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VALIDITY OF RETROSPECTIVE DIET HISTORY: ASSESSING RECALL OF MIDLIFE DIET USING FOOD FREQUENCY QUESTIONNAIRE IN LATER LIFE

T. EYSTEINSDOTTIR[1], I. GUNNARSDOTTIR[1,2], I. THORSDOTTIR[1,2], T. HARRIS[3], L.J. LAUNER[3], V. GUDNASON[4], L. STEINGRIMSDOTTIR[1,2]

1. Unit for Nutrition Research, University of Iceland and Landspitali-University Hospital, Reykjavik, Iceland; 2. Faculty of Food Science and Human Nutrition, School of Health Sciences, University of Iceland; 3. Laboratory of Epidemiology, Demography, and Biometry, Intramural Research Program, National Institute on Aging, Bethesda, MD; 4. Icelandic Heart Association, Kopavogur, Iceland and the University of Iceland. Correspondence to: Laufey Steingrimsdottir PhD, Professor, Unit for Nutrition Research, Landspitali-University Hospital, Eiriksgata 29, IS-101 Reykjavik, Iceland. Tel: +354 5438410. Fax: +354 5434824 E-mail: laufey@hi.is

Abstract: *Objectives:* Limited information exists on the validity of dietary information given by elderly people on their past diet. Here we test the relative validity of a food frequency questionnaire asking older persons about their midlife diet. *Design:* Retrospective food intake of 56-72-year-old subjects was estimated using a food frequency questionnaire designed for the AGES-Reykjavik Study (AGES-FFQ), an epidemiological study of older individuals. Results were compared with detailed dietary data gathered from the same individuals 18-19 years previously, i.e., in midlife, as part of a national cohort. Spearman correlation and cross-classifications were used to assess the ability of the AGES-FFQ to rank subjects according to their intake. *Setting:* Nationwide, Iceland. *Participants:* Subjects, born 1937-1952 (n=174), who participated in the 1990 Icelandic National Dietary Survey. *Measurements:* Dietary intake, estimated by the AGES-FFQ (2008-2009), and dietary history obtained from the 1990 Icelandic National Dietary Survey as a reference method. *Results:* The strongest correlation between the AGES-FFQ and the reference method was found for cod liver oil, $r=0.53$, $p<0.001$ and $r=0.56$, $p<0.001$, for men and women, respectively. For men the corresponding correlation coefficient for milk and dairy products was $r=0.43$, $p<0.001$. The correlation coefficients were lower but within a reasonably acceptable range ($r=0.26$-0.40) for meat, fish and potatoes for both genders, as well as fresh fruits and milk/dairy products for women and whole-wheat bread, oatmeal/muesli and blood/liver-sausage for men. No correlation was found between the AGES-FFQ and the dietary history for rye bread and vegetable consumption. Subjects were categorized into five groups according to level of consumption by the two methods. Cross-classification showed that 16-59% were classified into same group and 43-91% into same or adjacent group, 0-14% were grossly misclassified into opposite groups. *Conclusion:* The AGES-FFQ on midlife diet was found suitable to rank individuals by their intake of several important food groups.

Key words: Food frequency questionnaire, validity, midlife diet, elderly.

Introduction

With aging populations, demand on healthcare and social service systems is expected to increase, due to higher prevalence of chronic and degenerative diseases among older age groups (1-3). Investing in healthy ageing and studying determinants of health in older age groups can therefore have significant advantages for society as well as the aged.

Various environmental factors can affect health in late life (4), food habits and dietary intake being among the strongest (1, 4). As most lifestyle-related diseases develop over long periods before being detected (5), successful aging may partially be determined by eating habits and dietary choices made decades earlier (6, 7).

Studies on the relationship between diet earlier in life and healthy aging are of special interest in this regard. However, few methods studies have been able to examine information on remote intake from dietary studies of elderly cohorts, making the use of recalled diets from years back an interesting field of research. Information is limited on the validity of elderly people's answers when asked about remote diet. Studies suggest that past diet may be recalled with acceptable accuracy up to 10 years prior, though greater uncertainty exists beyond this period (5, 6, 8-10). Various factors influence our ability to recall past diet. Even though time is an important factor, frequency and pattern of consumption of individual foods may be even more important, and may affect the way people remember and report past diet (11).

