Mal J Nutr 6 : 33-44, 2000

Validation of a Dietary History Questionnaire against a 7-D Weighed Record for Estimating Nutrient Intake among Rural Elderly Malays

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ABSTRACT

Energy and nutrient intake estimated using a pre-coded dietary history questionnaire (DHQ) was compared with results obtained from a 7-d weighed intake record (WI) in a group of 37 elderly Malays residing in rural areas of Mersing District, Johor, Malaysia to determine the validity of the DHQ. The DHQ consists of a pre-coded dietary history with a qualitative food frequency questionnaire which was developed to obtain information on food intake and usual dietary habits. The 7-d WI requires subjects to weigh each food immediately before eating and to weigh any leftovers. The medians of intake from the two methods were rather similar and varied by less than 30% for every nutrient, except for vitamin C (114%). For most of the nutrients, analysis of group means using the Wilcoxon matched pairs signed rank sum test showed no significant difference between the estimation of intake from the DHQ and from the WI, with the exceptions of vitamin C and niacin. The DHQ significantly overestimated the intake of vitamin C compared to the WI ($p<0.05$), whilst, the intake of niacin was significantly underestimated ($p<0.05$). The consistency of ranking as assessed using the Spearman's rank correlation coefficient (r) was satisfactory since there were positive correlations between all of the investigated nutrients estimated using the DHQ with those assessed using the WI, except for niacin. Furthermore, both the DHQ and the WI classified approximately 38 to 62% of the subjects into the same tertile for all nutrients, except vitamin C. Therefore, the DHQ was modified by adding a checklist of foods rich in vitamin C and niacin. In conclusion, the DHQ was fairly valid for obtaining the usual intake of most nutrients, particularly on a group basis. These findings indicate that in an elderly population with a high prevalence of illiteracy, a specially designed DHQ can provide very similar estimations to that obtained from 7-d WI.

INTRODUCTION

Assessing dietary adequacy is essential in order to formulate nutrition recommendations with respect to nutrient intake and dietary habits. However, it is a great challenge to assess the dietary intake of elderly people as the decline in short term memory with age makes the usual 24-hr dietary recall particularly unreliable. In particular there is a tendency to underestimate energy and nutrient intake (Borrelli *et al.,* 1989; MacLeod, 1972). The 7-d weighed record (WI) is often

used in developed countries to estimate nutrient intake (Nelson *et al.,* 1989, Hankin, 1989). However, with the expected high rate of illiteracy and low education levels, it is usually not feasible to use this method to estimate nutrient intake among the rural elderly in Malaysia and other developing countries, (Chen *et al.,* 1986). Furthermore, weighed records require a higher degree of commitment and motivation among the subjects. A dietary history method with a single, extended interview to establish 'usual' food consumption patterns requires limited effort by the subjects and can provide detailed information about the food consumed and meal patterns over a longer period, provided that the data are collected by a trained interviewer. Validation studies for the estimation of nutrient intake among elderly people in developed countries have revealed that mean intake assessed by the diet history method is usually higher than by weighed intake (Jain *et al.,* 1980, Borrelli *et al.,* 1989 and MacLeod, 1972), although not always (Van Staveren *et al.,* 1986; Van Staveren *et al.,* 1994). Although diet histories may overestimate true intake, the average error is likely to be consistent between groups, allowing valid comparisons of group means (Nelson, 1991a). Only one previous validation study has been carried out in Malaysia using university students to validate a 24 hr dietary recall against a 1- d weighed intake (Zamaliah, Shamsul & Kandiah, 1999). As yet, no dietary assessment method has been validated for use among elderly Malaysians living in rural areas.

Therefore, this study aimed to develop a dietary history questionnaire (DHQ) for the collection of high quality dietary intake data amongst rural elderly Malays and to demonstrate the relative validity of the DHQ against a 7-d weighed intake (WI). This study used a 7-d weighed record method to validate the DHQ as this technique has been frequently regarded as the 'gold standard' or the most accurate way to assess dietary intake, providing people do not change their normal eating habits (Bingham *et al.,* 1988). In addition, a proxy of a biomarker, the ratio of Energy Intake to Basal Metabolic Rate (EI/BMR) was also computed to evaluate the validity of both methods. This is a pilot study to test the methods prior to the actual larger nutritional and health survey among rural elderly Malays. Findings of this survey have been previously reported (Shahar *et al.,* 1999a; 1999b).

