods, however, revealed that intake of many micronutrients intakes increased substantially from the 1st to 2nd trimester. For example, iron intake increased by 45% and folate increased by 31%.

As we saw for foods and food groups, while overall means of nutrient intakes from foods did not change appreciably from the 1st to 2nd trimester, individual changes showed moderate change over time. Such change was reflected both in the means and ranges of absolute individual change, as well as in the modest magnitude of the correlation coefficients. Pearson correlation coefficients (*r*) for energy-adjusted daily nutrient intake from foods, not including supplements, ranged from 0.32 for vitamin B12 to 0.67 for fibre (Table 3).

Figure 1 shows individual relative changes in quartiles of foods and food groups from the 1st to 2nd trimester. About 50% of participants stayed in the same quartile. About 37% of participants increased or decreased by one quartile, and about 10% increased or decreased by two quartiles. Few participants changed from the lowest to highest quartile or vice versa. For example, 0.8% (*n* = 13) of participants decreased fruit and vegetable intake from the highest to lowest quartile, and 0.5% (*n* = 8) increased from the lowest to highest quartile. Similarly, for nutrients, about 45% of participants stayed in the same quartile from the 1st to 2nd trimester, and few participants changed from the lowest to highest quartile or vice versa (Fig. 2).

For the 1st trimester FFQ, we assessed alcoholic and caffeinated beverage intake during two specified time periods: before and after the participant learned that she was pregnant. The mean (SD) number of alcoholic beverages per week was 2.6 (3.3) [median = 1] and 0.1 (0.4) respectively. For caffeinated beverages the mean (SD) number per day beforehand was 1.4 (1.3) and afterwards was 0.4 (0.7). Correlation coefficients for the comparison of alcoholic and caffeinated beverages before and after learning of the pregnancy were 0.24 and 0.51 respectively. Second trimester intakes of alcoholic and caffeinated beverages were very similar to 1st trimester after participants learned that they were pregnant [mean (SD) number of alcoholic beverages per week was 0.1 (0.5) and mean (SD) number of caffeinated beverages per day was 0.6 (0.8) in the 2nd trimester]. Correlation coefficients for the comparison of alcoholic and caffeinated beverages from the 1st trimester after participants learned that they were pregnant with 2nd trimester values were 0.43 and 0.70 respectively.

Discussion

To our knowledge, this is the first study to examine changes in dietary intake from the 1st to 2nd trimester of pregnancy. Overall means of foods and energy-adjusted nutrients from foods did not change greatly. Only skim or 1% dairy foods, whole-fat dairy foods, red and processed meat, saturated fat and vitamin D increased by at least 5% from the 1st to 2nd trimester. Including nutrients from vitamins and supplements in addition to foods, however, revealed that intake of many micronutrient intakes increased substantially from the 1st to 2nd trimester.

In contrast, we observed moderate changes on an individual level. Only about 50% of participants stayed in the same quartile for foods and 45% for nutrients from the 1st to 2nd trimester. Spearman correlation coefficients (r) for the selected foods and food groups ranged from 0.39 for alcoholic beverages to 0.68 for fruits and vegetables. Pearson correlation coefficients (r) for energy-adjusted daily nutrient intakes from foods ranged from 0.32 for vitamin B12 to 0.67 for dietary fibre.

In any comparison of individual questionnaire exposures over time, lack of perfect correlation reflects both measurement error and true changes in diet. One way to assess the magnitude of the individual changes from 1st to 2nd trimester is to compare our correlation coefficients with those of reproducibility studies using a similar FFQ. Colditz *et al.*¹⁶ compared frequencies of foods reported by 1497 non-pregnant women at an interval of approximately 9 months. Correlations were approximately 0.5–0.6 for foods and food groups that we examined, similar to our correlations. Willett *et al.*¹⁷ examined the reproducibility of a 61-item FFQ administered twice to 173 women at an interval of one year. Correlations were about 0.6 for nutrients that we examined, similar to our correlations. Those reproducibility studies were over 9–12 months while ours was over 3 months. Their correlations might have been higher over a 3-month interval. If this assumption were true, then we would infer that an individual's diet is more likely to change during pregnancy than at other times. Unfortunately, direct comparison data do not exist for 3-month intervals in non-pregnant women.

Rogers *et al.*¹⁸ assessed vitamin and supplement intake during early pregnancy, at 18 weeks gestation and at 32 weeks gestation in the ALSPAC Study, a cohort of 11 923 pregnant women in south-west England. They found that iron supplementation increased from 22.5% to 42.9% and folate supplementation increased from 9.0% to 18.3%, but unlike our findings, multivitamin use in ALSPAC decreased from 16.4% during early pregnancy to 11.6% later in pregnancy.

Brown *et al.*¹⁹ examined changes in nutrient intake from pre-pregnancy to mid-pregnancy as assessed by FFQs relative to food records among 56 participants in the DIANA Project. Correlation coefficients for the comparison of change measured by FFQs with change

measured by food records averaged 0.48 suggesting that an FFQ can detect pregnancy-related changes in dietary intake for a number of selected nutrients.

