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Validation of the European Prospective Investigation into Cancer (EPIC) Food Frequency Questionnaire for use among Adults in Lebanon

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Ethical Standards Disclosure: ["This study was conducted according to the guidelines laid down in the Declaration of Helsinki and all procedures involving research study participants were approved by the [Lebanese American University Institutional Review Board] IRB#: LAU.SAS.MB3.2/Dec/2019. Written informed consent was obtained from all subjects/patients."]

Abstract:

Objective: To validate the EPIC food frequency questionnaire (FFQ) in Lebanon.

Design: Validation of the EPIC FFQ was done against three 24-hour recalls. Unadjusted and energy adjusted correlations, Bland Altman plots, and weighed kappa statistics were used to assess the agreement between the two methods.

Setting: Lebanon.

Participants: 119 adults (staff and students) at a Lebanese University.

Results: Good unadjusted and energy-adjusted correlation coefficients were found between data from the two methods which ranged from -0.002 (vitamin A) to 0.337 (carbohydrates) and were all statistically significant except for vitamin D, vitamin E, vitamin A, selenium, and niacin. Slight/fair agreement was reported through weighed kappa estimates for unadjusted data ranging from -0.05 (vitamin C) to 0.248 (magnesium) and for energy-adjusted data ranging from -0.034 (vitamin A) to 0.203 (phosphorus). Individuals were categorised into exact and adjacent quartiles with an average of 78% for unadjusted data and 70% for energy-adjusted data, indicating a very good agreement between the EPIC FFQ and the average of the 24-HRs data. The visual inspection of the Bland-Altman plots revealed an over-estimation of energy, carbohydrates, protein, and fat intakes by the FFQ method.

Conclusion: Overall, when all tests were taken into consideration, this study demonstrated an acceptable agreement of the EPIC FFQ with the 24-hour dietary recall method and significantly good correlations between dietary intakes. Therefore, the EPIC FFQ can be considered a valid tool for assessing diet in epidemiological studies among Lebanese adults.

Keywords: Diet, Validation, Food frequency questionnaire, 24-hour recalls, Adults, Lebanon.

1. INTRODUCTION

The prevalence of obesity in the Middle East, especially the Arab Gulf States, is growing rapidly; 75% of adults are considered obese [(1)]. Lebanon is a middle income Middle Eastern country having food ingredients that are representative of the Mediterranean diet [(2)]. Traditionally, Lebanese cuisine has included cereals and legumes, fresh vegetables, along with sea food, meat, or chicken, filled or mixed with olive oil and herbs, ending up with common dishes known as “mezze” and “stews”. The traditional Mediterranean diet consisted of fruits, vegetables, seeds, whole grains, non-refined cereals, olive oil, and vegetable protein has shifted to a westernised dietary pattern based on animal proteins, low fibre, refined grains, and high in sugar and saturated fats [(3)]. However, Lebanon has experienced a dietary transition with the traditional Mediterranean diet being substituted by a more westernised diet in the past few years [(2)]. This change in eating pattern has contributed to the increase in obesity and consequently, the prevalence of nutrition-related diseases (e.g metabolic syndrome, diabetes, cancer, and heart diseases) has grown among the Lebanese population over the last decade [(4, 5)].

There is a need to study the link between food/nutrition and health outcomes through standardised and validated dietary tools [(6)]. For such studies, rigorous methods to estimate short-term and long-term dietary intake are needed. However, thorough dietary methods are often expensive, time-consuming and demand a high commitment from participants [(7)]. There are several dietary assessment methods including: diet records that ask individuals to report everything they consumed over several days/weeks, 24-hour recalls that involve reporting food consumed in the past 24 hours (including the Automated Self-Administered 24-hour dietary recall (ASA-24) and Intake-24 which are newer methods that reduce the burden on participants), food frequency questionnaires (FFQs), nutrition biomarkers e.g. urinary nitrogen or blood-lipid profile that confirm results of food intake [(6,8-10)]. Food frequency questionnaires has numerous advantages compared to other dietary tools as they allow the assessment of food intake over a long-time interval and can estimate the past intake of large populations [(11)]. Further, although FFQs are not the easiest dietary assessment tools to use, they are still deemed to be inexpensive, exert a low burden on participants, and easy to administer [(11,12)].

Self-reported FFQs collect from individuals their frequency of consumption and portion size of several foods. In large surveys that primarily demonstrate an overview of the health status within a particular population, the methods employed for dietary evaluations (e.g. dietary patterns) should be feasible before assessments [7]. FFQs assess the usual intake across a medium or long duration that is very crucial to be able to monitor individuals' behaviours. Medical surveys often use FFQs to compare groups or people based on their intake of various food groups, and thereby FFQ is a suitable method of choice for such surveys [12]. Yet, to minimse the burden on participants, ultimately an FFQ should be comprised of a limited number of food types. Additionally, it is necessary to adapt the food list according to the population's food consumption habits [11]. Similar to all other dietary tools, FFQs can exhibit measurement errors and it is strongly advised that they get validated among the studied population [7, 11]. In other words, FFQs ought to be culture and population specific [13]. This means that it is unacceptable for them to be used cross-culturally (in different countries) except if they were validated in those countries [11, 13].

