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ORIGINAL CONTRIBUTION

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Validation of a self-administered 24-hour recall questionnaire used in a large-scale dietary survey

Validierung eines in einer groß angelegten Ernährungserhebung eingesetzten selbstgeführten 24-hour-recall-Fragebogens

Summary This study investigated the relative validity of a self-administered 24-h recall questionnaire in a dietary survey on 3 653 men and women 7 years of age and older. The validation was carried out in a group of 41 men. An estimated dietary record kept over 3 days served as reference method. Comparison of the questionnaire and the estimated 3-day record showed good agreement. The Wilcoxon matched-pairs ranked signs test ($p < 0.05$) demonstrated that the only differences were the crude energy and carbohydrate intake and the estimated nutrient density of protein. The estimated proportion of calories from carbohydrate, fat, protein, and alcohol differed by no more than 2.4 %. The median percentage differences in crude nutrient intakes and nutrient densities between the two assessment techniques ranged from -9 % to 22 %. The daily food intake differed significantly in only three of ten food groups. Spearman's correlation coefficients were higher than 0,35 for all density measurements. The highest correlation coefficients of about 0.60 were observed for alcohol and dietary fiber intake. It is concluded that the self-administered 24-hour recall questionnaire is a valid method for estimating the median and mean dietary intake of large groups of subjects.

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Zusammenfassung Ziel der Arbeit war, die relative Validität eines selbstgeführten 24-hour-recall-Fragebogens zu untersuchen, der in einer Ernährungserhebung mit 3 653 weiblichen und männlichen Erhebungsteilnehmern im Alter ab 7 Jahren eingesetzt wurde. Die Validierung wurde an einer Gruppe von 41 Männern durchgeführt. Ein 3-Tage-Protokoll diente als Referenzmethode. Der Vergleich des 24-hour-recall-Fragebogens mit dem 3-Tage-Protokoll erbrachte gute Übereinstimmung. Mittels des Wilcoxon matched-pairs ranked signs test ($p < 0.05$) konnten nur für die absoluten Energie- und Kohlenhydrataufnahmen sowie für die Protein-Nährstoffdichte signifikante Unterschiede nachgewiesen werden. Die prozentuale Verteilung der Energie auf die Hauptnährstoffe und Alkohol differierte um maximal 2,4 %. Der mediane prozentuale Unterschied in der absoluten Nährstoffaufnahme und der Nährstoffdichte lag zwischen -9 und 22 %. Die tägliche Nahrungsaufnahme war nur für 3 von 10 Lebensmittelgruppen signifikant verschieden. Die Spearman rank Korrelationskoeffizienten betrugen für alle Nährstoffdichten mehr als 0,35. Die höchsten Korrelationskoeffizienten um 0,60 wurden für die Alkohol- und Nahrungsfaseraufnahme beobachtet. Die Ergebnisse zeigen, daß der 24-hour-recall-Fragebogen eine valide Methode zur Schätzung der medianen und mittleren Nahrungs- und Nährstoffaufnahme von großen Gruppen ist.

Key words Validation – 24-hour recall questionnaire – dietary survey – energy intake – nutrient intake – food intake

Schlüsselwörter Validierung – 24-hour-recall-Fragebogen – Ernährungserhebung – Energieaufnahme – Nährstoffaufnahme – Nahrungsaufnahme

Abbreviation index *BLS* = Bundeslebensmittelschlüssel · *24 HRQ* = 24-hour recall questionnaire

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Introduction

Assessment of the dietary intake is a complex but essential task. There is still the need to develop and evaluate short methods of diet assessment (20). The selection or development of appropriate assessment methods requires the consideration of many factors. A large-scale dietary survey was carried out from May to November 1991 in Zurich, Switzerland, in the framework of the National Research Exhibition HEUREKA (25). All visitors had the possibility to take part in the survey regardless of gender, age, and other personal factors. Since we were interested in the mean nutrient and food intake of a large, undefined voluntary series, a self-administered 24-h recall questionnaire (24 HRQ) was the method of choice. Such a questionnaire is limited with respect to the foods included and the quantified mean portion sizes. Since systematic errors of the measuring instrument affect the validity of the measurement, the relative validity of the 24HRQ method must be assessed. A number of validation studies of 24-h recalls have been published (6–14, 16–21). The 24-h recall was always conducted as personal interview or by telephone, never as a self-administered 24HRQ and the recalled dietary intake was compared either with observed intake or with assessed data from dietary records, food frequency questionnaire, or dietary history.

