

Original

Paper and pencil vs online self-administered food frequency questionnaire (FFQ) applied to university population: a pilot study

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Abstract

Objective: To test the reliability of dietary intake data measured with an online food frequency questionnaires (FFQ) applied to a university population by comparing the results with those from a paper and pencil version.

Materials and methods: A total of 50 students were recruited from the second-year Food Technology course at the Universitat Politècnica de València (Comunidad Valenciana, Spain) in the academic year 2008-2009. The students were between the ages of 20-32. The participants completed both presentation modes of the FFQ (paper and pencil and online) in a cross-over study with a time interval of 3-week. To study the effect of ordering of the questionnaires, participants were randomly assigned to group A (paper and pencil FFQ first) and group B (online FFQ first). Both self-administered semi-quantitative presentations of the FFQ included 84 food items divided into six groups (dairy products; eggs, meat and fish; vegetables, legumes and fruits; bread, cereals and similar; oils, fats and sweets; beverages and pre-cooked). Participants were asked how frequently and how much each food item they had consumed in the previous year.

Results: The response rate was 78% (39 students, 23% men and 77% women). For the total sample, the median dietary intakes were higher for the paper and pencil FFQ than the online version for energy (2,077 vs. 1,635 kcal/day), proteins (96 vs. 88 g/day), carbohydrates (272 vs. 211 g/day), and fat (70 vs. 58 g/day), respectively. These differences were statistically significant. However, there were not significant differences between the two presentations when the consumption by groups of food was calculated, except for "beverages and pre-cooked" group.

Conclusions: The pilot testing showed that this online FFQ is a useful tool for estimating the intake of food groups in this university population. On the other hand, the differences found in the results of the absolute quantities of energy and nutrients intakes were not clear. These differ-

CUESTIONARIO DE FRECUENCIA DE CONSUMO DE ALIMENTOS AUTOADMINISTRADO EN FORMATO PAPEL VS ONLINE APLICADO A LA POBLACIÓN UNIVERSITARIA: UN ESTUDIO PILOTO

Resumen

Objetivo: Estudiar la fiabilidad de los datos de ingesta dietética medidos con un cuestionario de frecuencia de consumo de alimentos online aplicado a la población universitaria comparando los resultados con los obtenidos mediante el cuestionario en formato papel.

Materiales y métodos: Un total de 50 estudiantes del segundo curso de Ciencia y Tecnología de los Alimentos en la Universitat Politècnica de València (Comunidad Valenciana, España) en el año académico 2008-2009 participaron en el estudio. El rango de edad de los participantes oscilaba entre 20 y 32 años. En un estudio cruzado, los participantes completaron ambas presentaciones del cuestionario (formato papel y versión online) en un intervalo de 3 semanas. Para estudiar el efecto del orden de autoadministración de los cuestionarios, los participantes fueron asignados al azar en el grupo A (realizaron primero el cuestionario en formato papel) y en el grupo B (realizaron primero la versión online). Ambas presentaciones del cuestionario eran autoadministradas y semi-cuantitativas e incluían una lista de 84 alimentos divididos en seis grupos (productos lácteos; huevos, carne y pescado; vegetales, legumbres y frutas; pan, cereales y similares; aceites, grasas y dulces; bebidas y precocinados). Para cada alimento que los participantes habían consumido el año anterior debían indicar la frecuencia y la cantidad consumida.

Resultados: La tasa de respuesta fue del 78% (39 estudiantes, 23% hombre y 77% mujeres). Para el total de la muestra, la mediana de la ingesta dietética fue mayor en el cuestionario en papel que en la versión online para la energía (2.077 vs 1.635 kcal/día), las proteínas (96 vs 88 g/día), los hidratos de carbono (272 vs 211 g/día) y las grasas (70 vs. 58 g/día), respectivamente. Estas diferencias fueron estadísticamente significativas. Sin embargo, no hubieron diferencias significativas entre ambas presentaciones cuando el consumo por grupos de alimentos fue calculado, excepto para el grupo de "bebidas y precocinados".

Conclusiones: El estudio piloto mostró que este cuestionario online es una herramienta útil para estimar la ingesta de los grupos de alimentos en esta población universitaria. En cambio, las diferencias encontradas en los resultados de energía y nutrientes no fueron concluyentes. Éstas pudieron deberse a los problemas que tuvieron

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ences could be due to the problems that the participants had for reporting portion size in the paper and pencil FFQ as photographs of portion sizes were not presented.

