Development and Validation of a Food Frequency Questionnaire for Preschool Children Using Multiple Methods

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Abstract: *Background*: The ability to determine the relationship between diet and health outcomes in children requires reproducible and validated long-term dietary assessment tools such as food frequency questionnaire (FFQ).

Objective: To test the reproducibility and relative validity of a FFQ for young children using 24-hour food recalls (24HRs), anthropometric measurements, and a comprehensive feeding practices questionnaire (CFPQ).

Methods: Children (aged 5-6) and their mothers were recruited during one school-year (2008) from preschools. Children's anthropometric measurements were obtained. Mothers provided during a personal interview on three occasions a 110-item semiquantitative FFQ, 24HRs and CFPQ. Pearson-correlation coefficients were calculated between the results of the FFQ and 3*24HR. Validity coefficients between the FFQ and the different measurements were calculated. Scores of the 12 factors of the CFPQ were calculated and related to dietary intake.

Results: Sixty-six healthy children (47% boys) were recruited. Pearson's correlations between the average of the FFQs and 3*24HRs ranged from 0.3-0.6 (P<0.05). The highest correlation coefficients were 0.59 for total fat intake and 0.56 for energy. Dietary intake of energy and carbohydrates differed significantly (P=0.05, 0.001 respectively) across the three BMI z-score levels (normal-weight, overweight, obese) and the three waist circumference tertiles (0.019, 0.006 respectively). Obesogenic factors from the CFPQ correlated with consumption of empty calories like sweets, snacks, junk foods and sweet drinks.

Conclusions: The modified FFQ is a relatively valid instrument to estimate mean energy intake in preschool children. The questionnaire performs reasonably well to rank children with respect to macronutrients intake as well as obesogenic food groups.

Keywords: Child(ren), Validation, Food Frequency Questionnaire (FFQ), Nutrition, Preschool, Nutrient Assessment.

INTRODUCTION

Estimating diet in young children is essential for clinical care and epidemiological research and for the evaluation of nutrition and lifestyle intervention programs. Previous studies demonstrated that collecting accurate and reliable nutritional data from this population can be a complicated task [1], since young children tend to eat irregularly, and their dietary intake, eating patterns, and portion sizes change rapidly as they grow [2, 3]. In most studies among children younger than 7 years of age, the mothers usually report the children's dietary intake [3].

The ability to determine the relationship between diet and health outcomes depends on the quality of the dietary assessment instruments. This, in turn, depends on how accurately the instrument is able to reflect the dietary patterns of the children assessed with it.

Rising childhood obesity rates followed closely by changing patterns of type 2 diabetes worldwide has stressed the need to examine and alter lifestyle behaviors starting with pre-school aged children. Assessing the dietary intake of children is an essential step in evaluating the effect of intervention studies designed to improve their dietary habits.

The Food Frequency Questionnaire (FFQ) is a common method used to assess individual long-term dietary intake of food and nutrients. It has been shown

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E-ISSN: 1929-4247/13

to provide a valid assessment of energy intake and nutrient ingestion among adults [4] compared with several twenty-four hour dietary recall (24HR) protocols and biomarkers. In young children, the majority of the studies used a modified adult FFQ [5, 6] that was validated relative to 24HR and food diaries [7-13]. A recent review found that using three 24HRs that include weekdays and weekends was the most accurate method for estimating the energy intake of children aged 4-11 years [3]. However, both 24HR and FFQ suffer from recall bias, as their respective accuracies depend on a subjective estimation of dietary intake. Other potential objective validation tools include doubly labeled water (DLW) and biomarkers, both of which are seldom used for children due to high cost and the significant burden on participants [3].

To compensate for the lack of biomarkers when using a research tool such as a questionnaire, a valid FFQ is expected to differentiate between energy and associated macronutrient intakes based on weight status [14, 15]. Anthropometric measurements such as weight, height, and waist circumference (WC) may also reflect energy intake and derived macronutrients.

In the current study, we present data on the development and validation process of an FFQ for preschool children using multiple assessment measures as validation tools. The questionnaire was tested against 24HRs, anthropometric measurements, and the extent to which the indicators used in a maternal feeding practices questionnaire (CFPQ) reflected an obesogenic environment. The CFPQ evaluated whether the child was exposed to an obesogenic environment based on a comparison of the self-reported food practices of the mothers with the accepted definitions of unhealthy food groups.

