Mal J Nutr 18(3): 283 - 293, 2012

# Development and Validation of a Food Frequency Questionnaire (FFQ) for Assessing Sugar Consumption among Adults in Klang Valley, Malaysia

**Nik Shanita S[1], Norimah A K[2*] & Abu Hanifah S[2]**

[1] *Dietetics Programme, School of Healthcare Sciences, Faculty of Health Sciences, Universiti Kebangsaan Malaysia, 50300 Kuala Lumpur*

[2] *Nutrition Science Programme, School of Healthcare Sciences, Faculty of Health Sciences, Universiti Kebangsaan Malaysia, 50300 Kuala Lumpur*

## ABSTRACT

**Introduction**: The aim of this study was to develop and validate a semi-quantitative food frequency questionnaire (FFQ) for assessing habitual added sugar consumption of adults in the Klang Valley. **Methods**: In the development phase, a 24-hour dietary recall (24-hr DR) was used to determine food items to be included into the FFQ among adults from three major ethnicities (n=51). In the validation phase, the FFQ was further validated against a reference method which was a multiple-pass 24-hr DR among 125 adults in Klang Valley. The response rate for the latter phase was 96.1%. **Results**: The semi-quantitative FFQ consisting of 64 food items was categorised into 10 food groups. The mean added sugar intake determined by the reference method was 44.2 ± 20.2 g / day while that from the FFQ was 49.4 ± 21.4 g / day. The difference in mean intake between the two methods was 5.2 g (95% CI = 2.6-7.9; SD = 14.9, $p<0.05$) or 11.8%. Pearson correlation was r=0.74 ($p<0.001$) for the two methods while Spearman rank correlations for the various food groups ranged between 0.11 (cake and related foods) to 0.61 (self-prepared drinks), with most groups correlating significantly ($p<0.05$). Cross-classification of subjects into quintiles of intake showed 47.2% of the subjects correctly classifying into the same quintile, 34.4% into adjacent quintiles while none were grossly misclassified. The Bland-Altman plot was concentrated in the *y*-axis range (-24.14 g to 34.8 g) with a mean of 5.22 g. **Conclusion**: This semi-quantitative FFQ provides a validated tool for estimating habitual intake of added sugar in the adult population of the Klang Valley.

**Keywords**: Food frequency questionnaire, added sugar, habitual intake

## INTRODUCTION

Sugar is a form of carbohydrate which is found in many foods, either in its natural form or added into foods. Dietary sources of naturally occurring sugars are fruits and dairy products, while processed foods contribute to the intake of added sugar in the diet. The main types of sugar that are frequently used in processed foods and during food preparation are sugarcane and beet. Currently, in Malaysia, there is no specific recommendation for sugar intake, albeit, there is a guideline which suggests

* Correspondence author: Norimah A Karim; Email: *nak@fskb.ukm.my; norimah_ak@yahoo.com*

intake of sugar not exceeding 15% from total energy intake per day (National Coordinating Committee on Food and Nutrition (NCCFN), 2005).

Most fruits and dairy products are rich in sugar, but the intake of sugar from natural sources is a good dietary habit. Sugars are also added into foods for various reasons, such as in food processing and preparation, but both natural and added sugars are much the same once absorbed by the body. For example, sugar with the same chemical structure from different sources has the same effect of increasing the blood sugar level after being absorbed into the body (Wolever & Miller, 1995). Added sugar is found in commercially processed products such as biscuits, cakes, buns, pastries, carbonated drinks, cordials and breakfast cereals and in forms commonly used in food preparation including table sugar, sweeteners and jam.

In Malaysia, data on sugar consumption was first reported from food availability data, more specifically, the Malaysian food balance sheet data. In 1985, the estimated sugar intake was 86 g/day or 13% of the total energy intake (Food and Agriculture Organization, 2002). Processed foods including ice cream, chocolate, sweetened condensed milk and soft drinks are among the items that contribute to the increasing levels of sugar intake (Fiji / FAO Asia Pacific Sugar Conference, 1997).

