

Development and Assessment of the Reliability and Validity of a Diet Quality Index in a Sample of Malaysian University Students

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Abstract Despite the fact that university students are at risk of having a poor diet quality, there is no reliable and valid instrument to measure the diet quality of Malaysian university students. The objectives of this study were to develop and validate a diet quality index among a sample of Malaysian university students, and assess their diet quality. The Malaysian Dietary Guidelines and Malaysian Food Pyramid were used in the formulation of a diet quality index. A cross-sectional study was conducted among 320 students at a local university. Data collected through face-to-face interview was used to determine the reliability and validity of the diet quality index. The diet quality of participants was also assessed and they were categorised into 'at risk' and 'at lower risk' of poor diet quality. A Cronbach's alpha value of 0.780, mean inter-item correlation of 0.353 and corrected-item total correlation above 0.3 were found after five items were deleted from the index. Principal component analysis revealed the presence of four components with eigenvalues exceeding 1. Only one component explaining 41.7% of variance was retained. This component consisted of seven items. The index also showed known-group validity with respect to gender with females (19.0) having higher median diet quality scores than males (18.0) ($p=0.006$). Diet quality scores showed significant negative correlation with sugar intake ($r=-0.150$, $p=0.008$) and significant positive correlation with intakes of fibre and nine micronutrients ($p<0.05$). The percentage of participants 'at risk' and 'at lower risk' of poor diet quality were 23.1% and 76.9% respectively. The 7-item diet quality index is a short, interviewer-administered, valid and reliable instrument to measure the diet quality of Malaysian university students. External validation will extend the application of this diet quality index.

Keywords: diet quality, university students, Malaysia, reliability, validity

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1. Introduction

The number of students pursuing higher education is rapidly increasing nowadays. According to latest statistics, from 2000 to 2013 there was a record increase of 6.5 million students in American colleges and universities [1]. Enrollment in Malaysian public universities has similarly experienced constant rise in the past few years, climbing from 437,420 in 2009 to 467,780 in 2010 [2] and 560,356 in 2014 [3].

Besides being an enjoyable period of their life, university students are faced with several difficulties and challenges such as new environment, accommodation problem, lack of cooking experience and facilities, time constraint, having to make autonomous decisions on food selection, economic insufficiency, high work load, inadequate sleep and stress. These challenges may lead to inadequate nutritional status that may compromise their physical and mental health and lead to an increase risk of acquiring chronic diseases later in life [4].

Since the past years there has been an increasing debate on the most appropriate way to analyse the human diet and

relate it to diet-related disease risk. Traditionally, the focus has been on associating the intake of single nutrient or individual food in relation to the risk of chronic diseases [5]. However, such an approach towards disease promotion and prevention is being overruled in the field of nutrition epidemiology. It is being increasingly recognised that the human diet is a complex amalgam of foods and each food component itself consists of several different nutrient and non-nutrient components that interact with one another [6].

Dietary pattern considers the whole diet as a single entity and can be examined using two different approaches namely, score-based approach (*a priori*) and data-driven approach (*a posteriori*) [7]. The score-based approach is based on existing dietary guidelines and scientific evidence on the role of nutrients in disease prevention. The second type relies on statistical methods such as factor or cluster analysis to reduce a set of food items into one factor or cluster which is found to be associated with health outcomes [6]. Diet quality is assessed using dietary indices and it falls under the score-based approach [6].

As expected, studies on the diet quality of university students have unanimously found that their diet quality is

either poor or in need of improvement. Studies in Spain, United Kingdom and Puerto Rico have all reported that the majority of university students were not following the recommended dietary guidelines and consequently there was a very high prevalence of poor diet quality among them [8,9,10,11].

There is very limited valid data on the diet quality of Malaysian university students. One previous study attempted to develop a Healthy Eating Index for Malaysian adults but the index was not tested for reliability or validity [12]. Previous studies among Malaysian university students have focused mostly on their nutritional status and eating habits. Insufficient intakes of certain nutrients [13], fruits and milk, and excessive intake of sodium has been reported among them [14].

Before any newly developed scale or index is used, it has to be thoroughly verified in order to avoid erroneous interpretation of the outcomes they are measuring [15]. This is of extreme importance as in most cases the parameters being assessed would guide clinical decisions and health policies [16]. Therefore, the determination of the reliability and validity is an important step to follow not only to avoid incorrect interpretation of outcomes but for an instrument to obtain recognition and for its wide use [15]. This study therefore aimed to develop a Malaysian diet quality index and to establish its reliability and validity based on internal consistency reliability, construct validity and concurrent validity.

