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Recall of Diet during a Past Pregnancy

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The authors conducted a study of women's ability to recall diet during a past pregnancy. For a prospective study, women completed self-administered food frequency questionnaires (FFQs) before and during pregnancy (1989–1992). These women, mostly White and well-educated, were contacted 3–7 years later (1996–1997) for a retrospective dietary assessment performed by either telephone interview (n = 154) or self-administered FFQ (n = 115). Energy-adjusted Pearson correlations ranged from 0.10 to 0.49 for the telephone interview group and from 0.02 to 0.67 for the self-administered questionnaire group. When participants' intakes were ranked, quintile agreement (within one quintile) between original diet and recalled diet ranged from 60% to 69% in the telephone interview group and from 69% to 79% in the self-administered questionnaire group. Correlations and percentages of agreement were higher among women who used the same questionnaire for both dietary assessments than among those who used different questionnaires. These results suggest that diet during pregnancy is recalled with similar accuracy as or perhaps slightly lower accuracy than adult diet generally. This may reflect, in part, the influence of current (nonpregnancy) diet on recall of past (pregnancy) diet. While the results of this study may not be generalizable to those obtained from other populations, to the authors' knowledge it is the first study of recall of diet during pregnancy. *Am J Epidemiol* 2001;154:1136–42.

diet surveys; pregnancy; recall; reproducibility of results

Maternal diet during pregnancy may play a role in the etiology of some congenital anomalies, childhood cancers, and conditions arising among offspring later in life (1–5). Many of these conditions are sufficiently rare that cohort studies are usually impractical. More feasible are case-control studies, which require that the mother recall her diet during a past pregnancy. For congenital anomalies, the time interval between the index pregnancy and the mother's diet recall may be short. For other conditions, such as childhood cancers, the interval can be much longer. In studies of childhood cancer, investigators have asked mothers about pregnancies that occurred up to 20 years in the past. There are virtually no data on how well pregnancy diet is recalled.

In preparation for a study of childhood brain tumors by the Children's Cancer Group, we conducted a methodological analysis to assess the ability of women to recall their dietary habits during a pregnancy that occurred several years previously. Here we report on the comparison of estimated nutrient intakes calculated from prospectively and retrospectively collected food frequency data and on whether the method of administration and minor differences in food items on the food frequency questionnaire (FFQ) affected the observed accuracy of recall.

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Abbreviations: FFQ, food frequency questionnaire; SAQ, self-administered questionnaire; SD, standard deviation.

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MATERIALS AND METHODS

Study population

Subjects for the study were selected from participants in the Diana Project, a prospective study of a variety of preconceptional and pregnancy exposures that may be related to reproductive outcomes (6). Participants were asked to complete an FFQ approximately each month while attempting to conceive and each month during the pregnancy. At initial recruitment, the women were 22–35 years of age, were planning to attempt pregnancy or had been attempting pregnancy for less than 3 months, and were members of Group Health, Inc., a health maintenance organization in the Minneapolis-St. Paul, Minnesota, metropolitan area. Women were excluded if they had a history of infertility, hypertension, diabetes mellitus, or kidney disease; if they had had more than one miscarriage; if they had had three or more voluntary abortions; or if they were planning to attempt pregnancy within 12 months of their most recent delivery. A cohort of 706 women were enrolled between October 1989 and March 1992 and had singleton livebirths.

The last participant completed the study in November 1993. A more detailed description of study recruitment and retention has been published elsewhere (6).

The current study was designed to assess recall by recontacting Diana participants and asking them to recall their diet during pregnancy. The women were recontacted in 1996 and 1997. We chose to focus on the second trimester, when women experience less nausea and are likely to have already made pregnancy-related changes in their diet. Excluded were 142 Diana participants with missing or incomplete second-trimester dietary intake data. The remaining 564 women were randomly assigned to receive either the same FFQ they had used during the Diana Project or a somewhat different FFQ administered by telephone. The institutional review boards of the Children's Hospital of Philadelphia and the University of Minnesota approved this research.

