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Validation of a food frequency questionnaire for retrospective estimation of diet during the first 2 years of life

Fabiola Mejía-Rodríguez, MSc¹, Lynnette M. Neufeld, PhD³, Armando García-Guerra, MSc¹, Amado D. Quezada-Sanchez, MSc¹, and Manuela A. Orjuela, MD, ScM²

¹Centro de Investigación en Nutrición y Salud, Instituto Nacional de Salud Pública (INSP), Cuernavaca, Morelos, México

²Department of Pediatrics (Oncology), and in Environmental Health Sciences, Mailman School of Public Health, Columbia University, New York, New York

³Micronutrient Initiative, Canada

Abstract

Objective—This study aims to validate a Food Frequency Questionnaire (FFQ), specifically designed to retrospectively estimate dietary intake and supplement consumption during the first two years of life in children from resource poor households in semi-rural Mexico.

Methods—The FFQ querying about diet during the first 2 years of life was administered to mothers of children (N=84), who participated in a prospective study 3 to 5 years earlier, in which complementary feeding practice questionnaires and 24-hour recall (24hrR) were collected at several time points during the first 2 years of life to evaluate dietary and vitamin supplement intake. The resulting FFQ data were compared to intake data collected during the original study using Spearman correlations, deattenuated correlations and Wilcoxon signed-rank tests.

Results—Total energy intake, as estimated by the retrospective and original instruments, did not differ in the second year (Yr2); correlations between the measures were significant ($r=0.40$, $p<0.001$). The 24hrR and FFQ-Yr2 were significantly correlated for dietary intake of vitamins B6, B12 ($p<0.001$) and folate ($p<0.01$); however, after including vitamin supplement intake, the two dietary instruments were correlated only for vitamins A and B12 ($p<0.05$).

Conclusions—The FFQ provides a reasonable estimate of a child's dietary intake of energy and key micronutrients during the second year of life, and permits accurate ranking of intake 3 to 5 years after birth.

Keywords

Validation Food Frequency Questionnaire; 24hour recalls; children; vitamins; Micronutrients; Dietary supplements

Introduction

Malnutrition, especially from a lack of vitamins and minerals, plays an important role during the first two years of life, irreversibly impairing both growth and brain development. (1–3) There are few dietary instruments that produce cost effective, time efficient assessments of

Address correspondence to: Fabiola Mejía-Rodríguez, Centro de Investigación en Nutrición y Salud, Instituto Nacional de Salud Pública, Av. Universidad 655, Santa María Ahuacatitlán Cerrada, Los Pinos y Caminera, Cuernavaca, Morelos 62100 Mexico, fmejia@insp.mx.

nutrient intake. It is therefore critically important to validate instruments that can reliably and retrospectively document and rank nutrient intake for children in this age group.

It is especially challenging to assess energy and micronutrient consumption, particularly those that are more commonly hypothesized to be associated with risk in early childhood disease (vitamins A, B6, B12 and folate) during developmental stages in which introduction to foods and feeding practices change rapidly. (4, 5)

Investigators working with rare diseases must rely on tools that can collect data retrospectively, making Food Frequency Questionnaires (FFQ) the best alternative for ranking past dietary intake in population studies. (6, 7) Although Roman-Viñas et al. showed that an FFQ can adequately estimate micronutrient levels in children and adolescents, data are limited for children under the age of 2 years. (8, 9) Questionnaires that are validated for one population may not necessarily be adequate for evaluating other populations, unless the populations share certain characteristics. (10, 11) Studies interested in estimating the relative importance of an infant and toddler's diet contributing to risk of disease in later childhood might need to differentiate between these periods of intake in order to differentiate associations during periods of varying growth and development.

The objective of our study is to validate a FFQ designed to retrospectively estimate dietary intake and supplement consumption during the first 2 years of life in children from families with limited economic resources living in semi-rural Mexico.

Methods

We relied on a population of mothers who had previously participated in a double-blind randomized clinical trial (RCT), which included prospective collection of infant dietary intake and took place from 1997 to 2000 in a semi-rural town in the state of Morelos, Mexico. Details of the RCT, its methods and its results have been published previously. (12–17) In the validation study, a subgroup of these mothers was re-interviewed when their children were between the ages of 3–5 years.

Double-blind clinical trial (RCT)

Background—The RCT's primary objective was to compare the impact of vitamin supplementation on fetal growth by randomizing 873 pregnant women to daily supplements containing either multiple micronutrients or iron. The secondary objective was to compare the growth and developmental effects of the offspring who were randomized to receive either multiple micronutrients (vitamins A, C, D, E, B1, B2, B6, B12, niacin, folic acid, iron, magnesium, and zinc) or iron with vitamin A in the form of syrup between the ages of 3–24 months.

Dietary information (RCT)—Information about the child's diet was obtained using a complementary feeding practice (CFP) questionnaire (see appendix A) at ages 3, 6, and 9 months. The CFP questionnaires documented whether children were breastfed as well as what types of complementary foods mothers gave their children during the study. Complementary food items included: water (with and without honey or sugar), tea (with and without honey or sugar), "atole" with water, coffee (with and without sugar or honey), juice, chicken broth, bean soup, eggs, raw or cooked fruits (any type) and vegetables (any type), beans, tortilla, rice, chicken, beef, pork, and cheese. The CFP also included blank spaces for recording intake of additional items consumed by the child that were not included in the questionnaire food list.