This paper describes the validation of the 24HRQ method with respect to an estimated 3-day record (reference method).

Subjects and methods

Study design

To judge the significance of the assessed mean consumption data of the baseline dietary survey with 3 653 men and women aged 7 years or older in 1991 (2–4) a validation study was carried out in spring 1993. The estimated 3-day record was used as reference method since, on the one hand, it is a common method of general acceptance (23) and, on the other, its main sources of error are independent of the main sources of error of the 24HRQ (memory, estimation of quantity of consumption, design of the questionnaire with a given limited food list). The 3-day records were kept on two weekdays and one weekend day (Thursday, Friday, Saturday). Participants of the validation study obtained a 24HRQ with regard to the same 3 days of the week without prior warning 1–2 months apart.

Subjects

Of a total of 45 randomly selected male volunteers 41 completed the validation study (91 %); 4 men dropped out during the study (2 refusals; 2 unusable records). The 41 men aged 19–55 years had a median body mass index of 22.5, which indicates standard weight. All were employed in light work, 73 % practised modest sports, and 27 % no sports at all. Only 3 were smokers; 3 were total alcohol abstainers, 11 consumed alcohol three times a month or less, 23 (56 %) between one and three times a week, and only 4 consumed alcohol daily. These personal data were comparable with the data from the baseline dietary survey for the same age group (4).

24-h recall questionnaire

The purpose of the self-administered 24HRQ was to assess the caloric and nutrient intake of a large series in a quick and simple way. A total of 240 typical foods and beverages for a Swiss diet were listed in a clearly structured questionnaire, grouped together, for example, as bread, cheese, and meat for better orientation. A photograph book served as aid to memory and to estimation of the real consumed portion size. The structure of the questionnaire is presented in Fig. 1. On the cover page of the questionnaire the participants were informed about the aim of the dietary survey and were instructed how to use the questionnaire. This instruction is based on six neutral questions "What did you eat and/or drink ...," as in an interview. The participants were asked to record for each meal the number of units of the consumed food items and beverages, for example, for breakfast 1.5 slices white bread, 1 cup full-fat yoghurt, etc. The last two pages of the questionnaire served to evaluate some personal data of the participants. It took approximately 20–30 min to read all instructions and to fill in the 24HRQ. The questionnaires were first checked for completeness (personal data) and obvious errors.

Estimated 3-day record

All participants received a structured, open diary (23) to record all the foods and beverages taken and to specify type and brand as exactly as possible. The amounts had to be specified by the participants' own household measures (list of capacity), in given household measures (teaspoon, tablespoon, 3-dl cup) or in standard serving sizes if sold in this way. One day before the beginning of the recording period (3 days), the participants were instructed by a nutritionist. The instructions and examples are also included in the diary. On the day after the last recording day the same nutritionist checked the diary with the participant.

Calculation of intake of nutrients, energy, and food groups

The entry and calculation of the intake of nutrients, energy, and foods is easy and quick for the 24HRQ. Based on the German computerized food composition table BLS version II (5) a special food composition table with the 240 foods and beverages of the questionnaire was created.

Fig. 1 24-hour recall questionnaire

Code	Amount (g)	Food items	Page Photograph Book	Unit	Breakfast (units)	AM Snack (units)	Lunch (units)	PM Snack (units)	Dinner (units)	EV Snack (units)
		Bread								
3	40	Brown Bread	2	Slice						
24	40	Croissant	2	Piece						
4	30	White Bread	2, 3	Slice						
6	10	Crispbread		Piece						
2	40	Wholemeal-Bread	2, 3	Slice						
5	50	Roll		Piece						
13	10	Rusk		Piece						
		Spreading Fats								
138	20	Butter	4	Portion						
139	20	Butter Light	5	Portion						
136	20	Margarine		Portion						
137	20	Margarine Light		Portion						
		Honey, Jam								
142	10	Honey	6	Teaspoon						