MATERIALS AND METHODS

Subjects

The study was carried out in Beer-Sheva, a town in southern Israel. Preschool children aged 5-6 years and their mothers were recruited. Participants were recruited from November 2008 through December 2008 using lists from the local municipality and the Ministry of Education. From the seven preschools that were willing to participate in the study, we recruited a convenience sample of 66 children-mother dyads, all of who were healthy and willing to participate in the current validation study. The mothers signed informed consent forms.

Study Design

Over a single school year, an FFQ, 24HR and CFPQ were obtained *via* personal interviews with the participating mothers on three separate occasions. Data collection was performed by research assistants who were trained (during three training sessions) to take the required measurements and administer the questionnaires. Parental report of children's food intake FFO during the day, included (1) food and beverages sent from home and, (2) lunch supplied by a single food catering to schools. To enable accurate parental estimation of children's food consumption, leftovers from mid-breakfast were sent back home and, parent received menus from preschool with an individual follow-up of their children's food consumption, conducted by the preschool staff. Children's weights and heights and their hip and waist circumferences were measured on the same days that their mothers were interviewed. To encourage compliance, we offered to provide each of the participants with a dietary intake report at the end of the project.

After obtaining permission from local authorities and from the Ministry of Education (*via* their ethics committees), the protocol of the study was approved by the ethics-committee of Soroka University Medical Centre. Exclusion criteria included developmental problems and language difficulties. Only parents who agreed to participate and who signed an informed consent were enrolled.

Definitions of Demographic and Sociodemographic Parameters

Information on maternal age, parity, marital status, and educational level were obtained during the initial interview with each mother. Maternal education was categorized as follows: did not complete high school (< 12 years), completed high school, and post-secondary education. Regular physical activity of the children was determined based on intentional leisure-time physical activity and the time spent playing outdoors (h/week).

Food Frequency Questionnaire

The FFQ for young children was developed based on the 126-item FFQ of Ben-Gurion University of the Negev (BGU) that was originally developed and validated for adult populations [16, 17]. The original questionnaire was designed based on a population survey of adults age 35 and over and thus did not include foods that are frequently consumed by young children. Additionally the portion sizes were based on the Israeli Ministry of Health portion size booklet that was developed for adult populations. The new questionnaire was modified to fit younger populations, and food types and portion sizes were adapted accordingly by a committee of 10 expert children's dietitians. A list of 110 food items, representing a range of food groups from which children may eat with an emphasis on frequently eaten foods, was constructed. A quantity food pictures booklet containing selected food items and their portion sizes was developed. Snack portion size was determined as the measure of a "handful" by a 'kitchen trial' with 10 preschool children. The kitchen trial was set at The S. Daniel Abraham International Center for health and Nutrition at Ben-Gurion University. A mean of 3 "handful" of a snack (for example) for each child was calculated and then the weighted mean of the group was used as the final portion. A photo of the final portion was taken and included in the final portion size booklet.

The newly developed FFQ was obtained on three separate occasions during the school-year. Each child's individual questionnaire was recorded in the Microsoft Access 2003 data entry program. Quality control was done in three stages: 1) Food frequency interviews were conducted individually by trained research assistances to assure high quality of data. 2) Food items were evaluated within 1-3 days after the interviews by a registered dietitian to detect unusual food items, missing values, and unexpected food portions. 3) Food records were then coded and typed by a research assistant specifically trained for nutritional data entry. 4) Food records were re-evaluated by a clinical dietitian to detect unusual results.

Twenty-Four Hour Recall Interviews

To assess long-term dietary intake, three 24HRs were obtained on three separate occasions during the school year. A standardized 5-pass method was used consisting of the following: 1) a "Quick List" pass in which the respondent is asked to list everything eaten or drunk the previous day; 2) a "Forgotten Foods" pass in which a standard list of food/beverages, often forgotten, is read to prompt recall; 3) a "Time and Occasion" pass in which the time and name of the eating occasion are collected; 4) a "Detail" pass in which detailed descriptions and portion sizes are collected and the time interval between meals is reviewed to check for additional foods; and 5) the "Final" pass, which provides one last opportunity for the respondent to remember foods consumed. For each food reported, interviewers referred to a standardized food-pictures and models booklet.The interviews were performed on random work days. Interviews after the weekend inquired about either the previous day (Saturday) or the previous two days (Friday and Saturday). A weighted average of three 24HRs is considered an accurate measure of dietary intake and is used to validate studies that use FFQs [3]. The US Department of Agriculture's multiple pass method (MPM) of questioning [18] was used.

