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Semi-Quantitative Food Frequency Questionnaire for Assessment of Energy, Total Fat, Fatty Acids, and Vitamin A, C and E Intake among Malaysian Women: Comparison with Three Days 24-Hour Diet Recalls

(Soal Selidik Kekerapan Makanan Semi-Kuantitatif untuk Penilaian Pengambilan Tenaga, Lemak Total, Asid Lemak dan Vitamin A, C dan E di kalangan Wanita Malaysia: Perbandingan dengan Ingatan Diet 24 Jam Tiga Hari)

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ABSTRACT

Food frequency questionnaire (FFQ) is a practical tool for the measurement of usual food intake in large surveys because it gives a quick approximation to 'true' dietary intake. This study was carried out to compare the semi-quantitative FFQ with three day 24-hour diet recalls (24-hr DR) in assessing intake of energy, total fat, fatty acids and vitamin A, C and E among Malaysian women. This semi-quantitative FFQ which was developed specifically for the Malay and Indian ethnicities has 200 food items and categorized according to three mealtimes namely breakfast, lunch or dinner and morning or afternoon snacks. A total of 51 Malay and 28 Indian women aged between 30 to 60 years were selected as study subjects. The result of the study shows that majority of study subjects were within the normal EI/BMR ratio when their energy intake was assessed by semi-quantitative FFQ (70%) and 24-hr DR (74%). However, 10% of study subjects became over-reporters when their intakes were assessed using the semi-quantitative FFQ. Analysis of t-test shows there is no significant difference ($p > 0.05$) on the mean intake of energy, total fats, saturated, monounsaturated and polyunsaturated fatty acids and vitamin A, C and E between semi-quantitative FFQ and 24-hr DR. Percent mean differences were also less than 10% for all nutrients included in this study. This indicates that the semi-quantitative FFQ can produce comparable results with 24-hr DR. Energy adjusted correlation coefficient values for all studied nutrients were total fat ($r = 0.64$, $p = 0.02$), saturated fatty acids ($r = 0.59$, $p = 0.01$), monounsaturated fatty acids ($r = 0.52$, $p = 0.03$), polyunsaturated fatty acids ($r = 0.57$, $p = 0.02$), vitamin A ($r = 0.69$, $p = 0.01$), retinol ($r = 0.55$, $p = 0.01$), beta carotene ($r = 0.74$, $p = 0.01$), vitamin C ($r = 0.64$, $p = 0.02$) and vitamin

E (r = 0.69, p = 0.01). Cross-classification for both methods into quartiles of intake resulted in correct classification into the same or adjacent quartile from 82% to 96% of the study subjects. Only 3% of the subjects were grossly misclassified. As a conclusion, this semi-quantitative FFQ gives estimation as good as 24-hr DR for intakes of energy, total fat, fatty acids and vitamin A, C and E among Malaysian women specifically for the Malay and Indian ethnicities. This semi-quantitative FFQ is a useful tool in dietary intake assessment for research use especially for epidemiological study on diet and disease relationship such as cardiovascular, cancer and diabetes.

Key words: Semi-quantitative Food Frequency Questionnaire, 24-hour Diet Recall, Diet, Energy, Total Fat, Fatty Acids, Vitamin A, C and E, Women, Malay, Indian.