A 24-hour recall questionnaire (24hrR) completed over two non-consecutive days at 12, 18 and 24 months of age. Trained interviewers administered both the CFP and 24hrR.

Demographic and anthropometric information (RCT)—During home visits, trained RCT study personnel recorded demographic and anthropometric information including level of maternal education, family size, indicators of socio-economic status (SES), and the child's weight and length. (12–17) The prevalence of undernutrition (<-2 z-score for weight/age, height/age and weight/height) was also calculated. (18) SES was classified into tertiles using the Brofman index: low, middle and high. (19) Maternal education was stratified into 4 categories: 0, 1–6, 7–9, and 10 years of formal schooling.

Validation Study

Subjects—For the current validation study (2004), we identified 90 mother-child pairs who participated in the RCT (1997–2000) and had complete CFP data and at least four 24hrR obtained on non-consecutive days and supplement intake data. (See Figure 1) Of these 90 mother-child pairs, 84 mothers agreed to participate in the validation of the FFQ. The remaining 6 participants no longer resided in the study area. All 84 pairs were included regardless of the child's current health status. We compared the subgroup of 84 mothers selected to participate in the validation study to the total population that participated in the RCT ($N=873$) to examine potential selection bias. The validation subgroup did not differ from the total RCT population in most demographic and anthropometric characteristics (including the child's birth weight, birth length, family size, years of schooling completed (maternal), and socio-economic status (SES)). The women in the validation subgroup weighed an average of 2kg less at baseline than the total group of women participating in the original RCT, and their BMI was only 0.9kg/m² lower.

Development of the New Food Frequency Questionnaire—The design of the specific FFQ we proposed to validate (see Appendix B) builds on our prior experience conducting dietary surveys of Mexican mother-child pairs. The FFQ is divided into three sections and is administered as an in-person interview to mothers of children in the study. The first section (FFQ-Yr1) queried mothers on the child's dietary consumption during the first year of life (from birth through 11 months of age), the second section (FFQ-Yr2) queried on dietary consumption in the second year (12–24 months of age), and the last section queried on vitamin supplement consumption in both periods. The first two sections (FFQ-Yr1 and FFQ-Yr2) included eight food groups and foods considered as significant contributors to intake of either energy or key micronutrients such as vitamins A, B6, B12, and folate (B9). Foods were selected based on their energy and/or micronutrient contribution to data collected in 24hrR from children who participated in a National Nutrition Survey (ENN99) (20) ensuring that selected food items were responsible for 90% of the calorie and micronutrient content in children's diets. Further details about the selection of food included in the FFQ have been published previously. (21)

The FFQ-Yr1 queried the mothers on the frequency (from None to More than 7 times per week) with which each food item was consumed from the time the children started to eat the item with regularity, until they turned 1 year of age. Mothers were also asked how many times per day their children consumed each food item and whether or not the food item was an industrialized food. The FFQ-Yr1 also included questions designed to obtain an approximation of the complimentary feeding practices in order to infer the timing of the introduction of foods in the first year, as well as to adjust for the starting month of food consumption during this period (first year of life) for each type of food, when calculating energy and nutrient estimates.

The questionnaire noted the actual portion sizes consumed by the child rather than the portion size that was served, thereby reducing the errors obtained with other instruments, given that most infants do not consume the entire portion offered. We used visual props to prompt mothers to recall the different age levels and calendars to remind mothers of the months in which each age period (11 months or 12 to 24 months) transpired. Interviewers also showed mothers appropriately sized spoons, measuring cups, drawings and photographs of foods in order to facilitate the estimation of portion sizes.

The FFQ-Yr2 queried on the frequency of food consumption during the second year of life. It is identical to the first section of the questionnaire (see Appendix B) but did not include questions that asked about the timing of the introduction and regular consumption of food items.

The third section of the questionnaire (see Appendix B) queried mothers about the consumption of supplements. Mothers were first asked if their children consumed supplements during each time period (years 1 and 2). If a mother reported that her child consumed any supplements, further questions were asked to determine the complete name of the supplement, quantity, frequency and duration of consumption.

Dietary intake quantification for the validation study

Complementary feeding practices in children during their first year of life—

The first step in estimating the dietary consumption during the first year, was to validate the foods reported in the CFP with those reported in the two additional “timing of introduction and regular consumption” questions that were asked in the FFQ-Yr1 regarding complementary feeding practices (“What was the first food item that your child ate regularly?” and “At what age did your child begin to eat this item regularly?”). We then compared the reporting of the age of introduction for given foods on both questionnaires, assuming that the month reported in the RCT is close to the time period of introduction. It should be noted that the third and last CFP questionnaire queried about consumption at 9 months of age.