Our study has several strengths, including a relatively large sample size, information on foods and supplements as well as nutrients, and information on beverage intake before and after the participant learned that she was pregnant. While the relatively high socio-economic position of our participants probably increases the accuracy with which we are able to measure change in diet from the 1st to the 2nd trimester, the degree of dietary change might not be generalisable to other populations. Additionally, as with all survey data, diet was self-reported and thus may under- or overestimate true intake.

In conclusion, overall means of food and energy-adjusted nutrient intakes from foods alone did not change appreciably from the 1st to 2nd trimester. Including nutrients from vitamins and supplements in addition to foods, however, revealed that intake of many micronutrients increased substantially from the 1st to 2nd trimester. For studies examining food-related behaviours, investigators might use nutrients from foods, and for studies examining diet–disease associations, investigators might use total nutrient intakes. For many outcomes of pregnancy and childhood, however, the incremental information obtained from assessing complete diet in both early and late pregnancy may not outweigh the burden to participants and investigators. Nonetheless, investigators should assess caffeine, alcohol, and vitamin and supplement use in both the 1st and 2nd trimester, and consider doing so for foods and nutrients for which trimester-specific hypotheses are well substantiated.

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Figure 1. Individual changes in quartiles of intakes of foods and food groups from the 1st to 2nd trimester of pregnancy. Data from 1543 women participating in Project Viva.

Figure 2.

Individual changes in quartiles of intakes of energy-adjusted nutrients from foods, not including supplements, from the 1st to 2nd trimester of pregnancy. Data from 1543 women participating in Project Viva. *Percentage of energy. fas, fatty acids.

Table 1
 Characteristics of 1543 pregnant women participating in Project Viva

Characteristic	Mean (SD, range)
Age (years)	32.4 (4.7, 15.5–44.9)
Pre-pregnancy BMI (kg/m ²)	24.5 (5.2, 15.2–50.1)
GA at completion of 1st trimester FFQ (weeks)	11.7 (3.1, 5.6–29.7)
GA at completion of 2nd trimester FFQ (weeks)	29.2 (2.4, 16.9–40.1)
Race/ethnicity	No. (%)
White	1152 (75)
Black or African American	165 (11)
Hispanic or Latina	83 (5)
Asian	90 (6)
Other/more than one race	53 (3)
Highest grade level completed	
Less than high school or high school diploma	120 (8)
Some college/tech school	312 (20)
College graduate	594 (39)
Postgraduate degree	517 (34)
Marital status	
Married or cohabitating	1453 (94)
Divorced/separated/never married/other	89 (6)
Number of previous pregnancies:	
0	498 (32)
≥1	1044 (68)
Household income (\$)	
20 000 or less	38 (3)
20 001–40 000	115 (8)
40 001–70 000	342 (23)
More than 70 000	956 (64)
Don't know	39 (3)
Asked at 1st trimester	
Had any new cravings for particular foods or beverages	887 (58)
Had any new aversions for particular foods or beverages	849 (55)
Felt nauseated during this pregnancy	1330 (86)
Felt nauseated for seven consecutive days	814 (61) ^a
Changed eating or drinking habits because of feeling nauseated	1078 (81)

^aPercentage of all those who had felt nauseated.

BMI, body mass index; FFQ, food-frequency question; GA, gestational age.

Table 2

Intake of selected foods and food groups during the 1st trimester, 2nd trimester and individual changes from the 1st to 2nd trimester. Data from 1543 women participating in Project Viva

Foods and food groups	1st trimester Mean (SD)	2 nd trimester Mean (SD)	% change in overall mean	Absolute value of individual change from 1st to 2nd trimester			Spearman <i>r</i>
				Mean (SE)	2.5th – 97.5th percentile range	% of 1st trimester mean	
Fruits and vegetables ^a	5.8 (2.9)	5.9 (2.9)	1.5	1.6 (0.0)	0.1, 5.3	28	0.68
Whole grain ^a	1.2 (1.2)	1.2 (1.2)	-0.4	0.7 (0.0)	0.0, 2.9	58	0.62
Fish ^b	1.7 (1.5)	1.7 (1.6)	-0.9	0.9 (0.0)	0.0, 4.0	53	0.61
Skim or 1% dairy foods ^a	1.4 (1.3)	1.7 (1.9)	22.4	1.3 (0.0)	0.0, 4.6	94	0.47
Whole-fat dairy foods ^a	1.3 (1.1)	1.5 (1.1)	14.9	0.7 (0.0)	0.0, 2.4	51	0.64
Red and processed meat ^b	3.6 (3.0)	4.0 (3.1)	11.1	1.8 (0.1)	0.0, 7.5	49	0.66
Fried food away from home ^b	0.9 (0.8)	0.9 (0.8)	-0.4	0.4 (0.0)	0.0, 2.0	40	0.49
Sugar-sweetened beverages ^a	0.6 (0.8)	0.6 (0.8)	-1.0	0.4 (0.0)	0.0, 2.5	72	0.62
Caffeinated beverages ^a	0.9 (0.9)	0.6 (0.8)	-29.8	0.5 (0.0)	0.0, 2.1	57	0.63
Alcoholic beverages ^b	1.2 (1.6)	0.1 (0.5)	-87.7	1.1 (0.0)	0.0, 5.4	91	0.39
Multi- or prenatal vitamins ^b	5.0 (3.2)	6.7 (2.3)	35.1	2.6 (0.1)	0.2, 7.4	52	0.32

