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Adaptation and validation of the EPIC-Norfolk food frequency questionnaire for assessing dietary intake in Ukrainian adults

Sofiia Shatylo , Galyna Solovyova

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Department of Internal Medicine, Faculty of Dentistry, Bogomolets National Medical University, Kyiv, T. Shevchenko boulevard, 13, Ukraine

Correspondence to
Sofiia Shatylo;
dr.shatylo@gmail.com

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ABSTRACT

Introduction Currently, there are no validated food frequency questionnaires (FFQs) for evaluating nutrient intake in Ukrainian adults. This study aimed to adapt and validate the European Prospective Investigation into Cancer Food Frequency Questionnaire (EPIC-Norfolk FFQ) for this population group.

Methods Adults aged 18–54 years (n=90) living in different regions of Ukraine completed the new Ukrainian version of the EPIC-Norfolk FFQ and provided information about their 24-hour dietary recall. Raw and energy-adjusted data were analysed using Spearman's correlation coefficients, Wilcoxon signed-ranks test, cross-classification method, weighted kappa and Bland-Altman analysis.

Results Correlations ranged from 0.0738 (retinol equivalents) to 0.458 (total energy and phosphorus) and were statistically significant for all nutrients except cholesterol and vitamin A (as retinol and retinol equivalents). The percentage of participants classified into the same and adjacent quartiles ranged from 61.11% (vitamin A as retinol equivalents) to 81.11% (vitamin D). Gross misclassification into the opposite quartile ranged from 3.33% (magnesium) to 10% (cholesterol, vitamin A as retinol and retinol equivalents). Using the weighted kappa, most nutrients had a fair agreement (κ=0.21–0.40). Energy adjustment did not affect the results for most nutrients. Bland-Altman plots confirmed overestimation of the absolute intake of most nutrients and appeared to underestimate total sugars intake by FFQ; nevertheless, there was good agreement between the two methods.

Conclusion The new Ukrainian version of the FFQ demonstrated reasonable relative validity for ranking an individual's nutrient intake. The overestimation of the absolute intake of most nutrients is comparable to or even less than that in other FFQ validation studies. We cannot recommend the current Ukrainian version of the FFQ for the assessment of vitamin A (as retinol and retinol equivalents) consumption because of significant differences in results between the two methods.

WHAT IS ALREADY KNOWN ON THIS TOPIC

⇒ Dietary intake can be assessed using food frequency questionnaires (FFQs). Currently, there are no validated FFQs for evaluating nutrient intake in Ukrainian adults.

WHAT THIS STUDY ADDS

⇒ This study aimed to adapt and validate the European Prospective Investigation into Cancer Food Frequency Questionnaire for this population group.

HOW THIS STUDY MIGHT AFFECT RESEARCH, PRACTICE OR POLICY

⇒ The new Ukrainian version of the FFQ can be used to assess the role of diet in Ukrainian adults and the possible association between food consumption and health outcomes.

INTRODUCTION

Extensive researches have been conducted to investigate the association between dietary habits and chronic non-communicable diseases.[1] Dietary intake is often evaluated in population-based epidemiological studies through the use of dietary assessment methods such as food diaries, food frequency questionnaires (FFQs) and 24-hour dietary recalls (24HRs). FFQs have gained immense popularity in large-scale population-based studies due to their ease of administration, lower participant and staff burden, and relatively lower cost compared with other assessment methods.[2] Numerous studies have been carried out worldwide to develop FFQs that take into account the specific dietary habits and patterns of people, living in different regions.[3–7] For example, The European Prospective Investigation into Cancer Food Frequency Questionnaire (the EPIC FFQ/the EPIC-Norfolk FFQ)[8 9] developed in the UK is one of tools, validated and used for dietary assessment in many countries, even outside European region.[10]

It is known that, at that time, there were no validated FFQs available for evaluating nutrient intake among Ukrainian adults. The purpose of this study is to make the EPIC-Norfolk FFQ suitable for use among adults in Ukraine and to validate the newly adapted Ukrainian version of the FFQ for this population group.

