Mal J Nutr 1:95-104, 1995

Evaluation of food photographs for 24-hour recall method

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ABSTRACT

The purpose of this study was to develop a visual aid to improve and increase accuracy of the 24-hour recall method. This aid in the form of a booklet, consists of life-sized photographs of common Malaysian foods, accompanied by the weight of its edible portion and nutrient values. These photographs used together with the recall method were tested against the weighed record method for its validity. For this preliminary test, a total of 23 photographs of food items were tested. Sixty healthy adult volunteers were selected as respondents for the test. These respondents were divided into 2 groups. Each group was given either a simple or complicated menus. The respondents were served 3 test meals: breakfast, lunch and tea. Each food item served and plate waste were weighed and recorded. The 24-hour recall was conducted the day following the weighed record day. The results of the paired t-tests indicated no significant difference in group's mean weights of food intake between the weighed record and recalled method for 13(57%) of the foods tested. The correlation coefficients between the two methods showed a moderate to strong positive relationships for 17 out of the 23 food photographs tested (ranged from $r=0.49$-0.92, $p<0.01$). Analysis on the nutrient intake for simple menus showed high correlation coefficients between both methods for all nutrients tested, $r=0.62$-0.95, $p<0.01$. For the complicated menus, the correlation coefficients were slightly lower than the simple menus, ranging from $r=0.38$-0.71, $P<0.0l$. Except for the fat intake in the complicated menus, all the correlation coefficients between the two methods reached 0.5 and above for both types of menus.

INTRODUCTION

The 24-hour recall method is a widely used approach to collect dietary information. It is a simple method that impose little burden to the respondents and is suitable for all levels of literacy. The household and standard measures, verbal descriptions are commonly used in this method. In Malaysia, food models and photographs are sometimes used. The use of food models is expensive and inconvenient due to the nature of the survey, whereby interviewers have to make home visits. This reason plus the involvement of a lot of interviewers in a community survey becomes a deterrent factor in using the food models. The use of photographs to quantify amounts of food eaten has been used, however little is known on the accuracy of photographs as an estimate of food intake and subsequently on nutrient intake. Consequently, as shown in some studies (Carter, Sharbaugh & Stapell, 1981 and Karvetti & Knuts, 1985) there occurs an underestimation and overestimation of intake.

It is the purpose of this study to develop a visual aid to improve and increase accuracy of the assessment of dietary intake using the 24-hour recall method. This aid is in the form of life-sized photographs of foods accompanied by the serving size, weight of edible portion and nutrients. This paper reports a preliminary study on the validity of the visual aid. It will examine the intake of foods (by weight) and nutrients from test meals using the recalled method with food photographs and the weighed record method.

METHOD

The methodology involved two phases, the development of visual aid and the validation of the visual aid.

Development of visual aid

In the first phase, about 250 common food items from food groups such as cereals, nuts and lentils, milk, vegetables, fruits, meat and fish, and ready made foods were selected to be included in the instrument. Dishes made from these foods were mainly prepared in the food preparation laboratory of the Department of Nutrition and Community Health, Universiti Pertanian Malaysia or bought. All foods prepared were weighed according to familiar serving sizes. The food items were then photographed, after which the edible portion of these photograped food items were weighed. The ingredients in store- bought foods were separated and weighed. The nutrient contents of each food item were calculated using the Demeter software, a computerized version of the Nutrient Composition of Malaysian Foods (Tee *et al.,* 1988) or based on recipes.

Validity test

Weighed record of intake

The validity test was carried out after the completion of the visual aid. Sixty healthy adult volunteers (25 men and 35 women aged 19-42 years) who met the criteria of being able to eat the meal and be interviewed the following day were selected for the tests. These respondents were divided into 2 groups of 30. Each group was given a different set of menus. The first set of menus consisted of simple dishes in which the ingredients could be easily singled out, and the second set of menus was more complicated. It consisted of mixed dishes (more than 2 ingredients in a dish). The meals consisted of representatives of the different food groups prepared in a manner familiar to the respondents.

A total of 8 foods were tested with the simple menu and 15 with the complicated one. Three meals: breakfast, lunch and tea were served to the respondents. Breakfast for a simple meal consisted of coffee, bread, egg and sausages. Lunch included rice, fried chicken, fried french beans and cuttlefish cooked in chilli. The respondents were served shrimp fritters and coffee during teatime. The breakfast for the complicated menus were curry noodles consisted of 7 food items such as noodles, fishballs, chicken pieces, shrimps, egg, carrots and curry gravy. For lunch the respondents were served rice, fried Chinese mustard with shrimp, mackeral with okra cooked

in chillie gravy, and fried chicken liver and gizzard. At tea time grambean porridge cooked with coconut milk was served.

