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Validation of a novel method for retrospectively estimating nutrient intake during pregnancy using a semi-quantitative food frequency questionnaire

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Abstract

Objective—Case control studies evaluating the relationship between dietary intake of specific nutrients and risk of congenital, neonatal or early childhood disease require the ability to rank relative maternal dietary intake during pregnancy. Such studies are limited by the lack of validated instruments for assessing gestational dietary intake several years post-partum. This study aims to validate a semi-quantitative interview-administered food frequency questionnaire (FFQ) for retrospectively estimating nutrient intake at two critical time points during pregnancy.

Methods—The FFQ was administered to women (N=84), who 4 to 6 years earlier had participated in a prospective study to evaluate dietary intake during pregnancy. The FFQ queried participants about intake during the previous month (FFQ-month). This was then used as a reference point to estimate consumption by trimester (FFQ-pregnancy). The resulting data were compared to data collected during the original study from two 24-hour recalls (24hr-original) using Spearman correlation and Wilcoxon sign-rank-test.

Results—Total energy intake as estimated by the retrospective and original instruments did not differ and was only weakly correlated in the trimesters (1st & 3rd) as a whole ($r = 0.18-0.32$), though more strongly correlated when restricted to the first half of the 1st trimester ($r=0.32$) and later half of the 3rd trimester ($r=0.87$). After energy adjustment, correlation between the 24hr-original and FFQ-pregnancy in the 3rd trimester were $r=0.25$ ($p<0.05$) for dietary intake of vitamin A, and $r=0.26$ ($p<0.05$) for folate, and $r=0.23-0.77$ ($p<0.005$) for folate, and vitamins A, B6 and B12 in the 1st and 3rd trimester after including vitamin supplement intake.

Conclusions—The FFQ-pregnancy provides a consistent estimate of maternal intake of key micronutrients during pregnancy and permits accurate ranking of intake 4-6 years post-partum.

Keywords

validation; Semi-quantitative food frequency questionnaire; pregnancy; micronutrients; dietary supplements

Introduction

Case control studies evaluating the relationship between dietary intake of specific nutrients and risk of congenital, neonatal or early childhood disease require the capacity to estimate relative maternal dietary intake during pregnancy. Cohort studies are not cost-effective for studying rare diseases. Therefore investigators must rely on tools that can be used retrospectively and Food Frequency Questionnaires (FFQ) provide the best alternative for ranking past dietary intake in population studies. Several studies [1-10] have attempted to collect data retrospectively on dietary intake during pregnancy. However, little work has been done to predict the validity of dietary intake data collected several years post-partum. This is a major limitation for studies on congenital diseases that are diagnosed in later infancy and early childhood.

One study has attempted to validate the use of a self-administered food frequency questionnaire applied 3 to 7 years after pregnancy [11], and demonstrated the utility of using a FFQ several years post-partum to estimate intake during pregnancy. However, this instrument would not be appropriate for studies involving populations with limited literacy that require in-person interviews.

Additionally, some hypotheses may require data on dietary intake during specific trimesters, depending on the embryologic origin of the tissues of interest [12-14]. The nutrients chosen for this analysis are restricted to energy and those micronutrients more commonly hypothesized to be associated with risk of congenital, neonatal or early childhood disease (Vitamins A, B6, B12 and folate). We additionally focused on the first and third trimesters because of the relevance of these periods for work involving organogenesis (first trimester) and [12-14] predictors of low birth weight, perinatal death and later chronic disease such as diabetes, in which intake during the third trimester may be most critical [15-17]. Studies interested in estimating the importance of maternal diet contributing to risk of malignancies in early childhood might need to differentiate between these periods of intake in order to differentiate associations during periods of initial tissue formation versus those of accelerated growth.

We present here a novel method for retrospectively estimating dietary and vitamin supplement intake during pregnancy in women of limited literacy. We report the validation of this interview-administered FFQ which was specifically designed to estimate dietary intake and supplement consumption, by trimester, in pregnancies that had occurred 4 to 6 years before the date of an in-person interview among a small population of women living in semi-rural Mexico.

MATERIALS AND METHODS

Population

To validate the new FFQ, prospective information from a randomized double-blinded clinical trial (RCT) carried out between 1997 and 2000 in a small urban community in the state of Morelos, Mexico was used [18]. The RCT's objective was to compare the impact of vitamin supplementation during pregnancy (873 women) on fetal growth by randomizing pregnant women to daily supplements containing either multiple micronutrients or iron. Highly trained personnel administered the supplements, visiting women's homes six days a week throughout pregnancy and documenting compliance. Women were not taking other nutritional supplements during pregnancy.

Dietary intake was estimated using 24 hour recall questionnaires (24h-original) obtained on 2 non-consecutive days during the first trimester, (weeks 4-13 of gestation) and during the

third trimester (weeks 26-40), Figure 1. These results have been published elsewhere [18-21].

In 2004, we identified 90 women who had participated in the RCT (1997-2000) 4-6 years earlier and had complete information on food intake (24h-original obtained on 2 non-consecutive days) and supplement intake in the two trimesters (1st & 3rd) of pregnancy. Of these, only 84 agreed to participate in the validation of the FFQ, as the other 6 no longer resided in the study area. Figure 1 depicts the structure and organization of the validation study.

The RCT and this validation study were both approved by the Ethics, Biosecurity and Research Commissions at the National Institute of Public Health (INSP), Cuernavaca, Mexico. Mothers also gave written informed consent for participating in the validation study and for the use of their socio-demographic and dietary data collected during the RCT study. The 24h-original and FFQ were administered by highly trained personnel during home-visits.

Development of the Questionnaire and validation study

The design of the pregnancy specific FFQ we present and validate (see Appendix) builds on our prior experience with dietary surveys of pregnant women in Mexico. The FFQ is administered as an in-person interview and is divided into three sections. FFQ-month (originally validated as a free-standing FFQ [22]) queries women regarding their dietary intake during the previous month of interview (FFQ-month). FFQ-pregnancy examines differences between current diet and diet during each trimester using the prior month's dietary intake as reference. The last section examines supplement intake during each trimester.

In the Section 1, FFQ-month, women were asked how often (from 0 to 6 times per day, or week) they consumed each food in the last month. Foods included in the FFQ-month were selected based on their energy and/or micronutrient contribution to data collected in 24hr recalls from 18,311 women of childbearing age who participated in the national survey, ENN99 [23] ensuring that selected food items were responsible for 90% of the calorie and micronutrient content in women's diets [23, 24]. Foods were grouped into eight categories. Participants were also asked to list any additional foods consumed and these were included in subsequent calculations.

The portion size for each food item in the FFQ-month was based on the mean portion size reported in ENN99 [23]. For those additional foods not reported in ENN99 portion size was derived by averaging the measurements of 10 servings of a given food.

In the FFQ-pregnancy, for each trimester, participants were asked to recall dietary intake in those 3 months, and to report whether intake of each food item was greater or lesser than that reported in the FFQ-month, and to report whether they had included or excluded any food. If a food had been included (i.e. consumed in that trimester, but not consumed in the prior month) mothers were asked about the frequency which it was consumed. The FFQ-month helped study participants recall short term intake by identifying first those food items ingested regularly as well as those habitually not ingested [39]. Subsequently the FFQ-pregnancy queried about modifications in consumption of these foods during pregnancy. Because mothers were from a small urban community and had low levels of literacy, interviewers used visual props in order to prompt mothers to recall the different trimesters by using images of different female silhouettes with varying corresponding abdominal shapes, and also reminding participants of the calendar months in which each trimester

transpired. The interviewers showed appropriately sized spoons, measuring cups, drawings and photographs of foods to the mothers in order to facilitate estimating portion sizes.