Anthropometric Measurements

In addition to evaluating the performance of the questionnaire vs. three 24h recalls we tested its performance against anthropometric measurements at 3 time points. Our hypothesis was that children's weights will be related to their energy intake. Children's heights and weights and their waist and hip circumferences were obtained using a standardized protocol. Weight was measured with a portable digital scale (Tanita HD-318; Tanita Ltd, Illinois, USA) while children were barefoot and dressed in light clothing, and height was measured with a portable stadiometer (SECA- 217; Seca Ltd, Hamburg, Germany). Measurements were obtained twice to the nearest 0.1kg and 0.1cm, respectively, and the mean value was used in the analysis. Body mass index (BMI) was calculated as weight in kilograms divided by height in meters squared (weight [kg] / height [m^2]). We used the growth curves of the World Health Organization (WHO) to compare the prevalence of excess weight among children using AnthroPlus version V1.0.2 software [19]. According to WHO recommendations, 'normal weight' (NW), 'overweight' (OW), and 'obese' (OB) were respectively defined as $-2SD <$ BMI z-score $\leq 1SD$, $1SD <$ BMI z-score $\leq 2SD$, BMI z-score $> 2SD$. Children's weights and heights were measured at baseline and after 3 and 6 months from baseline.

Comprehensive Feeding Practices Questionnaire

In order to further evaluate the new FFQ we tested its performance vs. parents' feeding practices. Our hypothesis was that obesogenic feeding practices will be related to higher intake of unhealthy foods and low intake of healthy foods. The Comprehensive feeding practices questionnaire (CFPQ) developed in 2007 by Musher-Eizenman *et al*. [20] is divided into 12 feeding practice subscales mainly composed from the two most widely used instruments in the child feeding literature [21, 22]. The questionnaire was validated among the parents of children aged 18 months to 8 years [20]. It captures a broad range of behaviors, which may be related to healthy or unhealthy eating, that parents may engage in when feeding their children. Five factors of the questionnaire were used to measure obesogenic feeding behaviors: 1) 'Environment,' i.e., the extent of the availability of sweets and snacks at home, with a high grade indicating that healthier food is available at home; 2) Using 'food as a reward,' i.e., a high grade indicates that food is frequently used to reward the child when he/she exhibits good behavior; 3) 'Monitoring,' i.e., the extent to which the child is monitored vis-à-vis his/her ingestion of unhealthy foods, with a high grade indicating greater parental supervision; 4) 'Restriction for health,' i.e., the extent to which restrictive parental behaviors are practiced, with a high grade indicating greater control of the child's food intake to limit his/her ingestion of less healthy foods and sweets; 5) 'Restriction for weight control,' i.e., a high grade indicates greater parental control exercised over the child's food intake either to maintain or reduce the child's weight; and 6) 'Emotional regulation,' i.e., a high grade indicates greater parental use of food to regulate the child's emotional state.

The CFPQ factor scores were calculated as an average continuous score for each dimension, and mothers' feeding practices were compared to the qualities of the children's diets and to the food groups consumed, the latter parameter as measured by the FFQ. This unique comparison allowed us to determine whether poor diet quality is associated with certain types of maternal feeding practices, and it also provided a behavioral dimension.

Validation Procedure

In this study we examined the validity of the children's FFQ relative to three different methods that differ in sources of error and bias, namely, 24HR interviews, anthropometric measurements, and CFPQ (Figure **1**).