Of the 284 women assigned to the telephone interview FFQ group, 161 (57 percent) completed the interview, 18 (6 percent) actively refused to participate, 72 (25 percent) could not be located, 30 (11 percent) could not be interviewed before the study ended, and three (1 percent) were not interviewed for other reasons. In the self-administered FFQ group, 280 women were sent a self-administered questionnaire; 124 returned a completed questionnaire (44 percent), and one actively refused. For 23 women (8 percent), the questionnaires sent were returned as undeliverable. Of the remaining 132 women (47 percent), women who passively refused to participate and those whose questionnaires did not reach them because they had moved could not be distinguished. A total of 154 women in the telephone interview FFQ group and 115 women in the self-administered FFQ group had adequate data for both the original dietary assessment and the recalled dietary assessment and were included in the nutrient analyses.

FFQs

For the self-administered questionnaire (SAQ) group, subjects were mailed the same FFQ that they had completed for the Diana Project. In the Diana Project, the subjects had been asked to complete monthly FFQs detailing their food intake in the previous month during the time they were trying to conceive and while pregnant. The instrument used was the Willett FFQ, which contains 127 food items (6, 7).

For the interview group, trained interviewers administered an FFQ by telephone. This FFQ was a modification of the Willett FFQ that was used in a Children's Cancer Group study of maternal diet and risk of childhood brain tumors (unpublished data). In the study of childhood brain tumors, cured meats, fruits, and vegetables were of particular interest; fiber and types of fat consumed were of less interest. Therefore, the modifications included the addition of several nitrite-cured meats, the addition of separate items for in-season and out-of-season consumption of several seasonal fruits, and the omission of questions distinguishing between homemade and ready-made baked goods. The modified FFQ included 112 food and beverage items. For each item, the interviewer asked first about the subject's intake in the year prior to pregnancy and then about intake of the same item during the second trimester of pregnancy. In addition to the FFQ, the telephone interview administered to former Diana subjects included questions about the use of alcohol, cigarettes, and selected medications and the index child's early diet.

Data analysis

Estimated nutrient intakes were calculated from the original food intakes reported by the Diana women and from recalled food intakes, and they were based on diet only (i.e., not including supplements). For the Diana women, second-trimester food frequencies were estimated as the mean value of the intakes reported for months 4, 5, and 6 of pregnancy. For women who completed FFQs for only two of the three months of their second trimester, the mean of the values from the two completed FFQs was used. For women who completed only one FFQ during the second trimester, estimated intake was based on that single FFQ. Nutrient intakes were adjusted for energy intake using the regression method described by Willett and Stampfer (8).

The original and recalled nutrient intakes were compared separately for the telephone interview and SAQ groups. Mean differences for crude and energy-adjusted intakes were calculated as recalled intake minus original intake and were compared using paired t tests. Crude and energy-adjusted Pearson and Spearman correlation coefficients for correlations between original and recalled nutrient intakes were calculated. Subjects were also assigned to a quintile of intake based on their original diet and to another quintile based on their recalled diet. The proportions of subjects who fell into the same quintile, the next-highest quintile, or the next-lowest quintile in both the original dietary assessment and the recalled dietary assessment were compared with regard to selected nutrients. For exploration of the effect on recall of the time interval since pregnancy, correlations were calculated after stratification by the index child's current age.

Pearson and Spearman correlation coefficients were similar, and only Pearson coefficients are presented. Logarithmic transformation of nutrient intakes did not substantially affect the results. All analyses reflect recall of second-trimester dietary habits and were performed with SAS software (version 6.12; SAS Institute, Inc., Cary, North Carolina).