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Key words: *Food frequency questionnaire. Diet. University population. Online.*

los participantes para indicar el tamaño de porción ingerida en el cuestionario en papel porque las fotografías de los tamaños de ración no se mostraban.

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Palabras clave: *Cuestionario de frecuencia de consumo de alimentos. Dieta. Población universitaria. Online.*

Abbreviations

BMI: Body Mass Index.
FFQ: Food Frequency Questionnaire.
ITACA: Instituto Universitario de Aplicaciones de las Tecnologías de la Información.
MUFA: Monounsaturated Fatty Acids.
PUFA: Polyunsaturated Fatty Acids.
SFA: Saturated Fatty Acids.
SD: Standard Deviation.
SPSS: Statistical Package for the Social Sciences.
SQL: Structure Query Language.
WHO: World Health Organization.

Introduction

Collecting dietary information is an important part of the research of the epidemiology of chronic diseases.^{1,2} These diseases represent an important percentage of annual deaths, besides supposing an important expenditure for the health services and high losses in labour productivity.³ Traditional dietary assessment instruments are diet records, 24-hour dietary recall, food frequency questionnaires, and diet histories. Each has its advantages and limitations and none of these can be considered as a “gold standard” in dietary research. The method of choice depends on numerous factors, such as the purpose of the study, the target population and the amount of time, money and human resources available.⁴⁻¹⁴ In contrast to the other dietary assessment instruments, food frequency questionnaires (FFQs) are extensively used in epidemiological research such when working with large sample sizes due to their low cost, time-effectiveness and ease-of-use.¹⁵⁻¹⁸ Furthermore, FFQ is a method valuable to classify participants correctly into groups by estimated intake.^{14, 18}

Adaptations of technology have led to incorporating changes in how dietary assessment is carried out.¹⁶ Internet and computers may offer a new presentation mode of the FFQ to obtain information about dietary intake which has traditionally been obtained using either face-to-face interviews or written questionnaires. This idea has caught the attention of many researchers.^{11,19} Health et al.²⁰ studied the validity of a computerized FFQ measuring iron intake by comparing data obtained with the results from weighed diet

records. In a similar way, Vandelanotte et al.²¹ determined the reliability and validity of a computerized FFQ to measure fat intake in relation to a 7-day diet record. Matthys et al.²² evaluated the validity and reproducibility of a Web-based FFQ to estimate dietary habits by comparing it with a 3-day estimated food record. Wong et al.²³ described the process of developing a computerized FFQ that allowed the quantitative estimation of calcium intake and compared its results with those estimated from 24-hour dietary recalls. All these studies show that before an FFQ can be useful in a particular epidemiologic study, an essential step is to do a pilot testing to evaluate its reproducibility and relative validity as an FFQ may perform differently when it works in other cultural and demographic groups or its purpose is to estimate the intake of other nutrients.^{2,15,20,24}

Online FFQs have practical advantages as compared with paper and pencil FFQs, as data can be automatically stored on file, reducing printing and hours of data entry as well as reducing coding errors and the danger of lost data.^{12,13,21} They can also be programed to require participants to answer all questions. Traditional paper and pencil questionnaires have numerous disadvantages, as they may present logistical problems in areas where subjects are less accessible for geographic reasons, data compilation by manual processing, and in addition paper and pencil questionnaires may result in low response rates or incomplete answers as they can be more boring and could introduce before answering-fatigue.²⁶⁻³²

In light of these considerations, in the present study a pilot test was carried out to assess the feasibility of a self-administered semi-quantitative online FFQ applied to a university population comparing its results with those of a paper and pencil presentation.

Materials and methods

Participants

During March and April 2009, 50 volunteer students (female and male, aged 20-32) from second-year Food Technology at the Universitat Politècnica de València (Spain) were asked to participate in the study. FFQ was self-administered on paper and online in class hours. Students were informed about the purpose of the study.

Study design

A cross-over method was used to study the effect of ordering on the questionnaires. Participants were randomly placed in two groups (Group A and Group B). Group A (one-half of the participants) completed the paper and pencil presentation of the FFQ, while Group B (the other-half of the participants) completed the online presentation. Three weeks later the groups were reversed, a sufficient time interval to avoid possible interferences. The time interval had to be short enough to avoid changes in dietary intake but not so short that subjects could remember their previous answers, for this reason, a time interval of three weeks was chosen.³² The participants marked the questionnaires with a private identification so that the investigators could match the paper and pencil and online FFQ by participant.