ABSTRAK

Soal selidik kekerapan makanan (FFQ) adalah alat yang praktikal untuk menentukan pengambilan makanan biasa dalam kajian yang besar kerana ia boleh memberikan gambaran 'sebenar' pengambilan diet dengan tepat. Kajian ini telah dijalankan untuk membandingkan FFQ semi-kuantitatif dengan ingatan diet 24-jam (24-hr DR) selama tiga hari untuk menilai pengambilan tenaga, lemak total, asid lemak dan vitamin A, C dan E di kalangan wanita Malaysia. FFQ semi-kuantitatif yang dibangunkan khusus bagi etnik Melayu dan India ini mempunyai 200 item makanan dan dikategorikan kepada tiga waktu makan utama iaitu sarapan pagi, makan tengah hari atau malam dan snek pagi atau petang. Seramai 51 orang wanita Melayu dan 28 orang wanita India berumur di antara 30 hingga 60 tahun telah dipilih sebagai subjek kajian. Hasil kajian menunjukkan bahawa majoriti subjek kajian berada dalam julat normal nisbah EI/BMR apabila pengambilan tenaga dinilai dengan menggunakan FFQ semi-kuantitatif (70%) dan 24-hr DR (74%). Walau bagaimanapun, 10% daripada subjek telah lebih lapor apabila pengambilan mereka dinilai dengan menggunakan FFQ semi-kuantitatif. Analisis ujian-t menunjukkan tiada perbezaan yang signifikan (p > 0.05) wujud bagi min pengambilan tenaga, lemak total, asid lemak tepu, monotaktepu dan politaktepu serta vitamin A, C dan E di antara FFQ semi-kuantitatif dan 24-hr DR. Peratus perbezaan min juga adalah kurang dari 10% bagi semua nutrien dalam kajian ini. Ini menunjukkan bahawa FFQ semi-kuantitatif boleh memberikan hasil yang hampir sama dengan kaedah 24-hr DR. Nilai korelasi koeffisi bagi kesemua nutrien yang dikaji selepas dibetulkan kepada pengambilan tenaga adalah lemak total (r = 0.64, p = 0.02), asid lemak tepu (r = 0.59, p = 0.01), asid lemak monotaktepu (r = 0.52, p = 0.03), asid lemak politaktepu (r = 0.57, p = 0.02), vitamin A (r = 0.69, p = 0.01), retinol (r = 0.55, p = 0.01), beta karotene (r = 0.74, p = 0.01), vitamin C (r = 0.64, p =

0.02) dan vitamin E (r = 0.69, p = 0.01). Klasifikasi bersilang kepada kuartil pengambilan nutrien bagi kedua-dua kaedah menunjukkan klasifikasi tepat ke dalam kuartil yang sama atau bersebelahan bagi seramai 82% hingga 96% daripada subjek kajian. Hanya 3% daripada subjek kajian telah disalah klasifikasi. Kesimpulannya, FFQ semi-kuantitatif ini memberikan anggaran pengambilan tenaga, lemak total, asid lemak dan vitamin A, C dan E yang sama baik seperti 24-hr DR di kalangan wanita Malaysia khususnya bagi etnik Melayu dan India. FFQ semi-kuantitatif ini adalah alat yang berguna dalam penilaian pengambilan diet bagi kegunaan penyelidikan terutama dalam kajian epidemiologi kaitan diet dan penyakit seperti kardiovaskular, kanser dan diabetes.

Kata kunci: Soal Selidik Kekerapan Makanan Semi-kuantitatif, Ingatan Diet 24-jam, Diet,Tenaga, Lemak Total, Asid Lemak, Vitamin A, C dan E, Wanita, Melayu, India.

INTRODUCTION

There is a growing interest among researchers in the role of fatty acids and antioxidant vitamins in the etiology and pathogenesis of diseases such as cardiovascular and certain types of cancer. Thus, a good dietary intake assessment tool suitable for large-scale epidemiologic study is required. Food frequency questionnaires (FFQ) have been used as quick approximations to 'true' dietary intake (Willet 1998). The major advantage of the FFQ is its representative as it covers intake over a longer period. It also appears to be low in cost during both administration and analyzing process (Subar 2004).

Theoretically a FFQ validation procedure is to test the FFQ against another method, which is known to be more accurate than other methods among the study population (Thompson & Byers 1994; Willet 1998). Cade et al. (2002) found that in most validation studies, FFQ measures were actually compared with an alternative method of assessing diet, but not necessarily more accurate than FFQ, since there is no 'ideal' method for the measurement of dietary intake as a whole. In Malaysia, 24-hour diet recalls (24-hr DR) and food records method have been more widely used than weighed intakes as it have high reliability, easy to administer, has high response rate and acceptable accuracy (Zamaliah et al. 1999; Norimah & Leong 2000; Chee et al. 2002; Moy & Suriah 2002; Poh et al. 2005). A new FFQ is usually validated by comparing the mean values for a particular nutrient from the FFQ and a comparison method. It also includes correlation analysis between the two methods and examining of its ability to classify individuals into the same groups as the comparison method (Paisley et al. 1996).

Several FFQ specifically designed to assess intake of fatty acids and vitamin antioxidants were validated namely in Singapore, Korea, United States and United Kingdom (Deurenberg-Yap et al. 2000; Kim et al. 2003; Subar et al. 2001; Broadfield et al. 2003). However, the FFQ developed in other populations are not suitable for use in Malaysian population due to differences in food choices and dietary habits. Previously, a FFQ specifically for assessing energy, total fat, fatty acids and vitamin A, C and E was developed and pilot-tested among Malaysian women (Mohd Razif & Suhaina 2005). Therefore, the objective of this study was to compare the semi-quantitative FFQ with three day 24-hour DR in assessing intake of energy, total fat, fatty acids and vitamin A, C and E among Malaysian women.