The last section of the questionnaire queried mothers regarding the amount, frequency and duration of supplement consumption during each trimester of pregnancy.

Dietary intake quantification

The 24hR-original and FFQ-month questionnaires were coded and transformed into daily nutrient intake using a food composition table compiled at the National Institute of Public Health, based on the USDA and INCAP Food Composition Tables [23-25] using software developed at the INSP. Estimations from the two 24hR-original questionnaires were averaged to provide a better estimation of usual intake [24].

FFQ-month was modified accordingly to report the dietary intake at each trimester of pregnancy in FFQ-pregnancy. Modifications included changing the frequency of each food they report at FFQ-month, addition of new foods and elimination of foods not consumed during pregnancy (Figure 1).

Once the modifications were made, energy and micronutrient intakes were quantified separately for the first and third trimester due to greater deviations from their usual diet. However, this questionnaire was applied over a wide range of weeks within the same trimester. In order to know if correlations were affected by the time within a trimester in which they had their original interview, women were stratified based on whether they were interviewed at the beginning or end of the trimester. The halfway point of each trimester was used as the cutoff point, week 9 for the first trimester and week 32 for the third trimester.

Supplement intake quantification

Nutrient intakes from supplements were estimated based on the frequency and duration of participation during the RCT for each trimester, and then compared to those reported in the FFQ-pregnancy, in order to evaluate whether mothers remembered the frequency of general supplement intake. A compilation of the nutritional content of the supplements available in Mexico was used for this purpose [26].

A composite variable generated using the sum of intake of supplemental nutrients and diet derived nutrients was generated for each trimester of pregnancy for both the 24hR-original and FFQ-pregnancy questionnaires. Supplement intake was not recorded for the FFQ-month.

Statistical analysis

Demographic information, including age, parity, years of schooling completed, socio-economic status (SES), as well as height and weight were obtained by trained fieldworkers and nurses during the RCT (before week 13 of gestation) as previously described [19] using standard procedures [27]. Unfortunately it was impossible to collect this information again during the validation study. Statistical comparisons were done in order to evaluate the possibility of selection bias. The subset of 84 women selected to participate in the validation study were compared with the remaining population of women recruited to participate in the RCT (873 women). Body Mass Index (BMI, kg/m²) was generated and categorized according to WHO cutoff points (underweight <18.5, normal 18.5 to 24.9, overweight 25 to 29.9 and obese >30 [28]. SES was classified into tertiles using the Brofman index [29] which had been designed and validated for similar populations in Mexico and takes into account housing conditions and ownership of appliances and explains 43.8% of the generalized variance of the set of variables included. Education was assessed by the number

of years of formal schooling completed and was stratified into 4 categories: 0, 1-6, 7-9, and >10 years (this latter category corresponds to having more than a secondary school education).

Energy and nutrient intakes reported in the first and third trimester interviews during the RCT (24h-original) were compared with the intakes reported in the validation study (FFQ-month and FFQ-pregnancy intake). The median and interquartile ranges were estimated for energy intake, folate and vitamins A, B6 and B12 during each period. Nutrient intake levels were compared between the 24hR-original and the FFQ-month and FFQ-pregnancy separately for each trimester using Wilcoxon rank sum tests. Correlation between dietary intakes of each trimester (24hR-original) and dietary intake of FFQ-month, and between the dietary intake of each trimester (24hR-original) and FFQ-pregnancy was examined using Spearman coefficients. Nutrients were energy adjusted using residual models [30, 31]. Because the supplements were largely non-caloric, we made similar comparisons taking into account supplement contribution, but without energy-adjustment.

For each trimester, the averaged 24h-original was compared to FFQ-pregnancy using the Bland and Altman method [32, 33]. Analysis of variance was used to examine the data from 24hR-original in order to estimate within- and between-subject variation. We used the ratio of the two variances to correct correlations for day-to-day variation using the formula for deattenuated correlation found in Rosner et al [34].

For multiple regression analysis of energy intake, we adjusted for the number of weeks of pregnancy at the time of each interview time-point and also adjusted for maternal age and years of schooling. With 84 participants we had sufficient power (0.80) to determine a correlation of $\rho=0.3$ with $p<0.05$ between 24hR-original, FFQ-month and FFQ-pregnancy [35]. Data was analyzed using SAS software, Version 9.1.2 (Institute Inc., Cary, NC, USA) and STATA, Version 9.0 (Stata Co., Santa Monica, SA). *P* values of less than 0.05 were considered statistically significant.

RESULTS

The 84 mother subset participating in this validation study did not differ from the total enrolled in the RCT study (873 women) in almost all of the demographic characteristics (age, parity, years of schooling completed, socio-economical status and height). For weight, the subset of 84 mothers weighed an average of 2kg less than the women of the original RCT, although their BMI was only 0.9kg/m² lower. The proportion of women whose BMI was in the range of normal was similar between the total population (58%) and the validation subgroup (64%). The women in the validation subset were evenly distributed between the two study arms with 40 women (47.6%) in the control arm and 44 women (52.4%) in the experimental supplement arm. Validation subset women in the two study arms did not differ in all of their demographic characteristics. At time of enrollment into the RCT, the validation study participants had a mean age of 23 years, a mean weight of 51.5 kg (SD 8.0 kg), height of 148 cm (SD 4.7 cm), 64% had Body Mass Index of 18.5 to 24.9 kg/m², 51.2% had 1 to 2 children and 70% had fewer than 9 years of schooling (Table 1).

Energy Consumption

Estimates of median energy intake did not differ significantly (Wilcoxon rank sum tests) between the three dietary instruments: 24hR-original, FFQ-month and FFQ-pregnancy in first trimester (Table 2). However, by Bland and Altman plots, energy intake varied with an average of -178.3kcal (SD 868.3kcal) between the 24hR-original and FFQ-pregnancy in both the first or third trimesters (Figures 2a and b). Energy estimates from the 24hR-original did not correlate with those from either the FFQ-month or the FFQ-pregnancy (Table 3).

Correlation between the FFQ's and the 24hR-original improved with the deattenuated correlation: (FFQ-month 1st trimester $r-D=0.26$, 3rd trimester $r-D=0.20$ and FFQ-pregnancy 1st trimester $r-D=0.18$, 3rd trimester $r-D=0.32$) as expected (Table 3).

Correlation further improved when energy estimates between the 24hR-original and FFQ-pregnancy were compared adjusting for whether interviews took place in the early or latter halves of the trimesters as well as for maternal age and schooling. Among women interviewed earlier in first trimester of pregnancy (<9 weeks gestational age) energy intake from the 2 dietary assessments correlated weakly ($r=0.23$, $p=0.087$). For the third trimester, correlation was highly significant for women interviewed in the latter half of the trimester (≥ 32 weeks of pregnancy) $r=0.87$, $p=0.004$ (Table 4).

Micronutrient Intake

Compared to the 24hR-original, the FFQ-pregnancy yielded higher estimates for intake of vitamins A and B12, though lower for vitamin B6 and folate, in both trimesters (Wilcoxon rank sum tests). Results were similar after including nutrient intake derived from supplements (Table 2).

Energy adjusted dietary intake in third trimester of pregnancy for vitamin A and folate were significantly correlated ($p<0.05$, Table 3). However, after including nutrient intake from supplements, the correlations between the 24hR-original and the FFQ-pregnancy improved with significant correlations for Vitamin A (first trimester, $p<0.05$; third trimester $p<0.001$) and for folate, and vitamins B6, B12 ($p<0.001$ in both the first and third trimesters) (Table 3). As expected the de-attenuated correlations were also higher for all micronutrients (Table 3). Correlations comparing micro-nutrient intake estimates from the FFQ-pregnancy and the 24hR-original did not change after adjustment for either maternal education or the number of weeks of gestation at the time of interview (values not shown).