2. Materials and Methods

2.1. Index Component Selection

The Malaysian Dietary Guidelines and recommendations from the Malaysian Food Pyramid [17] were used in the formulation of the diet quality index. Out of 14 key messages from the Malaysian Dietary Guidelines, seven key messages pertaining to dietary intake (key messages 4 to 10) were used and 12 food groups or items were created and are as follows: (1) Cereal, cereal products and tubers, (2) Wholegrain cereals, (3) Fruits, (4) vegetables, (5) Milk and dairy products, (6) Legumes and their products, (7) Fish, (8) Poultry, meat and egg, (9) High-fat protein foods, (10) Fat-rich foods, (11) Salt-rich foods, (12) Sugar-rich foods. Under each food group, examples of foods mentioned in the Malaysian Dietary Guidelines, Malaysian Food Pyramid and Malaysian Adult Nutrition Survey Food Frequency Questionnaire (MANS FFQ) [18] were cited. Information on how food groups were derived based on the key messages from the Malaysian Dietary Guidelines and food recommendation from the Malaysian Food Pyramid is available as online supplemental material (Supplemental Material 1).

2.2. Scoring Method

Scoring methods used previously [19,20,21,22] were combined to produce a five-point scoring method based on adherence to dietary guidelines and frequency of consumption of the twelve food groups. Serving size as recommended by the Malaysian Food Pyramid was also considered in giving scores for food groups 1 to 8. If participants report a daily intake for a particular food group, the amount of food ingested during the past 24

hour was recorded for that food group. Participants' recommended serving size was determined based on their calorie requirement as detailed in the Malaysian Food Pyramid [17]. Maximum score (score of 5) was given if participants answered 'daily' and if the recommended daily serving size for that particular food group was met. Participants consuming the food on a daily basis but not meeting the recommended daily serving size for that particular food group (either exceeding or consuming less) were given a score of 4. However, in the case of food groups 3 (Vegetables) and 4 (Fruits), the score was not reduced if participants exceeded the recommended amounts as it would not represent a health risk. According to the Malaysian Food Pyramid, active men, underweight men and underweight women may require more than 2500kcal energy per day [17]. For the present study, since the serving size of food groups for a calorie need of more than 2500kcal was not provided in the Malaysian Food Pyramid, the serving size of a 2500kcal diet was used for the aforementioned participants in the diet quality scoring process. The Atlas of Food Exchanges and Portion Sizes [23] as well as standard household measures were used to aid participants identify portion sizes. The total diet quality score was the sum of the scores from the food groups. Table 1 shows the scoring method used in this study to determine the diet quality scores for each food group.

2.3. Standard Dietary Assessment Method

The 126 item-food frequency questionnaire of the MANS FFQ [18] was used as the standard dietary assessment method. As described previously [25], the food frequencies in the MANS FFQ can be converted into the amount of food intake. From the values of amount of food per day, the daily energy intake and nutrient intake (protein, carbohydrate, sugar, fibre, total fat, cholesterol, saturated fat, monounsaturated fat, polyunsaturated fat, vitamin A, beta-carotene, vitamin C, vitamin E, thiamine, riboflavin, niacin, folate, iron, calcium, sodium, potassium, magnesium, zinc) were determined using the Nutritionist ProTM (Axxya Systems LLC, Washington, United States).

2.4. Assessment of Participants' Diet Quality

Using the composite diet quality scores calculated from seven food groups selected after reliability and validity testing, participants' diet quality was categorised into 'at risk of poor diet quality' and 'at lower risk of poor diet quality' as formerly described [26]. To determine the cut-off score for demarcating the two groups, sensitivity and specificity analysis were performed as described by a previous study [27]. A mean adequacy ratio (MAR) of 0.75 was used as a cut-off for inadequate diet [26,27]. Participants having MAR of ≤ 0.75 were classified as having an inadequate diet, and those having MAR > 0.75 were classified as having an adequate diet. A Receiver Operating Characteristic (ROC) curve was plotted using diet quality scores as the test variable and MAR (categorised into 'adequate diet' and 'inadequate diet') as the state variable. The curve was inspected and the highest point on the curve relative to the y-axis which is closest possible to the upper left corner of the graph was noted. The coordinates of that point which indicate the most appropriate sensitivity and specificity were used to find out corresponding cut-off diet quality score. Participants

scoring below the cut-off score were therefore classified as 'at risk of poor diet quality' and those scoring above it were classified as being 'at lower risk of poor diet quality'. The area under the ROC curve was also recorded.

2.5. Statistical Analysis

All statistical analyses were conducted using the software, Statistical Package for Social Sciences version 17.0 software (SPSS, Inc. Chicago, IL, USA) and $p < 0.05$ was considered statistically significant. Non-parametric tests were used and median was reported instead of mean since the variables did not show normal distribution. Values are given to three significant figures. Reliability of the diet quality scores was determined based on internal consistency. Cronbach's alpha, mean inter-item correlation and corrected-item total correlation were selected to determine internal consistency.

