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Validation of a Food Frequency Questionnaire to Assess Macronutrient and Micronutrient Intake among Jordanians

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ABSTRACT
The aim of this study was to examine the validity and reliability of a food frequency questionnaire (FFQ) among a convenience sample of healthy adults in Jordan. A modified version of the questionnaire known as Diet History Questionnaire I, which measures dietary intakes over a 1-year period, was administrated to 101 apparently healthy men and women recruited from three large medical centers in Jordan. Fifty-five participants completed the modified FFQ and three 24-hour recalls. Participants (N=101) completed the FFQ two times separated by a 1-month period. Reliability of the FFQ was assessed using test–retest method. Mean age of participants was 33.4±18.5 years. Energy, carbohydrate, fiber, fat, saturated fat, calcium, and iron had deattenuated correlations of .732, .563, .544, .487, .484, .451, and .459, respectively. The FFQ and 24-hour recalls produced similar agreement percentages ranging between 25.5% and 43.6%. Mean energy-adjusted reliability coefficients ranged from .695 to .943. A Cronbach's α for the total FFQ items of .857 was found. The modified FFQ has reasonable relative validity and reliability for energy, carbohydrate, fiber, fat, saturated fat, calcium, and iron intakes in Jordanian adults over a 1-year period. However, its application may require additional modifications and validation efforts. Future research is warranted to further modify and test the FFQ in a larger and more diverse sample of Jordanians as well as to develop FFQ for the use among other age groups.
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THE FOOD FREQUENCY QUESTIONNAIRE (FFQ) IS AN essential tool in epidemiologic research, and it is used to assess the long-term relationship between diet and chronic diseases.[1] FFQs are easy to use, relatively inexpensive to analyze, and, hence, can be applicable to studies with large sample sizes.[2,3] In addition, FFQs have been found to be valuable in assessing intake of energy, macronutrients, and micronutrients.[2,3] However, assessing validity and reliability of FFQs is crucial because nonvalidated FFQs may result in false relationships between dietary variables and chronic diseases.[4,5] It has been suggested that FFQs should be validated against each population because dietary habits vary greatly according to ethnic, social, and cultural features from one population to another.[4,6] There is no gold standard against which FFQs should be validated. However, FFQs are often validated against multiple 24-hour recalls or dietary records.[7] Three 24-hour recalls have been used in a number of studies.[8-10] Using three 24-hour recalls as a validation method has been found to be easier to use, less expensive, and to require less time and effort compared with diet records.

Developing a specific FFQ for the Jordanian population is essential. Jordanian cuisine is based on bread and is rich in rice dishes along with seasoned mixed stews, stuffed vegetables, and baked and grilled combined dishes in addition to a variety of sweets and beverages. Hence, developing a culture-sensitive FFQ for Jordanians will enable researchers and health care providers in Jordan to estimate nutrient intakes among this population. Our study aimed to validate a modified version of quantitative FFQ in a convenience sample of apparently healthy Jordanian adults against multiple 24-hour recalls.

METHODS

Study Design and Participants

Eligible participants were apparently healthy Jordanians randomly recruited between January 2012 and December 2012, from three selected medical centers in Jordan. Individuals accompanying patients during their visits to the medical centers were invited to participate in the study. A research assistant provided further explanations and details related to the study and obtained their consent to participate. Exclusion criteria included chronic diseases that require dietary modifications, such as diabetes, renal diseases, liver diseases, and many others. Inclusion criteria were Jordanian nationality, aged 18 years or older, and free of chronic diseases. Two hundred eighty-five adults from both sexes were approached to participate in this study. Only 101 out of the 285 committed to provide another FFQ 1 month later

following the initial visit for the reliability testing of the FFQ. Fifty-five participants agreed to complete the modified FFQ and three 24-hour recalls. The Institutional Review Board of the three medical centers (King Hussein Cancer Center, Prince Hamzeh Hospital, and King Abdullah University Hospital) approved the study.

Dietary Assessment

A modified version of the Diet History Questionnaire I (DHQ I)[11] developed by the National Cancer Institute was used as quantitative FFQ for dietary assessment. The original DHQ I provides structured questions about the frequency of intake of 144 food items over a 1-year period and provides choices of three portion sizes for food quantification. The DHQ I was translated—back translated by two bilingual experts. The first expert translated the first half of the FFQ into Arabic, whereas the second translator translated the second half of the questionnaire. The questionnaire was back translated to English with the translators swapping halves. An expert panel composed of researchers and translators finalized the Arabic version of the questionnaire. Twelve food items, common in Jordanian cuisine[12,13] were added to the questionnaire (ie, dates, fig, kiwi, cooked yogurt, falafel, hummus, pomelo, cactus fruit, kanafeh and baklava, dates-stuffed cookies and nuts-stuffed cookies, white cheese, and *labeneh*). Forty-four food items were removed from the original FFQ for cultural, ethnic, or religious factors. Food omission was done based on a pilot screening conducted on 50 individuals from different geographical areas in Jordan who were provided by the original FFQ food lists and were asked to identify uncommon, rarely consumed foods by Jordanians.