MATERIALS AND METHODS

Participants

It was a cross-sectional study involving Ukrainian adults aged 18 years or older. The exclusion criterion was pregnancy. The sample size was defined as at least 50 participants, as it was recommended by Cade *et al*.[11] From December 2022 to March 2023, we interviewed 143 adult residents of Ukraine living in different regions of the country. Due to Russia's war against Ukraine, we could not and therefore did not enrol people living in temporarily occupied territories in this study. Participants also provided information about their place of residency, weight, height and smoking status. At the beginning of the study, we excluded three women due to pregnancy.

FFQ adaptation

For adaptation, we chose FFQ 'the EPIC-Norfolk FFQ', provided by MRC Epidemiology Unit from Cambridge university. The questionnaire consists of two parts: the first part, which is the primary component of the questionnaire, presents a list of 130 commonly and less commonly consumed foods. For each item on the list, the participants are asked to specify their typical frequency of consumption by selecting one of nine frequency categories, ranging from 'never or less than once per month' to '6+ times per day'. The questionnaire also prompts participants to indicate the serving size using units, common portions or household measures such as glass, cup or spoon. Each questionnaire item has an average portion size assigned to it, which is uniform for all participants, regardless of their age or gender. The second part of the questionnaire includes supplementary questions, such as the quantity and type of milk consumed, the type of cooking fat used and the visible fat content of meat consumed.[8 9]

The EPIC-Norfolk FFQ was translated from English to Ukrainian by a bilingual person. Three adults tested the translated version and were asked about any difficulties they encountered while answering the questions. We removed food items that were either not available or not commonly consumed in Ukraine, such as marmite, watercress, quiche, Horlicks and some kinds of margarine. We presented traditional soup with and without meat ('borscht'). After making non-significant modifications, a final Ukrainian version was produced, comprising 124 food items.

Validation of the FFQ

We validated the FFQ against the 24-hour dietary recall (24HR). First, participants completed FFQ and then provided information about food consumed the previous day. We instructed participants to provide a comprehensive account of their dietary habits, recording qualitative (food type) and quantitative (portion size) information for all foods and beverages consumed the day prior. We instructed participants to use measurement tools such as tablespoons, teaspoons, cups and grams (if known) to describe the portion sizes of the foods and beverages consumed. We provided instructions about portion sizes with pictures to help with that. Besides, to decrease recall bias, before ending 24HR participants were asked if they did not forget to add anything by providing different examples (popcorn, nuts or other snacks; sweets; coffee, tea and other beverages, etc) We did not assess the validity of the new Ukrainian version of FFQ for the consumption of vitamin and mineral supplements. Initially, data were entered and encoded in Google and Excel sheets, then we used FETA software to calculate nutrient and food group data from the FFQs.[12] The assessment of 24HR was made with the help of the 24ASA tool.[13 14]

Statistical analysis

Categorical variables were presented as the number of cases and percentages. Continuous variables were checked for normality using Shapiro-Wilk test and histograms. We expressed continuous variables as median values with 25th and 75th percentile (Q1 and Q3). To assess relative validity of the FFQ, nutrient intakes were compared with corresponding 24HR data. Wilcoxon signed rank test was used to assess agreement at group level.[15] To assess the association of each nutrient between the FFQ and 24HR, we use Spearman's rank correlation coefficient (ρ). Data from both the FFQ and the 24HR were adjusted for energy intake using the residual method to produce a nutrient measure not correlated with energy intake.[16 17] Using this method, energy-adjusted nutrient intakes were computed as residuals from the regression model, with absolute nutrient intake as the dependent variable and total energy intake as the independent variable.[18]

Nutrient intakes were divided into quartiles for both the FFQ and 24HR. Participants were classified as being in the same quartile, adjacent quartile, one quartile apart and extreme quartile (gross misclassification). Cross-classification agreement was further investigated using the weighted kappa (κ)-statistic.[19] Agreement levels for the κ-statistic were considered as very good (>0.80); good (0.61–0.80); moderate (0.41–0.60); fair (0.21–0.40) and poor (<0.20).[20] These statistical tests were undertaken on both raw and energy-adjusted data.