To determine construct validity, exploratory factor analysis was conducted. The suitability of the data for factor analysis was determined through Kaiser-Meyer-Olkin (KMO) value and level of significance from Bartlett Test of Sphericity. The data was then subjected to principal component analysis (PCA) with varimax rotation. The number of components extracted were deduced based on eigenvalues greater than one, scree plot and minimum factor loading of 0.4 or above [28]. Another part of construct validity, namely known-group validity was also assessed by comparing the difference in diet quality scores with respect to gender through Mann-Whitney U test. Spearman's Rank Order Correlation of diet quality scores with energy and nutrient intake was used to establish concurrent validity.

3. Results

3.1. Socio-demographic Characteristics

The median age of participants was 22 years and the age range was from 19 to 40 years. Approximately equal number of males (46.6%) and females (53.4) were recruited. Most of the participants of this study belonged to the Malay ethnicity (64.7%), followed by Chinese (29.7%), Indian (3.13%) and other ethnicities (2.5%). Seventy percent of the participants were undergraduate students and the rest were doing their postgraduate studies at the time of data collection.

3.2. Internal Consistency Reliability

For the 12 food groups, the mean inter-item correlation was 0.171 which is less than the acceptable range of >0.3 [28]. Five food groups had corrected-item total correlation below the acceptable range of 0.3 [28] (Cereal, cereal products and tubers, Milk and milk products, Legumes and their products, Poultry, meat and egg, High-fat protein foods). The Cronbach's alpha coefficient was 0.686 and could be increased to 0.693, 0.696, 0.713 and 0.694 if the food groups Milk and dairy products, Legumes and their products, Poultry, meat and egg, and High-fat protein foods were respectively removed from the index.

A second attempt was therefore made to increase Cronbach's alpha by deleting these four food groups and the new alpha coefficient increased to 0.758 which is

above the acceptable range of >0.7 . Simultaneously, the mean inter-item correlation increased from 0.171 to 0.280. However, the corrected-item total correlation was still below 0.3 for the group Cereals, cereal products and tubers (0.101). Also, the same food group if excluded would bring the Cronbach's alpha value to 0.780 from 0.758.

Therefore, the food group Cereal, cereal products and tubers were removed from the index. This attempt increased the mean inter-item correlation to 0.353 which is above 0.3, and the Cronbach's alpha to a reliable value of 0.780. Moreover, the inter-item correlation ranged from 0.145 to 0.652 and the mean inter-item correlation (0.353) was in the acceptable range of 0.3 to 0.9 [28].

3.3. Construct Validity

The KMO value was 0.755, exceeding the recommended value of 0.6 [28] and Bartlett's Test of Sphericity reached statistical significance ($p=0.000$), justifying that the data could undergo factor analysis. PCA with varimax rotation revealed the presence of four principal components with eigenvalues exceeding 1, explaining 41.7%, 14.2%, 10.8% and 9.59% of the variance respectively (Table 1). The minimum factor loading was greater than 0.4. An inspection of the scree plot (Figure 1.) revealed a clear break after the first component. It was therefore decided to retain only the first component which explained 41.7% variance for further validation procedures.

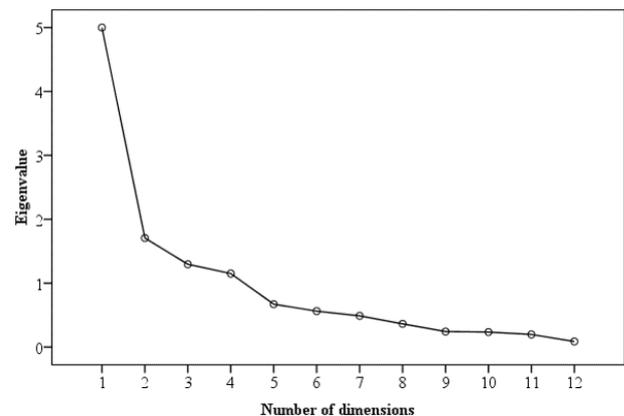


Figure 1. Scree plot from principal component analysis of the diet quality index

Table 1. Factor extraction from the 12 food groups of the diet quality index using principal component analysis

Food groups	Loadings			
	CP1	CP2	CP3	CP4
Vegetables	0.842			
Wholegrain cereals	0.821			
Salt-rich foods	0.813			
Fruits	0.792			
Sugar-rich foods	0.723			
Fat-rich foods	0.663			
Fish	0.595			
Cereal, cereal products and tubers		0.780		
High-fat protein foods		0.776		
Milk and milk products			0.958	
Legumes and their products				0.835
Poultry, meat and eggs			0.471	
Percentage of variance explained	41.7%	14.2%	10.8%	9.59%

CP: Component.

