Comparison of the short form of a Swiss Food Frequency Questionnaire with its long form and analysis of the application of an online, image-based nutrition record

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Abstract

A short-form food frequency questionnaire with 46 food items was developed based on the existing, validated online questionnaire with 129 items. A relative validation study compared both of these tools by using them in N = 61 participants and comparing the results. The analysis showed satisfactory, significant Spearman correlation coefficients for the macronutrients. The short version of the questionnaire is a workable and reliable instrument for recording dietary patterns that can also be used in combination with other data collection instruments.

Citation
Holzmann M, Steinemann N, Brombach C: Comparison of the short form of a Swiss Food Frequency Questionnaire with its long form and analysis of the application of an online, image-based nutrition record. Ernahrungs Umschau 2024; 71(10): 120–4.

Open access
The English version of this article is available online: DOI: 10.4455/eu.2024.035

Peer reviewed
Manuscript (Review) submitted: 04.12.2023; revised version accepted 14.03.2024

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Introduction

There are various ways to reduce the workload and effort involved in nutrition logging: existing Food Frequency Questionnaires (FFQs) can be shortened or adapted for use in web-based formats and innovative (e.g., image-based) logging methods can also be developed and used [1–4]. Devices with a digital camera are now ubiquitous, so these devices are the most commonly used tools for recording food intake when using an image-based nutrition record. Before eating, the person takes photos of the food and/or drink they are about to eat/drink [4, 5]. The photos can be used to identify the type of food the person has eaten and, if necessary, the portion sizes [4].

Study question

An abridged FFQ (Short FFQ, SFFQ) was compared with the corresponding long-form (LFFQ) of an online FFQ that had already been developed and validated [6]. Additionally, an image-based nutrition record (ibNR) was developed and its suitability for use in analysis was tested. The ibNR was used to determine whether and how the FFQs could be updated.

Methodology

The study design, the questionnaire completion aids and the web forms were tested in advance in a pilot study with 10 study participants and then adapted accordingly. The competent ethics authority determined that the study did not require ethics approval. The participants were entered into a draw for 5 vouchers worth CHF 25 each. All data collected was used and assessed in anonymized form.

The image-based nutrition record (ibNR)

The ibNR is based on photos that show the food and/or drinks to be consumed alongside a known everyday object (one with a defined size, such as a coin), taken with a smartphone prior to consumption (see examples in ◆ Figures 1 and 2). The participants then uploaded the photos via a web form, along with a brief description of the food and/or drink.

The FFQs

The long form of the semi-quantitative FFQ (LFFQ), which was developed and validated at the Zurich University of Applied Sciences (ZHAW), is based on a four-day weighed di-

Fig. 1: **Example of a meal photographed for the ibNR including several everyday objects with known dimensions**
ibNR: image-based nutrition record

Fig. 2: **Example of a meal photographed for the ibNR including a coin of known size**
ibNR: image-based nutrition record

etary record as a reference method [6]. A web-based short form of the FFQ with a total of 46 foods (SFFQ) was developed based on the validated long version, and in the present study, the short form version was compared with the web-based long-form version with 129 foods. Both FFQs were structured in the same way and both covered a study period of four weeks [6]. FFQs must indicate the usual portion sizes consumed, the frequency of consumption and the number of portions eaten. The food items from both FFQs were linked to the Swiss nutritional database *SwissFir Version* 3.0, which is now called the *Swiss Food Composition Database*.

Recruitment of study participants

117 participants aged 18 years or older living in German-speaking Switzerland were recruited via electronic communications (text messaging services or e-mail).

Video-based questionnaire completion guides

Because the study took place during the SARS-CoV-2 pandemic, physical meetings had to be reduced to a minimum, so no in-person training was provided. Instead, the participants were sent links to explanatory videos with specific instructions that were created for the study.

Study organization

A total of 66 participants received emails with the video-based questionnaire completion guide and a personal link to the ibNR. The ibNR was carried out on one weekday and one weekend day and the participants uploaded the photos together with additional information to the web form provided. Half of the participants completed the SFFQ first and the other half completed the LFFQ first. The participants were sent emails with a personal link to the FFQ and the video-based questionnaire completion guide. As soon as the participants completed the first FFQ, the personal link for the other FFQ was sent to them (randomized crossover design).