METHOD

Sampling and recruiting

Volunteers for participation in this pilot study were recruited from a traditional village in the district of Mersing, Johor on the east coast of Malaysia through the headman. The major economic activities of the villagers are rubber tapping, fishing, farming and being employed as laborers in estates. The inclusion criteria were that subjects were elderly Malays, aged 60-95 years, resident for at least 12 months before the survey, had no known terminal or mental illnesses and able to complete the 7-d WI either on their own or with help from a literate family member. It was necessary that the family member was residing in the same household and not in full-time employment. Forty eligible subjects volunteered to participate. However, three subjects had to be eliminated due to incomplete records.

Development of dietary methods

Dietary history questionnaire

A DHQ was developed to obtain information on food intake and usual dietary habits. The DHQ consisted of a pre-coded dietary history with a qualitative food frequency questionnaire (FFQ) (Bingham *et al.,* 1988, Hankin, 1989). The design was based on the local dietary habits. Figure 1 illustrates the DHQ technique. The DHQ was pre coded and formatted and included detailed instructions and guidelines for the interviewers so that information on the usual intake could be obtained using non-leading and open-ended questions (See Appendix). The interviewer began by asking the subject to recall all foods and drinks that are usually consumed every day. The recalls were built up to a week period. The subject was also asked when, where and with whom each meal was eaten. As specific items (food or drinks) were mentioned, more direct questions were used to clarify the type, the portion size and the description of the cooking method. The interviewers also obtained home recipes for dishes that were not included in the food composition tables (Tee *et al.,* 1988). Details of snacks taken in-between meals were also collected. The FFQ contained 18 food items frequently consumed in the diet of the study population. The FFQ was used to check the information collected in the dietary history questionnaire. If there were any inconsistencies, the interviewer needed to politely point this out to the subjects at once. Local familiar household measures such as bowls and spoons were also used to help better quantify the portion sizes.

Weighed record technique

For the 7-d weighed record method, subjects were required to weigh each food immediately before eating and to weigh any leftovers (Widdowson, 1936). In a situation where weighing would interfere with normal eating habits, a descriptive record of the foods consumed is accepted (Bingham *et al.,* 1988).

The validation study was carried out in a non-rainy season from May to June 1995. Cultural and religious ceremonies were also avoided to produce sample distributions of the usual dietary intakes. Each subject was visited three times in her/his household by interviewers (a dietitian and a graduate research assistant). During the first visit, the subject was interviewed for 30 to 45 minutes to estimate food intake using the DHQ with a qualitative FFQ checklist. Afterwards, the subject was given advice on how to complete a 7-d WI. This study used this sequence based on the judgement that the DHQ was less likely to influence the subsequent WI than vice versa (Mahalko *et al.,* 1985; Nelson, 1991b). If the subject was not able to complete his/her own record, a family member with numerical skills was instructed on how to record the weighed intake for the subject. A brief demonstration was also performed to ensure better understanding of the procedures. Each subject was provided with a record booklet and a diet scale weighing up to 1 kg in 5 g divisions. Subjects were weighed to the nearest 100 g using a Soehnle digital balance (Fidanza, 1991) and demispan (the length between sternal notch to the joint of middle finger of the left arm) (Bassey, 1986) was measured to the nearest mm using a steel tape. In the middle of the week, the subject was again visited to check on the progress of recording. Finally, after the seventh day, the subject was visited for the collection of the WI record. During this last

visit, the investigators went through the records with the subject or the family member to verify any missing or unclear information.