Figure 2 shows the items in the diet quality index before and after reliability and construct validity. The total diet quality score used in the subsequent statistical analyses were calculated from only seven food groups namely, Wholegrain cereals, Vegetables, Fruits, Fish, Fat-

rich foods, Salt-rich foods and Sugar-rich foods. The possible range of score from the seven food groups was 0 to 35. The seven-item diet quality index is available as online supplemental material (Supplemental Material 2).

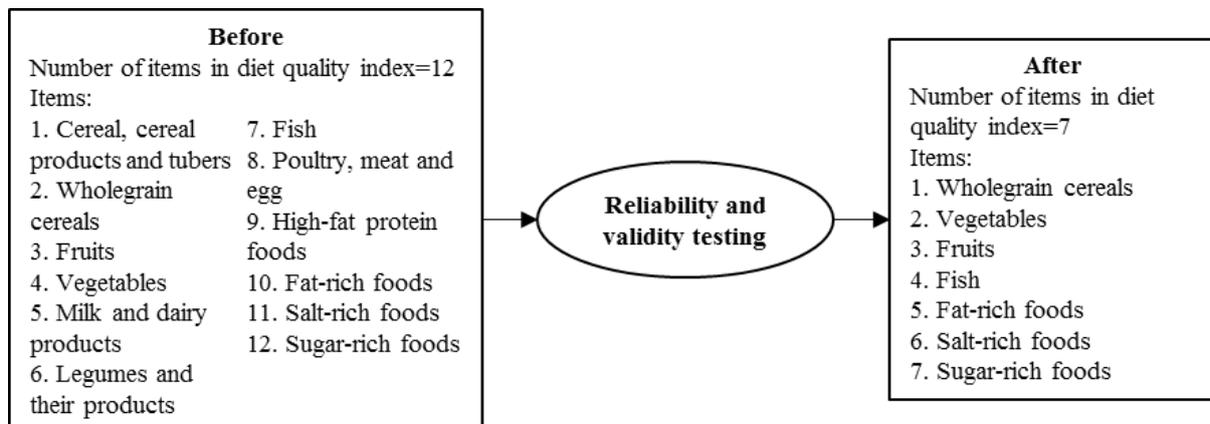


Figure 2. Items in the diet quality index before and after reliability and validity testing

3.4. Known-group Validity

Using Mann-Whitney U test, it was found that females (19.0) had significantly higher diet quality scores than males (18.0) ($p=0.006$).

3.5. Concurrent Validity

The minimum and maximum diet quality score recorded among the participants were 7 and 28 respectively. The median score was 19.0. Table 2 shows the intake of

energy and 24 nutrients by the participants. A small negative correlation was found between diet quality scores and intakes of energy, sugar, total fat, cholesterol and sodium. However, the negative correlation was statistically significant only for sugar intake. A statistically significant positive correlation was found between diet quality scores and intakes of fibre, vitamin A, beta carotene, vitamin E, vitamin C, riboflavin, niacin, folate, magnesium and zinc. Irrespective of the direction of the correlation, the range of the correlation coefficient was from 0.128 to 0.242 (Table 2).

Table 2. Daily nutrient intake of participants and correlation with diet quality scores

No.	Nutrients	Daily intake of participants (Median)	Spearman's Rank Order correlation
			rho (p value)
1	Energy (kJ)	7710	-0.057 (0.311)
2	Protein (g)	69.7	0.010 (0.860)
3	Carbohydrate (g)	278	0.002 (0.967)
4	Sugar (g)	30.8	-0.150 (0.008)*
5	Fibre (g)	4.30	0.176 (0.002)*
6	Total fat (g)	50.5	-0.062 (0.268)
7	Cholesterol (mg)	176	-0.007 (0.901)
8	Saturated fats (g)	7.59	0.048 (0.401)
9	Monounsaturated fats (g)	5.77	0.009 (0.871)
10	Polyunsaturated fats (g)	2.71	0.013 (0.823)
11	Vitamin A (IU)	6890	0.202 (0.000)*
12	Beta carotene (μg)	2500	0.242 (0.000)*
13	Vitamin E (mg)	3.08	0.158 (0.006)*
14	Vitamin C (mg)	94.4	0.207 (0.000)*
15	Thiamin (mg)	1.23	0.031 (0.581)
16	Riboflavin (mg)	2.15	0.159 (0.005)*
17	Niacin (mg)	12.3	0.128 (0.024)*
18	Folate (μg)	114	0.155 (0.007)*
19	Sodium (mg)	1128	-0.058 (0.309)
20	Calcium (mg)	602	0.065 (0.253)
21	Magnesium (mg)	115	0.170 (0.003)*
22	Phosphorus (mg)	952	0.056 (0.323)
23	Potassium (mg)	1290	0.094 (0.094)
24	Iron (mg)	14.3	0.102 (0.070)
25	Zinc (mg)	3.26	0.152 (0.007)*

IU: International Unit

1 kcal of energy is approximately 4.184 kJ

*Statistically significant results from Spearman's Rank Order correlation between diet quality scores and nutrient intake ($p<0.05$).