Paper and pencil and online presentations of the FFQ

A self-administered semi-quantitative paper and pencil food frequency questionnaire was developed and validated by Dr. Jesús Vioque to estimate daily dietary intake among the university population of University of Miguel Hernández de Elche (Comunidad Valenciana, Spain), over the preceding 12 months. The online version of the questionnaire was developed by means of web pages applying the technology ASP.NET 2.0 and using the database SQL (Structure Query Language) Server 2005 as support in cooperation with ITACA (Instituto Universitario de Aplicaciones de las Tecnologías de la Información). Both the paper and pencil and online FFQ had an identical format, except that the paper version did not have photographs of serving sizes. The two presentations contained 84 food items divided into six groups: dairy products (Group I); eggs, meat and fish (Group II); vegetables, legumes and fruits (Group III); bread, cereals and similar (Group IV); oils, fats and sweets (Group V); beverages and pre-cooked (Group VI). The food list was based on knowledge of the regional food supply and the products which are most consumed by the population in the Valencian Region (Spain). For each food item that participants had consumed within the last year, participants had to report their frequency of consumption and portion size. Participants were firstly asked how often, on average, the food item was consumed. For example, fruit available 6 months a year, which was eaten "three times per week" in season was converted to a frequency of 72 times yearly, in others words, 1.5 times weekly. Nine frequency response options ranging from "none or once/month" to "> 6 times/day" were given. To obtain serving size, in the paper and pencil version participants had to report the approximate quantity without photographs whereas in the online presentation all food item were quantified in terms of three portion sizes using color photographs:

small (A), medium (B) and large (C). Participants had to choose their usual serving size between seven possible response options: "a lesser quantity than in photo A", "an equal quantity to that in photo A", "a quantity between photo A and B", "an equal quantity to that in photo B", "a quantity between photo B and C", "an equal quantity to that in photo C", "a greater quantity than in photo C".

Other variables

Apart from questions of the FFQ, to monitor the health and lifestyle of participants, they had to fill in a general questionnaire consisting of three topics: corporal perception (3 items), habits (5 items), and physical activity (9 items). Weight and height were self-reported.

Data analysis

Energy and nutrient data were estimated by multiplying the frequency of consumption by the nutrient composition specified for each food item and its serving weight. The nine frequency response options ("none or once/month", "1-3 times/month", "once per week", "2-4 times/week", "5-6 times/week", "once per day", "2-3 times/day", "4-5 times/day", "> 6 times/day") were recoded into fractions of servings per day (0.00, 0.03, 0.14, 0.43, 0.79, 1.00, 2.50, 4.50, 6.00, respectively). Every photograph of serving size had a value assigned depending on the food item. Frequency and quantity data were converted to the following macronutrients: energy, total protein, total fat, monounsaturated, saturated and polyunsaturated fatty acids, cholesterol, total carbohydrates, dietary fibre and alcohol. The following vitamins and minerals were also calculated: vitamins A, B1, B2, B6, B12, C, D, E, niacin, folic acid, calcium, iron, iodine, magnesium, zinc, sodium, potassium, phosphorous and selenium. Data about vitamin and mineral supplements were not included in these calculations.

Statistical analyses are based on subjects (N = 39) who had completed two presentation modes (paper and pencil and online). The Shapiro-Wilk test was used to study normality. All data were non-normal distributions, even though natural logarithmic transformations were used to improve normality, several results were still positively skewed. Non-parametric tests were carried out. Frequencies, medians and means were calculated by descriptive statistics. The Wilcoxon matched-pairs signed rank test was used to determine differences between the two ways of presentation. Correlations were measured by the Spearman coefficient to assess the association between the two methods, paper and pencil and online. Spearman correlations were not adjusted for energy intake. Analyses were performed using SPSS (Statistical Package for the Social Sciences) version 16.0. A *P* value < 0.05 was considered

Table I
Age, weight, height and BMI of the study sample in total and by sex

	Total sample n = 39	Female n = 30	Male n = 9
Age (years)	24.8 ± 2.6	25.0 ± 2.5	24.6 ± 3.0
Weight (kg)	62.4 ± 12.04	57.8 ± 7.6	77.7 ± 11.7
Height (cm)	168.2 ± 8.2	165.1 ± 5.6	178.6 ± 7.02
BMI (kg/m ²)	21.9 ± 3.2	21.2 ± 2.5	24.4 ± 4.1

BMI (Body Mass Index) calculated as weight (kg)/height (m²).

significant. The proportions of the study were studied using a statistical hypothesis test of Statgraphics plus version 5.1.