Food surveys at the community level are useful in determining health problems associated with nutrition. Many food intake studies among the Malaysian population have been carried out (Norimah *et al.*, 2008; Mirnalini *et al.*, 2008). However, the limitations of these studies is that they lack suitable tools to evaluate the intake of local foods, especially the weekly or monthly intakes of individuals. Common dietary methods used in evaluating dietary intakes are 24-hour dietary recall, dietary records and food frequency questionnaires (FFQ). The development and validation of the FFQ are the norm in developed countries and several Asian countries, and the usage is considered standard in epidemiological studies (Kusama *et al.*, 2005).

Currently, the FFQ has been used in Malaysia to evaluate calcium among Chinese women (Chee *et al.*, 2002) and total energy, total fat, fatty acids and vitamin A,C and E among Malaysian women (Mohd Razif *et al.*, 2008) but there is no FFQ developed to evaluate added sugar intake among adults. Therefore, in this study, the development of FFQ was focused on the intake of added sugar, which is often added during the processing and preparation of foods. This is based on the finding that almost 59% of the Malaysian population consume sugar every day, usually added to beverages such as tea, coffee and chocolate-based drinks (Norimah *et al.*, 2008). In addition, foods that are high in sugar are always associated with foods that contain a low nutrient-to-energy ratio, whereas foods that contain naturally occurring sugar mostly have high nutrient density. Qualitatively, the usage of the FFQ could provide an overview of the intake of low nutrient density foods.

The aim of this present study was to develop the FFQ and have it validated with 7-day multiple-pass 24-hr DR. The food items to be included into theb FFQ were identified and the amount of added sugar consumed by adults in the Klang Valley, Malaysia was determined using the same validated added sugar FFQ.

## METHODS

### Study population and setting

The subjects in this cross-sectional study were adults in government and private institutions or shopping malls around the Klang Valley. Subjects of Malay, Chinese and Indian ethnicity for the developmental and validation phasesof the FFQ were recruited by convenient sampling. The sample size was calculated using independent two means difference formula (Colton, 1974) and

the standard deviation used was from the EPIC study (Kroke *et al.*, 1999). Based on a power of 80% and two-tailed significant level set at 0.05, a sample size of 120 subjects would be required.

Data collection was conducted from October 2009 to March 2010. Inclusion criteria for this study were adults aged 18-59 years with no reported medical history of any chronic diseases identified from the socio-economic status questionnaire. Informed consent was obtained from the subjects before the study protocol was conducted. The protocol was reviewed and approved by the Medical Research & Ethics Committee, Universiti Kebangsaan Malaysia Medical Centre (UKMMC).

## Study design

*Development study*

During the development phase, sugary foods or drinks, which contributed to the subject's dietary recall, were identified and the number of items needed to be included in the FFQ was determined. All of the subjects were interviewed for a 24-hour dietary recall because this method provides a high rate of response. Subjects were provided with a checklist of sugary foods as well as images of household utensils used in measuring quantity. A detailed explanation of all foods and drinks consumed by the subjects, including method of cooking, brand of products, and mealtime were recorded. Each food and drink reported by the subjects was analysed, and the average contribution to the added sugar intake was listed individually. For each item, the percentages of its contribution to the total added sugar was calculated. Items that contributed 90% (mainly from food and beverages) to the total sugar intake based upon the cumulative value of descending order in the list were included in the FFQ. Several items that were thought to represent the population of interest were also included.

The standard portion size for individual items was either based on the Atlas of Food Exchanges and Portion Sizes (Suzana *et al.*, 2009) or the median serving size reported by the subjects in the development phase. Subjects were also required to fill a column for information concerning brand or flavour for certain items mentioned. Open-ended questions such as this could enhance the accuracy of the food item. The conversion of food frequency to the amount of food intake was carried out using the formula developed by the Wessex Institute of Public Health Medicine (1995):

Amount of food (g) per day = frequency of intake (conversion factor) × serving size × total number of serving × weight of food in one serving

*Validation study*

In the validation phase, subjects were interviewed on their habitual dietary intake for seven days (in one sitting) by using multiple pass 24-hr dietary recall technique (referred to as reference method and this technique was chosen over other methods because it is more accurate, more practical and less burdensome). This was followed by a semi-quantitative FFQ (as the newly developed FFQ) which was administered two weeks apart.