3.6. Participants' Diet Quality

The area under the ROC curve was 0.792. The highest point on the curve relative to the y-axis which was closest possible to the upper left corner of the graph had coordinates of (0.9, 0.26). Using these coordinates, the most appropriate cut-off was determined to be a score of 16.5. At this score, the sensitivity and specificity were 90.2% and 73.8% respectively. The percentage of students at risk of poor diet quality was 23.1%. The percentage of participants at lower risk of poor diet quality was 76.9%.

4. Discussion

To ascertain that a newly developed index is reliable and valid is an important step before it is used. With regard to internal consistency, the Cronbach's alpha value of the 7-component index was 0.780. The results of this study corroborate with previous findings. The Healthy Eating Index (HEI) versions 2005 and 2010 have both been evaluated for reliability [30]. Their Cronbach's alpha values were reported as 0.65 and 0.68 respectively and both indices were claimed to have acceptable internal consistency as the Cronbach's alpha values were very close to 0.7 [30]. Instead of the mean-inter item correlation for each component, the inter-item correlation coefficients between components were reported for both HEI 2005 and HEI 2010. They were in the range of 0.01 to 0.57 for HEI-2005 [31] and 0.22 to 0.67 for HEI-2010 [30]. In the present study, the inter-item correlation was in the range of 0.145 to 0.652 which follows what was reported for both HEI indices.

Similarly, the corrected-item total correlations of the seven components were in the range of 0.397 to 0.697 in the present study, whereas those of the HEI-2005 and HEI-2010 were lesser, that is between 0.01 and 0.57 [31], and 0.22 and 0.67 [30] respectively. Acceptable internal consistency for both HEI-2005 and HEI-2010 was acclaimed by the authors based mainly on the Cronbach's alpha value. In the present study, the seven-component index was found to have acceptable internal consistency based upon Cronbach's alpha value, mean inter-item correlation as well as corrected-item total correlation.

The construct validity of HEI-2005 and HEI-2010 have also been examined through principal component analysis. For both indices, approximately five dimensions were extracted and the researchers retained all of the dimensions since none of them explained a significant amount of variance in the data [30,31]. However, in the present study one of the dimensions explained a significant amount of variance (41.7%) and was therefore the only one retained. The one component that was retained after construct validity comprised of seven food groups which were the same ones preserved after internal consistency reliability testing. Despite that reliability and validity are two separate aspects, they are closely related [32]. This could possibly explain why in the present study, the same food groups were bundled after internal consistency reliability testing and construct validity testing.

After both internal consistency reliability testing and construct validity testing, five food groups were excluded from the diet quality index and were Cereal, cereal products and tubers, High-fat protein foods, Milk and

dairy products, Poultry, meat and eggs, and Legumes and their products. A plausible explanation for the elimination of certain items from the index could be that the individuals who participated in this study were similar to each other in certain aspects. The fact that the participants were all young adults of almost the same age and that they were exposed to the same food environment within the university campus could have led to similar food choice and eating habits. Therefore, it could be inferred that in the case of university students, intake of foods from Cereal, cereal products and tubers, High-fat protein foods, Milk and dairy products, Poultry, meat and eggs, and Legumes and their products was consistent among all students and only the remaining seven food groups namely, Wholegrain cereals, Vegetables, Fruits, Fish, Fat-rich foods, Salt-rich foods and Sugar-rich foods were able to really differentiate in the diet quality of the students. The same scenario may occur in other universities of Malaysia due to exposure of students to a similar food environment which can produce a uniform trend in food selection.

In this study, females had better diet quality than males. Similar results have been found in other studies and there is substantial evidence that females have better diet quality than males among adolescents [26], adults [21,30,31,33], elderly [34] as well as university students [8,9,11,12]. Since there is consensus on the fact that females have better diet quality and the diet quality index developed herein has successfully shown this difference, this can be used as a further proof to support the construct validity of the index. This strategy has been previously used to ascertain the construct validity of the HEI-2005 [31] and HEI-2010 [30].