A good way to assess the validity of remotely recalled diet is resurveying individuals who have provided detailed dietary information in the past. Two different dietary assessment methods should ideally be used, the former being a detailed one, while the latter should be suitable for epidemiological studies, such as a food frequency questionnaire (5).

The food frequency questionnaire being assessed here is used in the Age/Gene Environment Susceptibility - Reykjavik Study (AGES-Reykjavik), conducted by the Icelandic Heart Association and the NIA (National Institute on Aging) Intramural Research Program. The study, initiated in 2002, includes 5,764 participants born 1907-1935. It was designed to examine risk factors, such as genetic susceptibility and gene/environment interaction, including diet, in relation to

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disease and disability in old age. Extensive health-related variables have been gathered for all participants, along with information on lifestyle and food intake (AGES-FFQ). The study was approved by the Icelandic National Bioethics Committee (VSN: 00-063) (12) and the MedStar IRB for the Intramural Research Program, Baltimore, MD.

In the present study, a detailed dietary history gathered 18-19 years previously presented a unique opportunity to test the validity of questions on remote diet. The objective of the study was to test the relative validity, i.e. the ability of the questions to acceptably rank individuals according to intake. Assessing the validity of the AGES-FFQ is essential for studying the relationship between health and diet at different periods of life in this large study, here focusing on the middle-aged (40-50y). Furthermore, it may shed important light on the limitations and use of recalled diet in epidemiologic studies of older individuals.

Subjects and methods

Subjects

The subjects were eligible participants in the Icelandic National Dietary Survey (INDS) conducted in 1990, for which detailed dietary information exists, gathered 18-19 years before the present study. The sample from 1990 included 1725 individuals, aged 15-80, selected randomly from the national registry of that time. The participation rate was 72%.

The present study aimed at assessing whether the AGES-Reykjavik food frequency questionnaire could acceptably rank individuals according to dietary intake in midlife (approximately 40-50 years of age). We therefore chose to include only participants who were 38-53 years of age at the time of the 1990 INDS. This slightly wider age bracket was chosen to enlarge the sample size (to approximately n=300) and increase the study's power.

Altogether 326 individuals were in the original sample; thereof fifteen individuals were deceased, and six had moved abroad. An invitation letter and the AGES-FFQ were sent to the 305 eligible participants, 167 women and 138 men, in October-December 2008. Of these, 174 returned completed questionnaires (57%), 107 women and 67 men. Their average age at the time of the 1990 survey was 44 (±4.6y).

Methods

The validity of the AGES-FFQ was assessed by comparing the answers to the questions on remote diet to the dietary data from the 1990 INDS.

The 1990 INDS gathered dietary information with a detailed dietary history focusing on the last three months. Each participant met with an interviewer in an hour-long interview taken in the participant's home, work place or a local clinic. The interviewers (n=32) were teachers or students of nutrition or food sciences. They took a ten-day course prior to the survey for training and synchronizing methods. The participants answered questions on usual diet as well as on socioeconomic factors and personal issues, i.e., age, height, weight, smoking habits, exercise, employment, working hours, education, family type and income. When assessing usual diet, the interviewer asked about each meal/snack of the day, which food groups/items were usually consumed, how often and in what quantities, also which cooking methods were commonly used (baked/boiled/fried, etc.). Quantities were estimated using photographs of different portion sizes, as well as measurement glasses and bowls. Consumption was recorded as times per month, and daily intake of food (grams per day) calculated accordingly (13).

The food frequency questionnaire

The food frequency questionnaire was developed for the AGES study and contains a total of 17 questions on midlife diet (40-50y). The questions ask the average frequency of intake of general food groups, e.g., milk and dairy, fish, meat, bread, fruits and vegetables. Foods and food groups were selected for the questionnaire on the basis of their importance in Icelanders' diet, according to former National Nutrition Surveys, or based on their unique nutritional qualities. Figure1 shows an example question from the AGES-FFQ. The AGES-FFQ was used to rank individuals according to level of intake of general food groups.