In this multiple-pass technique, the interviewer questioned subjects several times, passing through the day to search his or her memory to increase retrieval of the requested information. All subjects were assisted with a checklist of high sugar content foods for the dietary recall method. Household measurements such as a teaspoon, tablespoon and bowls of various sizes were shown to the subjects to help them estimate the portion size, as used in the one day 24-hour dietary recall during the development phase. This method asked the subjects questions on the dietary history of their usual intake over 7 days via multiple-

pass 24 hour dietary recall technique; therefore, their intakes during the weekends and weekdays were automatically included in the report.

A semi-quantitative FFQ was self-administered by the subjects, with clear instructions given on the written form of the questionnaire. In this FFQ, the subjects could report the frequency of consumption as the number of 'times per day', 'times per week' or 'times per month'. Each subject was only required to provide one option for each item. Each food item listed was given as a standard serving size. The subjects were asked about their usual frequency of consumption of the listed foods, with an additional question about the brand or flavour of the items consumed, over the one to two months prior to the administration of the FFQ.

**Nutrient calculation**

All subjects from both phases had their weight and height taken to obtain their body mass index (BMI) and estimated basal metabolic rate (BMR) was calculated using the formula of Ismail *et al.* (1998). Under-reporting subjects were determined and were excluded according to the cut-off point proposed by Goldberg *et al.* (1991). All of the foods obtained were analysed using the *DIET4* software for calculating energy and macronutrients. For added sugar content, databases were selected from either the USDA ARS *Nutrient Data Lab* version 21.0 (USDA ARS Nutrient Data Lab, 2009) or the Singapore Food Composition database (Food Composition Guide Singapore, 2003). For branded or specific items, nutrition information labels were primarily used. For food items that did not meet any of the options mentioned above, a recipe book was used.

**Statistical analysis**

Statistical tests were carried out using the Statistical Package for the Social Sciences (SPSS Inc. Version 15, Chicago, US). For socio-demographic data, descriptive analyses were used. For calculation of the consumption of added sugar, intakes were obtained from the different methods available: a 24-hr dietary recall, multiple pass 24-hr dietary recall (reference method), and the FFQ. The validity tests were carried out in order to compare the intakes between the reference method and the FFQ. Multiple tests were conducted in order to test validity, including the mean difference, correlation coefficients, cross-classification and a Bland-Altman plot.

Pearson correlations were applied to evaluate the comparative validity between the FFQ and the reference method which was the multiple pass 24-hr dietary recall. Spearman correlations were used to find the relationship between food groups from both methods. The degree of mis-classification across categories between the FFQ and the reference method was examined by dividing nutrient intake values into quintiles. The proportion of subjects classified into the same, adjacent and extreme quintiles was calculated. Gross mis-classification into the extreme quintiles comprised both mis-classifications from the first to the fifth quintiles, and vice versa. The Bland-Altman method assesses the agreement between the two methods across the range of intakes. By plotting the difference between the methods against the average of added sugar intake from the two methods, the dispersion and the extent to which the two methods agreed can be visualised.

**RESULTS**

In the development phase, 51 of the 60 subjects completed the required protocol (response rate 85%). The other nine subjects under-reported their 24-hr dietary recall. The development of the FFQ resulted in the identification of classification of a total of 64 food items into 10 groups of foods with added sugar.

The subjects had a mean age of 30.8 ± 8.6, with men being older than women. Most of the subjects had normal weight categories (18.5 – 24.9 kg / $m^2$) with mean body mass index (BMI) of 23.4 ± 3.8 kg / $m^2$. The mean energy intake reported from the 24-hr dietary recall was 2113 ± 359 kcal / day for men and 1766 ± 239 kcal / day for women, with the energy intake for men being significantly higher ($p$<0.05). The mean total added sugar intake for all subjects was 45.4 ± 28.8 g / day or 181 ± 115 kcal / day.

**Food group contribution to FFQ**

Table 1 shows the food groups classified into the descending order of their contribution to the intake of added sugar. The rank order was led by self-prepared drinks (e.g. tea, coffee, chocolate drinks, fruit juice) at 35.0%. This order was followed by non-carbonated soft drinks (11.7%), miscellaneous (including jam, preserves, coconut milk jam, honey) (10.0%) and carbonated soft drinks (8.6%).