The European Prospective Investigation of Cancer food-frequency questionnaire (EPIC FFQ) has been widely used for dietary assessment [14]. It represents a gold standard assessment tool of the diet in nutrition epidemiological studies. The EPIC FFQ has been validated for use in adolescents and adults in the United Kingdom (UK) [15-17], in patient groups (celiac disease patients) [18], and in other European countries such as Italy [19] providing a reasonable assessment of habitual diet; however, no validation study of the EPIC FFQ has been done in the MENA region. Although food frequency questionnaires are commonly used in the USA and European countries, nutrition epidemiology in the MENA (Middle East and North Africa) region and Lebanon is considered poor due to the scarcity of rigour and representative dietary questionnaires, specifically FFQs [20]. To date, there have been no studies on dietary patterns across different continents using a common FFQ. The aim of this study was to validate an existing tool, the EPIC food frequency questionnaire, in a new country context, Lebanon.

2. MATERIALS AND METHODS

The validation was done by comparing data collected from the EPIC FFQ with that collected from three 24-hour recalls (24-HRs).

2.1 Participants

The sample consisted of adults aged 18 years and older who were staff and students at LAU in Lebanon. A total of 119 participants were eligible for the study. This number was also recommended by professionals in this field who confirm that more than 105 individuals are required to assess the agreement between tools used to evaluate dietary intakes [7, 11]. Exclusion criteria included adults who were: suffering from a chronic disease such as: Cancer, Crohn's Disease, Diabetes, Heart Disease, HIV/AIDS/ Multiple sclerosis, Asthma, COPD, Cystic fibrosis, or mental health disorder, having food intolerance or allergy, pregnant/breastfeeding, on any medication known to affects appetite or have undergone bariatric surgery.

2.2 Methodological Procedure

Participants were approached by a licensed dietician through classroom and office visits during term where they were asked to fill out three 24-HRs in paper form: two on weekdays and one on a weekend day providing qualitative (e.g., type of food) and quantitative (e.g., portion) details about what they consumed in the last 24-hours. Participants were given guidance on how to use the 24-HRs and were filled out on different days. One week after completing the 24-HRs, participants were asked to fill in the adapted version of the EPIC FFQ. Additionally, their demographic characteristics were collected. Data was then entered electronically to an online survey in order to facilitate its analysis.

2.3 Measures

2.3.1 Socioeconomic and Physical characteristics

Self-reported age, body weight, height, education, income, race, and marital status were collected to describe the socio-demographic characteristics of participants.

2.3.2 24-hour recalls

The three 24-hour recalls (24-HRs) collected dietary data about foods and drinks consumed over the past 24 hours. Participants were asked to fill out the second 24-HR on a weekday two days after completing the first one while the third 24-HR to be completed in the weekend of the same week so that the data collected is representative of the individual's overall dietary intake.

2.3.4 EPIC FFQ

The EPIC FFQ consists of 130 food items and one additional question for milk (131 items). The tool was adapted to reflect the Lebanese diet (Appendix 1). To adapt the EPIC FFQ to the Lebanese diet, the researcher (Lebanese) substituted some foods from the original EPIC FFQ with foods that are commonly consumed in Lebanon. In order to retain its international comparability, most foods items from the original EPIC FFQ remained the same in each of the sections. Since students and staff at LAU were from different religions (Christians and Muslims), food items like pork and alcohol intake were kept unchanged, unlike other validation studies that took place in other Arab countries where pork and alcohol sections were excluded because participants were solely Muslims. The frequency of dietary intake of the adapted FFQ remained the same as the original version: never or less than once per month, 1-3 times per month, once a week, 2-4 times per week, 5-6 times per week, once a day, 2-3 time per day, 4-5 times per day, more than 6 times per day.

To ensure that adaptation was correct and improve content and face validity, the adapted version of the EPIC FFQ was cross checked by nutrition academic staff at LAU.

Additionally, before the main validation study, the adapted version of EPIC FFQ was completed by 10 adults in Lebanon as a pilot study. This step was essential to confirm the time required to complete the questionnaire and that the questions were easy to understand, and instructions were easy to follow. Also, any feedback from participants was taken into consideration and modifications were made such as changing unclear food items into more familiar ones.