^a Servings per day.

^b Servings per week.

Table 3

Energy-adjusted daily nutrient intake during the 1st trimester, 2nd trimester and individual changes from the 1st to 2nd trimester. Data from 1543 women participating in Project Viva

Nutrient	1st trimester Mean (SD)	2nd trimester Mean (SD)	% change in overall mean	Absolute value of individual change from 1st to 2nd trimester			Pearson <i>r</i>
				Mean (SE)	2.5th – 97.5th percentile range	% of 1st trimester mean	
Nutrients from foods only, not including supplements							
	2047 (655)	2137 (640)	4.4	408.9 (9.3)	15.5, 1344	20	0.65
Total energy (kcal)							
% energy from							
Protein	17.5 (3.0)	17.6 (2.8)	0.4	2.1 (0.0)	0.1, 6.3	12	0.55
Carbohydrates	55.4 (7.3)	54.5 (7.1)	−1.6	4.8 (0.1)	0.2, 15.5	9	0.60
Trans-fatty acids	1.0 (0.3)	1.0 (0.3)	3.0	0.2 (0.0)	0.0, 0.7	22	0.62
N-3 fatty acids	0.5 (0.2)	0.5 (0.2)	4.0	0.1 (0.0)	0.0, 0.5	28	0.45
N-6 fatty acids	5.3 (1.4)	5.5 (1.5)	3.9	1.0 (0.0)	0.0, 3.4	19	0.52
Saturated fat	10.5 (2.5)	11.1 (2.6)	5.9	1.7 (0.0)	0.1, 5.3	16	0.64
Glycaemic index	759 (137)	746 (133)	−1.7	99.1 (2.3)	4.5, 319.0	13	0.52
Fibre (g)	19.9 (5.7)	19.5 (6.2)	−2.0	3.4 (0.1)	0.1, 11.9	17	0.67
Iron (mg)	16.8 (5.8)	16.7 (5.9)	−0.4	3.8 (0.1)	0.1, 16.9	22	0.46
Folate (mcg)	367 (131)	367 (134)	−0.2	89.7 (2.6)	2.8, 319.9	24	0.48
Zinc (mg)	12.2 (3.9)	12.5 (4.0)	2.5	2.3 (0.1)	0.1, 12.3	19	0.38
Calcium (mg)	1118 (347)	1168 (344)	4.5	243.7 (5.5)	7.1, 800.0	22	0.57
Vitamin C (mg)	175 (72)	175 (72)	−0.1	52.9 (1.3)	2.0, 194.5	30	0.50
Vitamin D (IU)	216 (117)	230 (116)	6.6	79.1 (2.0)	1.9, 289.3	37	0.56
Vitamin B6 (mg)	2.2 (0.6)	2.2 (0.6)	−0.1	0.4 (0.0)	0.0, 1.7	18	0.46
	6.3 (4.1)	6.5 (4.0)	1.9	2.3 (0.1)	0.0, 13.0	37	0.32
Vitamin B12 (mcg)							
Nutrients from foods and supplements							
Iron (mg)	34.3 (17.0)	49.7 (25.0)	44.9	20.6 (0.6)	0.7, 89.6	60	0.23
Folate (mcg)	966 (401)	1270 (394)	31.4	439.6 (8.4)	18.2, 1216.2	45	0.34
Zinc (mg)	26.1 (10.9)	35.0 (10.8)	34.3	12.3 (0.3)	0.6, 32.9	47	0.30
Calcium (mg)	1320 (418)	1435 (387)	8.7	315.6 (7.3)	10.8, 1038.3	24	0.48
Vitamin C (mg)	278 (314)	281 (126)	1.2	103.7 (7.5)	2.2, 404.6	37	0.20
Vitamin D (IU)	504 (210)	602 (186)	19.4	182.0 (4.1)	4.1, 574.5	36	0.37
Vitamin B6 (mg)	5.2 (7.6)	5.3 (5.8)	1.4	2.5 (0.2)	0.0, 17.4	49	0.20
	11.9 (35.3)	10.6 (6.1)	−10.6	5.3 (0.9)	0.1, 21.6	45	0.11
Vitamin B12 (mcg)							