Results

The characteristics of the study sample

The only criterion for inclusion in the study was to have completed both paper and pencil and online presentations of the FFQ. After exclusion, 39 students of 50 students were included in the analyses (response rates 78%), 30 (76.9%) were females and 9 (23.1%) were males. There is not the same representation for both sexes due to the gender distribution in the course selected.

Data of the general questionnaire (table I and table II) did not differ significantly between the different presentation modes. Table I shows self-reported age, weight, height and body mass index (BMI) for the

Table II
Corporal perception, habits and physical activity of the total sample and by sex

Items	Total		Male		Female	
	%	n	%	n	%	n
<i>Corporal perception</i>						
<i>How do you considerate your weight?</i>						
Overweight	15.4	6	11.1	1	16.7	5
Normal	76.9	30	77.8	7	76.7	23
Underweight	7.7	3	11.1	1	6.7	2
<i>Compare with last year, your weight?</i>						
More	12.8	5	0.0	0	16.7	5
Less	12.8	5	22.2	2	10.0	3
Same	74.4	29	77.8	7	73.3	22
<i>Habits</i>						
<i>Change diet one year ago</i>						
Yes	33.3	13	44.4	4	30.0	9
No	66.7	26	55.6	5	70.0	21
<i>Perform special diet last year?</i>						
Yes	33.3	13	22.2	2	36.7	11
No	66.7	26	77.8	7	63.3	19
<i>Smoker</i>						
Yes	10.5	4	0.0	0	13.7	4
No	89.5	34	100.0	9	86.2	25
<i>Hours of sleep/ day</i>						
6 to 8 hours	76.9	30	55.6	5	83.3	25
More than 8 hours	23.1	9	44.4	4	16.6	5
<i>Physical activity</i>						
<i>Hours of spending time on TV, computer and reading/day</i>						
Less than 1 hour to 1 hour	23.1	9	33.3	3	20.0	6
More than 2 hours	77.0	30	66.6	6	80.0	24
<i>Time of doing sport/week</i>						
Less than 1 hour to 1 hour	26.4	10	22.2	2	27.5	8
More than 2 hours	73.6	28	77.7	7	72.4	21
<i>Consideration of overall physical activities</i>						
Little activity	46.2	18	22.2	2	53.32	16
Moderate activity	28.2	11	22.2	2	30.0	9
Intensive activity	25.6	10	55.6*	5	16.7	5

*Statistical hypothesis test (p < 0.05) for significant differences between sex.

Table III
Median (P_{25} - P_{75}) intakes of energy and nutrients per day according to paper and pencil and online FFQ (food frequency questionnaire) by sequence of presentation mode for the total sample, group A and group B

Nutrients	Total sample (n = 39)		Group A (n = 18)		Group B (n = 21)	
	Paper and pencil	Online	Paper and pencil	Online	Paper and pencil	Online
Energy (kcal)	2,077.0 (1,783.8-2,748.0)	1,635.2* (1,144.9-2,509.0)	2,205.9 (1,853.2-2,788.5)	1,638.1* (990.1-2,231.0)	1,635.2 (1,198.1-2,638.4)	2,073.5 (1,701.6-2,717.2)
Total Protein (g)	96.3 (76.3-120.8)	87.6* (55.4-112.6)	97.2 (78.5-116.4)	81.8* (53.4-112.3)	100.7 (57.7-113.1)	95.0 (72.6-123.9)
Total Carbohydrate (g)	272.1 (220.5-374.4)	210.9* (117.4-338.4)	265.4 (228.4-361.1)	195.8* (106.1-275.4)	236.6 (140.4-416.3)	279.6 (210.8-374.8)
Total fat (g)	70.1 (54.2-96.1)	58.1* (34.0-76.3)	70.1 (59.4-101.0)	55.6 (31.8-95.3)	58.1 (32.7-75.6)	68.1* (42.5-92.9)
SFA (g)	20.5 (16.6-26.7)	15.4* (9.2-23.8)	20.7 (17.7-28.8)	19.6 (9.7-24.4)	15.5 (7.3-23.02)	20.6* (14.1-26.1)
MUFA (g)	28.4 (22.4-41.6)	19.7* (12.2-32.4)	29.5 (23.5-43.3)	18.8 (11.2-39.8)	19.7 (12.6-32.8)	27.7* (18.9-38.3)
PUFA (g)	10.7 (6.7-15.5)	9.7 (5.6-13.1)	11.6 (8.4-15.1)	8.8* (4.8-13.1)	11.2 (6.3-14.6)	10.3 (6.4-19.09)
Dietary fiber (g)	31.6 (23.3-39.0)	24.8 (18.2-35.9)	30.5 (21.4-38.4)	21.1* (14.9-33.8)	25.8 (23.9-37.5)	32.0 (24.2-39.9)
Alcohol (g)	4.9 (0.9-9.9)	1.2* (0.0-6.0)	8.6 (1.8-22.0)	5.4* (0.6-9.4)	0.8 (0.0-3.4)	3.5* (0.7-7.5)