2.4 Data analysis

The FFQ data were analysed through FETA software that is designed to derive dietary data (energy, macro- and micro-nutrients, etc...) specifically from EPIC FFQs [21]. Data from the 24-hour recalls were entered into the NUTRITICS software, which is a dietary analysis tool containing more than 750,000 food items [22]. The mean (± Standard deviation) and median (with Interquartile range) for energy and nutrients were derived from the adapted EPIC FFQ and three 24-hour recalls. The adapted EPIC FFQ was compared to the average of three 24-hour recalls. Pearson's Correlation (or Spearman's Rank Correlation Coefficient for non-normally distributed data) was used to measure the correlations of unadjusted, energy-adjusted, and age, gender, and BMI-adjusted data between the energy and macro- and micro-nutrient intakes of the two methods [23, 24]. The residual method (from regression model) was used to obtain energy-adjustment data for nutrients correlations and age, gender, and BMI-adjustment data for energy and nutrients correlations [25]. Moreover, the unadjusted and energy-adjusted data of energy and all nutrients were categorised into quartiles and weighed kappa statistics was used to determine the agreement between the FFQ method and the 24-HRs method. The proportion of individuals categorised in same quartile by the FFQ and average 24-HRs and in contiguous quartiles as well as opposite (and/or 1 quartile apart) were calculated. We interpreted weighed kappa results based on Cohen suggestion as follows: value <0 indicates no agreement, 0-0.20 slight agreement, 0.21-0.40 fair, 0.41-0.60 moderate, 0.61-0.80 substantial, 0.81-1.00 nearly perfect agreement [26]. The Bland-Altman plot was performed to estimate agreement between the two methods [27, 28]. The intake values difference between FFQ and average of 24-hour recalls were plotted against the average intake values of these methods (intakes from FFQ + intakes from average of 24-hour recalls divided by 2). Limits of agreements (95%) were formed to illustrate the range of agreement between the two measures (mean ± 1.96 SD). Linear regression was performed to derive the slope coefficient for each nutrient where the average intake of the two measures was the independent variable and the intake difference was the dependent variable. Therefore, the slope coefficient was used to determine the degree of overestimation or underestimation of intakes from FFQ compared to the average of the three 24-HRs. Data were analysed using IBM SPSS statistics version 25 (Chicago, IL, USA).

3. RESULTS

We recruited 120 participants of those one was excluded due to completing only one 24-HR out of three, leaving a final sample of 119 participants. The median age of the validation study participants was 20 (3) years, and the median BMI was 22.7 (4.51) kg/m^2 (Table 1). Almost all participants were single (99.2 %), and most of them were females (71.4 %) and non-smokers (75.6 %). More than 60 % of participants' parents were university graduates and most of them were employees. The main source of income of participants was through the support of their families, and most participants reported a good/comfortable financial status with a family monthly income of >$3000. Participants had a family size of four to six persons, and more than 60% reported that two persons sleep in each room of the house.

Table 2 presents the median (IQR) intake for energy, macronutrients, and micronutrients calculated from the FFQ, the three 24-HRs, and their average. All data of energy and nutrients derived from FFQ were higher than those derived from the three 24-HRs and their average. It can be seen that the intakes of energy and macronutrients are approximately 1.3 times high in FFQ than the average of three 24-HRs. The difference of estimates of micronutrients ranged from 0.87 (Niacin) to 2.56 (Vitamin E) times higher through the FFQ method compared to 24-HR method.

Table 3 lists the unadjusted and energy-adjusted correlation coefficients between the FFQ and the average of the three 24-HRs of participants. Energy and nutrients in the unadjusted correlations were all statistically significant except for selenium, potassium, niacin, vitamin D, vitamin E, and vitamin A. Unadjusted and energy-adjusted correlation coefficients ranged from -0.002 (vitamin A) to 0.34 (carbohydrates). Energy-adjusted correlation coefficients were all statistically significant except for vitamin D, vitamin E, vitamin A, selenium, and niacin. Compared to unadjusted correlation coefficients, energy-adjusted correlation coefficients increased for protein, fat, folate, iron, magnesium, thiamine, sodium, selenium, and potassium, and decreased for zinc, vitamin E, riboflavin, pyridoxin, and phosphorus, and remained the same for carbohydrates, calcium, vitamin D, vitamin C, vitamin B_{12}, vitamin A, niacin. The correlation coefficient of potassium intake became statistically significant after energy-adjustment. For folate and phosphorus intakes, the significance level increased from <0.05 to <0.001 and decreased from <0.001 to <0.05, respectively. Adjusting for age, gender, and BMI did not show any change in the correlation coefficient than through energy-adjustment. Overall, a significant moderate correlation was observed between FFQ and average of the three 24-HRs.

Table 4 shows the kappa statistics for unadjusted and energy-adjusted data. The weighed kappa estimates for unadjusted data ranged from -0.05 (vitamin C) to 0.248 (magnesium). Weighed kappa values were statistically significant for energy, carbohydrates, protein, fat, calcium, iron, zinc, magnesium, vitamin E, thiamine, riboflavin, and niacin. Weighed kappa values were not statistically significant for vitamin D, folate, vitamin C, vitamin B_{12}, vitamin A, sodium, selenium, pyridoxin, potassium, and phosphorus. After energy adjustment, weighed kappa values were reduced for energy and all nutrients but increases for vitamin C, vitamin B_{12}, pyridoxin, and phosphorus and remained unchanged for folate. Weighed kappa for energy-adjusted data ranged from -0.034 (vitamin A) to 0.203 (phosphorus). Overall, the weighed kappa statistics showed a slight-to-fair agreement between the FFQ and the average of the three 24-HRs. The classification of subjects into the same quartile for unadjusted data ranged from 18% (vitamin D) to 50% (total energy). Exact plus adjacent agreement ranged from 58 (vitamin D) to 92% (carbohydrates) while the disagreement ranged from 4.5% (total energy) to 38% (vitamin D). For energy-adjusted data, the exact agreement ranged from 21% (calcium) to 49% (sodium) whereas the exact plus adjacent agreement ranged from 58 (calcium) to 94% (vitamin E) and the disagreement ranged from 15% (carbohydrates) to 38% (folate).