Agreement across the range of intakes was assessed using Bland-Altman plots, where the difference in intake was plotted against mean intake for each nutrient from FFQ and 24HR.[21] We performed logistic regression analysis to determine possible factors associated with the validity of FFQ. The agreement within one quartile for nutrients was set as the dependent variable and characteristics of participants as independent variables. These included sex (male, female), age (18–24 years, 25–44 years, 45–54 years), body mass index (BMI) (non-obese, <25; overweight and obese, ≥25), smoking status (smokers, non-smokers).

A $p<0.05$ was considered statistically significant. Data were analysed using MedCalc Statistical Software V.20.215.[22]

Table 1 The main sociodemographic and clinical characteristics of participants (n=90)

Characteristics	Results
Age (years), median (Q1, Q3),	26 (22; 29)
Sex, n (%)	
Female	78 (86.7)
Male	12 (13.3)
Smoking, n (%)	
No	78 (86.7)
Yes	12 (13.3)
Region of residence, n (%)	
Kyiv city	33 (37)
Cherkasy Oblast	10 (11)
Kyiv Oblast	8 (9)
Chernivtsi Oblast	5 (5)
Other regions	34 (38)
Place of residence, n (%)	
City/town	79 (88)
Village	6 (7)
Urban village	5 (5)
BMI (kg/m^2), median (Q1, Q3)	21.9404 (20.42; 24.02)
BMI category, kg/m^2, n (%)	
< 18.5	9 (10)
18.5 to <25	64 (71)
25.0 to <30	11 (12)
30 to <35	4 (5)
35 to <40	0 (0)
40 or higher	2 (2)

BMI, body mass index.

RESULTS

140 adults aged 18–68 years old completed both FFQ and 24HR. After reviewing the data, it became apparent that fifty participants did not adequately accomplish the 24HR and/or FFQ, leading to missing data. Therefore, 90 participants who fully completed FFQ and provided detailed information in 24HR were included in the following analysis. The age of participants ranged from 18 to 54 years, with 86.7% of participants being female. Approximately 71% of participants have normal BMI. Table 1 summarises the main sociodemographic and clinical characteristics of participants.

None of the participants reported alcohol consumption in their 24HR; as a result, we could not plot 24HR data against the FFQ results. However, participants answered a standard question about the frequency and amount of alcohol consumption at the beginning of the study. The results were 15% of participants reported no alcohol consumption at all, 63% of participants reported minor and occasional alcohol consumption (birthday, family celebration, New Year party, etc.) and 22% of participants reported moderate alcohol consumption. None of the participants reported a higher rate of alcohol consumption (more than one standard drink for women and more than two standard drinks for men per day). These findings could explain why none of the participants reported alcohol consumption at 24HR. Nevertheless, all participants, who reported zero alcohol consumption, also had 0 g per day of alcohol determined by calculation of the FFQ results. Participants reported minor and occasionally alcohol consumption shown the following FFQ results: median=0.76 g per day (Q1, Q3: 0, 1.36). For participants reported moderate alcohol consumption, median was 4.1 g per day (Q1, Q3: 1.95, 6.243).

Information about main nutrient intakes from the FFQ and 24HR, correlation coefficients, and Wilcoxon signed rank test is summarised in online supplemental material 1. Correlations ranged from 0.0738 (retinol equivalents) to 0.458 (total energy and phosphorus), with an average correlation of 0.339. Energy-adjusted correlations ranged from 0.0733 (vitamin C) to 0.409 (carbohydrates), with an average correlation of 0.26. The majority of nutrients had correlations of 0.3–0.5. The lowest values of correlation coefficients were observed for cholesterol and vitamin A (as retinol and retinol equivalents) for crude data and vitamin C, polyunsaturated fatty acids (PUFA), total folate, vitamin A (as retinol equivalents) and iron for energy-adjusted data.