FFQ and 24HR interviews suffer from a recall bias that depends on the mother's long- and short-term

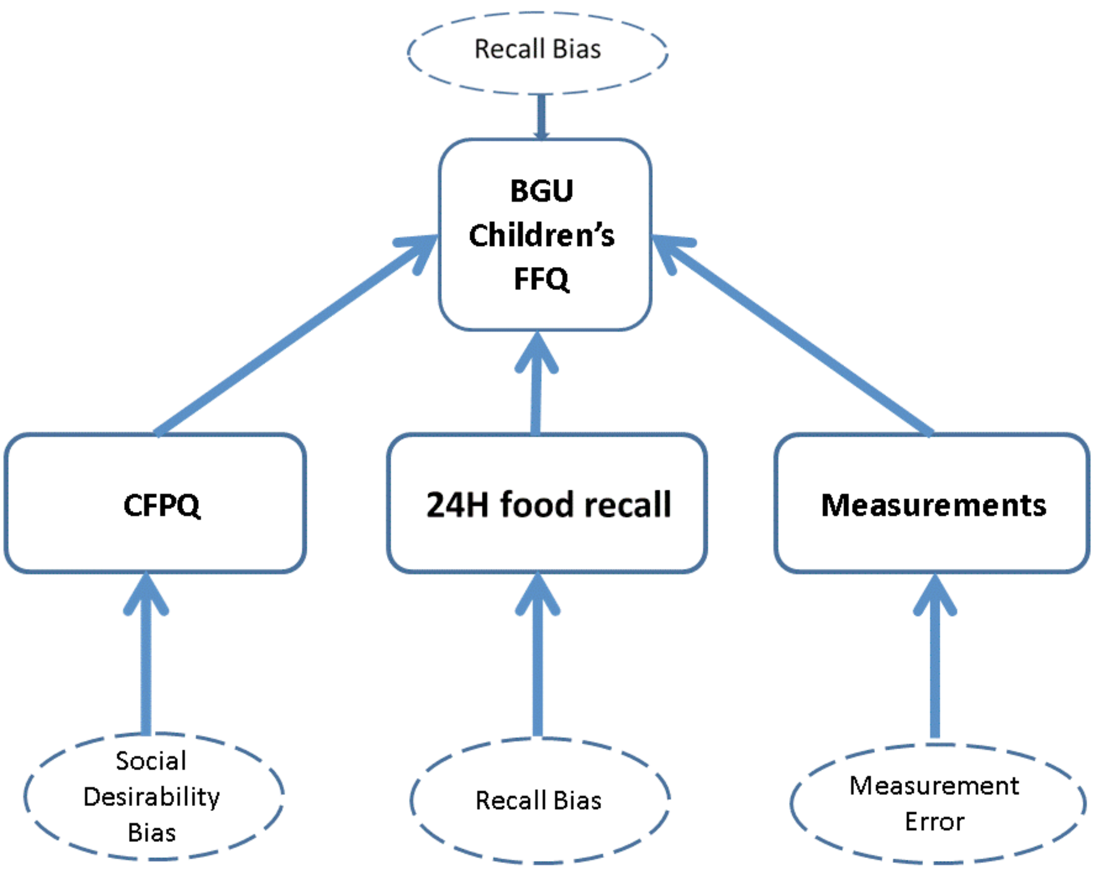


Figure 1: Validation procedure.
*BGU children's FFQ – Ben-Gurion University food frequency questionnaire for children.
** CFPQ – Comprehensive feeding practices questionnaire.

memories for both items and quantities. Research has also shown that parental food reporting accuracy varied as a function of children's relative weight and body composition, such that under-reporting tended to occur among heavier children [23]. Anthropometric measurements may suffer from measurement errors while using the CFPQ to evaluate mothers' feeding practices may lead to a social desirability bias in the reported behaviors [24].

Statistical Methods

For the FFQ, intakes of fruits and vegetables were adjusted for seasonality where required by considering availability during the year. We used natural log transformation to improve the normal distribution of dietary components, because the values were skewed to the right. The values were adjusted for energy. The nutrient composition of the reported dietary intake was calculated using the Israeli and S. Daniel Abraham food tables. In addition, total energy (Kcal/day), protein (grams), carbohydrates (grams), and fat (grams) intakes were determined. Pearson correlation coefficients were calculated to assess the reliability of the FFQ and the relative validity compared to the 24HR. Nutrients values were also tested using the natural logarithm function (LN) transformation. The chi squared test was used to compare categorical variables, and t-test comparison was used for continuous variables. One way analysis of variance (ANOVA) was used to compare macronutrient intake as derived from the FFQ between the groups (Categories of BMI: normal weight, overweight and obesity) with the Scheffe post-hoc test for detecting the source of the differences. Scores of the 12 factors of the CFPQ were calculated and then divided into tertiles. The ANOVA procedure was used to compare nutrient consumption of each category across the tertiles. All statistical analyses were performed using the SPSS 18.0 package for Windows (PASW Inc., Chicago, IL, USA). P-values < 0.05 were considered statistically significant.