METHODS

SUBJECTS

Volunteers were invited by poster advertisements to a nutrition screening programmes carried out at residential areas in Setapak and Wangsa Maju, Kuala Lumpur. All participants were free-living, women aged between 30 to 60 years, healthy and had no known terminal and mental illnesses according to their general practitioner. Exclusion criteria were women who were pregnant or lactating, recently changed their diet pattern and women currently practicing special diet which does not represent Malaysian eating pattern during the study period. A total of 88 women were recruited for this FFQ study. Although the Malaysian population consists of several major ethnicities namely Malay, Chinese, Indian, Sabah and Sarawak Bumiputeras, only Malays and Indians were included in this study due to the need of producing an ethnic specific FFQ. Malays and the Indians have similarities in food choices, meal patterns and cooking methods used compared to other ethnicities (Department of Information, Malaysia 2008). Both Malays and Indians prefer hot and spicy foods, coconut milk based foods for entrée and desserts and also sweet traditional *kuih*s (Martina 2002; Saw 2005; Nor Zailina & Fatihah 2005).

STUDY DESIGN

The study was carried out over a three month period i.e. March 2007 to May 2007. The participants were informed about the study and a verbal consent was obtained when approaching them. They were interviewed using a semi-quantitative FFQ to assess their habitual dietary intake. To avoid potential training effects, subjects were randomly assigned to first completing either the semi-quantitative FFQ (test method) or the three non-consecutive day 24-hour DR which served as a reference method as suggested by Wilson & Horwath (1996) and Cade et al. (2002). Demographic data and routine anthropometric measurement

such as weight and height were taken using calibrated tools during the study. Body Mass Index (BMI) was calculated and cut-off point was based on recommendation from WHO (2003). The basal metabolic rates (BMR) of the subjects were estimated using equation of Ismail et al. (1998).

SEMI-QUANTITATIVE FOOD FREQUENCY QUESTIONNAIRE

The semi-quantitative FFQ contained 200 food items commonly eaten by the Malays and Indian in Malaysia. Selection of items was based on results of a survey in Kuala Lumpur, in which 141 subjects were interviewed using 24-hour DR to evaluate their food intake, meal pattern and food recipes. The semi-quantitative FFQ was constructed using the methodology described by Block et al. (1986). Foods that contributed 90% of total energy, macronutrients and vitamin A, C and E intake of study population were included in the list. Additional items from previously validated FFQ for total fats were also included (Suhaina 2004). The FFQ was arranged according to meal items to be similar in format to the USA National Cancer Institute Diet History Questionnaire to gain greater details on the meal times, type of foods consumed, cooking methods and their serving size (Subar et al. 2001). This FFQ have three major columns which consist of food item list, frequency on intake and serving size of foods as shown in Appendix I.

This semi-quantitative FFQ includes both raw and cooked foods. The semi-quantitative FFQ also focused more on meals and their cooking method compared to other previously developed FFQ for Malaysian. When using this semi-quantitative FFQ, subjects were not be required to estimate oil intake as this was found to be difficult and may lead to under or overestimation of fat intake (Suhaina 2004). Therefore a standardized recipe was assigned to each cooked foods using data on food recipes collected in the FFQ development process. The food items and servings were also categorized according to three main mealtimes consisting of breakfast (e.g. milk, tea, bread, *nasi lemak*, fried noodles, chapatti and etc), lunch or dinner (e.g. rice, chicken curry, fried fish with chilli, fruits, vegetables, beverages and etc) and morning or afternoon snacks (*pisang goreng*, curry puff, traditional *kuih*, biscuits and etc). In addition, seven food groups were added to the FFQ for cross checking purposes. These allowed the interviewer to check estimation of poultry, meat, fish, offal, sea foods, vegetables and fruits intake. Questions on types of cooking fats or oils used were asked and adjusted manually in the FFQ template worksheet which originally uses palm olein as the standard cooking oil.