Energy and nutrient consumption during the first year of life—Because the quantity of consumption was not asked in the CFP, we could not validate FFQ-Yr1 for the first year of life. However, energy and micronutrient consumption were reported and quantified from the first section (FFQ-Yr1) of the FFQ correcting for the starting months of food consumption during this period for each type of food. For the month that is considered to be the starting month for regular consumption for each food item, mothers reported both the frequency and quantity of consumption. Therefore, if a child started to consume fruit at seven months of age, we then added a “weight” to account for the number of months of fruit consumption that occurred during the first year. Foods were then coded and equated with nutrient consumption per day using a food composition table compiled at the National Institute of Public Health, based on the USDA and Institute of Nutrition of Central America & Panama (INCAP) Food Composition Tables and software developed at the National Institute for Public Health (INSP) as previously reported. (17, 20–22)

Energy and nutrient consumption at 12 to 24 months of age (FFQ-Yr2)—The first step in validation of the FFQ-Yr2 was to estimate the nutrient consumption of both 24hrR and FFQ-Yr2. Using the 24hrR questionnaires administered (on two nonconsecutive days at 12, 18, and 24 months of age), the energy and micronutrient consumption was estimated from the portions reported; these were then averaged to obtain a better estimation of daily intake between 12 and 24 months of age. Food items from the FFQ-Yr2 (12 to 24 months of age) were also coded and were transformed into nutrients consumed per day using

the same databases and software developed at the INSP and utilized for the maternal FFQ and for the 24hrR data above. (17, 20–22)

Supplement intake quantification—The contribution of nutrients from food supplements was calculated from the third section of the FFQs. The intake of individual nutrient intakes derived from supplements was estimated based on the use and duration of participation during the RCT and then validated to those reported in the Yr1 and Yr2 in order to evaluate the accuracy of a mother's reporting of the frequency of child's supplement intake. Similarly to the methods used for the maternal intake,(17) we used a compilation of the nutritional content of the supplements available in Mexico.(23) Composite variables were generated for nutrients of interest for both (i.e. 24hrR and FFQ) questionnaires by summing nutrient intake derived from supplements to that derived from diet. Because we did not collect information on the portion sizes consumed in the CFP, we could not add supplement intake to the estimates of dietary nutrient intake for the first year of life. However, we were able to compare supplement consumption reported prospectively and retrospectively estimate for the first year of life in order to derive correlations for nutrient intake derived from supplements in Yr1. For the second year of life, we were able to obtain correlations comparing the 24hrR and the FFQ-Yr2 for nutrient intake derived from both supplements and diet.

Statistical analysis

With 84 participants we had power (0.80) to determine a $\rho=0.3$ with $p<0.05$ between 24hrR and FFQ-Yr2. (24) We estimated the median and interquartile range (IQR) of the average age at which a food was introduced in infancy according to what was reported in the CFP and in the 2 questions of the FFQ-Yr1 and used the Wilcoxon signed rank test to determine whether differences were significant ($p<0.05$). We calculated the median and IQR for total caloric intake, as well as intake of vitamins A, B6, B9, and B12 using the FFQ-Yr1, adjusting for the number of months during which a food was reported consumed during this period. Using the Wilcoxon signed Rank test and dietary data, we estimated the difference in dietary intake between that estimated from the FFQ-Yr2, and that estimated using the 24hrR for ages 12–24 months. We validated the intake reported in both instruments using Spearman correlations. For energy and for each of the vitamins examined (A, B6, folate or B9, B12) we validated the intake reported using both methods (FFQ-Yr2 and 24hrR) and included intake reported from supplements using residuals in order to adjust for energy intake. (25)

In order to minimize additional variation due to the timing of the interviews, data from 24hrR were detrended by centering consumption at the mean for each time point. We then recalculated the Spearman correlations between the 24hrR data and FFQ-Yr2. Significance was determined at the level of $p<0.05$ for all analyses. We compared the intake estimated with the FFQ to the 24hrR with the underlying assumption that the 24hrR data were more accurate. We therefore compared the averaged 24hrR data to the FFQ-Yr2 data using the Bland and Altman method. (26, 27) We used the ratio of the two sources of variance to correct correlations for day-to-day variation using the Rosner and Willett formula for deattenuated correlation. (28, 29) Data was analyzed using STATA, Version 9.0 (Stata Co., Santa Monica, SA).

Ethical Considerations

Both the RCT and this validation study have been approved by the Ethics, Biosecurity and Research Commissions at the National Institute of Public Health (INSP), Cuernavaca, Mexico. All participating mothers provided written informed consent to participate in the

validation data and to release socio-demographic and dietary data collected during the RCT study.

Results

We analyzed dietary intake from a total of 84 children with dietary information estimated by the CFP, 24hrR and the FFQ. As shown in Table 1, 83.9% of mothers had fewer than 9 years of schooling. Of the study children, 56% were boys, and 44% were girls. Their mean birth weight was 3.1 kg (SD 0.4 kg), and mean birth length 48.6 cm (SD 2.1 cm), while 6% had a length-for-age less than -2 z-scores, and 4.8% had a weight-for-length below -2 z-score).