Table 5 demonstrates the agreement between FFQ and average of the three 24-HRs. It shows the mean difference with the 95% limits of agreement (lower and upper) and the linear regression coefficients for energy, macronutrients, and micronutrients where data of the average of three 24-HRs were entered as predictor of FFQ data. The mean difference for energy (±SD) was 1212.7 ±2630.3 with wide limits of agreement (-3942.7; 6368.1). For energy and macronutrients, a positive slope coefficient with p-value <0.05 was found showing that the FFQ has overestimated higher energy and macronutrients intake levels. A positive slope was also found for all micronutrients except vitamin D (-0.45), vitamin C (-0.35), vitamin B_{12} (-0.28), and selenium (0.17). Further, the visual inspection of the Bland-Altman plots (figure 1) also shows a pattern of over-estimation of energy, carbohydrates, protein, and fat intakes by the FFQ method. A greater number of data points is observed to be below the mean difference line vs above the mean difference line for energy, protein, and fat intakes and as the mean intake of energy and macronutrients increases, the difference increases indicating a slight proportional bias. This has been also evidenced through the linear regression that found a statistically significant t score (p-value <0.05) for energy and macronutrients indicating that the null-hypothesis that there is no proportional bias is rejected. Linear regression of all micronutrients data indicated a slight proportional bias except for zinc (p=0.36), magnesium (p=0.54), vitamin E (p=0.557), vitamin B_{12} (p=0.065), vitamin A (p=0.686), selenium (p=0.345), riboflavin (p=0.244), pyridoxin (p=0.954), and niacin (p=0.27). β coefficients were all close to 0 indicating that there is no huge proportional bias. Overall, the FFQ was shown to slightly overestimate nutrient intakes compared to the 24-HRs.

4. DISCUSSION

The EPIC FFQ is an easy-to-use gold-standard tool that is widely used to assess the dietary intake of large populations. Nutrition epidemiology in Lebanon is deemed poor due to the scarcity of rigour and representativeness of dietary questionnaires, specifically FFQs [20]. To the best of our knowledge, this is the first validation study of the EPIC FFQ for assessing dietary intake among adults in the MENA region, and especially in Lebanon. Although the FFQ showed overestimation of intake of energy and some nutrients in comparison with 24-HRs, this validation study demonstrated an overall acceptable agreement compared to the 24-h recall method and significantly good correlation between intakes.

In our study, the moderate correlation coefficients reported between the FFQ and the average of three 24-HRs were statistically significant for all but six nutrients, and this has been similarly reported in validation studies from Bangladesh [11, 29, 30]. The correlation coefficient for zinc intake in the study by Mumu et al. [11] between FFQ and three 24-HRs was 0.161 which is very similar to that reported in the present study (0.192). Additionally, comparable validation studies of different FFQs done in Lebanon have found similar correlation coefficients with multiple 24-HRs. For example, in a recent validation study by Harmouch-karakir et al. [31] done among Lebanese adults, the correlation coefficient for magnesium was 0.38 (p<0.001) and for thiamine 0.33 (p<0.001) compared to 0.31 (p<0.001) and 0.32 (p<0.001) in the present study, respectively. On the other hand, another recent study by Aoun et al. [32] conducted with Lebanese adults found higher correlation coefficients than the present study; however, they were not statistically significant for energy and several nutrients. For example, the correlation coefficient for energy was 0.998 (p=0.098), 0.996 (p=0.877) for fat, 0.967 (p=0.073) for iron, 0.987 (p=0.348) for vitamin C, and 0.973 (p=0.289) for vitamin B_{12}. After energy adjustment, the correlation coefficients in the present study were improved for protein, fat, folate, iron magnesium, thiamine, sodium, selenium, and potassium intakes; however, for the majority of nutrients they showed no change or a decrease in correlation coefficients. The correlation of fat intake, which is a major predictor of cardio-vascular diseases, slightly increased after adjusting for energy (0.27 to 0.29). It is argued that if the correlation coefficient of a specific nutrient increased after energy-adjustment, the variability of this nutrient's intake is linked to energy intake [13]. In contrast, if the correlation coefficient decreased after energy-adjustment, it means that the variability depends on systematic error of under and overestimation of that nutrient's intake [13]. Willet et al. [7] recommends that the demographic confounder should be controlled-for in nutrition epidemiological research, and accordingly we adjusted for age, gender, and BMI for unadjusted correlations in this study. This is recommended because these confounders affect the between-person variation in food intake and usually manipulate the correlation between the dietary tools [7].