Using Wilcoxon signed rank test, we found a significant difference between results obtained by FFQ and 24HR for less than 50% of nutrients. The percentage of participants classified into the same quartiles ranged from 22.22% (vitamin A, as retinol equivalents) to 43.33% (sodium), with an average of 32.5% (table 2). The percentage of participants classified into the same and adjacent quartiles ranged from 61.11% (vitamin A as retinol equivalents) to 81.11% (vitamin D), with an average of 74.2%. Gross misclassification into the opposite quartile ranged from 3.33% (magnesium) to 10% (cholesterol, vitamin A as retinol and retinol equivalents) with an average of 6.1%. After adjustment for energy intake, the percentage of participants classified into the same quartiles ranged from 17.78% (total folate) to 40% (iron), with an average of 32.2%. The percentage of participants classified into the same and adjacent quartiles ranged from 63.32% (vitamin A, as retinol) to 81.1% (total sugars), with an average of 71.6%. Gross misclassification of more than 10% was recorded only for dietary intake of vitamin C (14.44%) and total folate (12.22%). Using the weighted kappa (κ), most nutrients had a fair agreement (κ=0.21–0.40). However, the values of the weighted kappa (κ) for total PUFA, niacin, vitamin C, cholesterol, total folate, vitamin A as retinol and retinol equivalents, and iron were defined as poor, even after energy adjustment (table 3). We used the Bland-Altman analysis for all nutrients to assess the presence, direction and extent of bias at the group level. Bland-Altman plots are shown in online supplemental material 2. The lowest values of the 'bias' between the FFQ and 24HRs were observed for energy,

Table 2 Cross-classification between the FFQ and 24HR (n=90)*

	Unadjusted				Energy adjusted			
	Same quartile (%)	Adjacent quartile (%)	One quartile apart (%)	Grossly misclassified (%)	Same quartile (%)	Adjacent quartile (%)	One quartile apart (%)	Grossly misclassified (%)
Energy (kcal)	28.9	51.1	15.56	4.44	–	–	–	–
Protein (g)	34.44	38.88	21.12	5.56	28.89	38.89	22.22	10
Fat (g)	34.44	43.33	16.67	5.56	34.44	43.33	16.67	5.56
MUFA (g)	32.22	42.22	21.12	4.44	33.33	38.89	20	7.78
PUFA (g)	27.78	46.67	16.66	8.89	25.56	38.89	25.55	10
SFA (g)	36.67	40	16.66	6.67	37.78	34.44	22.22	5.56
Cholesterol (mg)	31.11	34.44	24.45	10	34.44	33.33	27.79	4.44
Carbohydrates (g)	35.56	41.11	17.77	5.56	40	38.89	13.33	7.78
Dietary fibre (g)	30	43.33	18.89	7.78	36.67	34.44	21.11	7.78
Total sugars (g)	38.89	33.33	21.11	6.67	36.66	44.44	12.23	6.67
Thiamine (mg)	41.11	36.67	16.66	5.56	33.33	40	17.78	8.89
Riboflavin (mg)	33.33	37.78	20	8.89	36.67	34.44	23.33	5.56
Niacin (mg)	31.11	40	24.45	4.44	27.77	46.66	16.69	8.88
Pyridoxine (mg)	33.3	40	22.26	4.44	33.33	38.89	22.22	5.56
Vitamin B_{12} (µg)	41.11	34.44	18.89	5.56	32.22	46.67	12.22	8.89
Total folate (µg)	25.55	47.78	18.89	7.78	17.78	50	20	12.22
Vitamin C (mg)	27.78	43.33	23.33	5.56	31.11	32.22	22.23	14.44
Vitamin D (µg)	28.89	52.22	13.33	5.56	36.67	30	25.55	7.78
Vitamin E (mg)	31.11	44.44	20.01	4.44	27.78	42.22	21.11	8.89
Vitamin A, as retinol (µg)	24.44	36.67	28.89	10	38.88	24.44	26.68	10
Vitamin A, as retinol equivalents (µg)	22.22	38.89	28.89	10	27.78	41.11	25.55	5.56
Iron (mg)	30	40	23.33	6.67	24.44	40	26.67	8.89
Calcium (mg)	35.56	41.11	17.77	5.56	40	33.33	22.23	4.44
Magnesium (mg)	31.11	45.56	20	3.33	35.56	38.89	17.77	7.78
Zinc (mg)	30	48.89	16.67	4.44	30	45.56	16.66	7.78
Phosphorus (mg)	32.22	46.67	16.67	4.44	28.89	43.33	22.22	5.56
Sodium (mg)	43.33	37.77	14.46	4.44	27.78	43.33	18.89	10
Potassium (mg)	37.77	40	17.79	4.44	32.22	45.56	14.44	7.78