Food lists in the modified FFQ questions were classified based on types of foods: 21 items of vegetables; 16 items of meat such as red meat (lamb and beef), chicken, fish, cold meat, and others; 21 items of fruits and juices; nine items of milk and dairy products; eight items of cereals; four items of beans; four items of soups and sauces; five items of drinks; nine items of snacks and sweets; and 14 items of herbs and spices. A full version of the FFQ is provided in the Figure (available online at www.andjrnl.org).

Face-to-face interview technique was used for data collection. Two well-trained nutritionists interviewed the participants and completed the questionnaire. For each food item, participants were first asked whether they consume that specific item. If participants affirmed consumption, they were asked about the amount and frequency of food item consumption. With regard to consumption frequency, participants were asked how frequently, on average, during the past year they consumed one standard serving of a specific food item. Nine choices were provided ranged from <1 time per month to ≥ 6 times per day. Food models and standard measuring tools were used to help participants estimate the consumed portion size. Participants' responses were converted into average daily intake.

For the validity study, sample size was calculated according to Browner and colleagues.[14] To obtain correlation of 0.4 using a two-sided test, 5% significance level test (α=.05) with 80% power (β=.2), a sample size of 47 was required. Three nonconsecutive 24-hour recalls were collected from 55 participants (28 women and 27 men). In Jordan, the formal weekend is Friday. Therefore, 24-hour recalls were collected on Friday, Sunday, and Monday at three different occasions. Saturday was not included for data collection because not all institutions have Saturday as a day off. The three 24-hour dietary recalls were collected and reported in a week after FFQ application that was done usually on Tuesday. Participants were instructed about portion sizes to ease precise recall of their diet. Participants were also asked to estimate, with maximum details possible, all foods and beverages consumed in each day. For the reliability study, 101 participants completed the questionnaire two times, 1 month apart.

Dietary data obtained from the FFQ and 24-hour recalls were analyzed using dietary analysis software (Food Processor SQL version 10.1.1, 2008, ESHA Research) with additional data on foods consumed in Jordan. The estimated intake of energy, macronutrients, and some micronutrients was used to assess the validity of the FFQ.

Statistical Methods

The statistical package SPSS (IBM version for Windows, 2011, IBM-SPSS Inc) was used for all statistical analyses. A P value of 0.05 was considered statistically significant. Means±standard deviation were calculated for energy and total nutrient intakes from the average of the three 24-hour recalls and FFQ. Because all nutrients, as measured by the FFQ, were correlated with energy intake, variation due to energy intake and its associated measurement error was minimized by energy adjustment of the nutrients using regression analysis.[15] This method of energy adjustment is computed from the residuals of the regression model with total energy intake as the independent variable and the nutrient as the dependent variable. This regression equation was used to calculate the expected mean nutrient intake of the study population for the mean total energy intake of the study population. Next, for each participant the energy-adjusted intake was calculated by adding the expected mean nutrient intake of the study population to the residual derived from the regression analysis. Energy adjustment was conducted separately for each dietary method to provide a value that is uncorrelated with total energy intake. Normality of the distributions of dietary intake variables was assessed by the Shapiro-Wilk test. When the variables were not normally distributed, data were log transformed. Paired t test was conducted to examine the differences between the 24-hour recalls and FFQ. The nonparametric Spearman rank correlation coefficients between the FFQ and 24-hour recalls for both crude and energy-adjusted nutrients were obtained.[16] Deattenuated Spearman correlation coefficients were also calculated to account for random within-person variation in the 24-hour recalls as described previously by Willett and colleagues[17] and using the following formula:

$$r_{de}=r_{obs}\sqrt{1+(Var_w/Var_b)/n}$$

where r_{de} is the deattenuated correlation coefficient, r_{obs} is the observed correlation coefficient for adjusted nutrient intake, Var_w is the within-person variance of the 24-hour recalls, Var_b is the between-person variance of the 24-hour recalls, and n is the number of recalls per person. The Var_w and Var_b were estimated from a simple variance components analysis of the within- and between-person variability of the 24-hour recalls.