Statistical analysis

Statistical analysis was done using the computer program SPSS version 11.0. Kolmogorov-Smirnov tests for normal distribution of data showed that the distribution of the data from the AGES-FFQ was not normal; neither was most of the 1990 data for intake of food groups.

In assessing how well the participants represented the study sample in relation to average dietary intake, student t-tests or Mann-Whitney U tests were performed depending on distribution of data.

To assess correlation between the 1990 data and the answers from the AGES-FFQ, the 1990 data was transformed into times per week, agreeing with the classification of the answers from the AGES-FFQ. Predetermined portion sizes were used, taking into consideration both average daily consumption from the 1990 INDS and recommended portion sizes from the Public Health Institute of Iceland (Table 2). The Spearman's rank correlation test was used to assess correlation. The correlation gives an idea of the validity of the FFQ.

A question was considered to reasonably rank individuals according to their intake of food groups when correlation between the two methods was ≥0.25. For nutrients the correlation coefficient >0.3 has been suggested to be satisfactory when validating present diet (5, 14). Also, validation studies have suggested a correlation of ≥0.4, or even 0.5-0.7 to be optimal (5, 15) when comparing measurements of food intake; however, these studies have been on present diet. Jia et al. (16) validated a food frequency questionnaire on present diet in free-living older people and found a correlation coefficient of ≥0.2 to be reasonably valid. Taking these points

into consideration, the correlation coefficient of ≥0.25 ($p<0.05$) was considered acceptable in the present study, as the aim was to assess the validity of past diet. The number of participants was within the reference sample range for validation studies (100-200 persons), as found by Willet (5).

As the distribution of reported intake was skewed in the AGES-FFQ, it was not possible to divide subjects into quartiles or quintiles. For that reason the two lowest possible answers of the AGES-FFQ were combined, as well as the two highest ones. Answers to the questionnaire were then given values 1-5 according to recorded level of intake, level 1 being the lowest intake, never or less than once a week; level 2 equalling 1-2 times per week; level 3 equalling 3-4 times per week; level 4 equalling 5-6 times per week and level 5 being the highest, equalling daily or more than once per day. Data from the 1990 INDS was also transformed into categories agreeing with the 1-5 classification of the AGES-FFQ answers.

Cross-classification was then used to compare answers to the AGES-FFQ and data from the 1990 INDS to see the proportion of individuals falling into the same, adjacent or opposite category according to intake in the two surveys (using levels 1-5).

Results

Average food intake in 1990 was compared between the participants and the whole sample. No significant difference was found between average intake reported in the 1990 INDS of the whole sample (n=305), and intake of the 174 participants (Table 1).

Table 1
Comparison of consumption in the 1990 survey between whole sample and final participants. Consumption shown as median consumption along with 10th and 90th percentile

	Sample (n 305)			Participants (n 174)			
	P10	median	P90	P10	median	P90	p-value
Men							
Meat	62	145	278	57	138	249	0.476
Fish	30	85	160	21	89	155	0.823
Potato	63	150	286	58	146	314	0.889
Fruit	0	18	155	0	14	145	0.735
Blood-/liver sausage	0	0	43	0	0	45	0.514
Rye bread/flatbread	0	0	36	0	0	33	0.968
Whole-wheat	21	76	161	27	78	169	0.367
Oatmeal/muesli	0	0	96	0	0	97	0.733
Vegetable	7	41	110	8	33	111	0.521
Milk and dairy	113	485	1007	112	509	1022	0.748
Fish liver oil	0	0	13	0	0	13	0.442
Women							
Meat	30	82	146	41	85	147	0.593
Fish	27	54	97	28	57	96	0.878
Potato	30	91	180	29	92	183	0.854
Fruit	0	55	184	0	69	215	0.120
Blood-/liver sausage	0	0	28	0	5	30	0.263
Rye bread/flatbread	0	1	32	0	3	35	0.674
Whole-wheat	19	60	108	19	60	109	0.786
Oatmeal/muesli	0	0	53	0	0	75	0.495
Vegetable	12	55	135	18	64	163	0.302
Milk and dairy	74	341	662	74	336	677	0.861
Fish liver oil	0	0	13	0	0	13	0.150