As an interviewer administered semi-quantitative FFQ, subjects were asked to estimate how often on average they had taken the food items or servings on basis of per day or week or month or year over the previous year. Each food item and serving was assigned a portion size using local household units. The portion size was standardized using previous data from the same population which was then weighed using digital kitchen scale to compile a list of portion size with

their respective gram weight. Therefore, respondents have to estimate the number of portion size taken relative to given portion size with the aid of a local household measurement photograph. Approximately 15 minutes were taken to administer the FFQ for each participant by a trained interviewer. Questionnaire responses were then analyzed using Microsoft Excel 2007 worksheet that was generated by using food composition database by Suhaina et al. (2006). Briefly, the food composition database was developed using the Malaysian Food Composition Table (Tee at al. 1997) as the main reference for energy, macronutrients and vitamin A and C. Data from McCance and Widdowson's The Composition of Foods (Food Standards Agency 2002) were borrowed for fatty acids and vitamin E composition of raw food items. Meanwhile for cooked food, fatty acids composition data was derived from the Singapore Food Facts (Ministry of Health Singapore 1999). Data on fatty acids composition for cooking oil and fat were obtained from O'Brien (1998). Besides that, chemical analysis of raw foods such as marine and river fish, nuts, legumes and coconut milk and also several prepared dishes using standardized recipe were carried out to support the food composition database (Suhaina 2004).

REFERENCE METHOD: THREE DAYS 24-HOUR DIET RECALLS

Twenty four hour diet recalls were taken for three non-consecutive days (two weekdays and one weekend) by interviewing participants without prior announcement regarding the date of interview. This is to ensure that participants were not making any alteration to their habitual diet during study period. Participants were asked about all details including type of food, cooking methods, estimated portion size and brand of food and beverages consumed for the past 24 hours with the aid of a local household measurement photograph. For foods and beverages consumed outside the home, participants were asked to recall as much detail as possible about them. All information collected during the interview was recorded in a diet recall form by the interviewer. Data from diet recall form was transferred on to similar database as for the semi-quantitative FFQ. A wide range of mixed meals was included in the analysis database, but where an exact match was not found a similar meal was substituted.

STATISTICAL ANALYSIS

The Energy Intake/ Basal Metabolic Rate (EI/BMR) ratio was calculated to evaluate the ability of semi-quantitative FFQ and 24-hr DR in estimating the 'true' intake of energy. Cut-off point for EI/BMR ratio of less than 1.2 for under-reporting and more than 1.8 for over-reporting as recommended by Bingham (1994) was used. Mean and 95% confidence intervals (CI) were computed for energy and selected nutrients assessed by both semi-quantitative FFQ and reference method (24-hr DR). Mean difference (MD) and percent mean difference (%MD) was calculated

to summarize whether the semi-quantitative FFQ overestimated or underestimated intake of nutrients against the 24-hr DR. The two dietary assessment methods were compared using paired *t*-test to show if there were any significant differences between mean values of nutrient intakes. Significance level was set at $p < 0.05$. The ability of the semi-quantitative FFQ to correctly rank individuals as 24-hr DR was assessed by Pearson rank correlation coefficient. Cross-classification analysis was done by categorizing nutrient estimates of semi-quantitative FFQ and 24-hr DR into quartile of distribution separately. This is to examine whether both methods can classify the individuals into the same category of nutrient intake. All data were analyzed using the Statistical Product and Service Solutions (SPSS) version 15.0.

RESULTS

Out of total 88 women recruited, 79 women successfully completed both the three-day 24-hr DR and semi-quantitative FFQ with a response rate of 90%. Four study subjects failed to complete the three day 24-hr DR due to personal problems. Another five study subjects were excluded on the basis that their diet recalls were incomplete and unlikely to represent habitual intake.

CHARACTERISTICS OF STUDY PARTICIPANTS

Table 1 shows the characteristics of study subjects. A total of 51 Malay and 28 Indian women were involved in this study. All subjects were aged between 30 to 60 years. Most of them are married (90%) and have secondary level of education (49%). Majority of study subjects are employed (67%) with a household income more than RM 3500 (49%). Almost half of the study subjects were within the normal BMI range and 39% of them were overweight or obese.

COMPARISON OF ENERGY ESTIMATES BY EI/BMR RATIO

Table 2 shows the prevalence of under and over-reporters of energy intake based on calculations of EI/ BMR ratio. Among the study subjects, 20% under-reported their energy intake when assessed using the semi-quantitative FFQ, while 26% under-reported when using the 24-hr DR. Majority of study subjects were within the normal EI/ BMR ratio when their energy intake was assessed by semi-quantitative FFQ (70%) and 24-hr DR (74%). However, 10% of study subjects became over-reporters when their intakes were assessed using the semi-quantitative FFQ.