*23 participants in 1 and 3 quartile, 22 participants in 2 and 4 quartiles.
FFQ, food frequency questionnaire; 24HR, 24-hour dietary recall; MUFA, monounsaturated fatty acid; PUFA, polyunsaturated fatty acid; SFA, saturated fatty acid.

carbohydrates, fat, vitamin B_2, vitamin D, iron and magnesium—the mean difference did not exceed 5% (plotting mean difference as percentage (%). The worst results were observed for the following nutrients: severe underestimation of sugars (total) and overestimation of vitamin C, vitamin E, vitamin B_{12} and vitamin A (as retinol and retinol equivalents) by FFQ.

Determination of factors associated with the validity of the FFQ

Analysing factors, which may be associated with the validity of the FFQ, such as sex, age, smoking status and BMI, we found that age affected two nutrients: for vitamin E and total folate participants aged 18–24 years were less likely to be correctly classified into same quartile.

DISCUSSION

This study investigated the relative validity of the new Ukrainian version of the EPIC-Norfolk FFQ for use in Ukrainian adults. The correlation coefficients between FFQ and 24HR ranged from 0.0738 to 0.458. These results were similar to the validity correlations found in other studies conducted worldwide (0.11–0.59,[23] 0.11–0.60.[24]) After adjusting for energy intake, most correlations remained the same but improved for total sugars and cholesterol and decreased for some nutrients, such as protein, PUFA, vitamin B_1, vitamin C, vitamin D, magnesium, sodium, ranging from 0.0733 to 0.409. However, correlation coefficients only measure the degree to which dietary assessment measures are associated and do not measure absolute agreement.

Table 3 Weighted kappa (n=90)*

	Weighted kappa	
	Unadjusted	**Energy adjusted**
Energy (kcal)	0.23548	–
Protein (g)	0.21770	0.09324
Fat (g)	0.25326	0.25326
MUFA (g)	0.21770	0.18214
PUFA (g)	0.14658	0.03991
SFA (g)	0.25326	0.23548
Cholesterol (mg)	0.09324	0.18214
Carbohydrates (g)	0.25326	0.28882
Dietary fibre (g)	0.16436	0.19992
Total sugars (g)	0.23548	0.28882
Thiamine (mg)	0.30660	0.18214
Riboflavin (mg)	0.16436	0.21770
Niacin (mg)	0.18214	0.14658
Pyridoxine (mg)	0.21770	0.19992
Vitamin B_{12} (µg)	0.28882	0.21770
Total folate (µg)	0.12880	–0.01343
Vitamin C (mg)	0.14658	0.03991
Vitamin D (µg)	0.23548	0.16436
Vitamin E (mg)	0.21770	0.11102
Vitamin A, as retinol (µg)	0.00435	0.12880
Vitamin A, as retinol equivalents (µg)	–0.01343	0.12880
Iron (mg)	0.14658	0.03991
Calcium (mg)	0.25326	0.27104
Magnesium (mg)	0.23548	0.21770
Zinc (mg)	0.23548	0.18214
Phosphorus (mg)	0.25326	0.16436
Sodium (mg)	0.35994	0.11102
Potassium (mg)	0.28882	0.21770

*23 participants in 1 and 3 quartile, 22 participants in 2 and 4 quartiles
MUFA, monounsaturated fatty acid; PUFA, polyunsaturated fatty acid; SFA, saturated fatty acid.