In table 2, average daily intake in the 1990 INDS is compared with reported intake from the AGES-FFQ. Data is shown separately for men and women. The frequency of intake is similar between men and women according to the AGES-FFQ, but average consumption in grams from the 1990 INDS was different between the genders. As previously reported, the main characteristics of the Icelandic diet in 1990 were high intake of animal-based products, such as fish, meat, milk and dairy products, as well as relatively low intake of fruits, vegetables and cereals, especially cereals rich in fibre (13).

Validity of eleven of the seventeen questions in the AGES-FFQ was tested. Questions about certain foods could not be tested as information from the two methods could not be compared; consumption was either too low or sporadic, or the questions were not directly on frequency of intake. Six questions could not be tested for these reasons, i.e., consumption of fish bread toppings and salted/smoked fish and meat, type of milk commonly used, type of butter/margarine commonly used and amount of butter/margarine used per slice of bread.

Five of the eleven questions tested were found to be acceptable for ranking individuals according to level of food intake. Slight variation in results was found between genders. The strongest correlation was found for cod liver oil for both genders and milk and dairy products for men (r=0.43-0.56). The correlation coefficient was lower (r=0.26-0.35) for meat, fish and potatoes for both genders, and milk and dairy products for women. Furthermore, the question on fresh fruit consumption was found to be reasonably acceptable among women (r=0.31; p=0.001) but not men (r=0.18; p=0.168), and the questions on whole-wheat bread, oatmeal/muesli and blood/liver sausage were found to be reasonably acceptable among men (r=0.40; p=0.001; r=0.28; p=0.026; and r=0.34; p=0.007, respectively) but not women (r=0.05; p=0.582; r=0.22; p=0.027 and r= 0.21; p=0.029, respectively). The questions on rye bread and vegetable consumption were not valid for either gender.

Data from the 1990 INDS was transformed into categories agreeing with the 1-5 classification of the AGES-FFQ answers to see the proportions of subjects falling into the same groups by the two methods using cross-classification (Table 3).

The percentage of participants classified into the same group was 16-59% (average 37%) and 43-91% (average 69%) into the same or adjacent group. Between 0-14% (average 4%) were grossly misclassified into the opposite group. Individuals were most likely to be classified into same/adjacent category in relation to their fish and blood/liver sausage consumption and most likely to be grossly misclassified in relation to their vegetable and cod liver oil consumption.

Table 2
Consumption of participants in the 1990 survey compared to reported consumption according to the AGES-FFQ

	1990 g/d				1990 times per week			FFQ times per week				
	P10	median	P90	g per portion	P10	median	P90	P10	median	P90	correlation	p-value
Men												
Meat	57	138	249	150	2.6	6.5	12.3	1.5	3.5	5.5	0.298	0.016
Fish	21	89	155	150	1.1	3.8	7.8	1.5	3.5	3.5	0.260	0.037
Potato	58	146	314	120	3.4	8.5	18.3	4.3	7.0	7.0	0.348	0.005
Fruit	0	14	145	100	0	0.8	9.8	0.3	1.5	4.7	0.176	0.168
Blood-/liver sausage	0	0	45	70	0	0	4.5	0.3	0.3	1.5	0.335	0.007
Rye bread/flatbread	0	0	33	40	0	0	5.8	0.3	1.5	5.5	0.154	0.224
Whole-wheat bread	27	78	169	54	3.5	10	22.0	3.5	5.5	7.0	0.395	0.001
Oatmeal/muesli	0	0	97	100	0	0	6.8	0	0.3	7.0	0.277	0.026
Vegetable	8	33	111	100	0.6	2.3	7.8	0.3	1.5	5.5	0.153	0.222
Milk and dairy	112	509	1022	400	1.8	8.8	18.5	1.5	7.0	14.0	0.432	0.000
Cod liver oil	0	0	13	13	0	0.3	7.0	0	3.5	7.0	0.534	0.000
Women												
Meat	41	85	147	150	1.8	3.7	6.7	1.5	3.5	5.5	0.255	0.009
Fish	28	57	96	150	1.1	2.3	4.4	1.5	3.5	3.5	0.281	0.004
Potato	29	92	183	120	1.7	5.4	10.7	3.5	7.0	7.0	0.259	0.008
Fruit	0	69	215	100	0	5.0	15.1	0.3	3.5	7.0	0.313	0.001
Blood-/liver sausage	0	5	30	70	0	0.5	3.0	0.3	0.3	1.5	0.214	0.029
Rye bread/flatbread	0	3	35	40	0	0.5	6.1	0.3	3.5	7.0	0.066	0.507
Whole-wheat bread	19	60	109	54	2.5	7.8	14.2	3.5	7.0	7.0	0.054	0.582
Oatmeal/muesli	0	0	75	100	0	0	5.3	0	1.5	7.0	0.215	0.027
Vegetable	18	64	163	100	1.2	4.5	11.4	0.3	3.5	7.0	0.079	0.418
Milk and dairy	74	336	677	400	1.1	5.8	12.0	0.3	7.0	7.0	0.290	0.003
Cod liver oil	0	0	13	13	0	0	7.0	0	3.5	7.0	0.563	0.000