TABLE 1. Socio-demographics characteristics and BMI classifications of study subjects (n = 79)

Characteristics	No. (Percent %)
Race	
Malay	51 (65%)
Indian	28 (35%)
Age	
30 to 40 years	32 (41%)
41 to 50 years	34 (43%)
51 to 60 years	13 (16%)
Marital status	
Single	6 (7%)
Married	71 (90%)
Divorced	2 (3%)
Education level	
No formal education	2 (3%)
Primary	12 (15%)
Secondary	39 (49%)
Tertiary	26 (33%)
Working status	
Unemployed	26 (33%)
Employed	53 (67%)
Household income	
Less than RM 1500	12 (15%)
RM 1500 to RM 3500	28 (35%)
More than RM 3500	39 (49%)
Body Mass Index (BMI) classification	
Underweight (< 18.5 kgm^{-2})	9 (12%)
Normal weight (18.5 to 24.9 kgm^{-2})	39 (49%)
Overweight/ Obese (≥ 25.0 kgm^{-2})	31 (39%)

TABLE 2. Prevalence of under and over-reporters of energy intake by FFQ and DR (n = 79)

Dietary method	EI/ BMR ratio		
	Under-reporters <1.2	Normal 1.2 – 1.8	Over-reporters >1.8
FFQ	16 (20%)	55 (70%)	8 (10%)
DR	21 (26%)	58 (74%)	0 (0%)

COMPARISON OF INTAKES FOR SEMI-QUANTITATIVE FFQ AND 24-HOUR DIET RECALL

The comparison of energy and nutrient intakes for both methods were presented in Appendix II. Overall, the semi-quantitative FFQ gave comparable estimates with 24-hr DR for energy and all nutrients. Statistical analysis by paired *t*-test shows that there were no significant differences when intakes were estimated using semi-quantitative FFQ and 24-hr DR for mean value of energy, protein, carbohydrate, total fat, saturated fatty acids, monounsaturated fatty acids and polyunsaturated fatty acids and vitamin A (retinol and beta carotene), C and E. Percent mean differences between both methods were lower than 10% in all nutrients studied including energy intake. Highest mean difference percentage was for vitamin C (6%) and the lowest was for monounsaturated fatty acids (2%). Pearson correlation coefficient for energy unadjusted nutrients were statistically significant and ranged from 0.51 to 0.71. Correlation coefficient value slightly increased when energy adjusted for all nutrients and ranged between 0.52 and 0.74. A correlation coefficient for all nutrients as in descending order are beta carotene ($r = 0.74$, $p = 0.01$), vitamin E ($r = 0.69$, $p = 0.01$), vitamin A ($r = 0.69$, $p = 0.01$), vitamin C ($r = 0.64$, $p = 0.02$), total fat ($r = 0.64$, $p = 0.02$), protein ($r = 0.63$, $p = 0.03$), carbohydrate ($r = 0.60$, $p = 0.02$), saturated fatty acids ($r = 0.59$, $p = 0.01$), polyunsaturated fatty acids ($r = 0.57$, $p = 0.02$), retinol ($r = 0.55$, $p = 0.01$) and monounsaturated fatty acids ($r = 0.52$, $p = 0.03$).

CROSS-CLASSIFICATION OF INTAKES BETWEEN SEMI-QUANTITATIVE FFQ AND 24-HOUR DIET RECALL

Data for energy and nutrients intake from semi-quantitative FFQ and 24-hr DR were distributed into quartiles of intakes and cross-classified. A subject will be correctly classified if her energy or nutrients intake were ranked into the same quartile by both methods. Table 3 presents the summary of cross-classification analysis. About 35% to 58% of study subjects were correctly classified into same quartile by both methods for intakes of energy and selected nutrients. In addition, 82% to 96% of study subjects were correctly classified into same quartile or adjacent quartile by both methods. Only 3% of study subjects were grossly misclassified.