Complementary feeding practices in children during their first year of life

For diet during infancy, we compared the CFP with the FFQ-Yr1 and found great overlap between the types of foods reported as “introduced” and the timing reported for their introduction (Table 2). There was only one food (yogurt) which appeared as “introduced” in the FFQ though it was never reported in the CFP. Significant differences in the child’s reported age at time of food introduction ($P<0.05$) were found for infant formula, atole, juice, bean soup, rice, and noodle soup (Table 2).

Energy and nutrient consumption in the first year of life

Table 3 shows the estimated energy and nutrient intake derived from FFQ-Yr1, as well as the groups of foods which contributed to the energy estimates. The greatest contributors to energy intake were infant formula and powdered milk as well as fruits and miscellaneous foods such as gelatin and candies. The principal contributors to micronutrient intake were formula, powdered milk, and vegetables. No correlations were found between the two estimates for supplement intake in the first year of life (data not shown).

Energy and nutrient consumption in the second year of life

Table 4 compares intake estimates derived from the 24hrR and the FFQ-Yr2. There was no significant difference by Wilcoxon rank sum tests in the estimates of energy consumption derived by using the two instruments. The correlation between the two estimates for energy intake was $r=0.40$, $p<0.001$. However, by Bland and Altman plots, energy intake varied with an average of 59.9 kcal (SD 210.1 kcal) between the 24hrR and FFQ-Yr2 (Fig. 2). In calculating the detrended correlations for energy, we noted similar correlations ($r=0.44$). However, the deattenuated correlation was $r=0.53$, while that without detrending was further corrected for within-subject variation with a resulting correlation of $r=0.81$.

Table 4 shows the validation of micronutrient intake (vitamins A, B6, B12 and B9) between the 24hrR and the FFQ-Yr2. Compared to the 24hrR, the FFQ-Yr2 yielded higher estimates for intake of vitamins B9 (folate) and B12; though lower for vitamins B6 and A (Wilcoxon rank sum tests). For energy unadjusted micronutrient intake, correlations were significant for vitamins B6, B12 ($p<0.001$) and B9 ($p<0.01$). However, after energy adjustment, correlations were significant only for B12 ($p<0.001$) and marginally for B6 ($p=0.09$). Once time-centered or detrended correlations were calculated, correlation estimates for vitamins B6, B9 and B12 improved and vitamin A became marginally correlated ($p=0.07$).

Once supplement intake was added to the estimates of dietary nutrient intake, correlation was significant only for energy-unadjusted B12 ($p<0.05$); however, with detrending, correlations were significant for vitamins A and B12 but marginally so for B6 ($p=0.08$), with similar deattenuated correlations for vitamins A, B6, and B12 (Table 4).

Discussion

The FFQ which we validated here permits a reasonable estimation of the foods that are introduced in the first year of life, and of energy and nutrient intake in the second year of life. This validation study demonstrated significant correlations with the energy intake estimated using the 24hrR as reference. The FFQ predicts dietary intake of B6, B9 and B12 during the second year of life particularly when not adjusting for energy intake. Our data suggest that women can remember their children's diet even after several years and they are able to remember the children's use of supplements with relative precision.

Complementary feeding practices in children during their first year of life

The FFQ-Yr1 and the CFP appear to agree widely in the data elicited for types of food introduced, however, they did not agree as consistently in the reporting of the months in which the foods were introduced. Although the CFP food item list was very short (appendix a) the major agreement between the two questionnaires was for those foods reported in the additional blank spaces (to record dietary intake of additional items) in the CFP, while only yogurt (reported in FFQ-Yr1) was never reported in the CFP. For the months in which the foods were introduced, significant differences were found only in infant formula, atole, juice, bean soup, rice, and noodle soup ($p<0.05$). Prevalence of breast feeding was reported similarly in both questionnaires. Our results are thus similar to those reported in the infant dietary questionnaire validation study by Andersen et al, (30) in which there was a similar agreement by type of foods.

Because of the original design of the CFP for the RCT, we were unable to validate the energy and macronutrient intake during infancy, although our results suggest that the FFQ-Yr1 may be a reasonable instrument for estimating intake during this period.

Marriot et al. (31, 32) demonstrated that an interviewer-administered FFQ that has been validated with 4-day weighted diaries is a useful tool for estimating dietary consumption in infants between 6 and 12 months of age. At 6 months of age, they obtained a correlation of $r=0.41$, $p<0.05$ for energy intake (querying on the intake in the prior 7 days), and $r=0.46$, $p<0.01$ for 12 months of age (querying on the past 28 days). Andersen et al, (30) validated a FFQ querying on the last 2 weeks of dietary intake in 12 month old infants against 7-day weighted food records and had a similar correlation for energy intake $r=0.43$. Given the overlap between the types of foods reported in the CFP particularly in blank spaces and those reported in the FFQ-Yr1, it appears that mothers are able to remember their infant's dietary intake in the first year.

Energy and nutrient consumption in the second year of life

The energy estimates derived from the 2 instruments used for the second year of life were well correlated ($r=0.44$, $p<0.001$) with correlation estimates close to those obtained in the studies by Andersen et al, (33) ($r=0.31$) and Marriot et al, (32) ($r=0.46$). However, those studies estimated intake for the 14 to 28 days prior to the FFQ, while we queried regarding consumption occurring 1 to 3 years before the interview, and thus compared estimates obtained from dietary instruments administered 1 to 3 years apart.