Data from the 1990 survey in grams/day and transformed into times per week using predetermined portion sizes. Data from the AGES-FFQ shown as times per week

Table 3
Cross-classification of participants, portion in same/adjacent group or grossly misclassified

	Same category N (%)		Same or adjacent category N (%)		Grossly misclassified N (%)	
	Men	Women	Men	Women	Men	Women
Meat as a main meal	13 (20.0)	42 (40.8)	35 (53.9)	88 (85.4)	1 (1.5)	1 (1.0)
Fish as a main meal	21 (32.3)	51 (48.6)	51 (78.5)	96 (91.4)	0 (0)	1 (1.0)
Potatoes	37 (58.7)	37 (35.6)	51 (81.0)	73 (70.2)	1 (1.6)	1 (1.0)
Fruits	20 (31.7)	23 (22.8)	41 (65.1)	57 (56.4)	4 (6.3)	4 (4.0)
Blood/liver sausage	39 (60.9)	53 (51.0)	53 (82.8)	93 (89.4)	2 (3.1)	2 (1.9)
Rye bread	10 (15.6)	23 (22.3)	40 (62.5)	56 (54.4)	1 (1.6)	8 (7.8)
Whole-wheat bread	31 (47.7)	50 (47.6)	53 (81.5)	76 (72.4)	2 (3.1)	2 (1.9)
Oatmeal/muesli	32 (49.2)	44 (41.9)	43 (66.2)	72 (68.6)	6 (9.2)	11 (10.5)
Vegetables	12 (18.5)	21 (19.8)	34 (52.3)	46 (43.4)	5 (7.7)	9 (8.5)
Milk/dairy products	28 (43.1)	33 (32.0)	47 (72.3)	64 (62.1)	1 (1.5)	5 (4.9)
Cod liver oil	31 (50.0)	48 (46.6)	40 (64.5)	63 (61.2)	8 (12.9)	14 (13.6)

Discussion

Information is limited on the reliability of elderly people's answers to questions about their diet years or even decades earlier. In the present study we used detailed data from 1990 on the diet of middle-aged people to assess the validity of a questionnaire on remote diet. The frequency of intake of different food items, reported by the AGES-FFQ was found to correlate most strongly with the reference method for cod liver oil and milk and dairy products for men. The correlation coefficients were lower, though within an acceptable range, for meat, fish and potatoes for both genders, as well as fresh fruits and milk and dairy products for women, and whole-wheat bread, oatmeal/muesli and blood/liver-sausage for men. The questions on rye bread and vegetable consumption were not found to be acceptable for either gender.