**Validation study**

For the validation study, 125 of the 150 subjects successfully completed both the FFQ and the reference methods without under-reporting (participant rate 83.3%). Twenty-five subjects were excluded either because of under-reporting or non-completion of either of the two dietary assessments required in the validation study. The subjects involved in the development phase were not included in the validation phase.

*Demographics and BMI*

Subjects consisted of 49 men and 76 women, mostly in the age group of 18 – 29 years (52.0%) and of Malay ethnicity (60.8%). Almost half (49.6%) of the subjects had university education with 50.4% falling into the middle household income (RM1500 to RM3500). About 35.2% of the subjects fell in the normal BMI categories, followed by overweight (18.4%), obese (16.0%) and underweight (14.4%).

*Dietary intake from reference methods*

The mean energy intake reported from the multiple pass 24-hr dietary recall was 2129 ± 265 kcal / day for men and 1628 ± 218 kcal / day for women. Mean percentage of carbohydrate for men was 63.5% and 67.9% for women. Both daily energy and carbohydrate intakes were significantly different in men and women ($p$<0.05). For daily added sugar intake, a mean of 47.7 ± 21.5 g / day was calculated for men and their intake was similar (P>0.05) to women (41.9

**Table 1.** Food group contribution to added sugar intake of 51 subjects for FFQ development

| *Rank order* | *Food group* | *% of added sugar intake* |
|---|---|---|
| 1 | Self-prepared drinks | 35.0 |
| 2 | Non-carbonated soft drinks | 11.7 |
| 3 | Miscellaneous (jam, honey) | 10.0 |
| 4 | Carbonated soft drinks | 8.6 |
| 5 | Commercial and traditional kuih | 8.1 |
| 6 | Biscuit and breakfast cereal | 7.2 |
| 7 | Sweet and chocolate | 5.8 |
| 8 | Cake and variation | 5.4 |
| 9 | Bun and dumpling | 5.3 |
| 10 | Ice cream and variation | 2.9 |

± 19.1 g / day). The Malaysian recommended sugar intake (NCFFN, 2005) for added sugar is 15% of total energy intake per day. This study revealed that consumption of added sugar in men (9.0%) and women (10.3%) did not exceed the recommended range.

*Added sugar intake by age groups and ethnicity from reference method*

Based on the reference method, added sugar intake was further classified according to three age groups (young adult-18-29 years old; middle adult-30-50 years old; old adult; 51-59 years old) and ethnicity (Malay, Chinese and Indian). Added sugar intake was reported to be higher in younger subjects across age groups ($p<0.05$). It decreased significantly in ascending order for the three age groups. Intakes were also significantly different across ethnicity, with the Malay ethnic group being the highest consumers of added sugar (54.0 ± 19.9 g / day), followed by Indian (44.4 ± 17.4 g / day). Chinese were reported to consume the lowest amount of added sugar (29.8 ± 15.4 g / day) in their daily diet, nearly half of the amount consumed by the Malay.

*Validation of FFQ against multiple pass 24-hr dietary recalls (reference method)*

Table 2 shows that the FFQ estimates of added sugar intake were higher than those reported in the Multiple Pass 24-hr Dietary Recall method (MP24HDR). The percentage of the mean difference between those two methods was significant for total and women subjects ($p<0.001$) using a paired *t*-test. Overall, a strong and significant correlation between the FFQ and the MP24HDR method ($r=0.74$, $p<0.001$) was obtained from this study. Women showed significantly lower correlation ($r=0.72$) compared to men ($r=0.77$). The Spearman rank test based on food groups ranged from 0.11 to 0.61. The highest correlation was shown for the self-prepared drinks group, and the lowest association was recorded for the cake and variations food group. The interquintile agreement, determined by the Kappa index, was 0.34 ($p<0.05$). When the FFQ was compared to the reference method, the percentage of subjects classified into the same quintile was 47.5%. There were no subjects who were grossly mis-classified (Table 3). A Bland-Altman plot of agreement was also carried out (Figure 1). The 95% limit of agreement is shown at the *y*-axis where the line intercepted at 34.6 g / day and -24.14 g / day. Between those figures, there was 58.6 g / day to be considered, where within this range, the FFQ could effectively provide intakes of added sugar.

