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Validation of a Food Frequency Questionnaire in Assessing the Omega-3 Polyunsaturated Fatty Acids Intake for Malays and Chinese Elderly in Malaysia

(Pengesahan Soal-selidik Kekerapan Makanan untuk Menilai Pengambilan Asid Lemak Omega-3 Poli-tak-tepu untuk Warga Tua Melayu dan Cina di Malaysia)

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ABSTRACT

Omega-3 polyunsaturated fatty acids (PUFAs) is crucial to prevent a wide range of chronic diseases from a global view point. However, no suitable dietary assessment tool is available for usage among Malaysian population. The present study aimed to evaluate the validity of interviewer-administered semi-quantitative Food Frequency Questionnaire (FFQ) for assessing the omega-3 PUFAs intake among the Malays and Chinese elderly individuals in Klang Valley, Malaysia. Thirty-seven elderly people (54.1% women and 45.9% men), aged 60 years and above, were recruited from a community setting. Omega-3 PUFAs intake for the past one month was assessed using a 45-food item FFQ and validated against 3 days Food Record (FR). Wilcoxon signed rank test indicated no significant mean intake difference between two assessment methods. Significant correlation was found for total omega-3 PUFAs (r=0.926), α-linolenic acid (ALA) (r=0.745), eicosapentaenoic acid (EPA) (r=0.579) and docosahexaenoic acid (DHA) (r=0.912). Bland-Altman analysis exhibited no apparent systematic bias between the two methods for total omega-3 PUFAs intake, while quartile analysis classified 73% subjects assigned into the same quartile. Conclusively, the newly-developed FFQ yielded a reasonable validity in the tested population and provided a convenient means to estimate omega-3 PUFAs intake within healthy Malays and Chinese elderly individuals. Further study to evaluate its validity and reproducibility for different age groups is required.

Keywords: Elderly; food frequency questionnaire; food record; omega-3 PUFAs; validity

ABSTRAK

Asid lemak omega-3 poli-tak-tepu (PUFAs) adalah penting untuk mencegah pelbagai penyakit kronik mengikut pandangan global. Namun, tiada alat penilaian dietari yang bersesuaian untuk kegunaan populasi di Malaysia. Kajian ini bertujuan untuk menilai kesahihan soal-selidik kekerapan makanan (FFQ) untuk menilai pengambilan omega-3 PUFAs bagi warga tua Melayu dan Cina di Lembah Klang, Malaysia. Tiga puluh tujuh orang warga tua (54.1% perempuan dan 45.9% lelaki), berumur 60 tahun dan ke atas telah direkrut daripada satu komuniti. Pengambilan omega-3 PUFAs bagi sebulan lepas dinilai menggunakan FFQ yang mengandungi 45 item dan kesahihannya dibandingkan dengan Rekod Makanan (FR) 3 hari. Ujian Wilcoxon signed rank menunjukkan bahawa tiada perbezaan min yang signifikan antara kedua-dua kaedah penilaian. Korelasi yang signifikan didapati untuk jumlah omega-3 PUFAs (r=0.926), asid linolenik alfa (ALA) (r=0.745), asid eikosapentanoik (EPA) (r=0.579) dan asid dokosaheksanoik (DHA) (r=0.912). Analisis Bland-Altman menunjukkan tiada bias sistematik yang ketara antara dua kaedah bagi jumlah pengambilan omega-3 PUFA, manakala analisis kuartil mengklasifikasikan 73% subjek ke dalam kuartil yang sama. Sebagai kesimpulannyai, FFQ yang baru dibina menunjukkan kesahihan yang munasabah bagi populasi kajian dan memberikan satu cara mudah untuk menganggar pengambilan omega-3 PUFAs bagi warga tua Melayu dan Cina yang sihat. Kajian lanjut bagi menilai kebolehulangan dan kesahihannya bagi kumpulan umur yang berbeza adalah amat diperlukan.

Kata kunci: Kesahihan; omega-3 PUFAs; rekod makanan; soal-selidik kekerapan makanan; warga tua

INTRODUCTION

Within the last several decades, intensive nutritional deficiency related to the adverse human dietary patterns has intensified a fastidious concern among the nutritionists. In particular, omega-3 fatty acids, the polyunsaturated fatty acids (PUFAs), consisting mainly α-linolenic acid (ALA, 18:3n3) and the longer chain of eicosapentaenoic acid (EPA, 20:5n3) and docosahexaenoic acid (DHA, 20:6n3) has been linked to its capability to aid in brain development (Dangour & Uauy 2008), protest against hemorrhagic stroke (Parka et al. 2009), coronary heart disease (Logan et al. 2009), rheumatoid arthritis (Cleland et al. 2003), depression (Su 2008) and Alzheimer's disease (Freund-Levi et al. 2006).