DISCUSSION

We propose a novel method for retrospectively estimating dietary intake during critical periods of organogenesis. We have demonstrated that the FFQ-pregnancy allows estimation of diet 4 to 6 years post-partum, and enables investigators to reliably differentiate micronutrient intake during 2 critical windows of pregnancy, corresponding to very different time points in fetal development. This new FFQ instrument allows investigators to differentiate windows of nutritional susceptibility in studies of rare diseases for which prospective cohort studies are not a viable alternative.

This validation study demonstrated no significant difference in the estimated energy intake evaluation using the 24h-original in this population of mothers as a reference. The FFQ-pregnancy predicts dietary intake of folate, vitamin A, B6, and B12 in both the first and third trimesters, particularly after adjusting for energy intake, and especially after including intake from dietary supplements. Our data suggest that women can remember their diet during pregnancy even after several years, and that they are able to remember the use of prenatal supplements with precision.

The 24hR-original was applied in two repeated measures during the first and third trimesters in order to be able to account for intra-individual variability [30]. Analysis of the deattenuated correlations showed within-subject variation in 24hr-original, thus reducing the correlations [30, 34]. Analysis of these correlations is therefore similar to validating an FFQ with a large number of 24hr recalls.

We suspected that high reporting in FFQ may be due to the study participant's familiarity with answering food intake questionnaires and therefore more accurate reporting. Moreover, in the time elapsed, it is also possible that socioeconomic conditions changed, thus influencing the study participant's knowledge. Because maternal literacy and education can influence both dietary intake and detailing of dietary intake, we examined the correlation of caloric intake after adjusting for maternal education. The correlation between caloric intake in FFQ-pregnancy and 24hR-original for women interviewed in both the first half of the first trimester, (<9 weeks gestation) and the latter half of the third trimester (≥32 weeks gestation), after adjusting for level of maternal education was larger and more significant. Attention to details regarding variation in dietary intake may vary according to educational levels [11]. In addition, these periods (first 9 weeks of pregnancy and after week 32) correspond to those in which dietary intake for pregnant women varies the most from women's non-pregnancy diet and may therefore be remembered more accurately.

Hernandez-Avila et al. showed in a validation study of sixteen 24hr recall versus two FFQ in non-pregnant Mexican women, that there was a correlation of 0.14 ($P<0.01$) for folate [22]. In our validation, the correlation for the third trimester was 0.16 and deattenuated 0.63, though these results were not significant ($p=0.15$). However, as noted above, correlation in the third trimester ($r=0.73$, $p<0.001$) was very high after taking into account supplement intake. Our results are comparable to those of Block et al., who found a correlation of 0.33 for vitamin A in a validation study comparing three 24hr recalls to one FFQ in a population of non-pregnant Mexican Americans [36]. In our study, food-derived vitamin A intake between the two instruments had a correlation of 0.17 ($p=0.12$) and 0.25 ($p=0.02$) for the first and third trimesters, respectively, and 0.26 ($p=0.02$) and 0.38 ($p<0.001$) for the first and third trimester for food and supplement derived intake, respectively.

We consider that our instrument is a valid tool for estimating micronutrient intake derived from diet and supplements for use in studies in which the goal is to rank intake in populations. Correlations between 24h-original, FFQ-month and FFQ-pregnancy are close to the values reported in validations of other FFQ instruments ($r=0.14$ to 0.53 depending on size and population of the study group) [1-10, 22, 37, 38]. That we know of, this FFQ is the first that permits estimating food and supplement intake by trimester of pregnancy, in semi-rural populations that are 4 to 6 years post-partum.

It is generally difficult to collect food intake information retrospectively from women who come from a semi-rural area, and whose habitual micronutrients and energy intake is known to be low [7]. Our utilization of visual props assisted women to remember their intake during the different periods of their pregnancy. Similarly, the design of the FFQ-pregnancy facilitated recall by first reminding study participants of intake in the immediate past before querying about their intake in the more remote past (4-6 years in the past) [39].

After adjusting for energy, we found that the 24hR-original and FFQ-pregnancy were correlated for vitamin A and folate ($p<0.05$). However, since supplement intake accounted for a large portion of total nutrient intake within the RCT, it is not surprising that correlations would improve when intake from supplements was included in the FFQ-pregnancy values.

FFQs were validated against only two dietary recalls per trimester, and as observed using the deattenuated correlations there was high intra-individual variability. Since the same factors that affected the reference method (24hR-originals) may also have affected the FFQ, we cannot assume independent random errors in the two methods, as this could lead to overestimation of the correlations [40].

According to our analysis, the over-estimation of folate, and vitamins A, B6, and B12 from diet can be expected due to this bias [26, 37, 40, 41]. Alternatively, it may also be attributed to the long period of time over which participants had to remember their diet. However, once adjustments for energy and supplements were made, the estimation of habitual intake tends to improve, especially in the third trimester. Mejía-Rodríguez et al. demonstrated that intake of folate, and vitamins A, B6, and B12 in Mexican women of reproductive age is underestimated if nutrients obtained from supplements are not considered [26].

Limitations of this study include the possible tendency for study participants to have their recall of past diet be affected by recent consumption, however, the FFQ-month and FFQ-pregnancy were not correlated (data not shown). Another limitation is that we were not able to have a second measurement of FFQ-month and FFQ-pregnancy to ensure reproducibility. We also do not have information regarding the number of pregnancies participants experienced in the interim between the original RCT and the validation study. It is likely that participants' diets would be similar from pregnancy to pregnancy, so correlations between 24hR-original and FFQ-pregnancy could be attributed to more recent recall periods rather than to the index pregnancy.

The validity of this instrument is limited to populations in semi-rural areas with characteristics similar to our small population of 84 women. The women enrolled in this validation study and the study participants of the original RCT did not differ significantly in age, schooling, parity, SES or height. However, the women in this study weighed an average of 2kg less than the women of the original RCT, although their BMI was only -0.9kg/m² lower. Despite these relatively small differences, our comparisons are still valid, as we had sufficient power to detect correlations between the 2 time points [34, 36], and the deattenuation confirmed that the low correlations between 24hR-original and FFQ-pregnancy were due to the large intra-person variability for the two 24hR-original. Adjusting for this variability yields results comparable to validating with multiple 24hr recalls [31].

CONCLUSION

In conclusion, we have designed and validated a method to retrospectively assess dietary intake and supplement use during pregnancy using the FFQ-pregnancy. This method provides a reasonable estimate of gestational maternal intake of critical micronutrients (vitamins A, B6 and B12 and folic acid). Estimation of micronutrient intake is particularly strong after accounting for energy and dietary supplement intake. The FFQ-pregnancy instrument provides valid estimates of intake 4 to 6 years post-partum. Importantly, mothers in our population demonstrated the ability to remember gestational supplement intake with relative precision, even after several years. In future studies, it will be necessary to evaluate the reproducibility of FFQ-month and FFQ-pregnancy and to test its validity in larger and more heterogeneous populations in both urban and rural settings in order to examine the generalizability of this instrument for retrospective use several years post-partum.