From the analysis of the data, it can be concluded that FFQ resulted in an overall overestimation of total energy, macronutrients, and micronutrients intakes compared to the 24-HRs. Similar findings have been found in previous research [13, 33, 34]. It is widely accepted that an accurate estimation of energy intakes using self-report tools is hard to achieve, however energy-adjustment improves the estimation of other macro- and micro-nutrients [35]. It is argued that when participants are asked to recall the frequency of different foods, they usually overestimate the overall intake [13]. However, others suggest that FFQs generally contains a large list of foods that covers usual and local foods of the population under study, which explains the need for energy adjustment [36]. The larger the food list is, the more inflated the estimates of total dietary intake will be when summing the foods [33]; and in the present study we used a 130-food item FFQ which is considered a quite large food list. Moreover, participants tend to overreport the frequency of consumption of foods in an FFQ because of recall and social-desirability biases, and this leads to over-estimation of dietary intake [11]. Interestingly in our study, data collection was done during the COVID-19 pandemic, which might have manipulated the reporting of dietary intake of participants [37]. Nevertheless, this study indicates that there exists an agreement (slight-/fair) between the FFQ and the average of three 24-HRs for most of the nutrients, which is in line with what other validation studies, that validated different FFQs, have reported [38, 39]. A study by Sauvageot et al. [40] aimed to validate an FFQ against 3-day food record and found a slight/fair agreement between the two methods. For example, the study reported kappa values of 0.02 for energy, 0.12 for lipids, 0.22 for protein, 0.02 for iron, 0.17 for potassium. Similar to the present study, these authors considered this agreement acceptable and the FFQ was validated for use among their specific population. Regarding the cross-classification of subjects into quartiles, the FFQ showed quite good results. Individuals were correctly categorised into the exact and adjacent quartiles with an average of 78% for unadjusted data and 70% for energy-adjusted data, which is similar to other studies [13, 38, 41].

One strength of the present study is that the food list of the EPIC FFQ was adapted to accurately reflects the Lebanese diet and hence it represents this population. Another strength is the statistical methodologies conducted in this paper. Although applying one to three statistical approaches is considered enough in such studies [42], the present study used several statistical methods to assess the validity of the EPIC FFQ [11].

A great challenge of validation studies is considered choosing a suitable reference method to validate the target dietary tool since there is not one gold standard tool for dietary intake measurement [7, 13]. Although other dietary tools (e.g., weighed food records) have been utilized in validation studies, they were not practical because of the increased cost involved. One limitation of this study is that both dietary tools that we used rely on memory. However, the 24-HRs have several advantages such as being inexpensive, quick to administer, and able collect detailed information on food consumed during the day. Moreover, the 24-HRs require only short-term memory and are eligible to be used among all populations [12, 33, 43]. A study by [43] mentions that 24-HRs might sometimes have a higher objectivity than FFQ and that their use as a dietary tool does not alter the habitual diet of participants as the prospective food record dietary tool. In this study, we collected 24-h recall for 3 days and on both a weekend day and two weekdays to minimize the day-to-day variability. Our sample was selected from a university campus and contained a high proportion of young females who are educated and from a high socioeconomic status and at a higher educational level; and thus, caution should be taken regarding the generalization to all Lebanese adults. This is the first Lebanese validation study of the food frequency questionnaire and future research should ensure a broader sample is selected. Another limitation of the present study is the use of Nutritics software which is based on UK guidelines which is different than the Lebanese nutrition guidelines. In the same context, there is no existing Lebanese software to analyse the dietary intake of Lebanese population. Estimating the dietary composition in Lebanon is challenging and nutritionists should aim to continuously implement accurate food databases [44]. In the present study, the 24-HRs were collected one week after collecting the FFQ, data due to time restraint, which might be less representative than if they were collected through out several months.

5. CONCLUSION

This study showed that the EPIC FFQ is a valid tool to assess diet in epidemiological studies among Lebanese adults. Caution is needed as the EPIC FFQ may overestimate individuals' dietary intake; however, this is not yet clear. Future studies should further assess the validity of the EPIC FFQ among Lebanese adults using nutritional biomarkers.