SFA = Saturated fatty acids; MUFA = Monounsaturated fatty acids; PUFA = Polyunsaturated fatty acids.

P_{25} -25th percentile; P_{75} -75th percentile.

*Wilcoxon ($p < 0.05$) for paired differences medians (paper and pencil, Internet).

Group A: paper and pencil FFQ first; Group B: Internet FFQ first.

whole sample and by sex. The mean age for the overall group was 24.8 ± 2.6 years, with a range of 20 to 32 years; the mean weight and height was 62.4 ± 12.04 kg and 168.2 ± 8.2 cm, respectively; and the mean BMI was 21.9 ± 3.2 kg/m². The participants were predominantly normal body weight (79%) using the World Health Organization (WHO) cut-off points³³. Table II shows the most important items of corporal perception, habits and physical activity. There were not significant differences by sex between the responses in the paper and pencil and the online FFQ in the items in the general questionnaire, except for the item "consideration of overall physical activity".

The time invested in completing both questionnaires was measured. Participants' mean completion time was 24 minutes (SD = 10.1) for paper and pencil and 19 minutes (SD = 6.6) for online. Participants spent 5 minutes more on the completed paper and pencil FFQ, one reason for this difference in time could be that in this presentation mode serving size photographs were not shown and the participants spent more time thinking about the serving size.

Intake of energy and nutrients estimated by the paper and pencil and online FFQ

Medians and percentiles of nine selected dietary components estimated by both presentation modes for the whole group, group A and group B are presented in table III. Medians of energy were higher measured with the paper and pencil FFQ than with the online version for the total sample and the two groups. The only nutrients that were overestimated with the online FFQ were total protein and polyunsaturated fatty acids (PUFA) but just in group B. The Wilcoxon test presented significant differences ($p < 0.05$) when the total sample and Group A were

Table IV
Spearman correlation coefficient between paper and pencil and Internet-FFQ for total sample, group A and Group B

Nutrients	Total simple (n = 39)	Group A (n = 18)	Group B (n = 21)
Energy (kcal)	0.43**	0.60**	0.30
Protein (g)	0.58**	0.75**	0.48*
Carbohydrate (g)	0.44**	0.59*	0.29
Total fat (g)	0.44**	0.33	0.48*
SFA (g)	0.54**	0.51*	0.58**
MUFA (g)	0.40*	0.20	0.54*
PUFA (g)	0.53**	0.53*	0.54*
Dietary fiber (g)	0.18	0.27	0.06
Alcohol (g)	0.70**	0.81**	0.29

SFA = Saturated fatty acids; MUFA = Monounsaturated fatty acids; PUFA = Polyunsaturated fatty acids

* $p < 0.05$.

** $p < 0.01$.

studied, except dietary fibre in the total sample and total fat, saturated fatty acids (SFA) and monounsaturated fatty acids (MUFA) in the group A. The Wilcoxon test in Group B only presented significant differences ($p < 0.05$) for total fat, SFA, MUFA and alcohol.

Spearman rank correlation coefficients between paper and pencil and online FFQ for selected measures of energy and nutrients for the total sample, group A and group B were studied. Coefficients for energy and nutrient for the total sample varied between 0.18 for dietary fibre and 0.70 for alcohol (median $r = 0.47$); for group A (0.27-0.81; median $r = 0.51$); for group B (0.06-0.63; median $r = 0.39$).