DISCUSSION

This study shows that a well constructed, interviewer-administered, semi-quantitative FFQ can provide useful and reliable estimates of dietary intakes. The difference between the semi-quantitative FFQ and 24-hr DR in estimating mean intake of energy and nutrients were not more than 6% which suggests that this semi-quantitative FFQ performs better in estimating group mean dietary

TABLE 3. Percentage for cross-classification of dietary intakes into quartiles by FFQ and DR (n = 79)

Nutrient	% CC	% CCI	% GM
Energy	47	82	0
Carbohydrate	45	88	3
Protein	49	92	1
Total fat	44	90	0
Saturated fatty acids	37	85	3
Monounsaturated fatty acids	35	92	0
Polyunsaturated fatty acids	42	88	3
Vitamin A	56	94	1
Retinol	53	88	0
Beta carotene	58	96	1
Vitamin C	50	93	1
Vitamin E	51	88	3

CC, correctly classified into the same quartile
CCI, correctly classified into the same quartile or adjacent quartile
GM, grossly misclassified

intakes compared to other FFQ validation studies (Norimah & Margetts 1997; Duerenberg-Yap et al. 2000; Subar et al. 2001; Suhaina 2004). Under-reporting of energy intake by study subjects as calculated by EI/BMR ratio was 20% while over-reporting was 10% when assessed by the semi-quantitative FFQ. When responding to FFQ, respondents tend to either include or exclude a lot more of foods than possibly they could need or have consumed. The length of FFQ food list contributes to the problem of over-reporting or under-reporting. According to Cade et al. (2002), when using a lengthy food list, subjects might be influenced to choose more food item while a shorter food list will restrict their choices. This will further indicate incorrect estimates of intakes and will result in over-reporting or under-reporting of energy intake. A good memory among the study population in recalling food items that have been consumed in a long period of time is important to decrease the prevalence of under-reporting or over-reporting (Willet 1998). Therefore, an interviewer-administered FFQ is more reliable when dealing with older study subjects.

Bland and Altman (1999) stressed that assessment of validity cannot rely only on correlation coefficients due to the fact that it is not an indicator of agreement but indicator of how one measurement technique relates to another. For that reason, correlation coefficients are now being used as a complimentary test in validation studies (Cade at al. 2002; Molag et al. 2007). Previous validation studies on fat, fatty acids and vitamin antioxidants have shown that correlation coefficient varied from $r = 0.34$ to 0.66 (Duerenberg-Yap et al. 2000; Subar et al.

2001; Kim et al. 2003). The correlation coefficient obtained in this study which ranged from $r = 0.52$ to 0.74 were somewhat higher which indicates higher relation between measurement from both semi-quantitative FFQ and 24-hr DR. It has been noted that correlation coefficients tend to improve when adjusted for energy intake as suggested by Willet (2001). As a result, correlated measurement error in energy and nutrient intake in this study were cancelled out.

Besides estimating nutrient intake, an important purpose of the semi-quantitative FFQ is to classify individuals into categories of nutrient intake (Wilson & Horwath 1996). Cross-classification analysis has the ability to measure how good the test method in classifying the measurements into surrogate categories towards the reference method. Cade et al. (2002) supports that cross-classification will also give a much clearer picture on validity of FFQ compared to correlation coefficients. In the present study, cross-classification according to quartiles of intakes showed reasonable agreement between semi-quantitative FFQ and 24-hr DR. It shows that almost half of the study subjects were correctly classified into the proper quartiles of intakes. Even though there are study subjects who were grossly misclassified, the semi-quantitative FFQ were still able to classify most of the study subject into the same or adjacent quartiles. To obtain a high percentage of subject that were correctly classified might be difficult and challenging since most studies on FFQ validation reported similar pattern of cross-classification (Paisley et al. 1996; Duerenberg-Yap et al. 2000; Kim et al. 2003). Nevertheless, correct cross-classification of 82% to 96% was significantly higher than the expected 65% correct cross-classification due to chance alone in this study.

This semi-quantitative FFQ showed comparable estimates of intake with 24-hr DR which acts as reference method in this study because of its unique design and contents. It was designed by arranging foods into mealtime categories as a cognitive approach to help study subjects recall their dietary habits (Subar et al. 1995). The basic content of semi-quantitative FFQ which are food item list were the first to include gravies and sauces separately from the entrée because they contribute significantly to fat intake (Suhaina 2004). Moreover, respondents do not have to estimate their cooking oil usage since cooked food which uses a standardized recipe were included in this semi-quantitative FFQ. This proved as true when this semi-quantitative FFQ managed to estimate intakes of energy, fat, fatty acids and vitamin A, C and E as good as the 24-hr DR in this study. Even though this have further increased the length of food list, detailed questions cannot be excluded as they were important to assess dietary fat, fatty acids and vitamin A, C and E that spread largely in Malaysian diet. Molag et al. (2007) agreed that a detailed FFQ are better at ranking individuals than a simple FFQ version. In addition, the strength of this semi-quantitative FFQ is in the guided portion size for quantification of intakes which were found to be beneficial in this study as the study subjects can roughly estimate their intake relative to given portion size. However for some foods such as vegetables, it is difficult to