Data preparation

Image-based nutrition record (ibNR)

A total of 993 photos from 66 participants were uploaded to the ibNR, which corresponds to a daily average of 7.52 photos. If a description was imprecise, it was supplemented with additional information from the image descriptions provided by the participants. The food and drinks described were then assigned to the LFFQ's food and drink items and groups. If it was not possible to assign a certain food or drink to an LFFQ food or drink item, this food or drink was put on a list. The items on the list were then assigned to groups and the frequency of mentions of the grouped list items was determined. This list was used as the basis for a proposal for updating the current LFFQ.

FFQs

To exclude outliers, energy intakes below the 25th percentile (– 1.5 × interquartile range) or above the 75th percentile (+ 1.5 × interquartile range) were considered implausible [13]. This approach resulted in the exclusion of five participants, which left a study population of 61 people (male: 24, female: 37). The average age of the participants was 50.21 (± 18.56) years and the average body mass index was 24.25 (± 3.11) kg/m² (self-reported by the participants).

The two food frequency questionnaires (FFQs) were compared using the Spearman correlation coefficient (r) to assess the possibility of systematic biases in the data. The corresponding one-sided Wilcoxon signed-rank tests (WSRT) were used for this purpose. Additionally, Bland-Altman plots were created and the differences and percentage differences between the mean values from the LFFQ and SFFQ were calculated (mean value according to ◆ Table 1 [SFFQ–LFFQ]).

Results

ibNR

Foods and drinks that could not be definitively assigned to the LFFQ items and that were recorded by at least 9.09% (= 6 out of 66) of participants included various sauces (19.70%), syrup (13.46%), schnitzel cordon bleu (12.12%), seeds (10.61%), various types of desserts (10.61%), plant-based milk alternatives not including soy milk (9.09%) and rice cakes (9.09%).

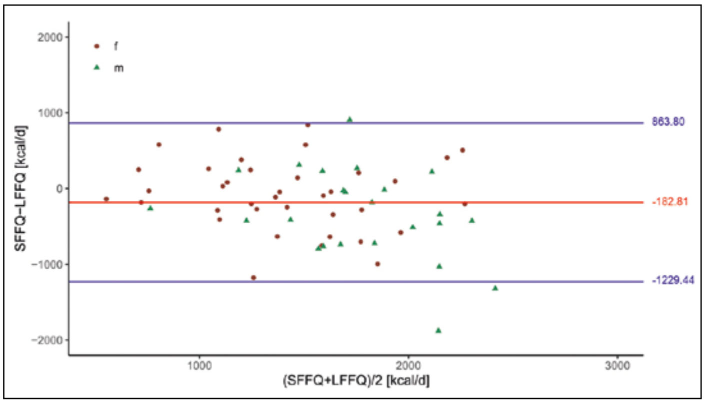

Fig. 3: **Bland-Altman plot for the recorded energy intake [kcal/d]**
calculated from SFFQ and LFFQ. Calculated for the entire sample. Different symbols indicate whether the values are from male (triangle) or female (circle) participants.

FFQs

◆ Table 1 compares the LFFQ and SFFQ in terms of energy and macronutrients for the entire study population. Both the energy data and the macronutrients correlate significantly, with r between 0.41 (carbohydrates) and 0.53 (protein). The difference in the mean values between the SFFQ and the LFFQ for the macronutrients and energy recorded was negative. The Wilcoxon signed-rank test showed that with the SFFQ, participants recorded significantly lower energy and macronutrient intakes than with the LFFQ ($p \leq 0.05$), with the exception of fat ($p = 0.069$).