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Appendix

I. FREQUENCY OF NUTRIENT CONSUMPTION FOR WOMEN IN THE PAST MONTH

Participant ID _____

No.	Foods	Never (0)	Times per week					Times per day					Consumption Frequency	Food usually eaten raw? 1= cooked? 2=	
			1 (03)	2 (04)	3 (05)	4 (06)	5 (07)	1 (07)	2 (08)	3 (09)	4 (09)	5 (09)			
Dairy Products															
1	1 glass of milk	1	2	3	4	5	6	7	8	9					
2	1 slice of cheese (any type)	1	2	3	4	5	6	7	8	9					
3	1 glass of yogurt (any type)	1	2	3	4	5	6	7	8	9					
Fruits															
4	1 tangerine	1	2	3	4	5	6	7	8	9					
5	1 Clementine Orange	1	2	3	4	5	6	7	8	9					
6	1 sweet Orange	1	2	3	4	5	6	7	8	9					
7	1 glass of orange juice or grapefruit	1	2	3	4	5	6	7	8	9					
8	1 tangerine	1	2	3	4	5	6	7	8	9					
9	1 banana	1	2	3	4	5	6	7	8	9					
10	1 banana	1	2	3	4	5	6	7	8	9					
11	1 slice of cantaloupe	1	2	3	4	5	6	7	8	9					
12	1 slice of watermelon	1	2	3	4	5	6	7	8	9					
13	1 mandarin orange	1	2	3	4	5	6	7	8	9					
14	1 orange (whole)	1	2	3	4	5	6	7	8	9					
15	1 slice of watermelon	1	2	3	4	5	6	7	8	9					
16	1 slice of yellow papaya	1	2	3	4	5	6	7	8	9					
17	1 slice of red papaya	1	2	3	4	5	6	7	8	9					
18	1 apple	1	2	3	4	5	6	7	8	9					
19	1 peach	1	2	3	4	5	6	7	8	9					
20	1 pear	1	2	3	4	5	6	7	8	9					
21	1 grapefruit	1	2	3	4	5	6	7	8	9					
Vegetables															
22	1/2 cup of broccoli	1	2	3	4	5	6	7	8	9					
23	1/2 cup of asparagus	1	2	3	4	5	6	7	8	9					
24	1/2 cup of corn/beans	1	2	3	4	5	6	7	8	9					
25	1/2 cup of cauliflower	1	2	3	4	5	6	7	8	9					
26	1/2 cup of carrots (cooked)	1	2	3	4	5	6	7	8	9					
27	1/2 cup of carrots (raw)	1	2	3	4	5	6	7	8	9					
28	1/2 cup of carrots (cooked)	1	2	3	4	5	6	7	8	9					
29	1/2 cup of carrots (raw)	1	2	3	4	5	6	7	8	9					
30	1/2 cup of carrots (cooked)	1	2	3	4	5	6	7	8	9					
31	1/2 cup of carrots (raw)	1	2	3	4	5	6	7	8	9					
32	1/2 cup of carrots (cooked)	1	2	3	4	5	6	7	8	9					
33	1/2 cup of carrots (raw)	1	2	3	4	5	6	7	8	9					
34	1/2 cup of carrots (cooked)	1	2	3	4	5	6	7	8	9					
35	1/2 cup of carrots (raw)	1	2	3	4	5	6	7	8	9					
36	1/2 cup of carrots (cooked)	1	2	3	4	5	6	7	8	9					
37	1/2 cup of carrots (raw)	1	2	3	4	5	6	7	8	9					
38	1/2 cup of carrots (cooked)	1	2	3	4	5	6	7	8	9					
39	1/2 cup of carrots (raw)	1	2	3	4	5	6	7	8	9					
40	1/2 cup of carrots (cooked)	1	2	3	4	5	6	7	8	9					
41	1/2 cup of carrots (raw)	1	2	3	4	5	6	7	8	9					
42	1/2 cup of carrots (cooked)	1	2	3	4	5	6	7	8	9					
43	1/2 cup of carrots (raw)	1	2	3	4	5	6	7	8	9					
44	1/2 cup of carrots (cooked)	1	2	3	4	5	6	7	8	9					
45	1/2 cup of carrots (raw)	1	2	3	4	5	6	7	8	9					
46	1/2 cup of carrots (cooked)	1	2	3	4	5	6	7	8	9					
47	1/2 cup of carrots (raw)	1	2	3	4	5	6	7	8	9					
48	1/2 cup of carrots (cooked)	1	2	3	4	5	6	7	8	9					
49	1/2 cup of carrots (raw)	1	2	3	4	5	6	7	8	9					
50	1/2 cup of carrots (cooked)	1	2	3	4	5	6	7	8	9					
51	1/2 cup of carrots (raw)	1	2	3	4	5	6	7	8	9					
52	1/2 cup of carrots (cooked)	1	2	3	4	5	6	7	8	9					
53	1/2 cup of carrots (raw)	1	2	3	4	5	6	7	8	9					
54	1/2 cup of carrots (cooked)	1	2	3	4	5	6	7	8	9					
55	1/2 cup of carrots (raw)	1	2	3	4	5	6	7	8	9					
56	1/2 cup of carrots (cooked)	1	2	3	4	5	6	7	8	9					
57	1/2 cup of carrots (raw)	1	2	3	4	5	6	7	8	9					
58	1/2 cup of carrots (cooked)	1	2	3	4	5	6	7	8	9					
59	1/2 cup of carrots (raw)	1	2	3	4	5	6	7	8	9					
60	1/2 cup of carrots (cooked)	1	2	3	4	5	6	7	8	9					
61	1/2 cup of carrots (raw)	1	2	3	4	5	6	7	8	9					
62	1/2 cup of carrots (cooked)	1	2	3	4	5	6	7	8	9					
63	1/2 cup of carrots (raw)	1	2	3	4	5	6	7	8	9					
64	1/2 cup of carrots (cooked)	1	2	3	4	5	6	7	8	9					
65	1/2 cup of carrots (raw)	1	2	3	4	5	6	7	8	9					
66	1/2 cup of carrots (cooked)	1	2	3	4	5	6	7	8	9					
67	1/2 cup of carrots (raw)	1	2	3	4	5	6	7	8	9					
68	1/2 cup of carrots (cooked)	1	2	3	4	5	6	7	8	9					
69	1/2 cup of carrots (raw)	1	2	3	4	5	6	7	8	9					
70	1/2 cup of carrots (cooked)	1	2	3	4	5	6	7	8	9					
71	1/2 cup of carrots (raw)	1	2	3	4	5	6	7	8	9					
72	1/2 cup of carrots (cooked)	1	2	3	4	5	6	7	8	9					
73	1/2 cup of carrots (raw)	1	2	3	4	5	6	7	8	9					
74	1/2 cup of carrots (cooked)	1	2	3	4	5	6	7	8	9					
75	1/2 cup of carrots (raw)	1	2	3	4	5	6	7	8	9					
76	1/2 cup of carrots (cooked)	1	2	3	4	5	6	7	8	9					
77	1/2 cup of carrots (raw)	1	2	3	4	5	6	7	8	9					
78	1/2 cup of carrots (cooked)	1	2	3	4	5	6	7	8	9					
79	1/2 cup of carrots (raw)	1	2	3	4	5	6	7	8	9					
80	1/2 cup of carrots (cooked)	1	2	3	4	5	6	7	8	9					
81	1/2 cup of carrots (raw)	1	2	3	4	5	6	7	8	9					
82	1/2 cup of carrots (cooked)	1	2	3	4	5	6	7	8	9					
83	1/2 cup of carrots (raw)	1	2	3	4	5	6	7	8	9					
84	1/2 cup of carrots (cooked)	1	2	3	4	5	6	7	8	9					
85	1/2 cup of carrots (raw)	1	2	3	4	5	6	7	8	9					
86	1/2 cup of carrots (cooked)	1	2	3	4	5	6	7	8	9					
87	1/2 cup of carrots (raw)	1	2	3	4	5	6	7	8	9					
88	1/2 cup of carrots (cooked)	1	2	3	4	5	6	7	8	9					
89	1/2 cup of carrots (raw)	1	2	3	4	5	6	7	8	9					
90	1/2 cup of carrots (cooked)	1	2	3	4	5	6	7	8	9					
91	1/2 cup of carrots (raw)	1	2	3	4	5	6	7	8	9					
92	1/2 cup of carrots (cooked)	1	2	3	4	5	6	7	8	9					
93	1/2 cup of carrots (raw)	1	2	3	4	5	6	7	8	9					
94	1/2 cup of carrots (cooked)	1	2	3	4	5	6	7	8	9					
95	1/2 cup of carrots (raw)	1	2	3	4	5	6	7	8	9					
96	1/2 cup of carrots (cooked)	1	2	3	4	5	6	7	8	9					
97	1/2 cup of carrots (raw)	1	2	3	4	5	6	7	8	9					
98	1/2 cup of carrots (cooked)	1	2	3	4	5	6	7	8	9					
99	1/2 cup of carrots (raw)	1	2	3	4	5	6	7	8	9					
100	1/2 cup of carrots (cooked)	1	2	3	4	5	6	7	8	9					