measure how much is consumed when they are part of a mixed dish (Kim & Holowathy 2003). Subar et al. (2000) noted that it is more cost effective if portion size were calculated using existing data on average portion size of general population or even precisely using gender and age specific portion size. This is not possible in Malaysia since data on average portion size have not been established yet.

This study has several limitations that must be considered. First, the three days 24-hr DR are not a gold standard, especially for total fat, fatty acids and vitamin A, C and E that requires more days of record to satisfactorily reduce the amplitude of day-to-day variability. Willet (2001) suggested that three days of 24-hr DR or diet records used as reference method may not be sufficient when using less than 100 subjects. Margetts and Nelson (2004) proposed that five to ten days of 24-hr DR or diet records are needed to get good validity results. Stram et al. (1995) on the other hand emphasized that less than five days of 24-hr DR or diet records are optimal for a cost-efficient design of a validation study. This was also agreed by Molag et al. (2007) who demonstrated that correlation coefficients between nutrients assessed using FFQ and reference method were lower when more than five days of 24-hr DR or diet records were used which will incorrectly indicate poor validity of a FFQ. Most self-report dietary assessment methods may be biased and results in underestimating true intake (Black et al. 1991; Kroke et al. 1999). Thus the true degree of bias in the absolute values derived from the semi-quantitative FFQ is unknown, if any. There may be correlated errors that would result in overestimation of correlation values, namely the fact that both 24-hr DR and semi-quantitative FFQ method are dependent upon recall. Furthermore, the same nutrient database was used to estimate nutrient intake for both methods. Cade et al. (2002) and Molag et al. (2007) agreed that these sources of error are common to all validations of FFQ instruments that use 24-hr DR as the reference method. Finally, the reproducibility or repeatability of this semi-quantitative FFQ cannot be assessed since the semi-quantitative FFQ was only administered once during the study period. To assess whether a FFQ is reproducible or repeatable, the FFQ should be administered at the onset and end of study period (Margetts & Nelson 2004).

CONCLUSION

As a conclusion, this semi-quantitative FFQ shows similar estimates of dietary intakes for energy, total fats, fatty acids and vitamin A, C and E when compared to three days 24-hr DR among Malaysian women specifically for the Malays and Indians. This illustrates that this semi-quantitative FFQ is also an adequate tool for estimation of dietary intakes for research, especially for epidemiological studies of diet as a risk factor for chronic diseases such as cardiovascular, cancer and diabetes in Malaysia. However, the semi-quantitative FFQ clearly

cannot replace the three day 24-hr DR in estimating intake for individual women. It is also recommended that a well designed validation/ calibration study using adequate sample size of more than 100 subjects, suitable time frame and frequency for recording dietary estimates using the reference method such as seven days 24-hr DR or diet records taken four times apart in a year would be beneficial. The relevance of this semi-quantitative FFQ design for other specific ethnic subgroups in Malaysia would need to be established with further development and validation studies.

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APPENDIX I. Example of Food Frequency Questionnaire (Lunch or Dinner Items)