For micronutrient intake, without adjustment for energy intake, our study found significant correlations between the 24hrR and the FFQ-Yr2 for vitamins B6 ($r=0.44$, $p<0.001$), B12 ($r=0.45$, $p<0.001$) and B9 (folate) ($r=0.35$, $p<0.01$), which is similar to those found by Marriot et al, (31) in which correlations were ($r=0.62$), ($r=0.42$) and ($r=0.39$) for vitamins B6, B12, and B9 respectively. However, after adjusting for energy intake, only vitamin B12 remained significant ($r=0.37$, $p<0.001$) which is similar to the findings reported by Marriot (32). Once we deattenuated the correlations, our correlation for B12 was 0.51 which is close

to the deattenuated correlation reported by Blum et al ($r=0.47$) in a similar study in children under five. (34)

In our study, correlations with detrended 24hrR data were similar to those without detrending, except in the case of vitamin A which became significant when time detrending was removed. The deattenuated correlations were greater in those not detrended than in those detrended. This may be attributable to the lengthy time interval between interviews potentially introducing an additional source of within subject variation in non detrended data.

By eliminating “aging” as a source of intra-subject variation, through the use of detrended estimates, we can better estimate the intake from 24hrR since this procedure removes the naturally occurring increase in food intake that occurs as the children age which coincides with ages during which patterns of consumption change rapidly. Analysis of these correlations is therefore similar to validating an FFQ-Yr2 with a larger number of 24hrR.

It is generally extremely difficult to collect food intake information retrospectively for toddlers and children whose mothers come from semi-rural areas, where habitual micronutrient and energy intake is known to be low. (35) This is especially challenging because dietary habits during this life-phase change rapidly. We are not aware of any other study that has attempted to validate an FFQ for retrospectively collecting dietary intake during infancy and the second year of life. In our case, the retrospective collection was performed 3 to 5 years after the birth of the child and thus 1–3 years after the two periods of interest.

We believe we are the first to compare the results of such an FFQ with data collected prospectively using 24hrR collected at regular intervals (months 3, 6, 9, 12, 18, 24) throughout the first two years of life. Our FFQ is also the first to reliably estimate supplement intake particularly for vitamins A and B12 which are critical for growth, development and immune function in children under five. (1) We believe that our utilization of visual props facilitated a mother’s recollection of their child’s intake during their second year of life.

Our study has several limitations which although notable do not detract from the overall utility of our approach. One limitation is that we do not know how many additional pregnancies transpired in the interim between the births of the children who participated in the original RCT and the time of the validation study. It is likely that within a given family, children’s diets would be similar from child to child, thus correlations between 24hrR and FFQ might reflect correlations with a more recent recall period rather than the index diet of children (this might explain the appearance of yogurt as a food administered in infancy despite its not having been reported in the CFP).

However, one of the challenges in comparing the prospective CFP against our FFQ-Yr1 is that the CFP did not document details about when a food began to be eaten routinely after the age of 9 months; thus, we were unable to compare FFQ-Yr1 data for foods reported to be introduced during months 10 and 11 of life. The differing numbers of children who reported introducing a given food item in Table 2 is likely due to inaccurate recall by some mothers at the time of the second interview (FFQ).

The lower correlations that we saw between the two estimates for supplement intake may explain some of the difficulty in collecting food intake information retrospectively for toddlers because dietary habits during their first year of life change rapidly. Another limitation is that we had a large number of missing 24hrR, particularly at the 18 month time

point. On average we collected 4.3 24hrR questionnaires per child rather than the expected 6, which may explain some of the lower correlations that we saw in the second year.

Nevertheless, since the 24hrR was applied in two repeated measures during the 12, 18 and 24 months, we were able to account for intra-individual variability. Analysis of the deattenuated correlations showed that within-subject variation was a major component of the total variance, thus reducing the correlations (e.g. B9 (folate): 0.27 (without deattenuated) vs. 0.94 (deattenuated). (27, 28) Since the same factors that affected the variability in the reference method (24hrR) may also have affected variability in the FFQ-Yr2, we cannot assume independent random errors in the two methods, as this could lead to overestimation of the correlations.(36) According to our analysis, the over-estimation of vitamins B9 and B12 from diet can be expected due to this bias, (7, 36–38) or, alternatively, the overestimation could be attributable to the relatively long period of time over which participants had to remember their child's diet.