Each food and beverage was assigned its own code (first column of the questionnaire) and a sign for a food group. The entry and calculation of intake was made with the data management system "Diet recall" version 2.0 (1). The 3-day food record forms were first coded. For this purpose the food composition table of the 24HRQ had to be enlarged. If the participants were not able to record food items more accurately or as specified in the 24HRQ, the codes of the questionnaire were selected; otherwise a new, more specified food with its own code was inserted from the BLS into the composition table. The food composition table then consisted of approximately 900 foods and beverages. After conversion of the household measures into grams, the entry and calculation of intake was made with "Diet recall". The mean individual dietary intake per day was calculated from the record as the average of the 3 recording days.

Statistical analysis

In comparing the two methods we considered crude intake of energy, carbohydrate, fat, protein, alcohol, and dietary fiber as well as nutrient density as an energy-independent figure from carbohydrate, fat, protein, alcohol, and dietary fiber. These are expressed as median and mean ± standard deviation. We also considered caloric density (percentage of calories) from carbohydrate, fat, protein, and alcohol. The nonparametric Wilcoxon matched-pairs ranked signs test was used to analyze the difference in central tendency between the dietary variables obtained by the 24HRQ and the estimated 3-day record (22). Spearman's rank correlation coefficient was calculated to evaluate the extent to which the methods rank individuals comparably according to dietary intake (22). Statistics were calculated using the statistical package Statgraphics (Statistical Graphics, Rockville, MD, USA). A p value less than 0.05 was considered statistically significant.

Results

The daily crude intakes of energy, carbohydrate, fat, protein, alcohol, and dietary fiber estimated from the 24HRQ and the 3-day record are presented in Table 1. Only the recalled crude intake of energy and carbohydrate differed significantly from the corresponding record estimates. Generally the recalled nutrient intake was higher than the recorded one. As expected, the correlations for energy and carbohydrate were low and not significant (Table 1). The intermediate correlation for fat and the high correlations for alcohol and dietary fiber were significant. Although the correlation for protein was low and not significant, the agreement in median and mean protein intake was good. Because there was an obviously higher energy intake based on the 24HRQ, density measures of nutrient intake were also compared (Tables 2, 3). The nutrient density did not differ significantly according to the dietary assessment techniques with the exception of protein (Table 2). The significant correlation coefficient of 0.42 for protein does not signify an agreement between the two methods. In caloric density there were significant differences for carbohydrate and protein (Table 3), despite rather high correlation coefficients. The median and mean proportion of calories from carbohydrate, fat, protein, and alcohol differed by no more than 2.4 % and provided a very similar distribution of caloric density for both assessment techniques.

Table 1 Median (mean ± standard deviation) daily crude nutrient intake of 41 men according to 24-h recall questionnaire (24HRQ) and estimated 3-day record (DR): Wilcoxon matched-pairs ranked signs test (Wilcoxon) and Spearman's rank correlation coefficient (Spearman)

	24HRQ	DR	Wilcoxon (p)	Spearman (p)
Energy (MJ)	13.3 (13.6 ± 4.2)	11.1 (11.5 ± 2.5)	*	0.23
Carbohydrate (g)	381.9 (399.9 ± 137.6)	345.9 (331.5 ± 73.7)	*	0.22
Fat (g)	120.6 (122.8 ± 50.8)	100.1 (108.1 ± 37.6)	n.s.	0.35*
Protein (g)	91.9 (98.1 ± 31.8)	87.3 (92.0 ± 22.4)	n.s.	0.10
Alcohol (g)	11.2 (17.9 ± 20.9)	8.1 (13.5 ± 15.6)	n.s.	0.63*
Dietary fiber (g)	30.1 (31.8 ± 16.0)	25.5 (27.1 ± 12.9)	n.s.	0.65*

* $p < 0.05$

Table 2 Median (mean ± standard deviation) nutrient density according to 24-h recall questionnaire (24HRQ) and estimated 3-day record (DR): Wilcoxon matched-pairs ranked signs test (Wilcoxon) and Spearman's rank correlation coefficient (Spearman)