A developing research devoted to investigate the suitability of Food Frequency Questionnaire (FFQ) for emphasizing the dietary intakes of fatty acid among the children, adults, pregnant women and cardiac patients has been exerted (Table 1). However, to our best knowledge, no omega-3 PUFAs FFQ has been developed for usage among Malaysian population. Although Zhang et al. (2009)

TABLE 1. Previous validation studies examining different fat intakes

Country	Study population	Para–meters examined	Validation tools	Reference
Belgium	Pregnant women	Fat and fatty acids	FFQ, estimated record	De Vriesea et al. (2001)
Germany	Adults aged 35–64 years	Total fat, saturated, monounsaturated, polyunsaturated fatty acids and cholesterol	Short food list, food record, FFQ	Rohrmann & Klein (2003)
Germany	Adults aged 35–64 years	Total fat, saturated, monounsaturated, polyunsaturated fatty acids and cholesterol	Short questionnaire, FFQ	Rohrmann & Klein (2006)
United Kingdom	Staff and students from University	Total fat, saturated, monounsaturated and polyunsaturated fatty acids	FFQ, weighed dietary record	Broadfield et al. (2003)
Ireland	Healthy adults aged 23-63 years	Fatty acids	FFQ, diet history	Cantwell et al. (2005)
United States	Cardiac patients	Omega-3 fatty acids	FFQ, 24-hours recall	Ritter-Gooder et al. (2006)
Australia	Staff and students from University	Long chain n-3 polyunsaturated fatty acids	FFQ, RBC and plasma total fatty acids	Sullivan et al. (2006)
Australia	Adults aged 29-72 years	PUFAs	Plasma phospholipid fatty acids and weighed food record	McNaughton et al. (2007)
Australia	Staff and students from University	Long chain n-3 polyunsaturated fatty acids	FFQ, weighed food records	Sullivan et al. (2008)
Canada	Women aged 40 – 55 years	EPA and DHA	FFQ and erythrocyte membrane fatty acid	Lucas et al. (2008)
United States	Children	Omega-3 and omega-6 PUFAs	FFQ and erythrocyte membrane fatty acid	Orton et al. (2008)
Germany	Children	SFA, MUFA, LA, AA, EPA and DHA	FFQ, 24-h recall	Stiegler et al. (2009)
Sweden	Adults aged 30 – 60 years	Fatty acids	FFQ, 24-h recall	Wennberg et al. (2009)
Greece	Adults aged 40 – 67 years	Fatty acids	FFQ, MedDietScore and plasma fatty acids	Panagiotakos et al. (2009)
China	Adults aged 40 – 65 years	Fatty acids	FFQ, 3 days dietary record and erythrocyte membrane fatty acid	Zhang et al. (2009)
Present study	Elderly people aged ≥ 60 years	Omega-3 PUFAs	FFQ, 3 days food record	NA

FFQ, food frequency questionnaire; EPA, eicosapentaenoic acid; DHA, docosahexaenoic acid; PUFAs, polyunsaturated fatty acids; RBC, red blood cell; NA, not applicable

have conducted a validation study in Southern China for evaluating the fatty acids intake among middle-aged Chinese, the available FFQ could not be adopted, due to the deviation of habitual dietary patterns and food sources (McNutt et al. 2008), which lead to the conduct of this present study.

With the aforementioned, the focus of this research was to develop an interviewer-administered FFQ for estimating the omega-3 PUFAs intake among the Malays and Chinese elderly population in Malaysia. The validity of this newly developed FFQ was analyzed using statistical tools and compared against the 3 days Food Record (FR). In this context, we hypothesized that there would be no significant difference between the newly-developed FFQ and the food record (FR) for evaluation of omega-3 PUFAs intake among elderly people.