The validity of this instrument is limited to populations in semi-rural areas with characteristics similar to ours. The women enrolled in this validation study weighed an average of 2kg less than the women of the original RCT, although their BMI was only 0.9kg/m² lower. These women might be more attentive to food intake and therefore report more accurately on an FFQ than the general population. Despite this caveat, our validation is still valid for the second year of life, as we had sufficient power to detect correlations between the 2 time points, (28, 38) and the deattenuation confirmed that the low correlations between 24hrR and FFQ were due to the large intra-person variability for the two 24hrR at the given time points. Adjusting for this variability yields results comparable to those obtained by validating with multiple 24hrR. (39)

CONCLUSION

In conclusion, we have designed and validated a method to retrospectively (3 to 5 years post-birth) assess dietary intake and supplement use during first two years of life using a FFQ which provides a reasonable estimate for energy and micronutrient intake (for vitamins A, B6 and B12 and B9). Our retrospective instrument provides valid estimates of intake in interviews performed 1 to 3 years after the time period of interest. Importantly, mothers in our population demonstrated the ability to remember their child's dietary intake with relative precision, even after several years. In future studies, we plan to validate FFQ-Yr1 of the questionnaire with a gold standard questionnaire and evaluate whether FFQ-Yr1 will be more sensitive if we use narrower intervals such as three or six months. It will also be necessary to evaluate the reproducibility of both this FFQ and the one with narrower intervals and to test its validity for retrospective use several years post-partum.

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Figure 1.

Child questionnaire study validation and chronology

CFP: Complementary feeding practice questionnaire to children during first year of life;**24hr:** 24 hour recall questionnaire performed during second year of life; **FFQ:** retrospective

food frequency questionnaire from year two of life to validation survey

*At 12 months 82 children had two 24 hour Recalls(24hr-R), at 24 months 71 children had two 24 hr-R, while at 18 months 27 children had at least 1 24 hr-R

Figure 2.
Differences in estimated energy intake calculated using the 24hr-R and the FFQ-Yr2 in children 12 to 24 months of age.

Table 1Anthropometric and demographic characteristics of 84 participating children at birth^a

Anthropometrics	Mean	SD	Range
Birth Weight (kg)	3.1	0.4	(2.5, 4.3)
Birth Height (cm)	48.6	2.1	(44.7, 59.9)
Demographics	n	%	(95%CI)
Sex			
Girls	37	44.0	(33.2, 54.9)
Boys	47	56.0	(45.1, 66.8)
Anthropometrics (-2 z-score)^b			
Length-for-age	5	6.0	(0.8, 11.1)
Weight-for-age	4	4.8	(0.1, 9.4)
Weight-for-length	5	6.0	(0.8, 11.1)
Socio-economic level^c			
Low	26	37.1	(25.5, 48.7)
Medium	21	30.0	(19.0, 41.0)
High	23	32.9	(25.6, 44.1)
Birth order of child			
1	2	2.4	(-0.1, 5.7)
2 to 3	43	51.2	(40.3, 62.1)
4 to 5	11	13.1	(5.7, 20.5)
> 6	28	33.3	(23.0, 43.6)
Mother Schooling (years)^d			
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)

^aThese data were collected during the RCT (1997–2000). There were 84 Mother-child pairs^bWHO Multicentre Growth Reference Study Group. (22).^cSocioeconomic status was stratified into three levels based on principal component analysis of household possessions (23).^dYears of schooling completed by mother

Table 2

Average age (months) at introduction of complementary foods during the first year of life ^a

Food	Complementary Feeding Practices (CFP 1997–2000)						Food Frequency Questionnaire (FFQ 2004)			
	N ^b	Mean Age ^a	SD	Median Age	IQR	N ^b	Mean age ^a	SD	Median age ^a	IQR
Breast milk	84	0.0	0.0	-	-	84	0.0	0.0	-	-
Infant formula	30	2.7	2.5	1.0	1.0–3.0	21	2.2*	2.4	0.0	1.0–4.0
Plain water	84	2.3	1.9	1.0	1.0–3.0	72	2.9	1.5	3.0	2.0–4.0
Liquids										
Sweetened water or carbonated beverage	5	9.0	0.0	9.0	9.0–9.0	3	6.0	2.7	5.0	4.0–9.0
Atole (any type)	48	7.9	1.5	9.0	6.0–9.0	23	6.0*	1.8	6.0	5.0–7.0
Sweetened tea or coffee	20	6.6	3.1	9.0	3.0–9.0	2	7.4	0.2	7.3	6.7–8.0
Tea or coffee with no sugar	26	4.8	3.3	6.0	1.0–9.0	9	4.9	1.8	5.0	4.0–6.7
Juice (any type)	72	6.5	2.0	6.0	6.0–9.0	28	5.4*	2.3	4.5	4.0–7.5
Dairy										
Milk	3	7.0	1.7	6.0	6.0–9.0	2	7.0	1.4	7	6.0–8.0
Yogurt	-	-	-	-	-	61	5.8	1.9	6.0	4.0–7.0
Powdered Milk	6	7.7	3.3	9.0	9.0–9.0	9	6.9	3.1	7.0	6.0–9.0
Cheese (any type)	36	8.3	1.3	9.0	9.0–9.0	2	5.0	0.0	5.0	5.0–5.0
Fruits										
Any kind	91	6.2	1.8	6.0	6.0–6.0	95	6.6	2.3	6.0	4.0–9.0
Vegetables										
Any kind	36	7.8	1.8	9.0	6.0–9.0	31	7.8	2.0	8.0	6.0–10.0
Broth										
Bean	64	7.8	1.5	9.0	6.0–9.0	34	6.6*	2.0	7.0	5.0–8.0
Chicken, beef or fish	66	7.2	1.5	6.0	6.0–9.0	42	6.7	2.2	6.0	5.0–8.0
Meat/eggs										
Eggs (whole eggs, yolk, or white)	49	8.1	1.4	9.0	6.0–9.0	20	8.2	2.4	8.5	6.5–10.5
Chicken (except liver) or Fish (fresh or canned)	41	8.3	1.3	9.0	9.0–9.0	19	7.9	1.8	8.0	6.0–9.0
Beef or Pork (any type)	14	8.4	1.3	9.0	9.0–9.0	22	7.5	2.1	7.5	6.0–9.0
Cereals										