II. FREQUENCY OF NUTRIENT CONSUMPTION FOR WOMEN IN THE PAST MONTH

Participant ID _____

No.	Foods	Never (0)	Times per week					Times per day					Consumption Frequency	Food usually eaten raw? 1= cooked? 2=
			1 (03)	2 (04)	3 (05)	4 (06)	5 (07)	1 (07)	2 (08)	3 (09)	4 (09)			

9. In the following trimesters, which foods did you consume MOST frequently?	1st Trimester			2nd Trimester		
	A FOOD	B FREQ	C CODE	A FOOD	B FREQ	C CODE
PLEASE SPECIFY THE FOOD IN COLUMN A.						
PLEASE SPECIFY HOW OFTEN YOU CONSUMED THE FOOD IN COLUMN B.						
1 - LESS THAN ONCE						
2 - 1 - 3 TIMES PER MONTH						
3 - ONCE PER WEEK						
4 - 2-4 TIMES PER WEEK						
5 - 5-6 TIMES PER WEEK						
6 - ONCE PER DAY						
7 - 2-3 TIMES PER DAY						
8 - 4-5 TIMES PER DAY						
9 - 6 TIMES PER DAY						
PLEASE SPECIFY THE CODE OF THE FOOD IN COLUMN C (AFTER THE INTERVIEW AT THE OFFICE)						
10. When comparing to your current diet, did you include/exclude some foods to/from your diet during the following trimesters?	1st Trimester			2nd Trimester		
Included other foods.	1			1		
Excluded other foods.	2			2		
Both (included some, but excluded others)?	3			3		
Consumed the same foods as current diet.	4			4		
(continue with item 7 referring to the next trimester)						

	from Month _____ to Month _____			from Month _____ to Month _____		
11. In the following trimesters, which foods did you INCLUDE in your diet during pregnancy?	1st. Trimester			2nd. Trimester		
	A FOOD	B FREQ	C CODE	A FOOD	B FREQ	C CODE
PLEASE SPECIFY THE FOOD IN COLUMN A.						
PLEASE SPECIFY HOW OFTEN CONSUMED PER MONTH IN COLUMN B.						
1 = LESS THAN ONCE						
2 = 1 - 3 TIMES PER MONTH						
3 = ONCE PER WEEK						
4 = 2-4 TIMES PER WEEK						
5 = 5-6 TIMES PER WEEK						
6 = ONCE PER DAY						
7 = 2-3 TIMES PER DAY						
8 = 4-5 TIMES PER DAY						
9 = 6 TIMES PER DAY						
PLEASE SPECIFY THE CODE OF THE FOOD IN COLUMN C (AFTER THE INTERVIEW AT THE OFFICE)						
12. In the following trimesters, which were the foods you EXCLUDED from your diet?	1st. Trimester			2nd. Trimester		
	A FOOD		C CODE	A FOOD		C CODE
PLEASE SPECIFY THE FOOD IN COLUMN A.						
PLEASE SPECIFY THE CODE OF THE FOOD IN COLUMN C (AFTER THE INTERVIEW AT THE OFFICE)						

	from Month _____ to Month _____			from Month _____ to Month _____		
13. Compared to your current diet did you eat more, less or the same during pregnancy and breastfeeding?	3rd. Trimester			BREASTFEEDING		
1 = consumed more						
2 = consumed less						
3 = consumed increased quantities of certain foods, but less of others						
4 = consumed the same amount of foods						
ASK BY TRIMESTER/BREASTFEEDING						
14. In the following trimesters, which foods did you eat less frequently?	3rd. Trimester			BREASTFEEDING		
	A FOOD	B FREQ	C CODE	A FOOD	B FREQ	C CODE
Please write food in column A.						
Please specify how often you consumed the food in column B.						
1 = LESS THAN ONCE						
2 = 1 - 3 TIMES PER MONTH						
3 = ONCE PER WEEK						
4 = 2-4 TIMES PER WEEK						
5 = 5-6 TIMES PER WEEK						
6 = ONCE PER DAY						
7 = 2-3 TIMES PER DAY						
8 = 4-5 TIMES PER DAY						
9 = 6 TIMES PER DAY						
PLEASE SPECIFY THE CODE OF THE FOOD IN COLUMN C (AFTER THE INTERVIEW AT THE OFFICE)						

	from Month _____ to Month _____			from Month _____ to Month _____		
15. In the following trimesters, which foods did you consume MORE frequently?	3rd Trimester			BREASTFEEDING		
	A FOOD	B FREQ	C CODE	A FOOD	B FREQ	C CODE
PLEASE SPECIFY THE FOOD IN COLUMN A.						
PLEASE SPECIFY HOW OFTEN YOU CONSUMED THE FOOD IN COLUMN B.						
1 = LESS THAN ONCE						
2 = 1 - 3 TIMES PER MONTH						
3 = ONCE PER WEEK						
4 = 2-4 TIMES PER WEEK						
5 = 5-6 TIMES PER WEEK						
6 = ONCE PER DAY						
7 = 2-3 TIMES PER DAY						
8 = 4-5 TIMES PER DAY						
9 = 6 TIMES PER DAY						
PLEASE SPECIFY THE CODE OF THE FOOD IN COLUMN C (AFTER THE INTERVIEW AT THE OFFICE)						
16. When comparing to your current diet, did you include/exclude some foods to/from your diet during the following trimesters?	3rd Trimester			BREASTFEEDING		
Included other foods.....1						
Excluded other foods.....2						
Both (included some, but excluded others).....3						
Consumed the same foods as current diet.....4						
(continue with item 7 referring to the next trimester)						

	from Month	to Month		from Month	to Month	
17. In the following trimesters, which foods did you INCLUDE in your diet during pregnancy?	3rd Trimester		BREASTFEEDING			
	A FOOD	B FREQ	C CODE	A FOOD CODE	B FREQ	C
	PLEASE SPECIFY THE FOOD IN COLUMN A.					
	PLEASE SPECIFY HOW OFTEN YOU CONSUMED THE FOOD PER MONTH IN COLUMN B.					
	1 = LESS THAN ONCE					
	2 = 1 - 3 TIMES PER MONTH					
	3 = ONCE PER WEEK					
	4 = 2-4 TIMES PER WEEK					
	5 = 4-6 TIMES PER WEEK					
	6 = ONCE PER DAY					
7 = 2-3 TIMES PER DAY						
8 = 4-5 TIMES PER DAY						
9 = 6 TIMES PER DAY						
PLEASE SPECIFY THE CODE OF THE FOOD IN COLUMN C (AFTER THE INTERVIEW AT THE OFFICE)						
18. In the following trimesters, which were the foods you EXCLUDED from your diet?	3rd Trimester		BREASTFEEDING			
	A FOOD	C CODE	A FOOD	C CODE		
	PLEASE SPECIFY THE FOOD IN COLUMN A.					
	PLEASE SPECIFY THE CODE OF THE FOOD IN COLUMN C (AFTER THE INTERVIEW AT THE OFFICE)					

III. VITAMIN/NUTRIENT SUPPLEMENT USE DURING PREGNANCY Now I will ask you some questions regarding vitamin/nutrient supplement use before or during your pregnancy with (CHILD NAME). Once more, I will ask you about their use at different periods: approximately 3 months before your pregnancy and by each trimester of your pregnancy.