			LUNCH OR DINNER						
Item No.	Please tick (✓) if you usually consume these items for LUNCH OR DINNER		Please state how frequent you consume those items by filling the box with frequency and tick the suitable code as given (D = Day, W = Week, M = Month, Y = Year)					Reference serving size	How many serving size?
1	CHICKEN* (food group)		PER	D	W	M	Y	1 piece, medium	
2	Chicken, fried		PER	D	W	M	Y	1 piece, medium	
3	Chicken, fried with chilli	Chicken	PER	D	W	M	Y	1 piece, medium	
		Chilli *sambal*	PER	D	W	M	Y	1 dessert spoon	
4	Chicken, curry	Chicken	PER	D	W	M	Y	1 piece, medium	
		Curry, with coconut milk	PER	D	W	M	Y	1 dessert spoon	
		Curry, with milk	PER	D	W	M	Y	1 dessert spoon	
		Curry, without coconut milk or milk	PER	D	W	M	Y	1 dessert spoon	
5	Chicken, *masak lemak*	Chicken	PER	D	W	M	Y	1 piece, medium	
		Masak lemak gravy	PER	D	W	M	Y	1 dessert spoon	
6	Chicken, *kurma*	Chicken	PER	D	W	M	Y	1 piece, medium	
		Kurma gravy	PER	D	W	M	Y	1 dessert spoon	
7	Chicken, masak kicap	Chicken	PER	D	W	M	Y	1 piece, medium	
		Masak kicap, gravy	PER	D	W	M	Y	1 dessert spoon	
8	Chicken, rendang	Chicken	PER	D	W	M	Y	1 piece, medium	
		Rendang, gravy	PER	D	W	M	Y	1 dessert spoon	
9	Chicken, soup	Chicken	PER	D	W	M	Y	1 piece, medium	
		Soup	PER	D	W	M	Y	1 dessert spoon	
10	Chicken, grilled/ barbequed		PER	D	W	M	Y	1 piece, medium	
11	Chicken, steamed		PER	D	W	M	Y	1 piece, medium	
12	Chicken, *satay*		PER	D	W	M	Y	5 *cucuk*	
13	FISH* (food group)		PER	D	W	M	Y	1 piece, medium	
14	Fish, fried		PER	D	W	M	Y	1 piece, medium	
15	Fish, fried with chilli	Fish	PER	D	W	M	Y	1 piece, medium	
		Chilli *sambal*	PER	D	W	M	Y	1 dessert spoon	
16	Fish, curry	Fish	PER	D	W	M	Y	1 piece, medium	
		Curry, with coconut milk	PER	D	W	M	Y	1 dessert spoon	
		Curry, with milk	PER	D	W	M	Y	1 dessert spoon	
		Curry, without coconut milk or milk	PER	D	W	M	Y	1 dessert spoon	

APPENDIX II. Comparison of mean (95% CI) and correlation coefficient (*r*) for dietary intakes between FFQ and DR (n = 79)

Nutrient	Mean FFQ (95% CI)	Mean DR (95% CI)	Sig. test[a]	MD[b]	%MD[c]	Correlation coefficient (*r*)	
						unadj[d]	adj[e]
Energy (kcal)	1745 (1655, 1837)	1673 (1615, 1732)	NS	72	4	0.51*	-
Carbohydrate (g)	237.2 (224.0, 250.5)	226.3 (217.4, 235.3)	NS	10.9	5	0.59*	0.60*
Protein (g)	68.4 (64.6, 72.2)	66.1 (63.1, 69.1)	NS	2.3	3	0.61*	0.63*
Total fat (g)	58.1 (54.2, 62.1)	55.9 (53.0, 58.7)	NS	2.2	4	0.63*	0.64*
Saturated fatty acids (g)	26.9 (25.0, 28.7)	25.4 (24.0, 26.7)	NS	1.5	6	0.57*	0.59*
Monounsaturated fatty acids (g)	22.2 (20.7, 23.6)	21.7 (19.7, 23.0)	NS	0.5	2	0.53*	0.52*
Polyunsaturated fatty acids (g)	9.0 (8.4, 9.6)	8.8 (8.1, 9.5)	NS	0.2	2	0.55*	0.57*
Vitamin A (µg)	665.7 (489.3, 791.3)	632.5 (477.1, 769.1)	NS	33.2	5	0.67*	0.69*
Retinol (µg)	357.8 (270.1, 473.9)	339.2 (252.8, 484.0)	NS	18.6	5	0.54*	0.55*
B-carotene (µg)	1858.3 (1522.6, 2194.0)	1764.4 (1408.7, 2120.1)	NS	93.9	5	0.71*	0.74*
Vitamin C (mg)	77.8 (65.9, 89.7)	73.4 (57.4, 87.4)	NS	4.4	6	0.62*	0.64*
Vitamin E (mg)	10.5 (9.6, 11.4)	10.1 (9.0, 11.1)	NS	0.4	4	0.68*	0.69*

[a] Paired *t*-test, significant at $p<0.05$, NS = not significant
[b] Mean difference, (mean FFQ – mean DR)
[c] Percent mean difference, (MD/ mean DR) x 100
[d] Energy unadjusted nutrients
[e] Energy adjusted nutrients
[*] Pearson correlation, significant at $p<0.05$