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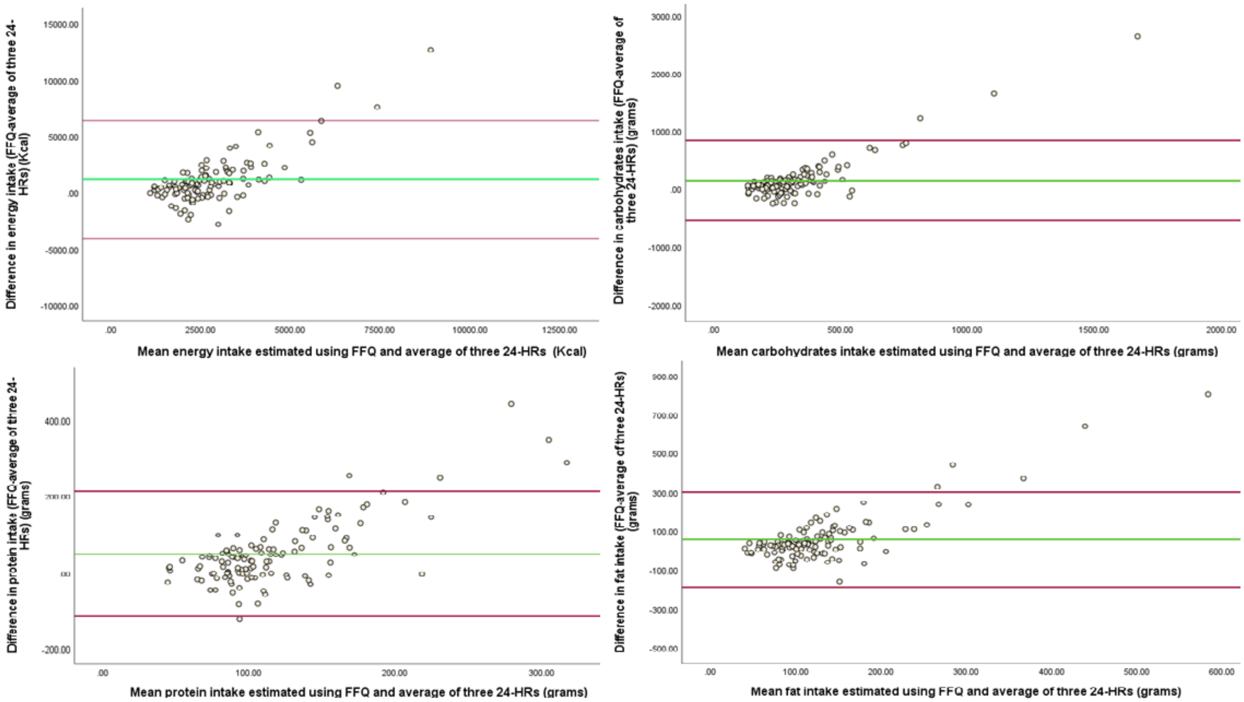

Figure 1. Bland Altman plots for energy, carbohydrates, protein, and fat intakes.

Tables:

Table 1. Socio-demographic characteristics of study participants

Socio-demographic characteristics	**N (%)**	**Median (Interquartile Range)**
Gender		
Male	34 (28.6)	-
Female	85 (71.4)	
Age (years)	-	20 (3)
BMI (kg/m^2)	-	22.75 (4.51)
Marital status		
Single	118 (99.2)	-
Married	1 (0.8)	
Father's educational level		
No education	8 (6.7)	
Grade 9 (Brevet)	12 (10.1)	-
Grade 12 (Baccalaureate)	25 (21.0)	
University graduate	74 (62.2)	
Mother's educational level		
No education	2 (1.7)	
Grade 9 (Brevet)	11 (9.2)	-
Grade 12 (Baccalaureate)	3 (2.5)	
University graduate	73 (61.3)	
Father's employment status		
Unemployed	4 (3.4)	
Unable to work due to health problems	4 (3.4)	-
Employee	99 (83.2)	
Full-time homeworker, parent, or caregiver	3 (2.5)	
Retired	8 (6.7)	
Mother's employment status		
Unemployed	34 (28.6)	

Unable to work due to health problems	1 (0.8)	-
Employee	45 (37.8)	
Full-time homeworker, parent, or caregiver	37 (31.1)	
Retired	2 (1.7)	
Main source of income		
Family support	98 (82.4)	-
Self-support	10 (8.4)	
Scholarship or stipend	11 (9.2)	
Family monthly income		
< $500	3 (2.5)	
$500-$1499	23 (19.3)	-
$1500-$2999	33 (27.7)	
>$3000	59 (49.6)	
Financial status		
Do not have enough to make ends meet	5 (4.2)	-
Have enough to make ends meet	54 (45.4)	
Have more than enough to make ends meet	59 (49.6)	
Family size		
Four or below	48 (40.3)	-
Five or above	69 (57.9)	
Persons in each room of the house		
One	41 (34.5)	
Two	72 (60.5)	-
Three	3 (2.5)	
Four	2 (1.7)	
Five	1 (0.8)	
Smoking status		
Non-smoker	90 (75.6)	-
Ex-smoker	2 (1.7)	
Smoker	27 (22.7)	

Table 2. Median (IQR) of energy and nutrients in the FFQ, average 24-hour recalls, first 24-hour recall, second 24-hour recall, and third 24-hour recall.

	FFQ	**Average 24-HRs**	**24-HR 1**	**24-HR 2**	**24-HR 3**
Energy (kcal)	2721.33 (2048.3)	2245.1 (1124.33)	2326.0 (1534.0)	2116.0 (1368.0)	1900.0 (1243.0)
Carbohydrates (grams)	309.29 (234.4)	231.66 (126.0)	248.0 (173.0)	229.0 (165.0)	217.0 (134.0)
Protein (grams)	117.34 (81.76)	87.0 (34.63)	100.0 (61.0)	76.0 (56.0)	79.0 (56.0)
Fat (grams)	124.54 (95.8)	95.6 (56.67)	103.0 (91.0)	83.0 (67.0)	79.0 (66.0)
Calcium (mg)	1243.86 (826.58)	669.0 (475.33)	684.0 (696.0)	653.0 (557.0)	612.0 (599.0)
Vitamin D (µg)	3.35 (4.35)	1.51 (2.36)	1.1 (2.67)	1.1 (2.54)	1.2 (2.47)
Folate (µg)	312.13 (275.36)	226.0 (155.67)	215.0 (196.0)	195.0 (220.0)	198.0 (168.0)
Iron (mg)	13.64 (12.72)	10.76 (5.9)	10.4 (7.8)	9.2 (9.8)	9.3 (7.6)
Zinc (mg)	13.51 (10.81)	8.26 (5.63)	7.6 (7.5)	6.9 (6.4)	7.1 (5.7)
Magnesium (mg)	384.1 (299.0)	260.0 (165.0)	247.0 (226.0)	208.0 (236.0)	229.0 (213.0)
Vitamin E (mg)	22.1 (19.47)	8.6 (8.37)	8.4 (9.4)	7.6 (10.0)	7.6 (9.10)
Vitamin C (mg)	126.8 (143.33)	63.76 (58.97)	51.0 (82.3)	54.0 (112.0)	49.0 (118.3)
Vitamin B_{12} (µg)	8.26 (10.24)	3.16 (3.01)	2.5 (3.8)	2.4 (4.16)	2.9 (4.0)
Vitamin A (µg)	1417.48 (1988.38)	640.33 (643.0)	506.0 (1161.0)	336.0 (911.0)	454.0 (1017.0)