◆ The Bland-Altman plot in Figure 3 shows that the energy intake of the entire study population as recorded with the SFFQ is significantly lower than that recorded with the LFFQ ($p = 0.007$; Wilcoxon signed-rank test). This effect increases with increasing energy intake. ◆ Figures 4–7 show Bland-Altman plots for fat, protein, carbohydrates and dietary fiber. A similar effect to the one seen in the energy intakes can also be seen in all of the Bland-Altman plots for the macronutrients. The mean fat intake was slightly lower in the SFFQ than in the LFFQ (–3.28 g), the mean protein intake was also lower in the SFFQ than in the LFFQ (–14.66 g), the mean carbohydrate intake was lower in the SFFQ than in the LFFQ (–38.56 g) and the mean dietary fiber intake was also lower in the SFFQ than in the LFFQ (–3.77 g).

	Mean LFFQ	Mean SFFQ	Difference between means SFFQ–LFFQ	Difference between means SFFQ–LFFQ [%]	r	p
Energy [kcal/day]	1642.12	1459.30	-182.82	-11.13	0.50	***
Fat [g/day]	64.77	61.49	-3.28	-5.07	0.49	***
Protein [g/day]	79.14	64.48	-14.66	-18.52	0.53	***
Carbohydrates [g/day]	234.56	196.00	-38.56	-16.44	0.41	**
Dietary fiber [g/day]	25.05	21.27	-3.77	-15.07	0.47	***

Table 1: **Difference between SFFQ and LFFQ for the recorded energy and macronutrient intakes. Table also shows the correlation coefficient**
* $p \leq 0.05$, ** $p \leq 0.01$, *** $p \leq 0.001$

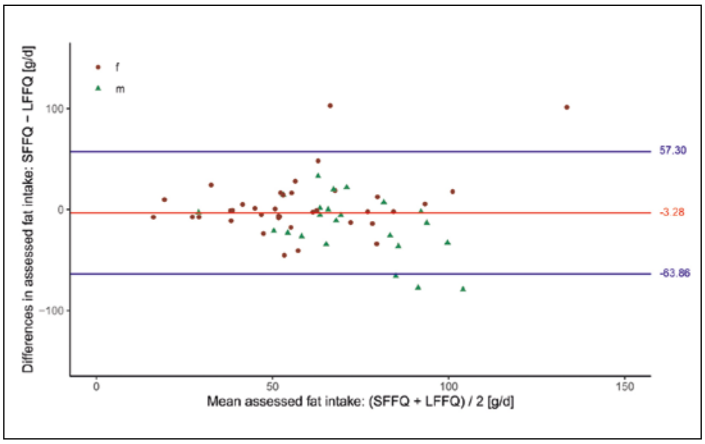

Fig. 4: **Bland-Altman plot for the recorded fat intake [g/d]** calculated from SFFQ and LFFQ. Calculated for the entire sample. Different symbols indicate whether the values are from male (triangle) or female (circle) participants.

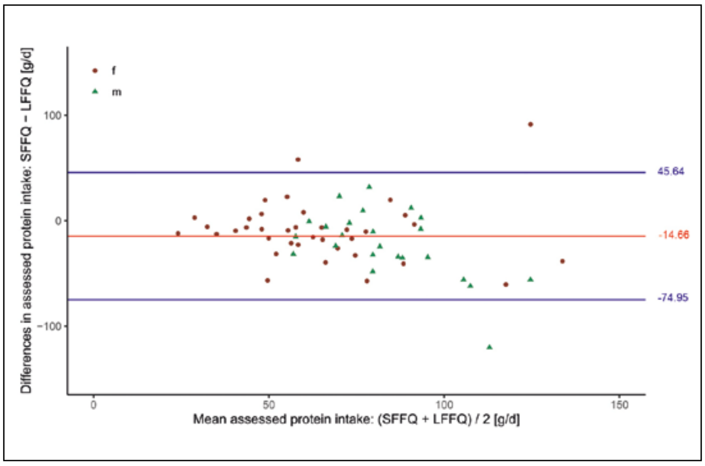

Fig. 5: **Bland-Altman plot for the recorded protein intake [g/d]** calculated from SFFQ and LFFQ. Calculated for the entire sample. Different symbols indicate whether the values are from male (triangle) or female (circle) participants.