RESULTS

Study subjects

Subjects in the telephone interview group and the SAQ group were similar demographically (table 1). Mean age at conception was 29.7 years (standard deviation (SD), 3.1) for the telephone interview group and 29.3 years (SD, 3.0) for the SAQ group. In both groups, approximately two thirds of the subjects had graduated from college, and over 95 percent were White. The time period from delivery to completion of the follow-up questionnaire was similar for the two groups of women: 4.5 years (SD, 0.5) in the telephone interview

TABLE 1. Demographic characteristics of the study population in a study of maternal recall of pregnancy diet, Diana Project, 1989–1997

Characteristic	Telephone interview group (n = 154)†		Self-administered FFQ* group (n = 115)†	
	No.	%	No.	%
Annual income (dollars)				
≤40,000	54	39.4	33	30.8
40,001–70,000	67	48.9	60	56.1
>70,000	16	11.7	14	13.1
Race				
Caucasian	146	96.7	115	100
Other	5	3.3	0	
Education				
College graduate	95	62.9	76	66.1
Less than college graduate	56	37.1	39	33.9
Mean age (years) at delivery	29.7	(3.1)‡	29.3	(3.0)

* FFQ, food frequency questionnaire.
† Totals may be less than the stated sample size because of missing data.
‡ Numbers in parentheses, standard deviation.

group and 4.4 years (SD, 0.5) in the SAQ group, with a range of 3–7 years in both groups.

Mean values and mean differences

Mean nutrient intakes for the telephone interview and SAQ groups are shown in table 2. For both groups, differences in the mean intakes of several nutrients between the original reported diet and the recalled diet were calculated (results not shown). In the telephone interview group, absolute crude mean differences ranged from 0.03 to 957, with the smallest difference being seen for alcohol and thiamine and the greatest difference being seen for retinol. In the telephone interview group, the crude differences for major macronutrients such as total fat, animal fat, vegetable fat, cholesterol, and protein were all highly statistically significant ($p < 0.001$), as were those for some of the B vitamins. However, after adjustment for total caloric intake, the mean differences ranged from 0.00 (grams of omega-3 fatty acid and milligrams of several B vitamins) to 109 (IU of β-carotene); none were statistically significant.

In the SAQ group, the absolute crude mean differences between the original and recalled diets ranged from 0.00 to 905, with the lowest being found for omega-3 fatty acids and the highest for β-carotene; none were statistically significant. After adjustment for total caloric intake, the absolute mean differences ranged from 0.00 to 16.6, with the largest difference being seen for calcium.

The absolute crude mean differences were substantially greater in the telephone interview group than in the SAQ group for all nutrients except total vitamin A and β-carotene. After energy adjustment, the correlations were generally small and similar in the two groups.

Nutrient correlations

Unadjusted Pearson correlation coefficients comparing original nutrient intakes with recalled nutrient intakes ranged from 0.14 to 0.43 for the telephone interview group (table 3). Retinol, vitamin B_{12}, and vitamin E had the poorest correlations, with coefficients of 0.14–0.16 (not significant). The correlations for total vitamin A, β-carotene, vitamin C, alcohol, all macronutrients except carbohydrates, and all fat components except omega-3 fatty acids were greater than 0.3 ($p \leq 0.0001$). The correlations for the micronutrients were generally lower than those for the macronutrients. After adjustment for total caloric intake, most correlations either increased slightly or remained the same; correlations for niacin and zinc dropped.

In the SAQ group, unadjusted Pearson correlations ranged from 0.13 to 0.61. Vitamin E had a correlation of 0.13 (not significant); the remaining correlations ranged from 0.27 to 0.61, and were all significant, mostly at the $p < 0.0001$ level. Alcohol had the highest correlation at 0.61. After adjustment for total caloric intake, most correlations increased in the SAQ group, and half were 0.50 or higher. For vitamin E and folate only, the energy-adjusted correlations were 0.30 or less and lower than the unadjusted ones; the correlation for vitamin E decreased from 0.13 to 0.02 (not significant), and that for folate decreased from 0.38 ($p < 0.0001$) to 0.30 ($p < 0.01$) with energy adjustment.

Generally, unadjusted Pearson correlations were higher in the SAQ group than in the telephone interview group. However, for total fat and all fat components other than omega-3 fatty acids, correlations were higher in the telephone group. Energy-adjusted correlations were higher in the SAQ group for all but two nutrients (vitamin E and folate).