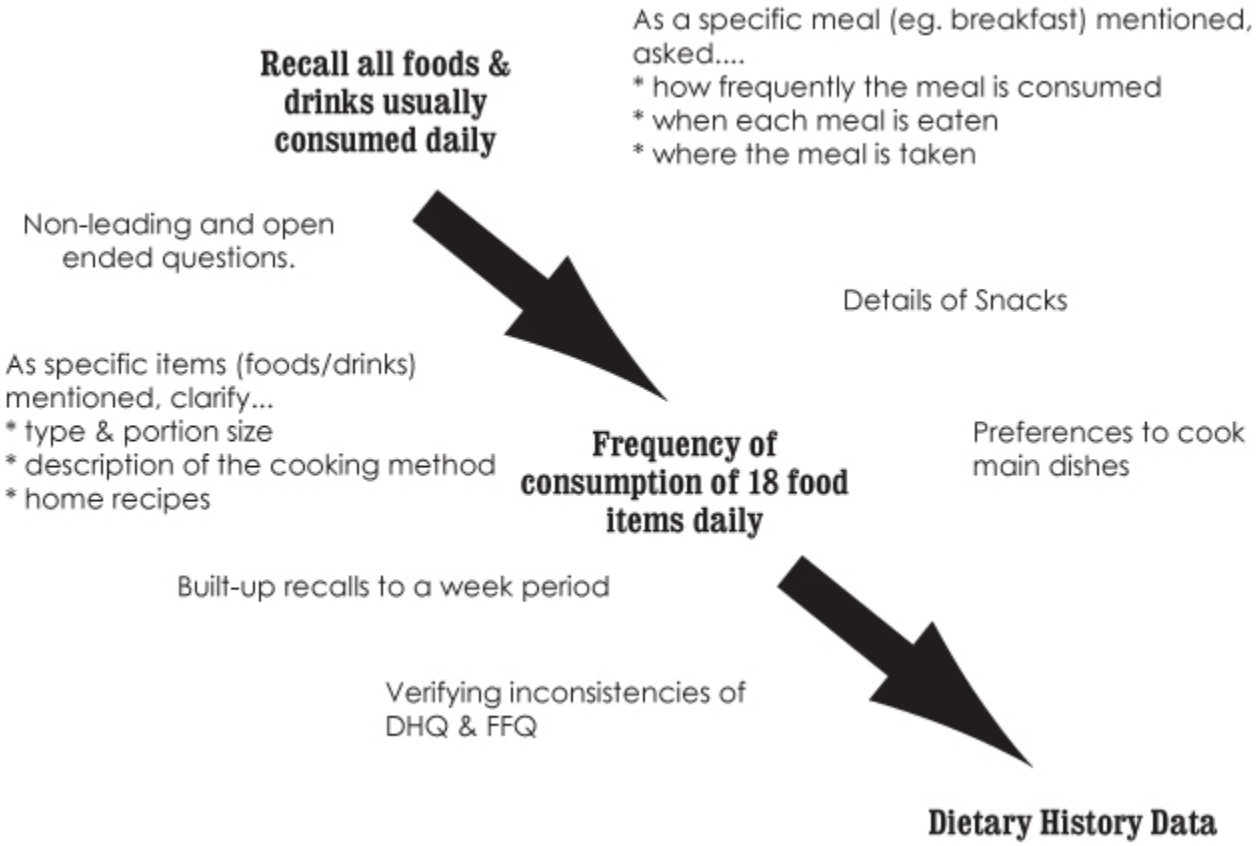

Figure 1. Dietary history technique

DATA ANALYSIS

Body Mass Index (BMI) was derived from weight and demispan using the following equations (Bassey, 1986):

Male: $$\frac{\text{Weight (kg)}}{[(1.40 \times \text{Demispan (cm)} + 57.8)/100]^2\ (\text{m}^2)}$$

Female: $$\frac{\text{Weight (kg)}}{[(1.35 \times \text{Demispan (cm)} + 60.1)/100]^2\ (\text{in}^2)}$$

Subjects with a BMI of less than 18.5 kg/m^2 were classified as having Chronic Energy Deficiency (James, Ferro-Luzzi & Waterlow, 1988). The EI/BMR was calculated to estimate under and over-reporters of energy intake (Goldberg *et al.,* 1991) in both dietary methods. The BMR was calculated using the following equations (Schofield, Schofield & James, 1985):

Male: [0.049 x wt] + 2.459

Female: [0.038 x wt] + 2.755

Intake of nutrients was calculated using the UK Foodbase software (Institute of Brain Chemistry and Human Nutrition 1993) supplemented by 180 Malaysian Foods (Tee *et al.,* 1988). Data were analysed using SPSS for Windows version 6.0. Descriptive findings were presented as percentages and median (95% confidence interval). Analysis of group means (Wilcoxon matched pairs signed rank sum test) and the rankings of individuals (Spearman's correlation coefficients) (Mahalko *et al.,* 1985; Nelson, 1991b) were used to determine the agreement between the DHQ and WI methods. The similarity of both methods in classifying relative intake was examined by calculating the percentage of individuals who could be classified in the correct third of the distribution of the true exposure (WI) using the measured exposure (DHQ) (Mahalko *et al.,* 1985; Nelson, 1991b).