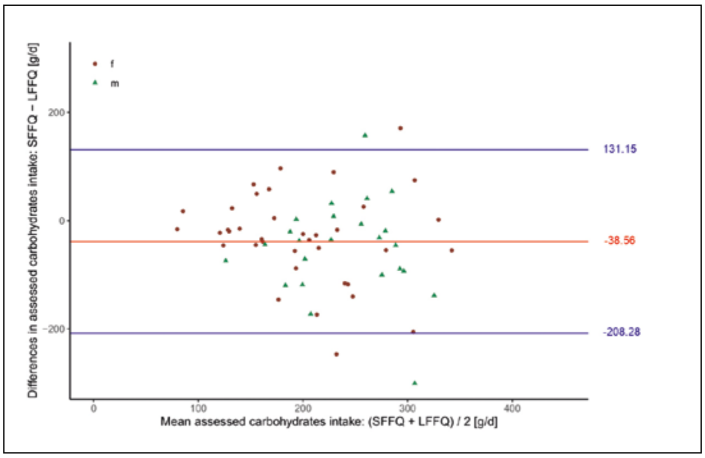

Fig. 6: **Bland-Altman plot for the recorded carbohydrate intake [g/d]** calculated from SFFQ and LFFQ. Calculated for the entire sample. Different symbols indicate whether the values are from male (triangle) or female (circle) participants.

Discussion

The correlations between the LFFQ and the SFFQ in terms of energy and macronutrient intake were satisfactory, however there was a tendency for the SFFQ to result in an underestimation of macronutrient intake, which has been similarly observed in other comparable studies [6–9, 13].

Due to the SARS-CoV-2 pandemic, opportunities for interaction with the participants were limited. Nevertheless, catering establishments in Switzerland were open without restrictions and people were not obliged to work from home. The online format of the study facilitated the extensive recruitment of a non-representative sample from German-speaking Switzerland. However, participation in the validation study required a certain level of computer literacy. It is possible that the ibNR increased the participants' interest in their diet prior to completing the FFQs [7]. These results are the results of a comparative study – both FFQs are susceptible to recall biases. For this reason, there is a tendency towards correlative errors due to the study design [7, 8]. The results from the ibNR suggest that the inclusion of schnitzel cordon bleu, seeds, plant-based milk alternatives and rice cakes should be considered when developing future FFQs. In the case of quantitative assessment of image-based nutrition records, it is recommended that the people carrying out the assessment receive prior training, such as the training developed by Knies et al [4].

Outlook

In summary, the SFFQ is a suitable tool for nutrition logging within the German-speaking population of Switzerland and is available for use. The SFFQ appears to be particularly suitable for settings where limited time or resources mean that quick, functional and simple tools are required, e.g. in everyday clinical practice, living labs, or other settings that make it difficult to use more detailed data collection tools. It is also feasible to use the SFFQ as a supplementary data collection tool for recording dietary patterns used in combination with other data collection tools, as was done in the studies by Wu et al. [11] and Nève et al. [12]. The 2-day ibNR has proven to be a suitable tool for gathering information about how

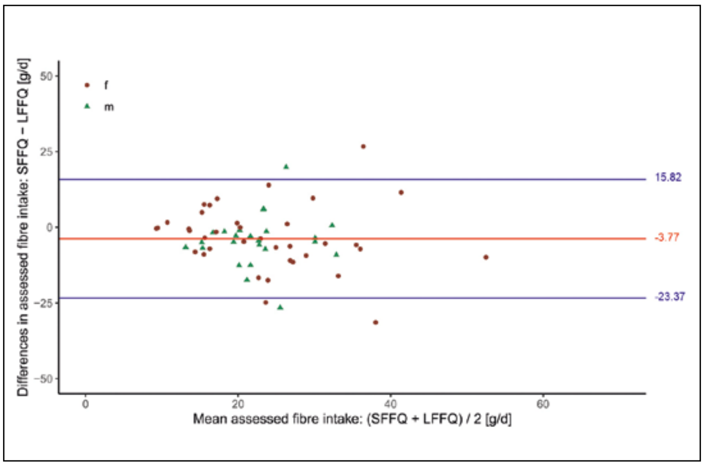

Fig. 7: **Bland-Altman plot for the recorded dietary fiber intake [g/d]** calculated from SFFQ and LFFQ. Calculated for the entire sample. Different symbols indicate whether the values are from male (triangle) or female (circle) participants.