Categorization by quintile

To further assess the reproducibility of nutrient classification, we divided subjects into quintiles of intake for selected nutrients. The quintiles based on the original and recalled diets were compared with regard to intakes of total fat, dietary fiber, folate, and calcium for both the telephone interview group and the SAQ group (4). In the telephone interview group, quintile assignments for the two dietary assessments agreed (within one quintile) for 69 percent of subjects for total fat, 68 percent of subjects for dietary fiber, 67 percent of subjects for folate, and 60 percent of subjects for calcium. In the SAQ group, the percentages were 79 for total fat, 79 for dietary fiber, 74 for folate, and 69 for calcium.

Analyses stratified by recall interval

We also examined whether the interval between pregnancy and recall of pregnancy diet influenced the accuracy

TABLE 2. Average recalled nutrient intake during pregnancy, by interview group, Diana Project, 1989–1997

Nutrient	Telephone interview group		Self-administered food frequency questionnaire group	
	Mean	Standard deviation	Mean	Standard deviation
Total calories (kcal)	1,867	536	2,150	768
Total fat (g)	61.7***	20.2	73.5	28.5
Animal fat (g)	33***	12.7	39.5	17
Vegetable fat (g)	28.7***	10.2	34	15.9
Saturated fat (g)	21.8***	7.8	28.4	11.2
Monounsaturated fat (g)	23.4*	7.9	25.7	10.3
Polyunsaturated fat (g)	11.2***	3.9	13.7	5.8
Linoleic acid (g)	9.8***	3.5	12.4	5.3
Oleic acid (g)	21.7	7.3	23.5	9.5
Omega-3 fatty acids (g)	0.13***	0.09	0.06	0.06
Protein (g)	79.6***	22.3	92.3	33
Animal protein (g)	53.1***	17.4	64.3	25.1
Cholesterol (mg)	206.1***	84.2	270.8	113.4
Carbohydrate (g)	258.4**	83.9	289.6	112.4
Dietary fiber (g)	23.3***	7.9	21.3	9.4
Total vitamin A (IU)	11,175	7,607	11,531	6,363
Retinol (IU)	2,046***	1,983	2,676	1,479
Beta-carotene (IU)	9,129	6,936	8,855	5,844
Thiamine (mg)	1.7	0.6	1.7	0.7
Riboflavin (mg)	1.9***	0.7	2.5	0.9
Niacin (mg)	41.1***	10.8	22.7	9.7
Vitamin B_6 (mg)	3.1***	1.5	2.3	0.9
Folate (μg)	366.4*	159.3	317.2	151.6
Vitamin B_{12} (μg)	6.3***	5.7	8	4
Vitamin C (mg)	186.8	98.4	148.7	81.4
Vitamin D (IU)	207.1***	89.6	342.9	165.3
Vitamin E (mg)	7.4	7.9	8	4.4
Calcium (mg)	801.1***	265	1,320.1	570.4
Iron (mg)	16	6.9	15.1	7.3
Zinc (mg)	11.9***	5.2	14.5	5.4
Alcohol (g)	0.1	1	0.3	1.2

*$p < 0.05$; **$p < 0.01$; ***$p < 0.001$ (difference between original and recalled mean intakes).

of recall (results not shown). Subjects were divided into those with children aged less than 4.5 years and those with children aged 4.5 years or older. In the telephone interview group, there was no clear pattern of differences in energy-adjusted correlations by recall interval. In the SAQ group, the energy-adjusted correlations tended to be higher in the group with the shorter recall interval.

DISCUSSION

We compared women's recall of their diet during a pregnancy 3–7 years in the past with their diet as they reported it during the pregnancy. We examined the effects of recall of diet by telephone interview or SAQ in comparison with the original questionnaire self-administered during pregnancy. To our knowledge, there are no other studies of pregnancy diet with which to compare our results. However, recall of adult diet is fairly well studied, and it is of interest to know whether pregnancy diet is recalled with similar accuracy.