Each respondent from a group was served different servings of the same foods. Each of the food item served and the plate waste were weighed and recorded. All the foods were cooked and served at the food preparation laboratory in the department.

24-hour recall

The 24 hour recall was conducted the day following the weighed record day. It was carried out in the laboratory by the investigator, who had no knowledge of the weights and serving sizes of the foods consumed. Life-sized photographs of the foods represented were used during the interview. With the help of the photographs the respondents were asked to recall the amount of foods that they had eaten. The photographs shown indicated single serving, but different serving sizes can be found for certain foods. The respondents quantified the amount of foods they consume in terms of fractions or multiples of the amount shown in the photographs. These serving sizes will then be converted to edible weight as indicated in the booklet and recorded by the investigator.

Data analysis

The weight of actual foods consumed and the weight of foods recalled were converted to energy and nutrients using the computerized Nutrient Composition of Malaysian Foods (Tee *et al.*, 1988). The Statistical Package for Social Sciences (SPSS-PC+) computer programme was used to analyze the data. The paired t-tests was used to compare the group's mean weights of food and nutrient intake between the weighed record method and the recalled method with photographs. Correlations between the two methods were also computed.

RESULTS

Intake of foods

Simple menus

The group's mean intake of foods from the simple menu as recorded by the weighed record method and recalled method is shown in Table 1.

The results of the paired t-tests indicated there was no significant difference in the group's mean weight of food intake between the weighed record method and the recalled method using photographs for all the foods tested except for egg, rice, cuttlefish, and French beans.

The recalled mean intake differed between - 20% to 12.05% from the weighed food record intake. For 50% of the foods tested, the difference were less than 10%. The differences between weighed record and recall weight for rice and cuttlefish were more than 20%. The sign of the mean difference indicated the underestimation and overestimation of foods recalled. Majority of

the food items were underestimated. The most underestimated food items were rice and cuttlefish.

Table 1. Mean weighed record (1) and recalled (2) intake of foods from simple menus (weight in grams)

Food items	Method	Mean intake (g)	s.d.	% difference #	Correlation coefficients
Bread	1	57.4	10.6	- 1.7	0.92**
	2	56.4	12.5		
Hot Dog	1	36.1	16.8	-1.4	0.88**
	2	35.6	19.3		
Egg	1	36.5	9.6	12.05*	0.87**
	2	40.9	12.6		
Rice	1	192.1	45.2	-20.8*	0.75**
	2	152.2	34.6		
Fr. Chicken	1	34.1	15.8	-12.9	0.49**
	2	29.7	14.1		
Cuttlefish	1	49.7	16.4	-20.7*	0.6**
	2	39.4	19.0		
Frenchbeans	1	42.8	12.5	-9.6*	0.64**
	2	38.7	13.9		
Fritters	1	84.6	20.8	-4.49	0.81**
	2	80.8	25		

Method 1 weighed record, method 2 recalled
* paired t-test significant difference at $P < 0.05$
** Correlations significant at $P < 0.01$
\# 100x (recalled-weighed record) / weighed record

Table 1 also presented the results of the correlation analyses. The correlation coefficients between the two methods for all the food items, except for fried chicken were highly significant, with a range of 0.49 to 0.92 ($p<0.01$). Foods that are easily quantifiable such as bread, hot dog and egg reached the highest correlations, that is 0.92, 0.88 and 0.87, respectively. For rice and cuttlefish, eventhough the percentage of difference was very high between the two methods, their correlation were significant $r=0.75$ and $r=0.6$, respectively.

Complicated menus

Table 2 presented the group's mean intake of foods as recorded by the weighed record and recalled method using photographs.

In the complicated menus the first 7 foods in Table 2 were combined together in one dish called curry noodles. The fish and okra were also prepared as one dish, so were the chicken liver and gizzard.

The results of the paired t-tests indicated there was significant difference in group's mean weight between weighed record method and recalled method using photographs for some of the food items except for noodles, fishball, carrot, curry gravy, egg, chicken liver, chicken gizzard,

watermelon and green gram porridge. The difference between recalled and weighed record intake was between -47.2% to 51%. A total of 5 food items were overestimated and 10 underestimated. The food items that were erroneously estimated were chicken pieces, shrimp, rice, mackerel and mustard. Two of these foods come from the very mixed dishes of curried noodles. Large estimation errors by a few individuals had affected the outcome. However, the difference between recalled and weighed record intake of 9 of the food items were less than 10%.