RESULTS AND DISCUSSION

Table 1 presents the characteristics of the subjects. Most of the subjects were married and approximately half had received formal education. Although approximately half of the subjects had normal body weight, about one-third of the subjects were classified as having Chronic Energy Deficiency, with Body Mass Index of less than 18.5 kg/m^2. Table 2 presents the results of the analysis of agreement between the DHQ and the WI. The medians of intake from the two methods were rather similar and varied less than 30% for every nutrient, except for vitamin C (114%). For most of the nutrients, analysis of group means showed no significant difference between the estimation of intake from both methods, with the exceptions of vitamin C and niacin. The DHQ significantly overestimated the intake of vitamin C compared to the WI ($p<0.05$), whilst the intake of niacin was significantly underestimated ($p<0.05$). The consistency of ranking was satisfactory since there were positive correlations between all of the investigated nutrients estimated using both methods, except for niacin ($r = -0.06$). The correlation coefficients, which ranged from 0.17 to 0.43 for all nutrients (except niacin) in this study, are only slightly lower than the correlation coefficients of 0.22 to 0.74 for similar data from a study on 54 elderly people (Mahalko *et al.,* 1985). Since the DHQ and the 7-d WI are not directly comparable (Block, 1982; Mahalko *et al.,* 1985), differences in mean nutrient intake (except for vitamins A, C and niacin) of less than 20%, as noted in this study, are acceptable (Block, 1982; Mahalko *et al.,* 1985). Furthermore, both the DHQ and the WI classified approximately 38 to 62% of the subjects into the same one-third tertile for all nutrients, except for vitamin C.

Table 1. Characteristics of subjects (expressed as %)

Mean (± SD) age (years)	Men (n = 22) 70.68 ± 8.03	Women (n = 15) 69.80 ± 9.41	Total (n = 37)
Married	77.3	66.7	73.0
Received formal education	77.3	33.3	59.5
Perceived poor health status	23.8	46.2	32.4
BMI categories			
CED (BMI < 18.5 kg/m²)	30.0	41.2	35.1
Normal (BMI 18.5-24.9 kg/m²)	55.0	58.8	56.8
Overweight (BMI >24.9 kg/m²)	15.0	0	8.1

CED – Chronic energy deficiency; BMI – Body Mass Index

Table 2. Analysis of agreement DHQ and WI for estimates of energy and nutrient intake

Nutrients	Average intake/subject/day				Analysis of agreement			
	DHQ Median	WI 95% CI	Median	95% CI	Sig. test[a]	Difference[b] (%)	Correlation Coefficient (r)	% correctly classifiedd
Energy (Kcal)	1345	1252-1601	1481	1426-1652	NS	-7.6	0.40[c]	45.9
Carbohydrate (g)	198.0	195-252	226.7	215.6-254.1	NS	-4.2	0.30	51.4
Protein (g)	51.7	43.5-59.6	55.7	51.4-60.5	NS	-8.6	0.34[c]	45.9
Fat (g)	33.4	31.3-43.5	43.1	38.1-45.6	NS	-10.5	0.36[c]	56.8
Vit. A (µg RE)	676.5	543.1-883.3	513.8	461.5-648.1	NS	27.9	0.33[c]	40.5
Thiamine (mg)	0.5	0.4-0.6	0.6	0.5-0.7	NS	-14.3	0.43[c]	45.9
Riboflavin (mg)	0.7	0.7-1.1	0.7	0.7-1.0	NS	6.9	0.24	37.8
Vitamin C (mg)	38.5	42.4-83.0	23.9	22.9-35.4	P<0.05	114.3	0.17	16.2
Niacin (mg)	5.1	4.5-6.4	6.4	6.2-8.3	P<0.05	-25	-0.066	2.2
Calcium (mg)	264.9	229.2-340.8	264.2	236.6-322.0	NS	2.1	0.29	48.6
Iron (mg)	7.4	7.2-10.7	9.9	9.2-12.7	NS	-19.3	0.23	56.8

a Analysis of group mean using Wilcoxon matched pairs rank sum test at 2-tailed significance
b Percent difference = [(DHQ-WI) ÷ DHQ] x 100
c Significant at p<0.05
d % correct classification at 1/3 tertile of WI

The poor agreement between the DHQ and WI for vitamin C was probably due to the difficulty of accurately reporting intake of fruits and vegetables that are highly seasonal. Therefore, the DHQ was modified by adding a checklist of fruits and vegetables to the FFQ. The under-reporting of niacin as assessed using the DHQ was probably due to errors in the estimation of

portion sizes or the under reporting of foods rich in niacin. Therefore, modification of the DHQ by adding a checklist of major sources of niacin such as meat and cereal products was essential. Additional training is also needed on the estimation of portion sizes using household measurements.