Concurrent validity is the most commonly used form of validity in the field of nutrition [35]. In this study, a significant negative correlation was found between total scores and sugar intake. A significant positive correlation was obtained between total scores and fibre, vitamin A, beta carotene, vitamin E, vitamin, riboflavin, niacin, folate, magnesium and zinc. Similar trend have been reported previously [20,36]. However, to validate the Australian Recommended Food Score using a food frequency questionnaire, the researchers found no significant correlation for sugar, vitamin E and zinc, but reported significant correlation for calcium, iron, phosphorus and potassium which were also investigated in the present study [36]. On the other hand, another group of investigators found no significant correlation for vitamin A but obtained significant correlation for total energy, carbohydrate, calcium and iron when they validated a Danish diet quality score using a food frequency questionnaire [20]. This shows that the nutrients being correlated varies from index to index.

The correlation coefficients ranged from 0.128 to 0.242 in the present study. However, the coefficients herein were less as compared to the values obtained from other diet quality indices. The Australian recommended Food Score, the Danish diet quality score and the Healthy Eating Index showed correlation coefficients in the range of 0.12 to 0.53 [36], 0.08 to 0.48 [20] and 0.06 to 0.42 [37] respectively. There is no ideal range for the coefficients, but it has been reported that in order for a dietary instrument to have an association with disease outcomes, the correlation with nutrients as measured by the standard dietary assessment method should be above 0.3 [38]. From this statement it

may be inferred that the diet quality scores being measured using this index may not show associations with disease outcomes.

The area under the ROC curve was 0.792 which is above 0.5. This implies that the individuals were not categorised by chance and that the diet quality index represents a fair test for diet quality assessment [39]. The cut-off value obtained from the curve was 16.50 and at this point the sensitivity and specificity of diet quality assessment were 90.2% and 73.8% respectively which are higher than previously reported [26]. Using the cut-off value of 16.50, the proportion of participants at risk of poor diet quality and at lower risk of poor diet quality identified in this study were 23.1% and 76.9% respectively. The proportion of students at lower risk of poor diet quality (76.9%) was higher as compared to what has been reported in Spain and Puerto Rico. In two Spanish studies, only 3.9% [9] and 6.4% [10] of university students had a diet quality classified as 'good'. In Puerto Rico, it was found that 36% of university students had a diet quality classified as 'adequate' [40]. Similarly, a study conducted in Universiti Kebangsaan Malaysia showed that a 73.4% of university students had poor diet quality while 23.6% consumed a diet that needed improvement [12]. However, none of the studies mentioned about the method they used to determine a cut-off score to describe their participants' diet quality as 'good', 'poor' or 'adequate'. Therefore, caution need to be exerted when interpreting diet quality from different studies as a 'good diet quality' may be a sub-category of 'at lower risk of poor diet quality'. There should be standardisation in the method to determine cut-off score in order to compare findings from study to study.

5. Conclusions

From the results of this study, it can be concluded that the 7-item diet quality index developed is a reliable and valid instrument to assess diet quality of Malaysian university students and is consistent with Malaysian Dietary Guidelines and recommendations from the Malaysian Food Pyramid. The instrument has the ability to produce a fair test for diet quality assessment. By means of the diet quality index, one-quarter of participants were found to be at risk of poor diet quality and this proportion should not be underestimated despite that it is less than reported abroad. As compared to females, males require more focus in nutrition intervention programmes as they may be at greater risk of poor diet quality. Currently, the 7-item diet quality index is applicable to the selected university only. However, future studies may consider to test the external validity of the diet quality index in other universities so as to broaden its application. It may also be tested among other Malaysian adults since the index was based on Malaysian Dietary Guidelines and Malaysian Food Pyramid.

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Statement of Competing Interests

The authors declare no competing interests.

List of Abbreviations

HEI: Healthy Eating Index, KMO: Kaiser-Meyer-Olkin, MAR: Mean Adequacy Ratio; MANS FFQ: Malaysian Adult Nutrition Survey Food Frequency Question, ROC: Receiver Operating Characteristic Curve