The FFQ appeared to overestimate the absolute intake of most nutrients. These findings were expected and were observed in other similar validation studies. Our version of the FFQ showed nearly the same degree of overestimation as in other studies[20 23] or even less than in other studies,[24–26] as was established using Bland-Altman analysis.

For nutritional studies, it is more valuable to distinguish between low and high nutrient intake and to rank individuals' intakes when exploring the relationship between dietary habits and health outcomes. In terms of nutrient classification, the Ukrainian version of the FFQ accurately placed a significant majority of participants (ranging from 61.11% to 81.11%) within one quartile when compared with the 24HR. Gross misclassification into opposite quartiles ranged from 3.3% to 10.0%.[23 26 27]

Energy adjustment did not change greatly percentage of ranking individuals in quartiles, except for vitamin C and total folate—gross misclassification was established as 14.44% and 12.22%, respectively. These findings are similar to another validation studies using quartiles, as was mentioned above.

Our study has some limitations. As the participants did not report alcohol consumption in their 24HR, we could not plot 24HR data against the FFQ results. Nevertheless, the participants' answers to the standard question about alcohol consumption allowed us to check whether it corresponded to the calculated FFQ data. Our findings were similar, making it possible to use FFQ to assess alcohol consumption.

Although conducting multiple 24HRs for validation studies is ideal, the ongoing war in Ukraine has made it challenging.

We made our best efforts to achieve a male-to-female ratio among participants as it was at the beginning of 2022–46% men and 54% women, provided by CARE International.[28]

However, due to the Russian invasion, it was not possible, as the majority of men were mobilised into the army. To address this limitation, we performed logistic regression analysis to determine whether it affected the validity of the FFQ. In addition, we checked other possible factors that could affect validity, such as age, BMI and smoking status. We only found that age affected two nutrients, vitamin E and total folate, in participants aged 18–24 years.

Despite this limitation, our study demonstrated satisfactory outcomes as previously described. Although both the 24HR and FFQs have the potential for recall bias, these methods remain essential and are widely used in nutritional research.

We recruited participants through social media, which may have resulted in selection bias due to the requirement of an available Internet connection, but it is important to acknowledge that over 75% of the population in Ukraine uses the internet, as reported by the International Telecommunication Union World Telecommunication/Information and Communications Technologies Indicators Database.[29]

Our study has several strengths. To our knowledge, there is no validated FFQ to assess dietary intake in Ukrainian adults, and this is the first attempt to adapt and validate FFQ in this population group. We interviewed participants living in cities, towns, villages and urban villages in different regions of the country. We used a range of statistical methods to evaluate the validity of the FFQ, including Spearman's coefficient of rank correlation, Wilcoxon signed rank test, cross-classification, weighted kappa and Bland-Altman plots, which is more than usually used in the similar nutritional studies.[30]

CONCLUSION

We adapted and validated the EPIC-Norfolk FFQ for use in Ukrainian adults. The new Ukrainian version of the FFQ is a 124-item, multinutrient FFQ that demonstrated reasonable relative validity for ranking an individual's nutrient intake compared with 24HR.

The new Ukrainian version of the FFQ can be used in nutritional studies to assess the role of diet in Ukrainian adults and the possible association between food consumption and health outcomes. We cannot recommend the current Ukrainian version of the FFQ for the assessment of vitamin A (as retinol and retinol equivalents) consumption, as it was shown in our study that there are significant differences between the FFQ and 24HR reported by multiple statistical methods.

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ORCID iDs

Sofiia Shatylo http://orcid.org/0000-0001-6201-3710
Galyna Solovyova http://orcid.org/0000-0001-8245-3051

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