Unadjusted Pearson correlation coefficients ranged from 0.14 to 0.43 in the telephone interview group and from 0.13 to 0.61 in the SAQ group. We compared the correlations we observed for specific nutrients with those for the same nutrients from previous studies, as summarized by Friedenreich et al. (9). The nutrients for which data from many studies are available are the macronutrients and fat components. Since the period of recall for our study was 3–7 years, we compared our results with those of other studies with recall intervals of less than 10 years. The energy-adjusted correlations in the SAQ group fell into the middle of the range of values from studies with recall intervals of less than 10 years. For example, the correlation for total fat was 0.56 in this study as compared with 0.37–0.74 in previous studies (9). The unadjusted correlations for the telephone interview and SAQ groups and the energy-adjusted correlations in the telephone interview group were generally at the lower end of the range of those from other studies or outside the lower end of the range. For total fat, the correlations were 0.40 and 0.30 in the telephone interview and SAQ groups, respec-

TABLE 3. Pearson's correlation coefficients for correlations between original and recalled diet during pregnancy, by interview group, Diana Project, 1989–1997

Nutrient	Telephone interview group (n = 154)		Self-administered food frequency questionnaire group (n = 115)	
	Crude	Energy-adjusted	Crude	Energy-adjusted
Total fat	0.40****	0.41****	0.30**	0.56****
Animal fat	0.43****	0.35****	0.43****	0.58****
Vegetable fat	0.35****	0.34****	0.33***	0.55****
Saturated fat	0.40****	0.33****	0.31***	0.51****
Monounsaturated fat	0.39****	0.38****	0.33***	0.54****
Polyunsaturated fat	0.38****	0.33****	0.27**	0.47****
Linoleic acid	0.37****	0.34****	0.30**	0.48****
Oleic acid	0.39****	0.38****	0.33***	0.55****
Omega-3 fatty acids	0.23**	0.25**	0.37****	0.40****
Protein	0.37****	0.37****	0.39****	0.57****
Animal protein	0.37****	0.33****	0.43****	0.55****
Cholesterol	0.31****	0.26**	0.40****	0.46****
Carbohydrates	0.29**	0.36****	0.40****	0.58****
Dietary fiber	0.42****	0.49****	0.54****	0.67****
Total vitamin A	0.40****	0.35****	0.42****	0.42****
Retinol	0.16	0.17*	0.39****	0.45****
Beta-carotene	0.34****	0.30***	0.47****	0.47****
Thiamine (vitamin B_1)	0.18*	0.18*	0.42****	0.54****
Riboflavin (vitamin B_2)	0.18*	0.20*	0.37****	0.45****
Niacin	0.19*	0.10	0.41****	0.37****
Pyridoxine (vitamin B_6)	0.25**	0.21**	0.44****	0.42****
Folate	0.29***	0.36****	0.38****	0.30**
Vitamin B_{12}	0.15	0.15	0.56****	0.62****
Vitamin C	0.31****	0.33****	0.43****	0.50****
Vitamin D	0.20*	0.26**	0.49****	0.57****
Vitamin E	0.14	0.21**	0.13	0.02
Calcium	0.25**	0.29***	0.38****	0.45****
Iron	0.25**	0.27***	0.45****	0.41****
Zinc	0.21*	0.12	0.41****	0.54****
Alcohol	0.31****	0.31****	0.61****	0.60****

*$p < 0.05$; **$p < 0.01$; ***$p < 0.001$; ****$p \leq 0.0001$.

tively, as compared with 0.37–0.74 in previous studies (9). The unadjusted and adjusted correlations in the telephone interview group were similar to those from studies with longer recall periods of 11–25 years (9).

All but one of the studies reviewed by Friedenreich et al. (9) that compared recalled diet with original diet used nutrient intakes that were not adjusted for energy intake. Generally, correlations based on energy-adjusted intakes will be higher than those based on crude intakes, partly because adjustment may remove some of the variance in nutrient intake that is attributable to differences in dietary assessment methods (10). If the correlations in the previous studies had been based on energy-adjusted intakes, it is reasonable to assume that they would generally have been

TABLE 4. Comparison of quintiles of intake of selected nutrients between original and recalled diet during pregnancy, Diana Project, 1989–1997

Nutrient	Percentage of agreement			
	Telephone interview group (n = 154)		Self-administered food frequency questionnaire group (n = 115)	
	Same quintile	Within one quintile	Same quintile	Within one quintile
Total fat	30	69	37	79
Dietary fiber	35	68	36	79
Folate	34	67	33	74
Calcium	28	60	36	69

higher. In the comparison with the previous unadjusted correlations, our energy-adjusted ones would tend to be inflated.