References

- [1] Roy, R., Kelly, B., Rangan, A. and Allman-Farinelli, M., "Food environment interventions to improve the dietary behaviour of young adults in tertiary education settings: A systematic literature review," *J Acad Nutr Diet*, 115(10). 1647-1681. 2015.
- [2] Ministry of Higher Education Malaysia (MOHE), "Report on the Statistics of higher education of Malaysia 2010," 2011 [Online]. Available: http://www.mohe.gov.my/web_statistik/perangkaan_2010.pdf. [Accessed Oct. 2, 2015].
- [3] Ministry of Education Malaysia (MOE), "Malaysia educational statistics quick facts 2014," 2014 [Online]. Available: http://www.emisportal.moe.gov.my/.../Quickfacts_2014/Buku. [Accessed Oct. 2, 2015].
- [4] Doygun, O. and Gulec, S., "The problems faced by university students and proposals for solution," *Procedia - Social and Behavioral Sciences*, 47. 1115-1123. 2012.
- [5] Hu, H.B., "Dietary pattern analysis: a new direction in nutritional epidemiology," *Curr Opin Lipidol*, 13(1). 3-9. 2002.
- [6] Kant, A.K., "Indexes of overall diet quality: A review," *J Am Diet Assoc*, 96(8). 785-791. 1996.
- [7] Moeller, S.M., Reedy, J., Millen, A.E., Beth Dixon, L.B., Newby, P.K., Tucker, K.L. and Krebs-Smith, S.M., "Dietary patterns: Challenges and opportunities in dietary patterns research, An Experimental Biology Workshop," *J Am Diet Assoc*, 107(7). 1233-1239. 2007.
- [8] Cooke, R. and Papadaki, A., "Nutrition label use mediates the positive relationship between nutrition knowledge and attitudes towards healthy eating with dietary quality among university students in the UK," *Appetite*, 83. 297-303. 2014.
- [9] García-Meseguer, M.J., Burriel, F.C., García, C.V. and Serrano-Urrea, R., "Adherence to Mediterranean diet in a Spanish university population," *Appetite*, 78. 156-64. 2014.
- [10] Amaral Alves, D., Hernández Regidor, N., Basabe Baraño, N., Rocandio Pablo, A.M. and Arroyo Izaga, M., "Body satisfaction and diet quality in female university students from the Basque Country," *Endocrinol Nutr*, 59(4). 239-45. 2012.
- [11] Moreno-Gómez, C., Romaguera-Bosch, D., Tauler-Riera, P., Bennasar-Veny, M., Pericas-Beltran, J., Martínez-Andreu, S. and Aguiló-Pons, A., "Clustering of lifestyle factors in Spanish university students: the relationship between smoking, alcohol consumption, physical activity and diet quality," *Public Health Nutr*, 15(11). 2131-9. 2012.
- [12] Lee, T.T., Norimah, A.K. and Safiah, M.Y., "Development of Healthy Eating Index for Malaysian adults," in *26th Scientific Conference and Annual General Meeting of the Nutrition Society of Malaysia*, Kuala Lumpur, Malaysia, 2011 [Online]. Abstract available: http://www.nutriweb.org.my/downloads/NS_M. [Accessed Nov. 9, 2015].
- [13] Abdull Hakim, N.H., Muniandy, N.D. and Danish, A., "Nutritional status and eating practices among university students in selected universities in Selangor, Malaysia," *Asian J Clin Nutr*, 4(3). 77-87. 2012.
- [14] Gan, W.Y., Mohd Nasir, M.T., Zalilah, M.S. and Hazizi, A.S., "Differences in eating behaviours, dietary intake and body weight status between male and female Malaysian university students," *Malays J Nutr*, 17(2). 213-228. 2011.
- [15] Anthoine, E., Moret, L., Regnault, A., Sbillé, V. and Hardouin, J., "Sample size used to validate a scale: a review of publications on newly-developed patient reported outcomes measures," *Health Qual Life Outcomes*, 12(2). 176-186. 2014.