MATERIALS AND METHODS

SUBJECT'S RECRUITMENT

Volunteers for participation in this study were recruited from a convenience group of free-living elderly people residing around Klang Valley area (Cheras, Hulu Langat, Keramat and Bandar Baru Bangi), Malaysia. The inclusion criteria were elderly people (both Malays and Chinese)

aged 60 years and above, able to communicate, literate and consumed a customary diet over the past 6 months. Subjects were interviewed to obtain detail information via a structured questionnaire. The questionnaire consists of socio-demography details (gender, race, age and marital status) and self-reported illness (diagnosed and received treatment). Informed consent for participation in the study was obtained from each subject and the study was approved by Medical Research Secretariat, National University of Malaysia Medical Centre.

DEVELOPMENT AND ADMINISTRATION OF OMEGA-3 POLYUNSATURATED FATTY ACIDS FOOD FREQUENCY QUESTIONNAIR

The specified semi-quantitative FFQ (Figure 1) was designed to assess omega-3 PUFAs intakes over the past month among the Malays and Chinese population in Malaysia. Specific food items were listed according to six categories (fish and seafood, meat and poultry, egg and eggs products, vegetables, cooking oils and dairy products) and the amounts of consumption were recorded. Detailed of information related to the brands, methods of cooking, parts of food been consumed and fortified foods were included to avoid under-reporting. Food models, household measuring utensils, printed visuals, food atlas, food booklets and open-ended questions were applied to assist the participants, while failure in providing the quantitative data was estimated by a normal serving size. The FFQ was administered by the well-trained nutritionists or dietitians.

3 DAYS FOOD RECORD

FR was performed to detect deviations from the prescribed diet and provide an insight into the food preferences. Generally, prolonging the recording period will reduce the validity of the gathered information. Thus, in the present study, a three days dietary intake was recorded. Demonstration for assisting the participant was provided and clarification of the reported information was verified.

OMEGA-3 POLYUNSATURATED FATTY ACIDS INTAKE

The average daily omega-3 PUFAs intake was analyze according to the US Department of Agriculture Nutrient Database (USDA 2007), while standard serving size of each food items was referred to the Malaysian Food Composition Table (Tee et al. 1997). When an exact matched food items do not existed in the composite meals, a substitute food was used. Additional information including nutritional labeling on canned food, fortified food and self-designed recipes was adopted into the database system. Mean daily ALA (or EPA or DHA) intake, omega-3 PUFAs (ALA, EPA and DHA) intake and total omega-3 PUFAs intake were derived as:

OMEGA-3 POLYUNSATURATED FATTY ACIDS FOOD FREQUENCY QUESTIONNAIRE

Date: _____ Subject code: _____

This form acquires about your habitual dietary intakes over the past month. Please follow the instruction carefully.

1. Read each food item carefully. Please mark in each line the frequency that matches best for usual consumption habits. If you have not eaten this specific food item, please mark "once a month, less or never" and move to next food item.
2. Please refer to the printed visuals to estimate usual serving size is small (S), medium (M), or large (L) by marking the serving size box.

Fish and seafood	Serving size			Frequency				
	S	M	L	Once a day or more	4 – 6 times a week	1 – 3 times a week	2 – 3 times a month	Once a month, less or never
Anchovy								
African bream								
Carp								
Sardine								
Tuna								
Spanish mackerel								
Oyster								
Stingray								

FIGURE 1. Omega-3 polyunsaturated fatty acids food frequency questionnaire sample page

Mean ALA intake = ALA content × frequency of consumption. (1)

Omega-3 PUFAs intake = ALA content + EPA content + DHA content. (2)

Total omega-3 PUFAs intake (3) = Total content of ALA + Total content of EPA + Total content of DHA (3)

STATISTICAL ANALYSIS

Baseline socio-demographic information between genders was analyzed by univariate analyses (crosstab). Mann-Whitney test was performed to measure the mean difference (±SD) of basic anthropometry measurements, daily energy intake and total fat intake. Mean differences (SD) of omega-3 PUFAs between FFQ and FR were assessed using the Wilcoxon signed rank test (since data were not normally distributed), while Spearman's correlation coefficients were performed to assess the linear association between FFQ and FR. To estimate inter-rater reliability, single measure intra-class correlation was performed. Correction of estimation for both unadjusted and energy-adjusted for omega-3 PUFAs and its subcomponent was applied using energy-adjusted method (Willett 1998). To assess the agreement between FFQ and FR, and to detect systematic bias with FFQ relative to the FR, Bland-Altman analyses were used (Bland & Altman 1986). Quartile's cross-classifications were applied based on total omega-3 PUFAs intake from both instruments. All statistical analysis was conducted using SPSS software (SPSS 15.0; SPSS Inc, Chicago, III) and two sided p value < 0.05 was considered to indicate the statistical significance.