Pearson estimates ranged from 0.10 to 0.49 in the telephone interview group and from 0.02 to 0.67 in the SAQ group after adjustment for total energy intake. Willett et al. (7) reported energy-adjusted correlations between original diet and recalled diet with a 3- to 4-year recall period. For the nutrients reported, they observed correlations that were similar to the energy-adjusted ones in our SAQ group and higher than those in our telephone interview group.

Similarly, the Willett et al. study observed percentages of agreement by quintile classification similar to those we observed in the SAQ group and slightly higher than those we observed in the telephone interview group. When original and recalled diets are assessed by different instruments, as was done in the Willett et al. study, the correlations tend to be lower than those seen when the same instrument is used for both assessments (11). In our SAQ group, the same instrument was used for both measurements, which might have inflated our correlations in comparison with those of Willett et al. (7). In their review, Friedenreich et al. (9) made similar observations across many studies; they concluded that those studies which used different tools for the original and recalled assessments had slightly lower correlations than those which used the same tool for both assessments.

The women in this study reported their diet during a pregnancy that was 3–7 years in the past. Generally, crude and energy-adjusted nutrient correlations were similar between women with shorter recall intervals and women with longer recall intervals (as approximated by the age of the child from the index pregnancy at the time of recall: <4.5 years vs. ≥4.5 years). Within this narrow range, the length of the recall interval did not seem to influence the accuracy of recall. Other recall studies have examined longer elapsed time spans (12–14), although only one compared recall ability over time in the same population (14). Dwyer and Coleman (14) examined recall accuracy for food groups at a 5- to 7-year follow-up, an 18-year follow-up, and a 30-year follow-up among 91 subjects. They did not find clear evidence of time-related memory loss with respect to dietary recall. No studies examining recall ability over different time spans for nutrient estimates were found.

Our study population consisted primarily of well-educated White women, and therefore our results may not be generalizable to other populations. Two thirds of the women had graduated from college, and over 95 percent were White. In addition, they were probably more aware of their diet than other mothers, since they had completed dietary assessments on a regular basis during pregnancy. The participation rates in both the telephone interview group and the SAQ group were low, making selection bias a concern. However, demographically the two groups were very similar to each other and to the entire Diana Study group. Of the Diana Study women, 97 percent were White, 63 percent were college graduates, and 62 percent had household incomes over $40,000 per year (6).

Overall, our results suggest that pregnancy diet is recalled no better than adult diet generally and is probably recalled slightly worse than general adult diet. We originally hypothesized that pregnancy diet would be recalled more accurately because of the unique and important role of pregnancy in a woman's life. Moreover, women often make specific and conscious dietary changes during pregnancy. We chose to examine diet during the second trimester, because anecdotally most pregnant women have made changes in their diet by that time. In retrospect, the literature might have predicted that pregnancy diet would not be better recalled than adult diet generally. Recall of past diet is heavily influenced by current diet (15). A woman's current diet at the time she is asked to recall her pregnancy diet will usually be a nonpregnancy diet. By analogy with the findings for recall of general adult diet, current nonpregnancy diet probably influences women's recall of past pregnancy diet.

We know of no other studies that have examined recall of pregnancy diet in any detail. These results suggest that pregnancy diet can be recalled with some accuracy—about as well as or perhaps somewhat less well than adult diet generally. However, more information is needed about recall of pregnancy diet. The present study used FFQs for both assessments. Ideally, a validity study would use a very detailed method of assessment, such as diet records, for the original measurement and a method that could be used epidemiologically, such as FFQs, for the second measurement (16). In this study design, the original measurement provides something close to a "gold standard" with which to compare the second measurement. Studies are also needed to examine recall of pregnancy diet in a more diverse population and to determine which characteristics of the women, their diets, or their pregnancies influence accuracy of recall. Especially important is the question of whether the index child's health affects the mother's recall. Since studies of rare childhood illnesses usually have a case-control design, investigators must evaluate whether or not bias exists in the recall of pregnancy diet and the extent to which it is present.

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