Food	Complementary Feeding Practices (CFP 1997–2000)						Food Frequency Questionnaire (FFQ 2004)					
	N ^b	Mean Age ^a	SD	Median Age	IQR	N ^b	Mean age ^a	SD	Median age ^a	IQR		
Rice	42	8.5	1.3	9.0	9.0–9.0	6	8.0 [*]	1.1	8.0	8.0–9.0		
Corn Tortilla or Bread	54	8.0	1.4	9.0	6.0–9.0	37	7.3	2.0	7.0	6.0–9.0		
Pasta	65	7.7	1.5	9.0	6.0–9.0	30	6.5 [*]	2.1	6.0	5.0–8.0		
Legumes (any type)	15	8.8	0.8	9.0	9.0–9.0	9	6.9	1.69	8.0	6.0–8.0		
Miscellaneous ^c	53	7.7	1.8	9.0	6.0–9.0	55	7.4	1.99	7.0	6.0–9.0		

^a Age in months

^b Number of children who consumed this food

^c Sweets, snacks, etc.

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

Table 3

Median and interquartile range (IQR) for energy and micronutrient intake listed by food group and supplement ^a as estimated by FFQ-Yr1 during the first year of life.

Food groups ^b N = 84	Energy (kilocalories)	Vitamin A (RetEq, mcg) ^c	Vitamin B6 (mg)	Folate (DFEs, mcg) ^d	Vitamin B12 (mcg)
	Median IQR (25,75)	Median IQR(25,75)	Median IQR(25,75)	Median IQR(25,75)	Median IQR(25,75)
Infant formula	587.0 (260.9–1252.4)	521.3 (231.7–1112.1)	0.35 (0.16–0.75)	92.8 (41.2–197.9)	1.7 (0.8–3.7)
Liquids					
Sweet water or Soda pop	2.7 (1.2–7.2)	1.2 (0.7–2.1)	^e	0.1 (0.07–0.2)	-
Atole (any type)	13.1 (3.9–34.6)	0.4 (0.2–1.0)	0.006 (0.002–0.02)	0.6 (0.004–1.8)	0.6 (0.2–0.2)
Sweetened Tea or coffee	14.8 (12.4–45.5)	3.8 (3.2–11.6)	0.003 (0.002–0.008)	0.5 (0.5–1.7)	0.1 (0.009–0.03)
Tea or coffee with no sugar	0.8 (0.4–1.7)	-	^e	-	-
Juice (any type)	4.9 (2.2–10.7)	1.0 (0.4–2.1)	0.004 (0.002–0.009)	0.3 (0.02–0.6)	-
Dairy					
Milk	4.4 (2.3–12.2)	0.08 (0.04–0.2)	0.002 (0.001–0.004)	0.2 (0.1–0.6)	0.01 (0.007–0.04)
Yogurt	6.8 (2.7–21.3)	0.8 (0.4–2.5)	0.002 (0.001–0.006)	0.5 (0.2–1.5)	0.02 (0.01–0.07)
Powdered Milk	32.5 (15.9–69.4)	18.1 (0.3–38.7)	0.02 (0.01–0.04)	2.4 (0.7–5.2)	0.2 (0.05–0.45)
Cheese (any type)	0.9 (0.6–2.5)	0.8 (0.5–2.0)	^e	0.09 (0.06–0.2)	0.002 (0.001–0.005)
Fruits					
Any type	17.0 (5.5–35.1)	5.6 (1.7–34.8)	0.06 (0.02–0.2)	3.1 (0.9–7.6)	-
Vegetables					
Any type	2.6 (0.9–6.7)	36.5 (10.2–111.2)	0.01 (0.003–0.02)	1.7 (0.7–9.6)	^e
Soups (broth only)					
Bean soup	0.8 (0.3–1.7)	0.006 (0.002–0.01)	0.001 (0.0004–0.002)	1.0 (0.4–2.0)	-
Chicken, beef o fish soup	5.2 (2.6–9.2)	11.3 (5.6–20.2)	0.001 (0.001–0.003)	0.1 (0.07–0.2)	0.007 (0.004–0.01)
Meat					
Eggs (Whole eggs, yolk, white)	4.3 (1.1–7.7)	5.3 (1.4–9.5)	0.003 (0.001–0.006)	1.2 (0.3–2.2)	0.03 (0.008–0.06)
Chicken (except liver) o Fish (fresh or canned)	5.6 (1.3–14.4)	0.9 (0.2–2.6)	0.01 (0.003–0.02)	0.3 (0.08–0.8)	0.02 (0.006–0.06)