RESULTS

Characteristics of the Study Population

Overall 66 children (47% boys) aged 64.4 ± 5.0 months (mean ± SD) were included in the sample. The characteristics of the study population by gender are

Table 1: Selected Background Characteristics of Children and Mothers Stratified by Gender
Mean ± SD is Presented Unless Indicated Otherwise

N(%)	Girls	Boys	Total	P value
	35(53)	31(47)	66	
	mean ± SD	mean ± SD	mean ± SD	
Age (months)	63.94 ± 5.8	64.09 ± 4.09	64.38 ± 5.03	0.94
Weight for age z-score	1.03 ± 0.43	1.25 ± 0.65	1.14 ± 0.53	0.43
Height for age z-score	1.05 ± 0.20	1.06 ± 0.35	1.05 ± 0.27	0.55
Waist circumference (cm)	53.58 ± 5.08	54.63 ± 5.13	54.08 ± 5.09	0.40
Physical activity (h/week)	2.56 ± 1.07	2.67 ± 0.93	2.61 ± 1.00	0.65
Family characteristics				
Single parents (%)	(10.3%)7	(10.3%)7	(20.6%)14	0.80
Maternal age(y)	35.0 ± 6.2	34.7 ± 6.2	34.9 ± 6.1	0.83
Country of origin (%)				
Israel	(7.4%)5	(8.8%)6	(16.2%)11	0.59
Western	(26.5%)18	(26.5%)18	(52.9%)36	
African and Mediterranean	(19.1%)13	(11.8%)8	(30.9%)21	
Level of education (%)				
Less than high school	(10.3%)7	(4.4%)3	(14.7%)10	0.27
High school	(5.9%)4	(13.2%)9	(19.1%)13	
Technical education or equivalent	(10.3%)7	(7.4%)5	(17.6%)12	
University degree	(26.5%)18	(22.1%)15	(48.5%)33	
Occupation status (%) employed	(26.5%)18	(22.1%)15	(48.5%)33	0.79

presented in Table **1**. No significant differences between boys and girls were found in height, weight, BMI z-scores, hip or waist circumferences, physical activity level, number of siblings, marital status, immigration status, country of origin, or level of education. Three children were lost to follow-up, resulting in total of 63 children-mother dyads in the final data analysis. No significant change in BMI z-score was detected during the collection period.

Repeatability and Relative Validity

The repeatability of the FFQ was estimated by the correlation coefficients for energy and macronutrients, which were all significant ($p < 0.001$) and above 0.6. The best correlation coefficients were between the second and the third FFQ and were 0.74 for energy, 0.78 for protein, 0.74 for carbohydrates, and 0.64 for fat.

Table **2** presents the relative validity of the mean FFQs and 24HRs. Overall, Pearson's correlation coefficients ranged from 0.3 − 0.6 ($P < 0.05$ for all correlations tested). The highest correlation values obtained were 0.59 for fat and 0.56 for energy. Correlation of the LN value for nutrients did not show any difference. Figure **2** presents the correlation coefficients for energy in validation research comparing FFQ to 24HR conducted among children aged 1-18.