	24HRQ	DR	Wilcoxon (p)	Spearman (p)
Carbohydrate (g/MJ)	29.8 (30.3 ± 5.1)	29.5 (28.9 ± 4.1)	n.s.	0.55*
Fat (g/MJ)	9.2 (8.9 ± 2.2)	9.1 (9.3 ± 1.8)	n.s.	0.35*
Protein (g/MJ)	7.1 (7.3 ± 1.6)	7.8 (8.0 ± 1.3)	*	0.42*
Alcohol (g/MJ)	0.9 (1.4 ± 1.6)	0.7 (1.2 ± 1.4)	n.s.	0.60*
Dietary fiber (g/MJ)	2.2 (2.4 ± 1.1)	2.2 (2.4 ± 1.2)	n.s.	0.54*

* $p < 0.05$

Table 3 Median (mean ± standard deviation) caloric density according to 24-h recall questionnaire (24HRQ) and estimated 3-day record (DR): Wilcoxon matched-pairs ranked signs test (Wilcoxon) and Spearman's rank correlation coefficient (Spearman)

	24HRQ	DR	Wilcoxon (p)	Spearman (p)
Carbohydrate (%)	49.8 (50.8 ± 8.6)	49.4 (48.4 ± 6.8)	*	0.55*
Fat (%)	34.5 (33.4 ± 8.4)	34.2 (35.0 ± 6.9)	n.s.	0.38*
Protein (%)	11.9 (12.3 ± 2.7)	13.1 (13.4 ± 2.2)	*	0.42*
Alcohol (%)	2.6 (4.0 ± 4.7)	2.2 (3.5 ± 4.0)	n.s.	0.61*

* $p < 0.05$

The percentage differences in nutrient intake and nutrient density between the 24HRQ and the 3-day record are presented in Table 4. The highest median percentage difference was registered for enery and carbohydrate intake, with 22 % and 19.8 %. Regarding the other nutrients the percentage difference ranged from 2.3 % (protein) to 14.4 % (dietary fiber). The values of percentage difference regarding nutrient density were much smaller. With the exception of carbohydrates 50 % of the nutrient density values from the 3-day record were higher than those from the 24HRQ, and therefore negative percentage differences resulted. Table 5 compares the 24HRQ and 3-day record concerning daily median and mean food intake. Ten food groups are distinguished. The intake of three food groups (vegetables/lettuce and potatoes, spreading fats, nonalcoholic drinks) was significantly different between the dietary assessment methods. For most food groups the recalled intake was higher than the recorded one. The correlation coefficients ranged from -0.17 (soups, dishes, sauces, dressings) to 0.62 (alcoholic drinks).

Table 4 Median (mean ± standard deviation) value of the percentage difference (%-Diff)[a] in crude nutrient intake and nutrient density between the 24-h recall questionnaire (24HRQ) and the estimated 3-day record (DR)

	Crude nutrient intake	Nutrient density
Energy	22.0	–
	(20.4 ± 35.1)	–
Carbohydrate	19.8	5.4
	(26.0 ± 39.2)	(5.7 ± 15.4
Fat	11.2	-6.3
	(20.9 ± 65.2)	(-2.7 ± 28.1)
Protein	2.3	-8.6
	(11.2 ± 42.8)	(-7.9 ± 19.6)
Dietary Fiber	14.4	-3.1
	(30.6 ± 84.1)	(6.5 ± 48.6)

[a] %-Diff = [(24HRQ-DR)/DR] x 100

Discussion

No dietary assessment method is completely free of systematic errors, which means a tendency to over- or underestimation (15). The recalled crude nutrient intake shows a tendency to overestimation, especially for the energy and carbohydrate intake (Table 1). This overestimation may result from the higher recalled food intake for some of the food groups (Table 5). The higher recalled food intake may be due to a predominant assessment on days with unusually high consumption (large day-to-day variation) or to an inadequate estimation of the portion sizes in either the 24HRQ or reference method. Even if the difference in daily food intake is significant only for three of ten food groups (Table 5), the portion sizes in the 24HRQ (units) should be adjusted, and/or the food photographs should be specified. Although the density measurements as energy-independent figures provided good agreement (Tables 2, 3) – thus emphasizing the importance of the described overestimation of food and energy intake – it should not be neglected that the 3-day record may underestimate the real food intake. The burden on the subjects is higher, and therefore the subjects' eating habits may change (reduced intake) during the recording period.