## DISCUSSION

This study found that the mean intake of added sugar was 44.2 ± 20.2 g / day, or

**Table 2.** Percentage of mean difference for sugar between the FFQ method and reference method

| *Sugar (g) (95% CI)* | *Mean FFQ* | *Mean reference method* | *Mean difference*[a] | *Percentage of mean difference*[b] |
|---|---|---|---|---|
| All subjects | 49.43*** | 44.22 | 5.22 | 11.8 |
| | (45.6, 53.2) | (40.6, 47.8) | (2.6, 7.9) | (5.9, 17.9) |
| Men (n=49) | 50.41 | 47.749 | 2.663 | 5.6 |
| | (44.5, 56.4) | (41.6, 53.9) | (-1.4, 6.7) | (-2.9, 14.0) |
| Women (n=76) | 48.80*** | 41.937 | 6.866 | 16.4 |
| | (43.8, 53.8) | (37.6, 46.3) | (3.3, 10.4) | (7.9, 24.8) |

***Significant difference between methods: $p<0.001$; Paired *t*-test

[a] Mean difference = Mean FFQ – Mean reference method

[b] Percentage of mean difference = $\frac{\text{Mean FFQ} - \text{Mean reference method}}{\text{Mean reference method}} \times 100$

**Table 3.** Cross-classification of calcium intake assessed by the FFQ and reference method

| | *FFQ quintile* | | | | | |
|---|---|---|---|---|---|---|
| *Reference method quintile* | *1* | *2* | *3* | *4* | *5* | *Total* |
| 1 | 15 | 6 | 2 | 3 | 0 | 26 |
| 2 | 7 | 12 | 5 | 3 | 0 | 27 |
| 3 | 4 | 3 | 8 | 2 | 6 | 23 |
| 4 | 0 | 0 | 8 | 11 | 5 | 24 |
| 5 | 0 | 2 | 3 | 7 | 13 | 25 |
| Total | 26 | 23 | 26 | 26 | 24 | 125 |