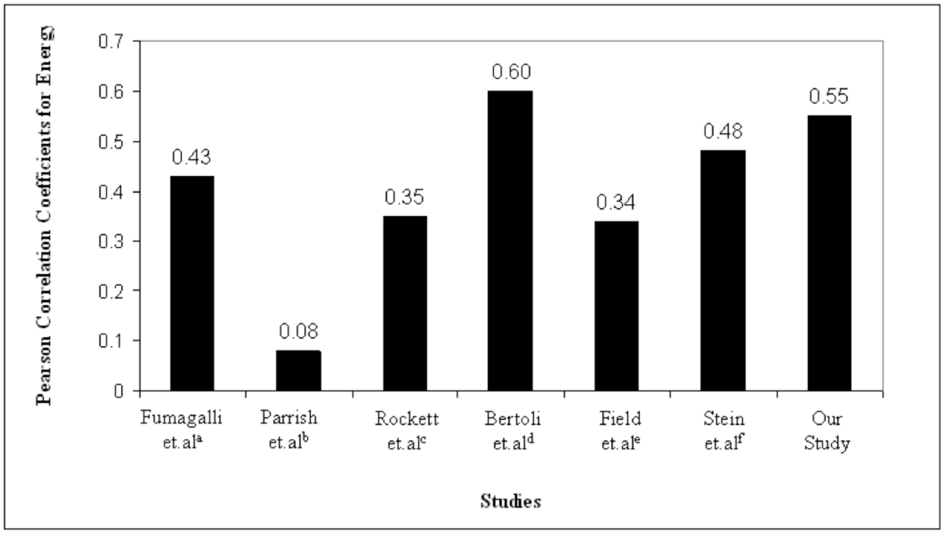
The mean macronutrient intake across three BMI categories (NW, OW, and OB) and tertiles of WC were compared using an ANOVA test (Table **3**). A significant difference was found between the OB and all other BMI z-score categories in the consumption of energy and carbohydrates ($P = 0.05$, 0.001 respectively) and for the consumption of magnesium, zinc, and calcium ($P < 0.001$ in all the comparisons). Differences in the consumption of vitamin B6, folate, and iron were found between the OW and OB categories. Nutrient consumption level was also compared between tertiles of WC. A significant difference was detected between the highest WC tertile to other tertiles in the reported consumption of energy and carbohydrates (0.019, 0.006 respectively).

Mean energy intake was also compared across the tertiles of obesogenic factors of the CFPQ scores. Three of the obesogenic factors of the questionnaire were correlated positively to the consumption of specific obesogenic food groups as shown by the FFQ. 'Food as a reward' (i.e., "parents use food as a reward for child behavior") was correlated to the consumption of sweets and snacks ($r = 0.30$, $P = 0.02$) and to the consumption of junk food ($r = 0.30$, $P = 0.01$). Restrictive parental behavior, known to encourage excessive eating habits, correlated positively in two subscales: 'Restriction for health' (i.e., "the extent to which restrictive parental behaviors are practiced to limit the child's ingestion of less healthy foods and sweets") was correlated to the consumption of sweets and snacks ($r = 0.40$, $P = 0.001$). 'Restriction for weight control' (i.e., "parental control of the child's food consumption to either maintain or reduce the child's weight") was positively correlated to the consumption of sweet drinks ($r = 0.30$, $P = 0.02$). Positive parental feeding practices were correlated to healthy food

Table 2: Relative Validity by Nutrient: Pearson Correlation Coefficients between Energy Adjusted 3*FFQs (mean ± SD) and 3*24HRs (mean ± SD), (n = 63)

Nutrient	FFQ[a]	24HRs[b]	r	P value
Energy (kcal)	2090.3 ± 81.3	1125.6 ± 14.6	0.55	P < 0.01
Protein (g)	69.3 ± 21.9	40.9 ± 14.6	0.35	P < 0.01
Fat (g)	73.7 ± 24.6	40.0 ± 20.8	0.59	P < 0.01
Carbohydrates (g)	309.3± 100.1	152.4 ± 64.9	0.49	P < 0.01
Ca (mg)	596.7 ± 207.4	418.8 ± 163.6	0.50	P < 0.01
Fe (mg)	9.0 ± 2.6	6.2 ± 2.1	0.28	P=0.03
Mg (mg)	217.0 ± 70.0	125.1 ± 34.3	0.37	P < 0.01
Zn (mg)	7.6 ± 2.4	4.9 ± 1.5	0.45	P < 0.01
B6 (mg)	1.4 ± 0.51	1.0 ± 0.4	0.36	P < 0.01
Folate (µg)	213.0 ± 79.6	99.5 ± 32.7	0.49	P < 0.01

FFQ = Food Frequency Questionnaire.
[a]Mean FFQ values were calculated from 3 FFQs ($r = 0.741$ for energy, $p < .001$).
[b]Mean 24HRs calculated from 3 24HRs.