Table IV shows medians (g/day) and the interquartile range of food group from paper and pencil and

Table V
Comparison of consumption of the food group (g/day) according to paper and pencil and Internet food frequency questionnaire for total sample (n = 39)

Food category	Paper and pencil		Internet	
	Median	IQR	Median	IQR
Dairy	35.5	30.0-41.9	30.8	20.0-55.2
Eggs, meats and fishes	10.0	7.0-12.9	7.9	5.0-13.5
Vegetables, legumes and fruits	25.5	19.6-35.1	22.1	18.5-29.6
Bread, cereals and similars	27.6	21.2-33.0	20.2	3.3-41.0
Oils, fats and sweets	4.7	2.6-6.5	3.3	1.0-6.0
Beverages y precocinados	14.2	8.1-24.3	5.9*	1.7-16.8

P_{25} -25th percentile; P_{75} -75th percentile.

*Wilcoxon ($p < 0.05$) for significant differences between paper and pencil and Internet-FFQ.

IQR = interquartile range (25th to 75th percentiles).

Table VI
Percent calories from fat, protein and carbohydrate for total sample (n = 39)

Percent calories from	Total sample (n = 39)		p	Recommendations (%)	p
	Paper and pencil	Internet			
Fat	29.91	28.93	0.92	30	0.95
Protein	18.48	19.79	0.88	15	0.63
Carbohydrate	52.32	52.76	0.97	55	0.83

No hay diferencias estadísticamente significativas entre ambos métodos de autoadministración (Internet y papel) haciendo el análisis estadístico con Statgraphics contraste de hipótesis proporción binomial. IQR = interquartile range (25th to 75th percentiles).

online FFQ for the total sample. The Wilcoxon signed ranks tests examined differences in food group between the two methods. Only the beverage and pre-cooked group were significantly different ($p < 0.05$).

Among all participants, there were not significant differences in the percentages of energy from fat, protein and carbohydrate between both methods. Moreover, these percentages agreed with the recommendations (table V).

Discussion

In the present study, a cross-over design is used to study the feasibility of the results of a self-administered semi-quantitative online FFQ in relation to the results of the paper and pencil version. Several studies have compared results from analysis software with those from transcription processing, and found reasonable concordance. Mangunkusumo et al.³¹ show that varying the survey method, Internet or paper and pencil, the results of an adolescent health questionnaire were equivalent. Data did not differ significantly between Internet and paper and pencil version, except for one item. In a similar way, Boeckner et al.¹¹ compared responses using paper and pencil and then World Wide Web version of the 1998 Block Health Habits and History Questionnaire. Results showed that Internet dietary assessment instruments could be a feasible

assessment tool for older women to self-administer. Knapp et al.²⁴ assessed whether responses to personally sensitive questions of a pencil and paper, Internet survey or touch-tone telephone are equivalent. There were no significant differences in participants' responses between survey methods. All these studies are not easy to compare with this present work because of the target population and the dietary components under study are not the same. To the authors, this is the first online FFQ developed for a university population.

Analysis data suggest that this online FFQ can be used to assess median intakes of five of the six food groups that have been studied. There were not significant differences between the two modes of presentation (paper and pencil and online) when the consumption of food group is calculated, except for "beverages and pre-cooked" group. These differences may be explained by the fact that these food items appeared at the end of the questionnaire, when answering-fatigue may have set in.

When the whole group was studied, there were significant differences ($p < 0.05$) for all nutrients (except dietary fibre) when participants entered their own responses in the paper and pencil FFQ with respect online version. A good reason for the disagreement between the results from the two methods may be that participants had difficulty reporting accurate portion sizes on the paper and pencil FFQ because photographs of serving size were not shown. This agrees with other studies that have concluded participants' difficulties

with portion size estimation as a cause for lower validity correlations between the diet records and the FFQ.³²

The results of the current study is in accordance with other authors¹⁵ who concluded that this method of dietary assessment is useful for ranking participants by levels of intake, rather than to provide estimates of absolute quantities of energy and nutrient intakes.

This study has several limitations to consider. Firstly, the small number of subjects studied would result in low power for detecting statistical differences. Before using the online FFQ for a large-scale nutrition research program, more testing should be done. Secondly, paper and pencil and online FFQ had an identical format but in the paper and pencil version food portion size photographs were not shown. The possible impact of these limitations on the results of the present study was not clear. For future studies, photographs of serving sizes should be incorporated in the paper and pencil version.

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