- [16] Roach, K.E., "Measurement of health outcomes: Reliability, validity and responsiveness," *Journal of Prosthetists and Orthotists*, 18(1S), 8-12. 2006.
- [17] National Coordinating Committee on Food and Nutrition (NCCFN), Ministry of Health Malaysia, "Malaysian Dietary Guidelines 2010," 2010 [Online]. Available: <http://www.moh.gov.my/images/gallery/Garispenduan/diet/introduction.pdf>. [Accessed Dec. 9, 2015].
- [18] Ministry of Health Malaysia (MOH), Nutrition Section, Family Health Development Division, Malaysian Adult Nutrition Survey 2003: Methodology, Ministry of Health Malaysia, Putrajaya, 2008.
- [19] Golley, R.K., Hendrie, G.A. and McNaughton, A., "Scores on the dietary guideline index for children and adolescents are associated with nutrient intake and socio-economic position but not adiposity," *J Nutr*, 141(7), 1340-1347. 2011.
- [20] Toft, U., Kristoffersen, L.H., Lau, C., Borch-Johnsen, K., and Jørgensen, T., "The Dietary Quality Score: validation and association with cardiovascular risk factors: The Inter99 study," *Eur J Clin Nutr*, 61(2), 270-278. 2007.
- [21] Dynesen, A.W., Haraldsdóttir, J., Holm, L. and Astrup, A., "Sociodemographic differences in dietary habits described by food frequency questions-results from Denmark," *Eur J Clin Nutr*, 57(12), 1586-1597. 2003.
- [22] Fokeena, W.B. and Jeewon, R., "Is there an association between socioeconomic status and body mass index among adolescents in Mauritius?" *Scientific World Journal*, 2012.
- [23] Shahar, S., Mohd Yusoff, N.A., Safii, N.S., Ghazali, R. and Ahmad, R., Atlas makanan: saiz pertukaran & porsi. Atlas of food exchanges and portion sizes, MDC Publishers Sdn Bhd, Kuala Lumpur, 2009.
- [24] Comrey, A. and Lee, H., A first course in factor analysis, Lawrence Erlbaum Associates, Inc., Publishers, New Jersey, 1992.
- [25] Norimah, A.K., Safiah, M., Jamal, K., Haslinda, S., Zuhaida, H., Rohida, S., Fatimah, S., Norazlin, S., Poh, B.K., Kandiah, M., Zalilah, M.S., Wan Manan, W.M., Fatimah, S. and Azmi, M.Y., "Food Consumption Patterns: Findings from the Malaysian Adult Nutrition Survey (MANS)," *Malays J Nutr*, 14(1), 25-39. 2008.
- [26] Rezali, F.W., Chin, Y.S., Shariff, Z.M., Yusof, B.N.M., Woon, F.C. and Sanker, K., "Evaluation of diet quality and its associated factors among adolescents in Kuala Lumpur, Malaysia," *Nutr Res Pract*, 9(5), 511-516. 2015.
- [27] Hatløy, A., Torheim, L.E. and Oshaug, A., "Food variety-A good indicator of nutritional adequacy of the diet? A case study from an urban area in Mali, West Africa," *Eur J Clin Nutr*, 52(12), 891-898. 1998.
- [28] Pallant, J. SPSS Survival manual. A Step by Step Guide to Data Analysis using SPSS for Windows, McGraw Hill: Open University Press, Berkshire, 2007.
- [29] Willett, W. Nutritional epidemiology. Oxford University Press, New Year, 2013.
- [30] Guenther, P.M., Kirkpatrick, S., Reedy, J., Krebs-Smith, S.M., Buckman, D.W., Dodd, K.W., Casavale, K.O. and Carroll, R.J., "The Healthy Eating Index-2010 as a valid and reliable measure of diet quality according to the 2010 Dietary Guidelines for Americans," *J Nutr*, 144(3), 399-407. 2014.
- [31] Guenther, P.M., Reedy, J., Krebs-Smith, S.M., Reeve, B.B., and Basiotis, P.P., "Development and Evaluation of the Healthy Eating Index-2005: Technical Report. Center for Nutrition Policy and Promotion", U.S. Department of Agriculture, 2007 [Online]. Available: <http://www.cnpp.usda.gov/HealthyEatingIndex.htm>. [Accessed Dec. 8, 2015].
- [32] Centre for Applied linguistics, "Understanding assessment: A guide for foreign language educators. Module 3: Reliability and validity," 2015 [Online]. Available: <http://www.cal.org/flad/tutorial>. [Accessed Dec. 8, 2015].
- [33] Hiza, H.A.B., Casavale, K.O., Guenther, P.M. and Davis, C.A., "Diet quality of Americans differs by age, sex, race/ ethnicity, income, and education level," *J Acad Nutr Diet*, 113(2), 297-306. 2013.
- [34] Freisling, H. and Elmafda, I., "Food Frequency Index as a measure of diet quality in non-frail older adults," *Ann Nutr Metab*, 52(1S), 43-6. 2008.
- [35] Waijers, P.M.C.M., Feskens, E.J.M. and Ocké, M.C., "A critical review of predefined diet quality scores," *Br J Nutr*, 97(2), 219-231. 2007.
- [36] Collins, C.E., Burrows, T.L., Rollo, M.E., Boggess, M.M., Watson, J.F., Guest, M., Duncanson, K., Pezdirc, K. and Hutchesson, M.J., "The Comparative validity and reproducibility of a diet quality index for adults: The Australian Recommended Food Score," *Nutrients*, 7(2), 785-798. 2015.
- [37] Kennedy, E.T., Ohl, S.J., Carlson, S. and Fleming, K., "The Healthy Eating Index: design and applications", *J Am Diet Assoc*, 95(10), 1103-8. 1995.
- [38] Cade, J., Thompson, R., Burley, V. and Warm, D., "Development, validation and utilisation of food-frequency questionnaires-a review," *Public Health Nutr*, 5(4), 567-587. 2002.
- [39] Hajian-Tilaki, K., "Receiver Operating Characteristic (ROC) Curve analysis for medical diagnostic test evaluation," *Caspian J Intern Med*, 4(2), 627-635. 2013.
- [40] Fabián, C., Pagán, I., Riós, J.L., Batancourt, J., Cruz, S.Y., González, A.M., Palacios, C., González, M.J. and Rivera-Soto, W.T., "Dietary patterns and their association with socio-demographic characteristics and perceived academic stress of college students in Puerto Rico," *P R Health Sci J*, 32(1), 36-43. 2013.