Table 2. Mean weighed record and recalled intake of foods from complicated menus (weight in grams)

Food Items	Weighed record method		Recalled method		% difference #	Correlation coefficients
	mean	s.d.	mean	s.d.		
Noodles	87.9	28.6	79.8	21.2	1.0	0.61**
Chicken pieces	19.8	7.5	29.9	17.5	51.0*	0.06
Shrimp	7.4	1.5	4.5	2.5	-39.5*	0.32
Fishball	12.4	5.0	12.7	4.4	2.4	0.27
Carrot	7.4	3.2	6.6	3.2	-1.1	0.22
Curry gravy	77.3	30.1	84.6	43.2	9.4	0.35
Egg	24.2	8.8	22.5	9.2	-7.0	0.78**
Rice	177.4	52.1	132.1	42.7	-25.5*	0.78**
Mackerel	34.0	15.8	25.8	9.8	-24.0*	0.32
Okra	22.4	13.9	17.9	14.4	-20.0*	0.74**
Mustard	33.7	11.2	17.8	10.4	-47.2*	0.62**
Chicken Liver	15.2	6.9	15.1	9.4	-0.01	0.73**
Gizzard	7.4	4.6	7.4	5.1	0.0	0.78**
Watermelon	77.2	26.3	72.3	29.0	-6.3	0.52**
Greengram porridge	156	56.0	163.7	61.8	4.9	0.58**

* paired t-tests significant difference at $P < 0.05$
** correlations significant at $P < 0.01$
\# 100x (recalled — weighed record) / weighed record

The correlations between the two methods are also presented in Table 2. Nine out of the 15 food tested showed highly significant correlations ranging from 0.52-0.78($p<0.01$). Such foods are noodles, egg, rice, okra, mustard, chicken liver, gizzard, watermelon and green gram porridge. A lower correlation coefficients ranging from 0.06-0.35 were noted for foods from the mixed dishes of curried noodles. They are chicken pieces, shrimps, fishballs, carrots, and curry gravy. The correlations between record and recalled intake of mackeral were also low, $r=0.32$ ($P<0.01$).

It was observed during the interview that the respondents had a difficult time trying to estimate small portion of foods consumed with photographs that showed a bigger portion, such as having to define small chicken pieces and shrimp with a photograph of a larger serving size. As for rice, even though the correlation coefficient between the two methods is high $r=0.78$, the difference between weighed record and recalled observations was also high. A photograph showing one portion size was inadequate for respondents to make good estimates. With one portion size shown, 1 cup of rice is no different than a 11/4 cup or 11/2 cup of rice to the interpretation of the

respondents. Its difficulty may also be due to its lack of shape and size. This poor interpretation was also observed when estimates were made on Chinese mustard.

Then underestimation or overestimation of foods have been recorded in other studies. Robson (1995) found large individual errors between estimates using photographs through diet recall and actual amounts of food consumed but at group level the differences were not significant. The individual errors ranged between +20-50%. The present study noted smaller differences between weighed record and recalled method for most of the foods tested.

Nutrient intake

Since the final usage of this visual aid is to calculate nutrient intake, all the foods consumed by each respondent were converted to energy, carbohydrate, fat, protein, calcium, iron, retinol equivalent and ascorbic acid using a computerized Nutrient Composition of Malaysian Foods.

Tables 3 and 4 showed a strong positive relationships between the two methods. In the simple menu the correlation coefficients between weighed record and recalled nutrient intake were moderate to strong ranging from r=0.62-0.95, whilst the complicated menus the correlations were in the lower range of 0.38 to 0.71. ($P<0.01$). In the complicated menus the correlations between intake of all nutrients recorded and recalled were more than 0.5 except for fat which is a low 0.38. The fact that the number of food items in the complicated menus were twice as much as the simple menus and not easily singled out may have affected the correlation coefficients.

Table 3. Mean Weighed Record (x) and Recalled (y) Nutrient Intake for Simple Meals

Nutrients	Weighed method		Recalled method		Correlation coefficients between x and y
	mean	SD	mean	SD	
Energy (kcal)	948	141	841	167	0.62**
Carbohydrate (g)	125	20	111	18	0.85**
Protein (g)	41.3	7.5	38.0	7.8	0.82**
Fat(g)	31.3	6.6	29.5	6.7	0.81**
Calcium (g)	184.0	33.3	169.3	34.6	0.64**
Iron (mg)	7.8	1.3	7.3	1.4	0.80**
Retinol equiv. (µg)	472.6	89.1	445.6	95.2	0.67**
Ascorbic acid (mg)	31.1	10.7	30.1	12.5	0.95**