Food groups ^b N = 84	Energy (kilocalories)		Vitamin A (ReEq, mcg) ^c		Vitamin B6 (mg)		Folate (DFE's, mcg) ^d		Vitamin B12 (mcg)	
	Median IQR (25,75)		Median IQR (25,75)		Median IQR (25,75)		Median IQR (25,75)		Median IQR (25,75)	
Beef o Pork (any type)	1.3 (0.4–3.6)		7.2 (0.7–34.4)		0.001 (0.001–0.005)		0.3 (0.09–1.3)		0.003 (0.001–0.03)	
Cereals										
Rice	13.3 (7.1–30.6)		1.5 (0.6–25.2)		0.006 (0.003–0.06)		0.9 (0.3–12.0)		0.002 (0.0003–0.005)	^e
Corn Tortilla o Bread	13.9 (5.7–35.6)		0.4 (0.1–1.0)		0.01 (0.003–0.02)		5.1 (1.6–10.9)		0.002 (0.0003–0.005)	
Noodle soup	5.5 (1.8–8.7)		0.7 (0.2–1.1)		0.002 (0.001–0.003)		0.4 (0.1–0.7)		0.005 (0.002–0.007)	
Legumes										
	2.7 (1.9–6.3)		1.7 (0.1–3.3)		0.002 (0.001–0.003)		2.8 (1.8–4.1)		0.003 (0.001–0.004)	
Miscellaneous										
	19.9 (8.2–31.0)		5.2 (2.2–8.5)		0.003 (0.001–0.006)		0.5 (0.3–0.8)		0.03 (0.01–0.05)	

^aIncluding Supplement use in double-blind clinical trial (RCT) during 1997–2000

^bFood grouped according to Food Frequency Questionnaire

^cReEq: Equivalents of retinol

^dDFE: Dietary Folate Equivalents

^eValues < 0.001

Table 4

Correlations between estimates of nutrient intake obtained using the 24hrR and the FFQ-Yr2 for the second year of life (N=84).

Nutrient	24hr ^f Median IQR (25,75) N= 84	FFQ ² Median IQR N=84	Correlations between FFQ and 24hrR data (not detrended)				Correlations between FFQ and 24hrR data (detrended)			
			24hrR versus FFQ	24hrR versus FFQ	24hrR versus FFQ	24hrR versus FFQ	24hrR versus FFQ	24hrR versus FFQ	24hrR versus FFQ	24hrR versus FFQ
			<i>r^b</i>	<i>p^c</i>	<i>d</i>	<i>r^e</i>	<i>p^c</i>	<i>d</i>	<i>r^e</i>	<i>p^e</i>
Nutrient intake from Diet alone without including supplement intake										
Energy (kJ)	666.3 (523.3, 838.4)	753.1 (497.5, 1133.81)	0.40***		0.81		0.44***		0.53	
Vitamin A (Eq Re, mcg)	300.0 (176.6, 654.9)	232.1 <i>d</i> (142.0, 401.4)	0.11	−0.09	0.29	−0.44	0.20	−0.07	0.46	−0.41
Vitamin B6 (mg)	0.52 (0.4, 0.7)	0.48 (0.3, 0.7)	0.39***	0.18	0.62	0.29	0.44***	0.16	0.59	0.25
Vitamin B12 (mcg)	0.9 (0.5, 1.6)	1.09 <i>d</i> (0.7, 2.4)	0.45***	0.37***	0.53	0.45	0.45***	0.37***	0.51	0.44
Folate (DHE ^e 's, mcg)	75.5 (56.5, 101.9)	113.2 <i>d</i> (77.5, 155.3)	0.27**	0.02	0.94	0.02	0.35**	0.02	0.47	0.03
Nutrient intake from Diet and supplement intake										
Vitamin A (Eq Re, mcg)	424.5 (293.0, 777.2)	451.7 (350.9, 619.2)	0.15		0.39		0.24*		0.55	
Vitamin B6 (mg)	1.0 (0.5, 1.2)	1.1 <i>d</i> (0.4, 2.1)	0.18		0.20		0.19		0.21	
Vitamin B12 (mcg)	1.3 (0.9, 2.2)	2.2 <i>d</i> (1.1, 3.7)	0.25*		0.28		0.25*		0.28	
Folate (DHE ^e 's, mcg)	109.4 (74.7, 139.4)	181.3 <i>d</i> (108.4, 254.3)	0.12		0.16		0.16		0.18	

¹ Mean of two 24h recalls performed at 12, 18 y 24 mo of age, without taking into account contributions from breast milk.

² Food Frequency questionnaire from 12 to 24 mo of age to validation survey, without taking into account contributions from breast milk.

^a Significant differences between FFQ and 24hrR (P<0.05) through Wilcoxon signed rank test (median and IQR).

^b Spearman correlation coefficient between FFQ and 24hrR

* p<0.05,

** p<0.01

*** p<0.001

^cEnergy Adjusted

^dDeattenuation: corrected for day-to-day variation between the two 24hrR; Deattenuation of the unadjusted correlations. The mean number of 24hrR per child was 4.3.

^eEnergy adjusted deattenuated correlations