19. Did you take any vitamin/nutrient supplement during your pregnancy?

YES → 1
NO → 2

IF NO VITAMIN/NUTRIENT SUPPLEMENTS WERE TAKEN BEFORE OR DURING PREGNANCY AND MOTHER BREASTED, CONTINUE TO SECTION IV, QUESTION 20. IF MOTHER DID NOT TAKE VITAMIN/NUTRIENT SUPPLEMENTS DURING PREGNANCY AND DID NOT BREASTFEED, THE QUESTIONNAIRE ENDS HERE.

20. INTERVIEWER: Calculate the months of each trimester and the period three months before pregnancy.	A	B	C	
	3 mo before pregnancy	1st Trimester	2nd Trimester	3rd Trimester
NINE MONTH PREGNANCY: Start with month of birth	from Month to Month	from Month to Month	from Month to Month	from Month to Month
SEVEN MONTH PREGNANCY: Start with month of birth + 2 months				
21. Were you taking vitamin/nutrient supplements during the 3 months before your pregnancy with (NAME)?	3 mo before pregnancy	1st Trimester	2nd Trimester	3rd Trimester
ASK FOR EACH TRIMESTER IN THE SAME MANNER				
YES → 1 NO → 2				
22. What vitamin/nutrient supplements did you take during the 3 months before your pregnancy (on a month to month basis)?	3 mo before pregnancy	1st Trimester	2nd Trimester	3rd Trimester
	a) _____	a) _____	a) _____	a) _____
ENTER THE EXACT NAME OF THE SUPPLEMENT. YOU CAN ENTER UP TO 3 CHOICES	Specify	Specify	Specify	Specify
	b) _____	b) _____	b) _____	b) _____
If the participant does not know the name of the supplement, please find out the CONTENT of the supplement and take down all the details. ASK FOR EVERY TRIMESTER IN THE SAME MANNER. Code for items at the office using the list of nutrient/vitamin supplements.	Specify	Specify	Specify	Specify
	c) _____	c) _____	c) _____	c) _____
	Specify	Specify	Specify	Specify
	d) _____	d) _____	d) _____	d) _____

	from Month	to Month	from Month	to Month	from Month	to Month	from Month	to Month	
23. For how long did you take the vitamin/nutrient supplements during the 3 months before your pregnancy with (NAME) (on a month to month basis)?	3 mo before pregnancy	1st Trimester	2nd Trimester	3rd Trimester					
	a) _____	a) _____	a) _____	a) _____					
	b) _____	b) _____	b) _____	b) _____					
	c) _____	c) _____	c) _____	c) _____					
	PLEASE NOTE THE NUMBER OF MONTHS EVEN IF LESS THAN ONE MONTH 99								
	ASK ABOUT EACH SUPPLEMENT ENTERED ABOVE FOR EACH TRIMESTER IN THE SAME MANNER								
	IF THE WOMAN DID NOT TAKE ANY SUPPLEMENT FOR MORE THAN 1 MONTH IN ANY GIVEN PERIOD (CODE 99 IN EACH SECTION) GO TO SECTION IV, QUESTION 20.								
	24. How often did you take the vitamin supplements during the three months before your pregnancy (on a month to month basis)? (READ THE NAME OF THE SUPPLEMENT ALOUD TO PARTICIPANT)	3 mo before pregnancy	1st Trimester	2nd Trimester	3rd Trimester				
		Period Times a day	Period Times a day	Period Times a day	Period Times a day				
		a) _____	a) _____	a) _____	a) _____				
b) _____		b) _____	b) _____	b) _____					
c) _____		c) _____	c) _____	c) _____					
ASK ABOUT EACH SUPPLEMENT ENTERED ABOVE FOR EACH TRIMESTER IN THE SAME MANNER									
Daily _____ 1									
Few days/week _____ 2									
Few days/month _____ 3									
On the days you took the supplement, how many times a day did you take it?									
25. In what form do you take the vitamin/nutrient supplement? (READ THE NAME OF THE SUPPLEMENT ALOUD TO PARTICIPANT) capsules? Powder? Liquid?	Form	Quantity/serving	Form	Quantity/serving	Form	Quantity/serving	Form	Quantity/serving	
	a) _____	a) _____	a) _____	a) _____	a) _____	a) _____	a) _____	a) _____	
	b) _____	b) _____	b) _____	b) _____	b) _____	b) _____	b) _____	b) _____	
	c) _____	c) _____	c) _____	c) _____	c) _____	c) _____	c) _____	c) _____	
	How much did you take each time? ASK ABOUT EACH SUPPLEMENT ENTERED ABOVE								
	SUPPLEMENT FORM CODES								
	Capsule or pill form _____ 1								
	Powder form _____ 2								
	(QUANTITY = SPOONFUL)								
	Liquid form _____ 3								
(QUANTITY = CUPS OF 250 ML)									

REFERENCES

1. Basch CE, Shea S, Zybert P. The reproducibility of data from a Food Frequency Questionnaire among low-income Latina mothers and their children. Am J Public Health. 1994; 84(5):861–4. [PubMed: 8179065]

2. Brown JE, et al. A food frequency questionnaire can detect pregnancy-related changes in diet. J Am Diet Assoc. 1996; 96(3):262–6. [PubMed: 8613661]

3. Cheng Y, et al. Validity and reproducibility of a semi-quantitative food frequency questionnaire for use among pregnant women in rural China. Asia Pac J Clin Nutr. 2008; 17(1):166–77. [PubMed: 18364342]