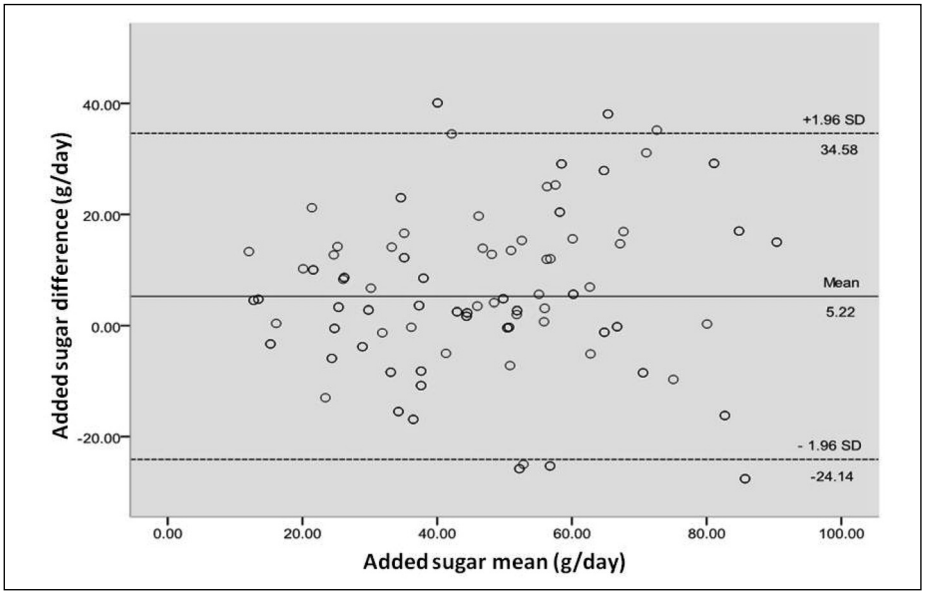


**Figure 1.** Bland-Altman plot of agreement between the FFQ and reference method

approximately 9 teaspoons. Interestingly, the Malaysian Adult Nutrition Survey (MANS) study reported that the Malaysian population consumed 7 teaspoonfuls of sugar per day per person, usually added into beverages such as coffee, tea and chocolate drinks (Norimah *et al.*, 2008). Due to the different classifications of sugar, it is inappropriate to compare the various intakes of sugar in other countries, especially with the European continent (Steyn, Myburgh & Nel, 2003). Three specific food groups that contributed to the FFQ were prepared (unprocessed) drinks, non-carbonated soft drinks and carbonated soft drinks, and all of the three beverages groups accounted for 55.3% of the total added sugar intake. Table sugar and sweetened condensed milk were regularly added to self-prepared drinks. Added sugar intake in the Western diet for adults mostly comes from sugar in the form of processed food, usually non-alcoholic soft drinks and sweetened grain products (Beghin & Jensen, 2000). The

development phase of the FFQ yielded a total of 64 food items that were identified and classified into 10 groups of foods with added sugar.

From the reference method, the results showed a decrease in added sugar intake across age groups. This result is similar to that reported in the Continuing Survey of Food Intakes by Individuals (CSFII) study, where added sugar intake was found to decrease across ages from 18 to 65 years (Guthrie & Morton, 2000). The difference in the three major ethnic groups in Malaysia has also been reported as contributing significantly to the added sugar intake. Western studies such as that by Steyn *et al.* (2003) also reported that ethnic differences do influence added sugar intake.

From a comparison of the FFQ and the MP24HDR (reference method) in the validation study, the percentage of the mean difference was 11.8%. The difference was significant, where the degree of estimation in the FFQ was generally higher than in the reference method, as in previous studies (Subar *et al.,* 2001). This phenomenon is attributed to the long list of food items and food groups (Chee *et al.*, 2002).

The correlation coefficient obtained in this study ($r = 0.74$) was similar to an earlier study (Liu, 1994) which had reported $r = 0.77$ by using a 12-day 24-hr dietary recall as the reference method. Previous studies usually compared the Pearson *r* value to the number of days covered in the reference method (Chee *et al.*, 2002). A shorter duration study may not reliably assess nutrient intake, while a longer duration study may cause a decrease in accuracy (Yunsheng *et al.*, 2009). A Pearson correlation based on gender was higher in men compared to women, with both showing significant correlation between methods. The results of the present study are similar to those of other FFQ validation studies, which have found that correlations are usually higher in men (Johansson *et al.*, 2002).

Correlations between methods according to food groups were assessed using the Spearman rank test, and the *r* values were found to be between 0.11 and 0.61 for all ten food groups. The highest correlation was recorded for self-prepared drinks ($r = 61$). Osler & Heitmann (1996) have suggested that foods which are consumed regularly by the majority of the population tend to have higher correlations. Self-prepared drinks were the most highly consumed ($24.1 \pm 14.3$ g / day) by most of the subjects (98.4% of total subjects) based on the reference method. Furthermore, the less popular food groups usually do not produce a good correlation because of the difficulties subjects have in remembering those kinds of foods as compared to more regularly consumed foods (Dwyer & Coleman, 1997). In this study, the three most infrequently consumed food groups possessed the lowest correlation, namely, cake and variations, buns and dumplings and the *kuih* group. The correlations obtained were somewhat low for certain groups. Possible explanations may be the non-specific records obtained and the failure of subjects to report items in a clear manner (Brown, 2006).

In epidemiological studies, the usefulness of the FFQ would be in its ability to classify individuals into categories of nutrient intake (Cade *et al.*, 2002). This FFQ demonstrated a reasonable ability to classify individuals into quintiles of added sugar intake, with 47.2% being correctly classified into the same quintile and 34.4% into the next quintile. No subjects were grossly misclassified. The European Prospective Investigation into Cancer and Nutrition (EPIC) - Potsdam study, which used similar classifications, reported that the percentage of individuals correctly classified into the same quintile is 29.9% for monosaccharide intake and 36.6% for disaccharide intake (Kroke *et al.*, 1999). From a weighted Kappa value, the Kappa index reported was 0.34, which was within the acceptable level (Casey, Altobelli & Pignatelli, 2009). The Kappa index is considered to be the best indicator of agreement between methods in a quintile-based classification.