RESULTS AND DISCUSSION

Table 2 depicted socio-demography, nutritional status and dietary intake characteristics of the participants. As suggested by the data, the study involved the participation of 37 elderly people (54.1% women and 45.9% men), with the mean (SD) 66.7 ± 4.3 years, of which 54.1% were Chinese. Comparison of nutritional status illustrated women have a statistically significant and lower standing height ($p < 0.05$) and dietary energy intake ($p < 0.05$), while the most prevalent self-reported chronic diseases were hypertension (43.2%), musculoskeletal disease (37.8%) and type-2 diabetes mellitus (18.9%) (data not shown).

TABLE 2. Socio-demography, nutritional status and dietary intake characteristics of the participants (n = 37)

Characteristics	Men (n = 17)			Women (n = 20)		
	n	%		*n*	%	
Age						
60 – 70 years	11	64.7		17	85.0	
≥ 71 years	6	35.3		3	15.0	
Races						
Malay	12	60.0		8	40.0	
Chinese	5	40.0		12	60.0	
Education level						
Primary school	9	52.9		13	65.0	
Secondary school	8	47.1		7	35.0	
Marital status						
Married	16	94.1		20	100.0	
Single	1	5.9		0	0.0	
	Mean	SD	Range	Mean	SD	Range
Standing height (cm)	163.2	5.8	152.8 – 171.0	152.8*	5.6	143.5 – 164.0
Body weight (kg)	65.9	13.2	46.5 – 97.8	58.7	9.1	45.4 – 77.8
BMI (kg/m^2)	25.4	4.1	19.4 – 33.8	25.0	3.0	20.6 – 29.0
MUAC (cm)	27.4	3.6	21.0 – 33.2	27.1	3.5	22.0 – 35.0
CC (cm)	35.0	3.4	28.9 – 40.0	33.1	3.7	25.5 – 39.5
Dietary energy intake (kcal/d)	1305.8	337.8	773.6 – 1914.3	1085.7*	232.8	798.2 – 1518.1
Total fat intake (g/d)	30.4	19.6	5.4 – 88.6	24.6	14.9	8.1-75.3

BMI, body mass index; MUAC, mid upper arm circumference; CC, calf circumference
Data are presented as number and percentage for categorical data using univariate analyses (2 × 2 cross tabulation). Continuous data are presented as mean (±SD) and range
*Statistical analysis is significant at $p < 0.05$ using Mann-Whitney test

Total omega-3 PUFAs intake for FFQ and FR ranged from 47 to 1209 mg/d and 93 to 1194 mg/d, with the mean differences 4, 2, -7 and 9 mg/d for total omega-3 PUFAs, ALA, EPA and DHA, respectively. Wilcoxon signed rank test indicated no significant mean difference between the two assessment methods, while total omega-3 PUFAs intake for Malays and Chinese elderly did not differ significantly (data not shown).

FFQ showed a higher total omega-3 PUFAs intake as compared with FR, possibly due to the overestimation of exact intake among the elderly participants (Bingham et al. 1994). Meanwhile, it can be clearly found that the consumption of total omega-3 PUFAs was generally low among the Malaysian community, with fish and seafood constitutes the major proportion; while ALA intake was relatively low (more popular as industrial animal feeds and added as omega-3 fortification products such as hen eggs, bread and canned meat), as majority of Malaysians use palm olein oil as cooking oil (Foo & Hameed 2009). Contradictory, nearly 50% of the long chain n-3 PUFAs intake in Australia is originated from the meat sources (Howe et al. 2006).

It is obvious that level of dietary omega-3 PUFAs intake in the present study was lower than the recommended level suggested by the National Academy of Sciences (1.6 g/d for men and 1.1 g/d for women for ALA between 14 years and over 70 years; DHA and EPA is 10% of the total Acceptable Macronutrient Distribution Range) (Institute of Medicine 2002), World Health Organization (1.0-2.0% of energy intake) (WHO 2003) and National Coordinating Committee on Food and Nutrition (0.3-1.2% of omega-3 fatty acids from 2000 kcal energy intake) (NCCFN 2005). Comparatively, omega-3 PUFAs intake reported in the previous studies were higher (McNaughton et al. 2007; Ritter-Gooder et al. 2006), mainly due to the alteration in food sources, selection of foods and habitual dietary patterns. Besides, it is co-related with the environmental factors (where, when and with whom food consumption takes place) and low socioeconomic status which limited the food choice (Erber et al. 2010).