** correlations significant at $P < 0.01$

Table 4. Mean Weighed Record (x) and Recalled (y) Nutrient Intake for Complicated Menus

Nutrients	Weighed method		Recalled method		Correlation coefficients between x and y
	mean	SD	mean	SD	
Energy (kcal)	1037	220	992	235	0.5**
Carbohydrate (g)	128	31	111	23	0.71**
Protein (g)	40.6	7.8	38.0	8.0	0.51**
Fat(g)	40.2	10.1	43.9	17.3	0.38
Calcium (mg)	194.3	34.9	168.6	34.2	0.51**
Iron (mg)	8.8	1.5	8.5	1.9	0.58**
Retinol equiv. (µg)	2894.6	1014.6	2650.0	1463.7	0.64**
Ascorbic acid (mg)	41.8	10.9	27.5	11.1	0.53**

** Correlations significant at $P < 0.01$

DISCUSSION

The 24-hour recall method is a more favored method because of its logistical simplicity as compared to the tedious and cumbersome techniques of weighed record method in the collection of dietary data. However, reports of its accuracies and inaccuracies have been noted (Cameron & Staveren, 1988). Todd, Hudes & Calloway (1983) concluded that a single 24-hour recall was not an accurate estimate of the intake of individuals as recorded in a diary for that same day. It was observed that the major contributions to total variance in the 24-hour recall method were within-subject and between-subject variances. These results confirmed the results of another study (Beaton *et al.*, 1979). The impact of a large interindividual and intraindividual variation can be reduced by standardizations and controlled procedures (Beaton *et al.*, 1979). This present study aimed at producing standardizations through photographs were unable to detect variance because the readings were taken only once from each respondent. However, statistical tests to determine differences in group's mean weight of food and nutrient intake between weighed record and recall method with instrument were encouraging. The correlation coefficients showed strong positive relationships between the two methods for all of the photographs of food items tested with coefficient ranging from 0.49 to 0.92 for the simple menus. The correlation coefficients between the two methods for 63% of the photographs tested were above 0.7, and 37% within the 0.5-0.6 range. Analysis on the nutrient intake of the simple menus showed a moderate to high correlations between weighed record and recalled nutrient intake (range of $r=0.62-0.95 (P<0.01)$. Lower correlation coefficients within the range of $r=0.38-0.71$ ($P<0.01$) were achieved by the complicated menus. These differences can be reduced and the correlation coefficient can be increased by re-photographing the food items involved in different portions and retesting for their validity.

This pictorial method using different portion sizes for quantifying food intakes has been used by other researchers. Howat & Mohan (1995) in their study using life-sized food photographs to improve accuracy of food portion estimates indicated a significant reduction in percent error of food portion estimates in subjects trained with photographs. Contrary to that, some studies demonstrated its flaws. Haraldsdottir, Tjonneland & Overvad (1994) in trying to validate the portion size estimates for foods through photographs with food frequency questionnaire reported

that individuals who selected photographs of small portion sizes tended to underestimate their actual portions, whereas those who selected photographs of large portions would overestimate them. This present study confirmed these findings. In the case of rice, chicken pieces, fish, shrimp and Chinese mustards which respondents underestimated, the photographs shown to them were of smaller portion sizes than what was consumed. For chicken pieces, the portion consumed was 6-9 times smaller than the photographs.

CONCLUSION

In conclusion, this visual aid would be useful for collecting dietary data, even though the agreement achieved between the weighed record and recall method was only for 13(57%) of the food items tested. A high correlation coefficients between the two methods for most of the foods tested indicated that the photographs evaluated can be considered as a precise devise in the quantification of the food intake estimates. However since the statistical tests used in this study did not take care of the problems of underestimation or overestimation of intake, studies that try to associate diet and diseases may have to take careful considerations. It cannot be generalised either whether this aid is suitable to be used by all age groups. However, data collection and analysis of 24-hour recall can be simplified by this visual aid in terms of its simple food to nutrient conversion and correct quantification of the foods consumed.

However, since agreement was better for some food items than others, further tests need to be done together with the other foods. Food items that did not validate with the weighed record method will be rephotographed and retested. In future, replications of studies will be conducted for each respondent in order to determine the source of variance.

ACKNOWLEDGEMENTS

This study was funded by the University Pertanian Malaysia under the short-term project. The author is grateful to students Normala Halim, Salmiah Uyob and Mariati Muslim for their assistance in the preparation of dishes. Special thanks to Encik Nasir Taib and Dr. Mumtazah Othman for reviewing the manuscripts.

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