FFQs can be further developed and updated and has also proven to be a valuable tool for gaining insights into individual dietary intake. The next steps will be to determine the intervals at which the ibNR could be used to update the existing SFFQ and create new food groups for it. This would allow the way market dynamics affect food choices to be taken into account without losing the advantages of an SFFQ.

Acknowledgments
The authors would like to thank Prof. Dr. med. et phil. Lia Bally of the Department of Diabetes, Endocrinology, Nutritional Medicine and Metabolism, Bern University Hospital, University of Bern (UDEM), for her constructive criticism and appreciative review of the manuscript. The authors would also like to thank all study participants for their willingness to take part in this study.

Disclosures on Conflicts of Interest and the use of AI
The authors declare that there is no conflict of interest and that no AI applications were used in the preparation of the manuscript.

References

1. *Mannato LW, Pereira TSS, Velasquez-Melendez G, Cardoso L de O, Benseñor IM, Molina M del CB: Comparison of a short version of the Food Frequency Questionnaire with its long version – a cross-sectional analysis in the Brazilian Longitudinal Study of Adult Health (ELSA-Brasil). Sao Paulo Med J 2015; 133: 414–20.*
2. *Riboli E, Hunt K, Slimani N, et al.: European Prospective Investigation into Cancer and Nutrition (EPIC): study populations and data collection. Public Health Nutr 2002; 5: 1113–24.*
3. *Boushey CJ, Spoden M, Zhu FM, Delp EJ, Kerr DA: New mobile methods for dietary assessment: review of image-assisted and image-based dietary assessment methods. Proc Nutr Soc 2017; 76: 283–94.*
4. *Knies JM: Photo method for nutrition logging. Development and evaluation of a photographic logging instrument. Ernahrungs Umschau 2017; 64(4) 58–66.*
5. *He J, Shao Z, Wright J, Kerr D, Boushey C, Zhu F: Multi-task image-based dietary assessment for food recognition and portion size estimation. In: 2020 IEEE Conference on Multimedia Information Processing and Retrieval (MIPR) Shenzhen, Guangdong, China: IEEE 2020, 49–54.*
6. *Steinemann N, Grize L, Ziesemer K, Kauf P, Probst-Hensch N, Brombach C: Relative validation of a food frequency questionnaire to estimate food intake in an adult population. Food Nutr Res 2017; 61: 1305193.*
7. *Willett W: Nutritional epidemiology. 3rd ed., Oxford, New York: Oxford University Press 2013. (Monographs in epidemiology and biostatistics).*
8. *Dehghan M, Ge Y, El Sheikh W, et al.: Comparability of a short food frequency questionnaire to assess diet quality: the DISCOVER study. Int J Food Sci Nutr 2017; 68: 726–32.*
9. *Keogh JB, Lange K, Syrette J: Comparative analysis of two FFQ. Public Health Nutr 2010; 13: 1553–8.*
10. *Pannen ST, Gassmann R, Vorburger R, Rohrmann S, Sych J, Steinemann N: Development of a multilingual web-based food frequency questionnaire for adults in Switzerland. Nutrients. 2023 13; 15(20): 4359.*
11. *Nève G, Bur L, Lampert L, et al.: Validation of a visually aided dietary assessment tool to estimate dietary intake in adult Swiss population. Frontiers in Nutr 2022; 9: 844156.*
12. *Wu J, Fuchs K, Lian J, et al.: Estimating dietary intake from grocery shopping data – a comparative validation of relevant indicators in Switzerland. Nutrients 2021; 14(1): 159.*
13. *Melkonian SC, Daniel CR, Hildebrandt MA, et al.: Joint association of genome-wide association study-identified susceptibility loci and dietary patterns in risk of renal cell carcinoma among non-Hispanic whites. Am J Epidemiol 2014; 180(5): 499–507. Erratum in: Am J Epidemiol. 2015; 181(11): 920.*