Comparison of a semi-quantitative food frequency questionnaire with 24-hour dietary recalls to assess dietary intake of adult Kuwaitis

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The lifestyle of the residents of Arab and Persian Gulf countries is changing due to globalization. They consume more fat, meat, fast foods, and sugar than before.[1] To assess an individuals' dietary intake, a valid dietary tool is needed. We developed such an instrument for the population of the United Arab Emirates (UAE). The foods consumed in UAE, however, are influenced by its large multicultural immigrant population, and are not typical of those eaten in other countries in the region. Thus, it was necessary to develop such an instrument. It is necessary to validate any food frequency questionnaires (FFQ) that are developed for specific populations, as incorrect information may lead to false associations between dietary factors and diseases or disease-related markers.[2] We developed a semi-quantitative food frequency questionnaire (SFFQ) and accompanying food composition database for Kuwait. The SFFQ effectively captures the type and quantity of food the population in Kuwait usually eat, and their frequency. When these data are combined with the food composition table for Kuwait, it is possible to determine long-term nutrient intake for this population. The developed SFFQ listed standard portions of food items traditionally consumed in Kuwait, and intake frequencies for the food items consisted of 9 categories ranging from "never/once a month" to "more than 6 times/day".[3] To validate the SFFQ a representative sample of 100 individuals was taken from the Hawally and Farwania governorates. However, as a result of loss of follow up and removing outliers, our sample size was reduced to 68 healthy adults, aged 23-59 years old.

We utilized 24-hour dietary recalls (DRs) as our reference method. Trained interviewers collected 24-hour DRs, and SFFQs twice over 4 months. As we were not able to find a food composition table listing the nutrient content of Kuwaiti foods, we used a nutrient database developed by the United States Department of Agriculture (USDA). Data collection took place over 4 months as Kuwait does not have distinct seasons, and availability of food such as fruits and vegetables are not dependent on season. The information on age, gender, education, and occupation was obtained from a questionnaire administered at the first visit. We were granted ethical clearance by the McMaster University, Hamilton, Ontario, Canada and the relevant local authorities, and written consent was obtained from the participants.

To estimate nutrient intake, we first multiplied the portion of each food listed in the SFFQ or 24-hour DR by the number of times it was consumed, and by the nutrient content of that quantity of food listed in the USDA nutrient database. Next, we summed up the nutrient contributions from each food over all the food in the respective SFFQ or 24-hour DR, to obtain the total nutrient intake estimated in that particular SFFQ or 24-hour DR administration. To estimate reproducibility, we compared the usual nutrient intake estimated from SFFQ1 (administered at the baseline), and SFFQ2 (administered 4 months later) using the intra-class correlation coefficient (ICC). To compare nutrient intake estimated using the SFFQ and 24-hour DRs, we used the Spearman correlation coefficient. To evaluate comparability, we reported the Spearman correlation coefficients between SFFQ2 and 24-hour DRs. We categorized participants into quartiles by intake category for each nutrient estimated by mean 24-hour dietary recall, SFFQ1, and SFFQ2. We then computed the following cross-tabulations of quartile categories for each nutrient: 24-hour dietary recall versus SFFQ1, 24-hour dietary recall versus SFFQ2, and SFFQ1 versus SFFQ2. We defined agreement as the percentage of persons correctly classified within one intake category. Overall, participants were 37.4 (9.3) years old, the mean body mass index (BMI) (weight [kg]/ height [m^2]) was 27.5 (4.8) kg/m^2. The mean daily energy intake was 2472 (803) kcal/d for women, and 2894 (815) kcal/d for men. We compared estimated nutrient measurements by SFFQs against DRs, which showed the minimal and maximal estimate of true comparability. We mainly focused on the comparison between SFFQ2 and DRs, as they both have conceptually the same reference time. The Spearman correlations between the 24-hour DRs, SFFQ1 and SFFQ2 are presented in **Table 1**. Unadjusted ICCs between SFFQ1 and SFFQ2 for macronutrients varied from 0.74 for carbohydrate to 0.69 for fat. For micronutrients, the highest ICC was noted for vitamin C, and the lowest for calcium. We assessed the comparability of SFFQ2 by comparing its nutrient intake estimates against the mean nutrient intake estimated from 2 24-hour DRs. The correlations between SFFQ2 and DRs for total caloric intake, protein, total fat, and carbohydrate were noted. Among micronutrients, vitamin A had the highest correlation, while the lowest correlation was noted for vitamin C. After adjusting for energy intake, the correlation coefficients did not improve (data not shown). The correlations between 24-hour DR and SFFQ1 were consistently lower than those for SFFQ2 (**Table 1**). For SFFQ1 and 24-hour

Table 1 - Mean (SD) nutrient intake measured by SFFQ1, SFFQ2 and average of 2 DRs, and estimated correlation and ICC between DRs and FFQs (n=68).