Thiamine (mg)	1.82 (1.50)	1.23 (0.78)	1.30 (1.0)	1.20 (1.17)	1.10 (0.95)
Sodium (mg)	3562.40 (2760.85)	2158.00 (1497.33)	2307.0 (1881.0)	2056.0 (2002.0)	1868.0 (1694.0)
Selenium (µg)	82.81 (56.53)	38.20 (30.07)	39.7 (53.0)	29.7 (30.30)	33.6 (33.5)
Riboflavin (mg)	2.71 (1.77)	1.17 (0.81)	1.2 (1.24)	0.95 (1.09)	1.1 (0.91)
Pyridoxine (mg)	2.7 (2.33)	1.46 (0.84)	1.6 (1.12)	1.2 (1.42)	1.3 (1.32)
Potassium (mg)	4428.67 (3372.37)	2236.66 (1121.33)	2296.0 (1531.0)	2011.0 (1679.0)	2034.0 (1742.0)
Phosphorus (mg)	1945.77 (1209.23)	1089.0 (624.33)	1132.0 (898.0)	963.0 (806.0)	965.0 (663.0)
Niacin (mg)	29.28 (24.89)	33.43 (21.73)	31.8 (32.2)	25.1 (27.2)	25.6 (24.9)

mg: milligrams. µg: micrograms.

Table 3. Correlation between energy and nutrients intake from FFQ and average of three 24-hour recalls

	Unadjusted [A]	Energy adjusted [AB]	Age, gender, & BMI adjusted [AB]
Energy (kcal)	0.33**	-	0.33**
Carbohydrates (grams)	0.34**	0.34**	0.34**
Protein (grams)	0.18*	0.21*	0.21*
Fat (grams)	0.27**	0.29**	0.29**
Calcium (mg)	0.26**	0.26**	0.26**
Vitamin D (µg)	0.15	0.15	0.15
Folate (µg)	0.23*	0.24**	0.24**
Iron (mg)	0.30**	0.31**	0.31**
Zinc (mg)	0.19*	0.18*	0.18*
Magnesium (mg)	0.31**	0.33**	0.33*
Vitamin E (mg)	0.18	0.18	0.18
Vitamin C (mg)	0.20*	0.2*	0.2*
Vitamin B_{12} (µg)	0.21*	0.21*	0.21*
Vitamin A (µg)	-0.002	-0.002	-0.002
Thiamine (mg)	0.32**	0.34**	0.34**
Sodium (mg)	0.22*	0.22*	0.22*
Selenium (µg)	0.05	0.06	0.06
Riboflavin (mg)	0.26**	0.26**	0.26**
Pyridoxine (mg)	0.25**	0.25**	0.25**
Potassium (mg)	0.18	0.18*	0.18*
Phosphorus (mg)	0.26**	0.23*	0.23*
Niacin (mg)	0.15	0.15	0.15

***Correlation is significant at p<0.01. * Correlation is significant at p<0.05. [A] Spearman's correlation. [B] Pearson's correlation. mg: milligrams. µg: micrograms.*

Table 4. Agreement (weighed Kappa) and cross classification of quartiles of energy and nutrients intake

Nutrients	Unadjusted data					Energy-adjusted data				
	***K*w**	95% CI	Exact agreement (%)	Exact agreement + adjacent (%)	Disagreement (%)	***K*w**	95% CI	Exact agreement (%)	Exact agreement + adjacent (%)	Disagreement (%)
Energy (kcal)	0.168	0.047;0.289	50.7	88.5	4.5	-	-	-	-	-
Carbohydrates (grams)	0.148	0.03;0.265	47.3	92.5	5.3	0.06	0.004;0.116	34.8	82.7	15.4
Protein (grams)	0.14	0.015;0.265	42.5	86.8	12.2	0.087	-0.081;0.265	33.2	74.1	27.9
Fat (grams)	0.134	0.013;0.265	29.0	74.5	23.5	0.052	-0.022;0.127	40.3	89.8	7.8
Calcium (mg)	0.179	0.077;0.281	35.2	71.4	25.8	0.042	0.012;0.072	21.6	58.6	31.8
Vitamin D (µg)	0.062	-0.043;0.168	18.6	58.4	38.1	0.004	-0.007;0.014	22.9	65.7	33.1
Folate (µg)	0.084	-0.035;0.204	37.2	77.8	21.4	0.084	-0.035;0.204	30.4	63	38.8
Iron (mg)	0.215	0.068;0.362	41.9	78.2	23.8	0.179	-0.011;0.369	35.2	67.2	26.8
Zinc (mg)	0.115	0.023;0.207	30.6	67.7	35.6	0.086	0.011;0.161	25.8	67.2	32
Magnesium (mg)	0.248	0.095;0.402	49.8	89.1	9.4	0.185	0.077;0.294	25.8	64.3	28.4
Vitamin E (mg)	0.167	-0.017;0.352	33.9	78.2	21.4	0.042	-0.046;0.131	38.6	94.6	15.4