4. De Vriese SR, et al. Estimation of dietary fat intake of Belgian pregnant women. Comparison of two methods. *Ann Nutr Metab.* 2001; 45(6):273–8. [PubMed: 11786650]
5. Erkkola M, et al. Validity and reproducibility of a food frequency questionnaire for pregnant Finnish women. *Am J Epidemiol.* 2001; 154(5):466–76. [PubMed: 11532789]
6. Greeley S, Storbakken L, Magel R. Use of a modified food frequency questionnaire during pregnancy. *J Am Coll Nutr.* 1992; 11(6):728–34. [PubMed: 1460189]
7. Kristal AR, et al. Associations of race/ethnicity, education, and dietary intervention with the validity and reliability of a food frequency questionnaire: the Women's Health Trial Feasibility Study in Minority Populations. *Am J Epidemiol.* 1997; 146(10):856–69. [PubMed: 9384206]
8. Robinson S, et al. Evaluation of a food frequency questionnaire used to assess nutrient intakes in pregnant women. *Eur J Clin Nutr.* 1996; 50(5):302–8. [PubMed: 8735311]
9. Suitor CJ, Gardner J, Willett WC. A comparison of food frequency and diet recall methods in studies of nutrient intake of low-income pregnant women. *J Am Diet Assoc.* 1989; 89(12):1786–94. [PubMed: 2592710]
10. Wei EK, et al. Validity of a food frequency questionnaire in assessing nutrient intakes of low-income pregnant women. *Matern Child Health J.* 1999; 3(4):241–6. [PubMed: 10791365]
11. Bunin GR, et al. Recall of diet during a past pregnancy. *Am J Epidemiol.* 2001; 154(12):1136–42. [PubMed: 11744519]
12. House JD, et al. Improvements in the status of folate and cobalamin in pregnant Newfoundland women are consistent with observed reductions in the incidence of neural tube defects. *Can J Public Health.* 2006; 97(2):132–5. [PubMed: 16620001]
13. Iqbal MM. Birth defects: prevention of neural tube defects by periconceptional use of folic acid and screening. *J Prev Soc Med.* 1999; 18(1):52–65. [PubMed: 12179656]
14. La Merrill M, et al. The association between first trimester micronutrient intake, MTHFR genotypes, and global DNA methylation in pregnant women. *J Matern Fetal Neonatal Med.* 2011
15. Ma AG, et al. Micronutrient status in anemic and non-anemic Chinese women in the third trimester of pregnancy. *Asia Pac J Clin Nutr.* 2009; 18(1):41–7. [PubMed: 19329394]
16. Painter RC, Roseboom TJ, Bleker OP. Prenatal exposure to the Dutch famine and disease in later life: an overview. *Reprod Toxicol.* 2005; 20(3):345–52. [PubMed: 15893910]
17. Strobel M, Tinz J, Biesalski HK. The importance of beta-carotene as a source of vitamin A with special regard to pregnant and breastfeeding women. *Eur J Nutr.* 2007; 46(Suppl 1):I1–20. [PubMed: 17665093]
18. de Lourdes Flores M, et al. Multiple micronutrient supplementation and dietary energy intake in pregnant women. *Salud Publica Mex.* 2007; 49(3):190–8. [PubMed: 17589773]
19. Ramakrishnan U, et al. Multiple micronutrient supplementation during pregnancy does not lead to greater infant birth size than does iron-only supplementation: a randomized controlled trial in a semirural community in Mexico. *Am J Clin Nutr.* 2003; 77(3):720–5. [PubMed: 12600867]
20. Ramakrishnan U, et al. Effect of prenatal multiple micronutrient supplements on maternal weight and skinfold changes: a randomized double-blind clinical trial in Mexico. *Food Nutr Bull.* 2005; 26(3):273–80. [PubMed: 16222918]
21. Ramakrishnan U, et al. Multiple micronutrient supplements during pregnancy do not reduce anemia or improve iron status compared to iron-only supplements in Semirural Mexico. *J Nutr.* 2004; 134(4):898–903. [PubMed: 15051844]
22. Hernandez-Avila M, et al. Validity and reproducibility of a food frequency questionnaire to assess dietary intake of women living in Mexico City. *Salud Publica Mex.* 1998; 40(2):133–40. [PubMed: 9617194]
23. Rivera-Dommarco, J., et al. Encuesta Nacional de Nutrición 1999. Instituto Nacional de Salud Pública; Cuernavaca, Morelos: 2001. Estado Nutricio en Niños y Mujeres en México.
24. Rodriguez-Ramirez S, et al. Methodology for the analysis of dietary data from the Mexican National Health and Nutrition Survey 2006. *Salud Publica Mex.* 2009; 51(Suppl 4):S523–9. [PubMed: 20464228]
25. Safdie, M., et al. Bases de datos de valor nutritivo de los alimentos. Compiled by Instituto Nacional de Salud Pública. Instituto Nacional de Salud Pública; Cuernavaca, Morelos: 2004.

26. Mejia-Rodriguez F, et al. Use of nutritional supplements among Mexican women and the estimated impact on dietary intakes below the EAR and above the UL. *J Am Coll Nutr.* 2007; 26(1):16–23. [PubMed: 17353579]
27. Lohman TG, Roche AF, Martorell R. Anthropometric standardization reference manual. Human Kinetics Books. 1988
28. Organization, WH. Physical status: the use and interpretation of anthropometry. World Health Organization; Geneva: 1995.
29. Bronfman M, et al. Strategies for improving the therapeutic patterns used in acute diarrhea in primary medical care units. II. The measurement of inequality: a methodologic strategy, analysis of the socioeconomic features of the sample. *Arch Invest Med (Mex).* 1988; 19(4):351–60. [PubMed: 3245751]
30. Willett, W. Nutritional epidemiology. Oxford University Press; 1990.
31. Willett WC, Howe GR, Kushi LH. Adjustment for total energy intake in epidemiologic studies. *Am J Clin Nutr.* 1997; 65(4 Suppl):1220S–1228S. discussion 1229S–1231S. [PubMed: 9094926]
32. Bland JM, Altman DG. Statistical methods for assessing agreement between two methods of clinical measurement. *Lancet.* 1986; 1(8476):307–10. [PubMed: 2868172]
33. Bland JM, Altman DG. Measuring agreement in method comparison studies. *Stat Methods Med Res.* 1999; 8(2):135–60. [PubMed: 10501650]
34. Rosner B, Willett WC. Interval estimates for correlation coefficients corrected for within-person variation: implications for study design and hypothesis testing. *Am J Epidemiol.* 1988; 127(2): 377–86. [PubMed: 3337089]
35. Zar JH. Significance Testing of the Spearman Rank Correlation Coefficient. *Journal of the American Statistical Association.* 1972; 67(339):578–580.
36. Block G, et al. Validation of a food frequency questionnaire for Hispanics. *Prev Chronic Dis.* 2006; 3(3):A77. [PubMed: 16776878]
37. Gibson, RS. Principles of nutritional assessment. Oxford University Press; 2005.
38. Romieu I, et al. Questionnaire assessment of antioxidants and retinol intakes in Mexican women. *Arch Med Res.* 1999; 30(3):224–39. [PubMed: 10427874]
39. Smith AF, Jobe JB, Mingay DJ. Retrieval from memory of dietary information. *Applied Cognitive Psychology.* 1991; 5(3):269–296.
40. Ocke MC, et al. The Dutch EPIC food frequency questionnaire. II. Relative validity and reproducibility for nutrients. *Int J Epidemiol.* 1997; 26(Suppl 1):S49–58. [PubMed: 9126533]
41. Kabagambe EK, et al. Application of the method of triads to evaluate the performance of food frequency questionnaires and biomarkers as indicators of long-term dietary intake. *Am J Epidemiol.* 2001; 154(12):1126–35. [PubMed: 11744518]

Figure 1.

Structure and chronology for this validation

- 24hR-original: Mean of two 24 hours recalls performed.
- FFQ-month: Food frequency questionnaire from last month to validation survey, unmodified for trimester during pregnancy.
- FFQ-pregnancy: Food frequency questionnaire of the last month modified for differences between first and third trimesters of pregnancy.

a.

b.

Figure 2.