Even though the consumption of fruits and vegetables among Icelanders has increased in recent decades, the consumption is still low and far from reaching recommended levels of ≥500g/d (17, 18). When compared to other Northern/European countries, Icelanders' consumption is especially low (18-20). In the present study, the question on

vegetable consumption was not found to be valid; neither was the question on fresh fruits for men. A plausible explanation might be the low intake and limited distribution of intake in this age group. An alternative hypothesis is that the extreme weight difference between individual vegetable types, such as leafy vegetables versus tubers, may contribute to the observed lack of relationship between the frequency of consumption and grams per day of this food group.

Figure 1
Example question from the AGES-FFQ

32. On average, how often did you eat fish or a fish dish for a main meal when you were middle aged (40-50y)?

- ❒ Never
- ❒ Less than once a week
- ❒ 1-2 times a week
- ❒ 3-4 times a week
- ❒ 5-6 times a week
- ❒ Daily
- ❒ More than once a day

However, validating questions on fruit and vegetable intake as part of Icelanders' present diet has yielded better results, in studies of both adults and children (21, 22).

The frequency and pattern of consumption seem to greatly affect how people remember past diet. Food consumed daily/several times per day (e.g., milk) may be reported more accurately than foods consumed sporadically/several times per month/week (e.g., poultry). Conversely, food consumed quite rarely, e.g., only on holidays, can also be remembered and reported fairly accurately (11). The present study verified these factors, formerly pointed out by Dwyer and Coleman. Both studies underline the importance of validation measures and studies for retrospectively collected intake data on food groups and special food items. The present study found that consumption of milk and dairy products, potatoes and cod liver oil (foods often consumed daily) was generally more accurately reported than, e.g., fresh fruits and vegetable, eaten several times per week on average. Inconsistency was also found in the reported intake of bread, especially rye bread, which is much less common in the Icelandic diet than wheat bread. Dwyer and Coleman (11) also stated that consumption of dietary supplements with special characteristics (such as cod liver oil) might be recalled especially well, which was also the case in the present study.

Reported consumption of cod liver oil had the strongest correlation to reported actual intake from 1990 ($r>0.5$ for both genders). The reason is perhaps that cod liver oil was generally consumed either every day or not at all; very few subjects consumed cod liver oil sporadically. Interestingly, cod liver oil was also most frequently grossly misclassified, as approximately 13% of participants were classified into the opposite category when comparing the AGES-FFQ to the 1990 data, subjects most commonly reporting daily intake according to the AGES-FFQ, while the data from 1990 reveal no intake. A likely explanation for this seeming discrepancy is that cod liver oil is taken seasonally by many Icelanders, to provide vitamin D during the dark winter months. The reference dietary history method from 1990 was designed to reflect the diet during the past 3 months, while the AGES-FFQ should reflect the usual diet during a whole decade. Therefore, some individuals interviewed in the summer of 1990 may not have been taking cod liver oil at that time, although it may have been a part of their daily diet for most of the year.

The AGES-FFQ on midlife diet was found to quite well represent intake of cod liver oil and thereby intake of vitamin D. The northern latitude of Iceland results in limited production of vitamin D3 during wintertime (23) and consequently very low 25(OH)D levels in adults not taking vitamin D supplements (24, 25). Cod liver oil is traditionally used in Iceland as a vitamin-D source, and the dietary intake of vitamin D from other sources is very limited. The acceptable validity of the AGES-FFQ regarding cod liver oil consumption makes it possible to estimate association between the consumption of cod liver oil and vitamin D intake with several important health-related endpoints.

It should be noted that the correlation coefficient of 0.25 was considered reasonably acceptable in the present study. Although the results show that the AGES-FFQ on remote diet is able to rank individuals according to their intake of several important food groups, one should always be aware of the limitations of the method and the different results seen for different food items. The present study highlights the importance of testing the validity of questions on different food groups, and assessing each question in the questionnaire separately, as validity might differ greatly between questions.

Due to the perception that healthy aging relies to some extent on a healthy and well-balanced diet in earlier life, the ability to recall remote diet is of great interest. With better understanding of the factors most strongly influencing the development of various diseases and having the strongest relations to health and quality of life in the elderly, special preventive measures could be promoted or strengthened and the likelihood of healthy ageing enhanced.

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