The median percentage differences in crude nutrient intakes and nutrient densities between the two assessment methods (Table 4) ranged from -9 % to 22 %. The largest percentage differences were registered for energy and carbohydrate crude intake, as expected. The high standard deviations reflect the interindividual differences in dietary intake. It is expected that a larger sample size would minimize the size of the percentage differences. Therefore the shorter and cheaper 24HRQ can be used as a valid substitute for the more time-consuming 3-day record when the median and mean nutrient and food intake of a large series is to be assessed, and when a percentage difference up to 20 % can be tolerated. Investigators of

Table 5 Median (mean ± standard deviation) daily food intake of 41 men according to 24-h recall questionnaire (24HRQ) and estimated 3-day record (DR): Wilcoxon matched-pairs ranked signs test (Wilcoxon) and Spearman's rank correlation coefficient (Spearman)

	24HRQ	DR	Wilcoxon (p)	Spearman (p)
Cereal products (g)	350 (324 ± 192)	245 (267 ± 181)	n.s.	0.34*
Vegetables/lettuce, potatoes (g)	273 (315 ± 238)	150 (169 ± 142)	*	0.35*
Fruits, fruit products (g)	0 (144 ± 209)	73 (118 ± 156)	n.s.	0.42*
Meat, sausages, fish, eggs (g)	140 (137 ± 107)	117 (116 ± 111)	n.s.	0.14
Soups, dishes, sauces, dressings (g)	100 (208 ± 246)	242 (262 ± 211)	n.s.	-0.17
Milk, dairy products (g)	375 (421 ± 312)	393 (471 ± 350)	n.s.	0.53*
Spreading fats (g)	20 (28 ± 28)	13 (19 ± 13)	*	0.39*
Sweet spreads, desserts, snacks, nuts (g)	150 (193 ± 152)	174 (172 ± 170)	n.s.	0.24
Alcoholic drinks (g)	150 (289 ± 376)	110 (231 ± 308)	n.s.	0.62*
Nonalcoholic drinks (g)	1530 (1526 ± 660)	1313 (1258 ± 659)	*	0.37*

* $p < 0.05$

future nutrition surveys should not feel justified by this conclusion unless their specific study objectives allow them to accept a percentage difference on this scale.

Our results are consistent with those of other studies. In the literature only 24-h recalls conducted as personal interview or by telephone have been validated. Only a few validation studies have compared 24-h recall with dietary record. Young et al. (24), comparing a 24-h recall with a 7-day record, found no differences between the estimates for the groups by tolerating errors (percentage difference) of 10 %. Generally good agreement in mean nutrient intake estimated by the 24-h recall and 3-day food record was reported by Posner et al. (20). Most of the Spearman's correlation coefficients were less than 0.50, as in the present study. The differences in the mean proportion of calories from the main nutrients are comparable with 2.2 % (20) and 2.4 % (Table 3), respectively. Mullenbach et al. (19) compared the 3-day food record and 24-h recall by telephone and concluded that 24-h recalls administered by telephone provide a valid estimate of dietary intake for group comparisons. The recalled crude nutrient intake tended to be underestimated. Caloric density measures did not differ less than in the presented validation study.

No method is universally the best, and the study purpose determines the choice. The proposed self-administered 24HRQ method has several pracitcal advantages. It is quick and easy to perform, places a limited burden on the subject, and is applicable for all persons able to read and write. Furthermore, no influence by the interviewer on the subject is possible. Response rates are high, and field costs are low. An ad hoc dietary survey on an unrestricted number of persons is possible because of the practicability of the 24HRQ.

Overall, the data demonstrate that the self-administered 24HRQ can determine levels of food and nutrient intake of large groups of subjects with an acceptable degree of validity.

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