Unadjusted Spearman's correlation coefficients presented a significant correlation (r = 0.926, p< 0.001) between the two methods for total omega-3 PUFAs intake (Figure 2). Typically, unadjusted correlation coefficients for ALA, EPA and DHA were 0.745 (p< 0.001), 0.579 (p< 0.001) and 0.912 (p< 0.001), respectively, while the energy adjusted correlation coefficients were determined to be 0.872 (total omega-3 PUFAs intake), 0.627 (ALA), 0.544 (EPA) and 0.875 (DHA) (all p< 0.001), which suggested that the correlation within the two tools is relatively high. The present results showing good correlation with the previous studies for total omega-3 PUFAs (r = 0.650-0.872) (Ritter-Gooder et al. 2006; Zhang et al. 2009) and DHA (r = 0.870-0.875) intakes (Woods et al. 2002). Conversely, weaker correlation (r = 0.290-0.450) have been shown for omega-3 PUFAs in a study conducted by Wennberg et al. (2009) while moderate correlations have been observed for EPA (r = 0.544) and ALA (r = 0.627) in the present study.

Intra-class correlation indicated satisfactory variation within and between individuals for total omega-3 PUFAs intake (cronbach's alpha = 0.987, r = 0.976, p< 0.001), ALA (cronbach's alpha = 0.935, r = 0.877, p< 0.001), EPA (cronbach's alpha = 0.925, r = 0.857, p< 0.001) and DHA (cronbach's alpha = 0.982, r = 0.965, p< 0.001). Bland-Altman plot and variation spread around the means exhibited no apparent systematic bias between the two methods for average total omega-3 PUFAs intake (Figure 3), ALA, EPA and DHA (data not shown). Table 4 shows analysis of agreement (25th quartile, 50th quartile, 75th quartile and 100th quartile) for FFQ and FR (total omega-3 PUFAs intake).

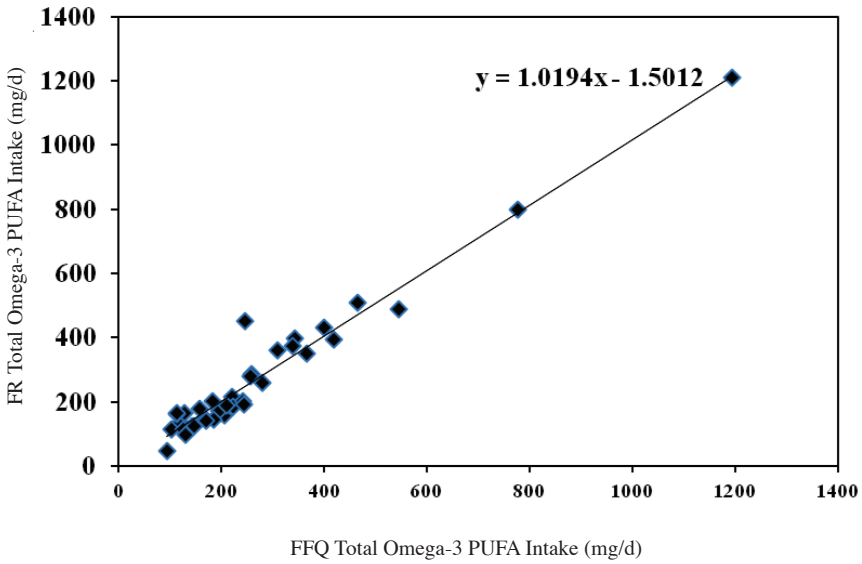

FIGURE 2. Scatter plot of total Omega-3 PUFA intakes measured using FFQ and FR (r = 0.926, p< 0.001)