[a][27], [b][7], [c][25], [d][5], [e][6], [f][26]

Figure 2: Pearson correlation coefficients for energy between the food frequency questionnaire (FFQ) and 24HRs in selected studies conducted among children. a) Fumagalli *et al*. [27], b) Parrish *et al*. [7], c) Rockett, *et al*. [25], d) Bertoli, *et al*. [5], e) Field *et al*. [6], f) Stein *et al*. [26].

Table 3: Macronutrients Intake Across BMI Categories† and Waist Circumference Tertiles

BMI categories					
P value[b]	**Total (N = 63) mean ± SD**	**Obese (N = 7) mean ± SD**	**Overweight (N = 16) mean ± SD**	**Normal weight[a] (N = 40) mean ± SD**	**Nutrient**
0.05	2084.7 ± 687.5	2261.4 ± 690.6	1980. 6 ± 680.5	2010.4 ± 666	Energy
0.07	69.2 ± 23.9	74.1 ± 22.8	67.5 ± 23.7	65.9 ± 24.5	Protein
0.14	71.8 ± 24.8	76.1± 23.2	70.3 ± 25.6	69 ± 25.37	Total fat
<0.01	311.9 ± 107.6	341.5 ± 116.9	290.1 ± 102.6	304 ± 96.8	Carbohydrates
Waist circumference tertiles					
P value	**Total (N = 63)**	**3 (N = 22)**	**2 (N = 21)**	**1 (N = 20)**	**Nutrients**
0.02[c,d]	2090 ± 598.0	2290 ± 575.5	1926.4 ± 573.6	2072 ± 601.7	Energy
0.19	69.3 ± 21.3	74.2 ± 20.4	66.0 ± 18.7	68.1 ± 24.2	Protein
0.15	72.0 ± 21.4	76.5 ± 18.2	67.4 ± 21.6	72.6 ± 23.4	Total fat
<0.01 [c,d]	312.7 ± 91.8	347.9± 97.1	284.4 ± 86.2	308.8 ± 82.8	Carbohydrates

[a]Normal weight defined as −2 SD < BMI z-score ≤ 1SD, overweight and obese defined as BMI ≥ 1 SD BMI z-score based on the new World Health Organization (WHO) growth standards.
[b]P value for the comparison between obese versus normal-weight children groups.
[c]First tertile versus third tertile.
[d]Second tertile versus third tertile.

consumption: 'encourage balance and variety' (i.e., "parents promote well-balanced food intake, including the consumption of varied foods and healthy food choices") was correlated to the consumption of vegetables ($r = 0.30$, $P = 0.01$). 'Modeling' (i.e., "parents actively demonstrate healthy eating habits for the child") was correlated to the consumption of vegetables ($r = 0.30$, $P = 0.03$). 'Involvement' (i.e., "parents encourage the child's involvement in meal planning and preparation") was correlated to the consumption of vegetables ($r = 0.30$, $P = 0.03$) and to the consumption of meat and fish ($r = 0.30$, $P = 0.009$).

DISCUSSION

The aim of our study was to evaluate the reproducibility and relative validity of a modified FFQ based on that of BGU for preschool children using multiple methods. Our FFQ was highly reproducible, with correlation coefficients ranging from 0.64 for fat to 0.78 for protein. The comparison with the results of the 24HR yielded correlation coefficients ranging from 0.3 −0.6. These are in line with the highest values reported from other countries [9, 25-27]. Increases in weight and waist circumference were related to higher energy and fat consumption, and obesogenic food practices by the mothers were associated with the higher consumption of unhealthy, calorie- empty foods.

Due to the lack of a gold standard for assessing dietary intake, most validation studies have entailed performing the validation by correlating the results of the FFQ with the results of one or more 24HRs. In these cases, the 24HRs were considered the gold standard. A study among 6-10-year-old children in Brazil showed that the correlations (Pearson's r) between the FFQ and the average of two recalls were 0.37 for protein, 0.58 for carbohydrates, and 0.59 for fat [9], another study among 1-3-year-old children in Denver, CO, showed Pearson correlation coefficients of 0.33 for protein, 0.41 for carbohydrates, and 0.39 for fat [7]. The correlation coefficients between nutrients obtained by our FFQ and the repeated 24HRs ranged from 0.3 to 0.6, which matched the highest correlation values found in other studies [5, 25, 27]. The FFQ seemed to overestimate the nutrient intake when compared with 24HRs; however, the two methods were highly correlated for all the nutrients considered, with fat and energy being the most highly correlated. The high correlations between the methods suggest that both questionnaires similarly rank the children's intake values within the sample population. However, since we cannot disregard the potential for correlated errors between the FFQ and 24HRs, we therefore used additional methods to test the performance of our questionnaire.