Bland and Altman plots comparing reported energy intake obtained from the 24hR-original^a and the FFQ-pregnancy^b in the first (Figure 2a) and third (Figure 2b) trimesters.

a. 24hR-original: Mean of two 24 hour recalls performed in: third trimester.

b. FFQ-pregnancy: Food frequency intake in the last month modified for differences between the first and third trimester of pregnancy

Table 1

Anthropometric and demographic characteristics of women participating in the validation study at time of recruitment into the original randomized double blinded clinical trial (1997-2000) ^a

	Mean	(S.D.)	(Minimum,	Maximum)
Age (years) *	23.1	(4.9)	(15.0,	37.0)
Weight (Kg)	51.5	(8.0)	(37.0,	72.5)
Height (cm) *	148.3	(4.7)	(135.9,	160.8)
BMI (kg/m²)	23.4	(3.5)	(16.7,	32.7)

	n	%	(95%CI)
BMI (kg/m²)			
<18.5	4	4.8	(0.1, 9.4)
18.5 to 24.9	54	65.5	(55.1, 75.9)
25.0 to 29.9	21	25.0	(15.5, 34.5)
>30.0	4	4.8	(0.1, 9.4)
Socio economical Level *			
Low	26	37.1	(25.5, 48.7)
Medium	21	30.0	(19.0, 41.0)
High	23	32.9	(25.6, 44.1)
Parity (No. Children) *			
0	2	2.4	(-0.1, 5.7)
1 to 2	43	51.2	(40.3, 62.1)
3 to 5	11	13.1	(5.7, 20.5)
> 5	28	33.3	(23.0, 43.6)
Schooling (year) *			
0	8	9.5	(3.1, 15.9)
1 to 6	39	46.4	(35.5, 57.3)
7 to 9	28	33.3	(23.0, 46.6)
>10	9	10.7	(4.0, 17.5)

* These characteristics did not differ ($p>0.05$) between women participating in the randomized double-blinded clinical trial who were included in this analysis (N= 84) and those excluded from this validation.

^a 84 Women, time at study entry was during first trimester

^b Socioeconomic status was classified into three levels, by a construct based on principal component analysis of household possessions and characteristics according to Bronfman.

^c School year completed

^d WHO cutoff points: underweight <18.5, normal 18.5 to 24.9, overweight 25 to 29.9 and obese >30

Table 2

Comparison of nutrient intake for the first and third trimesters, as estimated by three dietary instruments, with and without including contribution from intake of supplements^a

Nutrient	Intake from Diet alone (not including supplements)		Intake from both Diet and Supplements	
	24hR-original ^b	Median (p25, p75) FFQ-month ^c	24hR-original	Median (p25, p75) FFQ-pregnancy
First trimester of pregnancy				
Energy (kcal)	1515.6 (1133.8, 1837.4)	1570.8 (1306.0, 2032.5)	1515.6 (1133.8, 1837.4)	1499.9 (1163.1, 2053.9)
Vitamin A (EqRe, mcg)	535.5 (197.5, 1697.2)	1181.7 [*] (751.4, 1189.8)	910.0 (506.0, 1810.0)	1414.6 (902.9, 2305.7)
Vitamin B6 (mg)	1.16 (0.9, 1.6)	1.60 [*] (1.3, 2.1)	2.5 (1.29, 3.07)	2.51 ^{**} (1.5, 3.4)
Vitamin B12 (µg)	0.8 (0.4, 1.6)	1.69 [*] (1.08, 5.1)	2.5 (1.0, 3.20)	3.07 ^{**} (1.2, 5.3)
Folate (DFE ^e , mcg)	245.0 (179.2, 325.2)	183.1 [*] (144.7, 251.4)	492.3 (259.0, 609.5)	269.9 ^{**} (174.3, 502.1)
Third trimester of pregnancy				
Energy (kcal)	1679.9 (1318.1, 2110.0)	1570.8 [*] (1306.0, 2032.5)	1679.9 (1315.9, 2102.8)	1563.1 ^{**} (2053.9, 1269.8)
Vitamin A (EqRe, mcg)	665.1 (266.6, 2461.7)	1181.7 [*] (751.4, 1189.8)	985.5 (637.1, 2837.4)	1459.8 ^{**} (990.9, 2398.6)
Vitamin B6 (mg)	1.2 (0.9, 1.6)	1.6 (1.3, 2.1)	2.6 (1.2, 3.6)	3.02 (2.0, 3.6)
Vitamin B12 (mcg)	0.8 (0.4, 1.2)	1.7 (1.1, 5.1)	2.6 (0.8, 3.2)	3.4 (1.7, 6.0)
Folate (DFE ^e , mcg)	277.6 (209.9, 394.2)	183.1 (144.7, 251.4)	535.9 (316.7, 650.9)	479.0 (218.0, 544.4)

Significant differences (p<0.05) through Wilcoxon signed rank test.

* 24hR-original vs FFQ-month

** 24hR-original vs FFQ-pregnancy

d_{84} women

e_{24hR} -original: Mean of two 24 hours recalls performed.

f_{FFQ} -month: Food frequency questionnaire from last month to validation survey, unmodified for trimester during pregnancy.

g_{FFQ} -pregnancy: Food frequency questionnaire of the last month modified for differences between first and third trimesters of pregnancy.

h_{DFFE} : Dietary Folate Equivalents.

Table 3

Nutrient intake correlation per trimester estimated by three instruments

	Without including supplement intake ^d			Including supplement intake		
	FFQ-month ^b Vs. 24hR-original ^a	FFQ-pregnancy ^c Vs. 24hR-original ^a	r-D ^e	FFQ-month ^b Vs. 24hR-original ^a	FFQ-pregnancy ^c Vs. 24hR-original ^a	r-D ^e
First Trimester						
Energy	0.17	0.26	0.12	0.17	0.25	0.12
Vitamin A	0.22	0.44	0.17	0.23 [*]	0.40	0.26 [*]
Vitamin B6	0.18	^f	0.12	-0.01	0.01	0.66 ^{**}
Vitamin B12	0.10	0.19	0.13	0.07	0.08	0.33 [*]
Folate	-0.14	-0.26	-0.17	-0.07	-0.08	0.50 ^{**}
Third Trimester						
Energy	0.08	0.20	0.13	0.08	0.20	0.13
Vitamin A	0.25 [*]	0.47	0.25 [*]	0.26 [*]	0.47	0.38 ^{**}
Vitamin B6	0.19	0.37	0.14	0.04	0.04	0.77 ^{**}
Vitamin B12	0.10	0.19	0.10	0.10	0.12	0.44 ^{**}
Folate	0.26 [*]	1.00	0.16	0.21	0.25	0.73 ^{**}

* p<0.05

** p<0.001, Spearman Correlation Coefficient

^a 24hR-original: Mean of two 24 hours recalls performed during: first trimester and third trimester.

^b FFQ-month: Food frequency questionnaire assessing diet during last month to validation survey, unmodified for trimester of pregnancy

^c FFQ-pregnancy: Food frequency questionnaire of the last month modified for differences between first and third trimesters of pregnancy

^d Adjusted by energy

^eDeattenuation: Corrected for day to day variation between the two R24h-original

^fTotal variation wholly explained by within subjects variation.

Table 4

Comparison of correlations for estimates of energy intake generated by three dietary instruments, ^a by number of weeks of gestation at time of 24 hr Recall

	24hR-original ^b Vs. FFQ-month ^c		24hR-original Vs. FFQ-pregnancy ^d	
	r	r-D ^e	r	r-D ^e
First trimester				
> 9 Weeks	0.15	0.34	0.23	0.53
9 Weeks	0.13	0.18	0.21	0.29
Third trimester				
< 32 Weeks	0.01	0.02	-0.01	-0.02
32 Weeks	0.40	0.67	0.87 [*]	1.00

^{*} p<0.05 Multivariate analysis, adjusted by age and schooling in years.

^a 84 women

^b 24hR-original: Mean of two 24 hours recalls performed.

^c FFQ-month: Food frequency questionnaire from last month to validation survey, unmodified for trimester of pregnancy.

^d FFQ-pregnancy: Food frequency questionnaire of the last month modified for differences between first and third trimesters of pregnancy.

^e Deattenuation: Corrected for day to day variation between two R24h-original