A Bland-Altman plot is used because of its ability to evaluate the agreement between two methods at the individual level (Magkos *et al.*, 2006). Based on a Bland-Altman plot, the FFQ seemed able to provide estimates of added sugar intake from 34.5 g / day above to 24.1 g / day below the reference method. The plot observed tended to concentrate around the mean line when the *y*-axis showed a value of around 40 – 60 g, meaning that those dots were focused around the means of intake for both methods. Some dots, which were located outside of the 95% confidence interval, represented the obvious difference between the reported intakes from both methods.

The strength of this study is that it is the first study to develop an FFQ to evaluate the habitual intake of sugar added to beverages and it can be used by all ethnic groups in Malaysia since the development of food items listed in the FFQ involved all three major ethnic groups. The FFQ and the multiple-pass appeared to be methods which were well received by the subjects and this was demonstrated in the high correlation between test and reference methods. The response rate of the study was also high. A weakness in the study could be a selection bias that might have occurred as only those subjects who were interested and agreed to participate would give consent for their participation; further the sampling method adopted was convenient sampling. A larger number of subjects would also reduce random errors in the measurement. The effect of the section bias would likely be an overestimate of the association between the test and reference measures. Nevertheless the developed and validated FFQ would be useful tool to estimate habitual sugar intake in beverages.

In conclusion, the FFQ that had been developed consisted of 64 food items classified into 10 food groups. The main sources of added sugar intake in adults were from self-prepared drinks such as coffee, tea and chocolate drinks. From the validation analysis, the results showed that the mean difference and Pearson correlations demonstrated a good relationship between the FFQ and the reference method. In the cross-classification analysis, no subjects were grossly mis-classified. On the whole, the FFQ developed may be a useful clinical tool for assessing the intake of added sugar among adults in epidemiological studies.

## REFERENCES

Beghin JC & Jensen HH (2008). Farm policies and added sugars in US diets. *Food Policy* 33: 480-488.

Brown D (2006). Do food frequency questionnaires have too many limitations? *JADA* 106: 1541-1542.

Cade JE, Thompson R, Burley V & Warm D (2002). Development, validation and utilisation of food-frequency questionnaires – A review. *Public Hlth Nutr* 5: 567-587.

Casey P, Altobelli EG & Pignatelli TP (2009). Application of the hypothesis analysis method using Cohen's Kappa index to measure the agreement between leather sorters. [t.pt].

Chee WSS, Suriah AR, Zaitun Y, Chan SP, Yap SL & Chan YM (2002). Dietary calcium intake in post-menopausal Malaysian women: comparison between the food frequency questionnaire and three-day food records. *Asia Pac J Clin Nutr*. 11(2): 142-146.

Colton T (1974). Statistics in medicine. Massachussetts: Little, Brown & Co.

Dwyer JT & Coleman KA (1997). Insights into dietary recall from a longitudinal study: Accuracy over four decades. *Am J Clin Nutr* 65: S1153-S1158.

Fiji / FAO Asia Pacific Sugar Conference (1997). Part I: Theoretical outlook, framework analysis and background documentation. Food and Agriculture Organization, Rome.

Food and Agriculture Organization (2002). Food balance sheet. FAO statistics database. *http://faostat.fao.org/default.aspx* [Accessed December 2009].

Food Composition Guide Singapore (2003). Health Promotion Board, Singapore.

Goldberg GR, Black AE, Jebb SA, Cole TJ, Murgatroyd PR, Coward WA & Prentice AM (1991). Critical evaluation of energy intake data using fundamental principles of energy physiology: 1. Derivation of cut-off limits to identify under-recording. *Eur J Clin Nutr* 45(12): 569-581.

Guthrie JF & Morton JF (2000). Food sources of added sweetener in the diets of Americans. *JADA* 100: 43-48.

Ismail MN, Ng KK, Chee SS, Roslee R & Zawiah H (1998). Predictive equations for the estimation of basal metabolic rate in Malaysian adults. *Mal J Nutr* 4: 81-90.