The FFQ succeeded in most cases in distinguishing between obese and NW children: obese children reported higher consumption of energy, protein, and carbohydrates than NW children. The good accuracy of the FFQ was reaffirmed in the difference detected between the highest tertile of WC and other tertiles in terms of the reported consumption of energy and carbohydrates. Only a few studies have compared weight status to reported food consumption. A study of preschool-aged Canadian Inuit children showed no association between children's weight status and obesity and their food consumption as measured using an FFQ and 24HRs [28]. In contrast and similar to our study, higher energy consumption was linearly associated with higher BMI z-scores in a recent study among school-age children in Scotland [29]. In this study, FFQ showed a consistent association between dietary patterns classified as "healthy" or "unhealthy" and BMI group. In boys aged 5 – 11 years, a significant linear association was detected between the consumption of 'unhealthy snacks' and BMI.

Parental feeding practices, mainly the extent to which maternal feeding practices are restrictive as measured by the CFPQ, are suggested to affect children's food choices and, therefore, their corresponding weight status [30, 31]. Our findings demonstrated an association between maternal restrictive feeding practices and the consumption of sweet snacks and drinks, as measured by the FFQ. These specific food consumption patterns may contribute to a positive energy balance, also associated in other studies with children's fussiness and high food responsiveness [32], both of which may lead to overweight and obese conditions in the children.

The main limitation of our study is the lack of external biomarkers in the validation procedure. Biochemical measurements of nutrients in the blood or other tissues and fluids can provide an assessment of the intake of certain nutrients with non-related sources of measurement error. However, several studies in young children using biomarkers showed correlation results that are similar to those obtained using three 24HRs [7]. Additionally, it should be noted that children remain a special case with regards to obtaining biochemical samples [3, 33, 34]. Moreover, the original BGU-based FFQ which we modified in the current study for use with children, was successfully validated for adults against biomarkers [16, 17]. The questionnaire also performed well in distinguishing dietary intake by weight status. Although we have used robust methods, our study is limited by its sample size and the consequently small number of obese children therefore; the FFQ should be further validated in a larger population.

Our study showed that the adult BGU-based FFQ modified specifically for children with the help of trained dietitians who specialize in children's nutrition, is a relatively valid and reproducible instrument for assessing the dietary intake of preschool children. Furthermore, the correlations with weight and behavioral dimensions suggest that our FFQ can also be used for estimating food quality.

ACKNOWLEDGEMENTS

This article is dedicated to the memory of Professor Stanley Mills z"l that devoted his time, energy and resources to improving the lives of children at risk in Israel.

This research was conducted in collaboration with JDC-Ashalim Organization–The Association for Planning and Development of Services for Children and Youth at Risk and Their Families, Jerusalem, Israel.

We acknowledge the personal support the first author has received from The Israel National Institute for Health Policy Research.

The authors gratefully acknowledge the support of The Canadian Institutes for Health Research, and the Ontario Ministry of Health and Long-Term Care.

We also thank the administrators, research assistants, study coordinators, and interviewers: Zina Baruch, Miriam Brami, Efrat Radai, Chen Rozalio, Osnat Tangi-Rozental, Maayan Yaccobovitch, and Efrat Zach.

We are grateful to the research participants for their willing cooperation and patience; as well as to the Ministries of Education and Health and local Municipality for their role in facilitating the project.

FINANCIAL DISCLOSURE

The authors have no financial relationships relevant to this article to disclose.

CONFLICT OF INTEREST

The authors have no potential conflict of interest relevant to this article.

DISCLAIMER

The views expressed in this publication are the views of the authors and do not necessarily reflect the views of the Ontario Ministry of Health and Long-Term Care.

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Received on 16-10-2013 Accepted on 21-11-2013 Published on 28-11-2013

http://dx.doi.org/10.6000/1929-4247.2013.02.04.10