TABLE 3. Omega-3 PUFAs intake estimated by the FFQ and 3 days FR

Fatty acid	FFQ (mg/d)				FR (mg/d)				Mean difference (FFQ – FR)/FR	Wilcoxon-signed rank test *p* value
	Mean	SD	Median	Range	Mean	SD	Median	Range		
Total Omega-3 PUFAs	275	219	187	47 - 1209	271	209	218	93 - 1194	0.01	0.970
ALA	42	27	34	9 - 144	40	25	32	12 - 126	0.11	0.361
EPA	63	52	49	12 - 267	70	54	63	23 - 330	- 0.05	0.153
DHA	170	149	98	26 - 798	161	137	112	42 - 738	0.05	0.281

FFQ, food frequency questionnaire; FR, food record; PUFAs, polyunsaturated fatty acids; ALA, α-linolenic acid; EPA, eicosapentaenoic acid; DHA, docosahexaenoic acid; SD, standard deviation
No significant different was found on total omega-3 PUFAs, ALA, EPA and DHA intake for FFQ and FR using Wilcoxon signed rank test
Data are presented as mean values together with standard deviation, median and range

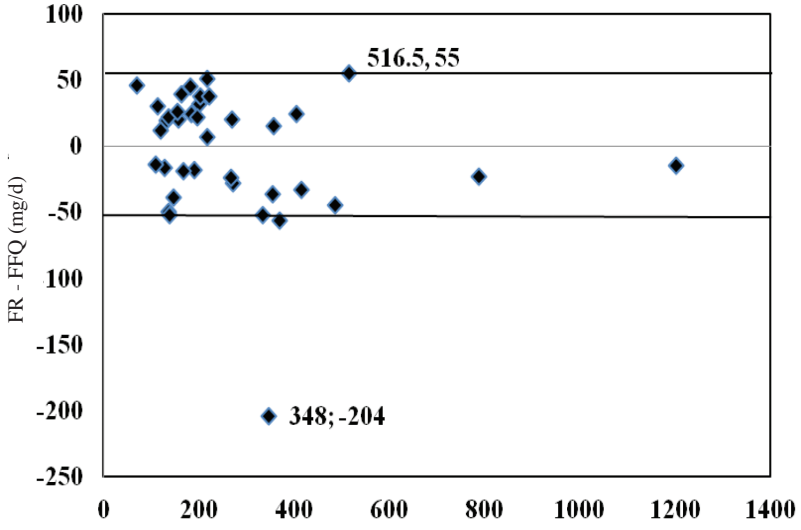

FIGURE 3. Agreement analysis between omega-3 PUFAs intake estimated from FFQ plotted against the average total omega-3 PUFAs intake as assessed by the Bland-Altman technique

TABLE 4. Agreement analysis between FFQ and FR for total omega-3 PUFAs intake

Quartile	Participants in the same quartile		Participants in the adjacent quartile	
	n	%	*n*	%
25th quartile	6	66.7	3 (3 above)	33.3
50th quartile	6	60.0	4 (3 below, 1 above)	40.0
75th quartile	7	77.8	2 (1 below, 1 above)	22.2
100th quartile	8	88.9	1 (1 below)	11.1

PUFAs, polyunsaturated fatty acids
Data are presented using quartile's cross-classification as number and percentage

In general, both FFQ and FR classified 73% subjects into the same quartiles and 13.5% were classified into lower and upper quartile. Surprisingly, 100% subjects were assigned into the same or adjacent quartiles. However, the absence of gross misclassification showed that participants in this study practice quite similar dietary patterns.

Data from the present study have shown that the newly-developed FFQ was well able to estimate omega-3 PUFAs intake and consistent with the previous studies. Additionally, it is the first tool to specifically investigate the intake of omega-3 PUFAs among the Malays and Chinese elderly population, thereby bridges the research gap in the

pool of currently available FFQ. Therefore, the FFQ is an adequate dietary assessment tool for direct extrapolation to older population at large. However, this FFQ could be developed further with larger and more representative samples to confirm the utilization of FFQ. Its reproducibility has to be tested in order to reflect the consistency of the designed FFQ.

CONCLUSION

The present research explores the versatility of population-focused FFQ for estimating the dietary intakes of omega-3 PUFAs among the Malays and Chinese elderly population and capture sufficient dietary coding. Wilcoxon signed rank test showed no significant difference between FFQ and FR, while moderate to good correlation coefficient was found for total omega-3 PUFAs, ALA, EPA and DHA. Bland-Altman analysis indicated low systematic bias between the two methods and 73% subjects assigned into the same total omega-3 PUFAs intake quartile. Further analyses validating regional variations and biological markers of PUFAs will be considered in the future studies.

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