Johansson I, Hallmans G, Wikman Å, Biessy C, Riboli E & Kaaks R (2002). Validation and calibration of food-frequency questionnaire measurements in the Northern Sweden Health and Disease cohort. *Public Hlth Nutr* 5: 487-496 doi:10.1079/PHN2001315.

Kroke A, Klipstein-Grobusch K, Voss S, Moseneder J, Thielecke F, Noack R & Boeing H (1999). Validation of a self-administered food-frequency questionnaire administered in the European Prospective Investigation into Cancer and Nutrition (EPIC) Study: comparison of energy, protein, and macronutrient intakes estimated with the doubly labeled water, urinary nitrogen, and repeated 24-h dietary recall methods. *Am J Clin Nutr* 70(4): 439-447.

Kusama K, Trung Le DSN, Minh Hanh TT, Takahashi K & Kim Hung NT (2005). Reproducibility and validity of a food frequency questionnaire among Vietnamese in Ho Chi Minh City. *J Am Coll Nutr* 24(6): 466-473.

Liu K (1994). Statistical issues related to semi-quantitative food-frequency. *Am J Clin Nutr* 59: S262-S265.

Magkos F, Manios Y, Babaroutsi E, Sidossis LS (2006). Development and validation of a food frequency questionnaire for assessing dietary calcium intake in the general population. *Osteo Inter* 17: 304-312.

Mirnalini K, Zalilah MS, Safiah MY, Tahir A, Siti Haslinda MD, Siti Rohana D, Khairul Zarina MY, Mohd Hasyami S & Normah H (2008). Energy and nutrient intakes: Findings from the Malaysian Adults Nutrition Survey (MANS). *Mal J Nutr* 14: 1-24.

Mohd Razif S, Suhaina S, Soraya Hanie S, Nurismah MI & Sharifah Noor Akmal SH (2008). Semi-quantitative Food frequency questionnaire for assessment of energy, total fat, fatty acids, vitamin A, C and E intake amo*ng* Malaysian women: comparison with three day 24-hour dietary recalls. *Mal J Hlth Sc* 6(2): , 75-91

National Coordinating Committee on Food and Nutrition (NCCFN) (2005). Recommended nutrient intake for Malaysians. A report of the Technical Working Group on Nutritional Guidelines. Ministry of Health Malaysia, Putrajaya.

Norimah AK, Safiah MY, Jamal K, Siti Haslinda MD, Zuhaida H, Rohida S, Fatimah S, Siti Norazlin, Poh BK, Kandiah M, Zalilah MS, Wan Manan WM, Fatimah S & Azmi MY (2008). Food consumption patterns: findings from the Malaysian Adult Nutrition Survey (MANS). *Mal J Nutr* 14(1): 25-39.

Osler M & Heitmann BL (1996). The validity of a short food frequency questionnaire and its ability to measure changes in food intake : A longitudinal study. *Inter J Epid* 25(5): 1023-1029.

Steyn NP, Myburgh NG & Nel JH (2003). Evidence to support a food-based dietary guideline on sugar consumption in South Africa. *Bulletin WHO* 81(8): 599-605.

Subar AF, Thompson FE, Kipnis V, Midthune D, Hurwitz P, McNutt S, McIntosh A & Rosenfeld S (2001). Comparative validation of the Block, Willett and National Cancer Institute Food Frequency Questionnaires. *Am J Epid 154(12): 1089 - 1099*.

Suzana S, Noor Aini MY, Nik Shanita S, Rafidah G & Roslina A (2009). Atlas of Food Exchanges and Portion Sizes (2nd ed.). MDC Publishers, Kuala Lumpur.

USDA ARS Nutrient Data Lab (2009). Version 21.0. U.S. Department of Agriculture, Agricultural Research Service,Washington DC.

Wessex Institute of Public Health Medicine (1995). University of Southampton.

Wolever MS & Miller JB (1995). Sugars and blood glucose control. *Am J Clin Nutr* 62: 212-217.

Yunsheng MA, Olendzki BC, Pagoto SL, Hurley TG, Magner RP, Ockene IS & Hebert JR (2009). Number of 24-hour diet recalls needed to estimate energy intake. *Annals Epid* 19: 553-559.