Both methods were also agreeable in classifying under and over-reporters with approximately 50% of subjects being identified as under-reporters. Women were more likely to fall into this category (Table 3). This indicates that both methods were more likely to under report true intake. It should be borne in mind that although the weighed record has been frequently regarded as the 'gold standard', its validity has been increasingly questioned. It has been demonstrated that energy intake from a 7-d weighed records agreed with energy expenditure estimated from the double labeled water method only in normal weight women, not in the obese group (Prentice *et al.,* 1985). More recently, it was reported that even in normal weight individuals, energy intake computed from 7-d weighed intakes underestimated true intake as measured by the doubly labeled water technique by 20% (Livingstone *et al.,* 1990).

Table 3. Prevalence of under and over-reporting of energy intake as estimated using DHQ and WI (expressed as percentages)

EI/BMR categories	DHQ			WI		
	Men (n = 22)	Women (n = 15)	Total (n = 27)	Men (n = 22)	Women (n = 15)	Total (n = 27)
<1.2 (under-reporters)	45.5	73.3	56.8	36.4	60.0	45.9
1.2 – 1.8 (Reporting habitual intake)	45.5	20.0	35.1	59.1	26.7	45.9
> 1.8 (Over-reporters)	9.1	6.7	8.1	4.5	13.3	8.1

In conclusion, in an elderly population with a high prevalence of illiteracy, a DHQ can provide very similar estimations to those obtained from a 7-d WI. The validity of dietary assessment methods need to be further investigated using independent biological markers of food intake such as the doubly labeled water technique and 24-hr urinary nitrogen excretion.

ACKNOWLEDGEMENT

We are grateful to Assoc. Prof Dr. Suriah A. Rahman for her assistance during data collection in the actual study, the elderly subjects and the fieldworkers. Financial assistance was received from Universiti Kebangsaan Malaysia (UKM N1/95) and the UK Nuffield Foundation. Preliminary report of the manuscript has been presented as a poster for the 5th Congress of the Parenteral and Enteral Society of Asia, 28 - 30th October 1999, Shangri-La Hotel, Kuala Lumpur.

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Appendix. Sample of a pre-coded dietary history questionnaire

Would you give a recall of what did you usually eat or drink every day from wakeup in the morning till time to bed at night?

Breakfast Frequency: 1-everyday 2-almost everyday (5-6x a week)
3-sometimes (3-4x a week) 4-often (1-2x a week)
5-seldom (less than once a week) 6-none

What time eaten: _____
Where eaten:
1-home 2-café 3-work place 4-other (please specify .....)

With whom eaten:
1-alone 2-family 3-friends 4-other (please specify .....)

Type of Meal	Portion size (household measures and food photographs)	Description/method of cooking	Portion size (household measures)	Comments (frequency of usual consumption)	Office use Food Amount code g)
Rice: Nasi lemak Nasi dagang Boiled/fried Other_____	___ bowl (L/S/M) ___ packet (___ cents)	Sauce/Gravy:	___ dsp (l/h) ___ bowl (L/M/S) (l/h)		
Mee/Bihun/Laksa: Fried/boiled/curry Soup/other	___ bowl (L/S/M) ___ packet (___cents)	Sauces/Gravy/Slide dishes:	___ bowl (L/M/S)		
Bread: White/wholemeal Pharatta/chapati Tosei/pharatta with egg	___ slices (thick/medium) ___ pieces (L/M/S) (___cents)	Spread: margerine/butter (what type: ___) jam (what type) Sauces/Gravy:	___ dsp/tsp ___ dsp/tsp		
Type of Meal	Portion size	Description/method of cooking	Portion size	Comments	Office use
		Fish _____ Meat _____ Poultry/egg_____ Beans/lentils/ dhalls_____	___ bowl (L/M/S)		
Pastry/pancake/cake Savoury cake	___ pieces (L/M/S) ___ cents/portion	Sauces/Gravy: _____	___ bowl (L/M/S) ___ tsp/dsp		
Biscuits:	___ pieces	Sauces/Gravy/ Spread:_____	___ bowl ___ tsp/dsp		
Other:					

Drinks:			
coffee/tea	___ cup	Sugar	___ tsp/dsp (l/h)
chocolate/milo/ ovaltine/horlicks	___ dsp/tsp (l/h)	milk (skimmed / lowfat / Full cream / evaporated /condensed)	___ tsp/dsp (l/h)
Plain water			
Snacking (between meals)			

Code: L=Large M=Medium S=Small l=level h=heaped; tsp=teaspoon; dsp=desertspoon