Variables	DRs	SFFQ1	SFFQ2	Correlation DRs and SFFQ1	Correlation DRs and SFFQ2	ICC, FFQ1 and SFFQ2
Energy (kcal)	2189 (807)	2265 (578)	2695 (831)	0.36	0.41	0.72
Protein (g)	89.9 (48)	97.5 (24)	116.4 (38)	0.36	0.35	0.70
Total fat (g)	69.5 (32)	77.4 (25)	93.5 (31)	0.33	0.41	0.69
Saturated fat (g)	21.8 (9.9)	21.3 (8)	26.3 (9.2)	0.20	0.20	0.62
MUFA (mg)	23.3 (11.4)	25.6 (9)	30.9 (11)	0.33	0.38	0.73
PUFA (mg)	13.9 (7.2)	14 (6)	16.8 (8)	0.25	0.32	0.64
Carbohydrate (g)	305.4 (111)	305.8 (89)	360.6 (132)	0.30	0.34	0.74
Fibre (g)	21.7 (10)	38.8 (14)	43.9 (17)	0.25	0.35	0.80
Calcium (mg)	1053 (621)	839 (299)	1069.9 (377)	0.18	0.17	0.50
Iron (mg)	14.6 (5.7)	20.7 (5)	22.2 (6.5)	0.20	0.34	0.73
Vitamin C (mg)	97.3 (63.4)	166 (84)	176.9 (98)	0.23	0.15	0.83
Vitamin A (Rae)	538 (311)	969 (461)	1039 (430)	0.21	0.38	0.74
Total folate (mg)	329 (138)	333 (128.5)	391.2 (151)	0.16	0.35	0.74
Cholesterol (mg)	330.7 (254)	320 (131)	373.3 (170)	0.44	0.47	0.81

SFFQ1 - semi-quantitative food frequency questionnaire (administered at the baseline), SFFQ2 - (administered four months later), DR - dietary recalls, ICC - intra-class correlation coefficient , FFQs - food frequency questionnaires, MUFA - monounsaturated fat, PUFA - polyunsaturated fat, Rae - retinol activity equivalent

DRs, the correlation for macronutrients varied from 0.30-0.36. For micronutrients, the highest correlation was for vitamin C, and the lowest was for total folate. Energy adjustment did not strengthen the correlations. Agreement between intake estimated by mean 24-hour DR and SFFQs for most nutrients varied from 69-88%. However, the lowest level of agreement between DRs and SFFQ2 was observed for vitamin C (58.8%), and between SFFQ1 and DRs was observed for vitamin A (58.7%). The reproducibility of our questionnaire is similar to the correlation found in other studies.[4] A diverse range of correlation coefficients between macro and micronutrients measured by SFFQ and other methods of dietary assessment has been reported in several validation studies.[2] For almost all macro and micronutrients, with the exception of vitamin C and calcium, the correlations between 24-hour DRs and SFFQ2 were close to 0.4, which is similar to other studies.[5] As seen in other studies, our SFFQ overestimated individual dietary intake, which may happen due to societal desirability and values, and also, misunderstanding of frequencies as the portion sizes are fixed. The mean of total dietary fiber intake measured by SFFQ1, and SFFQ2, which in comparison with Western diet may appear relatively high. Participants consumed on average 5.5 servings of vegetables and 2.7 servings of fruit per day, and when accounting for portion sizes (varies between 80-200 g), this may explain the high fiber intake.

Our study has several limitations, including a small sample size. According to Willett[2], 100-200 subjects provide reasonable information, and a small sample size (n=30) creates a wider confidence interval which affects estimated correlation. Another limitation was that we used just 2 replicates of the 24-hour DRs, which could result in underestimating the usual intake of nutrients highly concentrated in certain foods. Finally, the relatively short interval between the second SFFQ administration and the first SFFQ administration may have impacted the results. The reference period for the SFFQ is one year, but was 4 months for the 24-hour DR. There may also have been respondent fatigue because both the 24-hour DR and SFFQ were administered at the same time. These factors could have resulted in measurement error and attenuation of the associations. We could not explain the substantially higher usual intake estimated by SFFQ2, however, given the mean BMI of this population, the intake may be reasonable. Moreover, there were differences in the reported caloric intake between men and women, lending face validity to the results.

In conclusion, we developed a SFFQ that assesses the intakes of most macro and micronutrients with reasonable accuracy, and can be employed for assessing dietary intake of Kuwaitis.

Acknowledgment. *We thank Dr. Yusuf (Director of Population Health Research Institute) for his unwavering support and guidance. We are grateful to the nutritionists who collected the dietary data in Kuwait. We also thank the participants of the study for their cooperation.*

Received 19th October 2008. Accepted 20th December 2008.

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