Vitamin C (mg)	-0.05	-0.106;0.006	32.6	62.5	24.1	0.03	-0.025;0.084	26.6	62.2	33.2
Vitamin B_{12} (µg)	0.007	-0.02;0.035	34.4	71.5	25.9	0.15	0.018;0.293	39.9	70.8	28.3
Vitamin A (µg)	-0.003	-0.111;0.104	31.6	78	21.2	-0.034	-0.127;0.059	32.3	66.3	29.1
Thiamine (mg)	0.211	0.011;0.411	39.9	83.3	12.4	0.111	-0.064;0.286	35.9	81.7	19
Sodium (mg)	0.085	-0.041;0.21	49.5	84.6	15.3	0.046	-0.025;0.118	49.5	79.5	16.1
Selenium (µg)	0.075	-0.021;0.171	41.2	85.8	31.1	-0.008	-0.17;0.154	47.9	85	17.5
Riboflavin (mg)	0.064	-0.049;0.176	37.9	80.4	16.9	0.058	-0.003;0.119	33.4	64.8	25.9
Pyridoxine (mg)	0.044	-0.075;0.162	49.8	83.8	6.9	0.056	-0.009;0.12	32.2	67.5	30.1
Potassium (mg)	0.006	-0.079;0.09	41.2	85.2	10.2	0.018	-0.028;0.065	34.3	72.7	21.1
Phosphorus (mg)	0.075	-0.01;0.16	44.5	84.7	12.8	0.203	0.05;0.356	27.4	61.4	35.3
Niacin (mg)	0.181	0.001;0.36	40.1	81.9	16.9	0.023	-0.143;0.189	34.6	71.8	25.4

*Weighed **K** was performed between the FFQ and average of 24-HRs. **K**w: Weighed Kappa. mg: milligrams. µg: micrograms.CI: confidence interval.*

Table 5. Limits of Agreement (LOA) and β coefficients between FFQ and average of three 24-HRs

Energy and nutrients	Mean difference (FFQ & average 24-HRs) ± SD	95% LOA Lower; upper	β	P-value
Energy (kcal)	1212.7 ± 2630.3	-3942.7;6368.1	0.63	<0.001
Carbohydrates (grams)	151.2±343.7	-522.4;824.9	0.71	<0.001
Protein (grams)	49.8±83.1	-113.1;212.7	0.59	<0.001
Fat (grams)	56.8±124.6	-187.5;301.1	0.47	0.001
Calcium (mg)	664.5±769.8	-844.3;2173.4	0.42	0.003
Vitamin D (μg)	2.9±5.7	-8.2;14.0	-0.45	0.007
Folate (μg)	169.1±252.9	-326.7;664.9	0.36	0.014
Iron (mg)	6.8±11.4	-15.6;29.2	0.43	0.001
Zinc (mg)	8.3±10.5	-12.4;28.9	0.14	0.36
Magnesium (mg)	167.0±255.8	-334.3;668.4	0.08	0.54
Vitamin E (mg)	14.1±19.5	-24.1;52.4	0.09	0.557
Vitamin C (mg)	85.5±153.9	-216.2;387.2	-0.35	0.026
Vitamin B_{12} (μg)	8.3±11.0	-13.4;30.0	-0.28	0.065
Vitamin A (μg)	1520.8±2433.7	-3249.2;6290.8	0.08	0.686
Thiamine (mg)	0.8±1.3	-1.7;3.3	0.34	0.008
Sodium (mg)	2037.6±3031.7	-3904.6;7979.8	0.32	0.029
Selenium (μg)	56.1±66.9	-75.1;187.2	-0.17	0.345
Riboflavin (mg)	1.8±1.6	-1.2;4.9	0.17	0.244
Pyridoxine (mg)	1.7±1.8	-1.9;5.2	0.01	0.954
Potassium (mg)	2833.5±3146.5	-3333.6;9000.6	0.33	0.033
Phosphorus (mg)	1141.9±1299.8	-1405.7;3689.5	0.42	0.004
Niacin (mg)	1.9±23.2	-43.7;47.5	0.17	0.27

Mean difference and LOA were derived through a One-sample T test. Β coefficients and p-values were derived through a linear regression of Log-transformed data. LOA: Limit of Agreement. SD: Standard deviation.