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Major Dietary Patterns and their Associations with Socio-demographic Characteristics and Obesity among Adolescents in Petaling District, Malaysia

J.A. Garba, *L. Rampal, A.R. Hejar, M.S. Salmiah
Department of Community Health, Faculty of Medicine and Health Sciences
Universiti Putra Malaysia, 43400 Selangor, Malaysia

ABSTRACT

Dietary pattern analysis has emerged as important instruments to identify modifiable dietary risk factors for non-communicable diseases. The aim of this study was to determine the major dietary patterns among adolescents in Petaling District, Selangor and their associations with socio-demographic characteristics and obesity. An analytic cross- sectional study design was conducted in selected secondary schools in Petaling District. Sampling with probability proportionate to size was used and five schools were selected. Self-administered semi-quantitative food frequency questionnaire was used for data collection. Weight was measured with a digital bathroom scale (TANITA model) and height was measured using SECA body meter. Principal component factor analysis using varimax orthogonal transformation was used to identify the dietary patterns. Chi square was used to test for associations of dietary patterns with socio-demographic characteristics and obesity. Three major dietary patterns were identified: firstly, fruits and vegetables; secondly, sugar and fatand finally, meat and chicken which explained for 12.7%, 11.6% and 10.7% variation in food intake, respectively. There were significant associations between ethnicity, religion, family income, educational level of parents and the dietary patterns. However, there was no significant association between obesity and the dietary patterns. It may be more effective to describe a healthy diet using results of dietary pattern analysis in public health intervention, rather than describing single food items or nutrients. It is recommended that nutrition education programmes should be implemented in schools so as to prevent the development of obesity in the non-obese.

Keywords: Adolescents; Dietary Patterns; Principal Component Factor Analysis

INTRODUCTION

Dietary pattern analysis has emerged as an important instrument to identify modifiable dietary risk factors for non-communicable diseases. It provides a comprehensive alternative to the traditional approach based on single nutrients.[1] Dietary pattern means the distribution of food items by frequency and/or quantity in the habitual diet.[2] The effect of collection of food items is assessed instead of the individual foods or nutrients themselves.[3] This method is justifiable because food items are not eaten in isolation but consumed in meals which constitute a collection of different food items and nutrients that may have antagonistic or interactive effects.[3,4] Another public health advantage of studying dietary patterns is that it may be easier for the public to understand an overall pattern of dietary intake in the form of a dietary pattern.[3] Methods of identifying dietary patterns are factor analysis, cluster analysis and dietary indices. The commonly used method is the principal component factor analysis because the information on food frequency questionnaire is used to determine common underlying patterns of food consumption.[3]

A dietary pattern that is characterised by high consumption of meats (e.g. red meat), cheese, refined grains, sweetened drinks, as well as added fats and oils are associated with a high Body Mass Index (BMI) while a dietary pattern characterised by high consumption of low fat protein, breakfast cereal and whole grains, fruits, vegetables and legumes are associated with a low BMI. [5, 6] A previous study among Australian adolescents has identified three dietary patterns using factor analysis which were named as fruit, cereal, salad and fish pattern; high fat and sugar pattern and a vegetable pattern. [7] Another study among children and adolescents in Scotland has identified three dietary patterns which were named as healthy pattern high in fruits and vegetables, unhealthy pattern rich in snacks and pudding and a third pattern rich in fish and sauce. There was a significant association between fish and sauce pattern and obesity.[8]

*Corresponding author: *dr_rampal1@hotmail.com*

Several studies have reported the associations between dietary patterns and some chronic diseases like diabetes [7], metabolic syndrome [9], obesity [10] and cardiovascular diseases.[11] Unhealthy dietary patterns at the early growth period could increase the risk of development of obesity and other lifestyle-related chronic diseases later in life.[12] Hence, there is a need to identify major dietary patterns and their associations with non-communicable diseases.

Previous studies in Malaysia have focused on studying the eating behaviours, energy intake and dietary nutrient intake.[13-16] Studies among Malaysian adolescents that assessed eating behaviours and their associations with obesity found significant associations between eating behaviour and obesity [14] while some found no association.[17] Zalilah *et al* have reported that the overweight have higher energy intake than those with normal weight.[13] Some unhealthy dietary habits like snacking, meal skipping, fast-food consumption and infrequent breakfast consumption have been reported in previous studies among adolescents in Malaysia.[15, 16, 17]

Adolescents may find it easier to understand by describing the specific food items that are associated with specific diseases during nutrition education and intervention. Hence, the aim of this study was to determine the major dietary patterns among secondary school students in Petaling District, Selangor and their associations with socio-demographic characteristics and obesity.

MATERIALS AND METHODS

Study Population/Sample Size/ Sampling Frame

An analytic cross sectional study design was conducted in selected secondary schools in Petaling District, Selangor, Malaysia. The sampling frame was the list of secondary schools in Petaling District. The sample size obtained was 2,480 using the formula for hypothesis testing of two groups' comparison.[18]

Sampling Method

Phase I: Sampling with probability proportionate to size was used for the selection of schools.[19] This is a combination of simple random, cluster, stratified and systematic samplings. The steps followed in selecting the schools are shown in Table 1. The first step was calculating the sample size. The desired cluster size was obtained by getting the mean number of students in the schools with less than 1000 students. The next step was computing the number of clusters (schools) needed to achieve the calculated sample size, which was obtained by dividing the sample size by cluster size. The number of clusters obtained was 5. The estimated number of students (124,948) in Petaling District was obtained by adding the number of students in the list of schools obtained from the Ministry of Education.

Table 1. Sampling with probability proportionate to size.

Steps	
1. Calculated sample size.	2480
2. Desired cluster size (Mean number of students in group 1 schools).	11988/19= 630
3. Number of clusters needed to achieve the desired sample size (Sample size/cluster size).	2480/630=5.26
4. Estimated total number of students in Petaling district.	124,948
5. Cumulative number of students across all clusters (Schools) was obtained.	Table 3.2
6. Sampling interval for selecting clusters was calculated (Total number of students/cluster size).	124948/5.26= 23,753
7. Random starting point to select school within the sampling interval was obtained using table of random numbers.	03786
8. Sampling interval (23,753) added repeatedly until the number of clusters was obtained.	5 schools

The schools in Petaling District were stratified into three groups based on size (< 1000, 1000-1999 and ≥ 2000). This division was done in order to capture all students from both highly populated schools and less highly populated schools similar to the distribution in the real study universe. In step 5, the cumulative number of students across all the schools was obtained followed by calculating the sampling interval for identifying the schools. This was computed by dividing the total number of students by the target number of schools (124,948/5.26 = 23,753).

The school, into which every 23,753rd student falls based on cumulative frequency, was selected. A starting point within the sampling interval was identified using table of random numbers (3,786 was randomly selected). In the final step, the sampling interval (23,753) was added to the starting point and the next school from the cumulative frequency list was identified. The process was repeated until all the five schools were identified. The approval from the Ministry of Education was to sample only classes that were not taking major exams which were Forms 1, 2 and 4. The actual number of students in Forms 1, 2 and 4 was obtained from each of the selected schools. Proportionate allocation of the number of students to participate in the study was done. This is shown in Table 2.

Table 2. Proportionate allocation to each school.

School	Proportion	Allocated No.
School No.1	No. in school No.1/ Total students in 5 schools x sample size = 310/4040 X 2480	190
School No.2	No. in school No.2/ Total students in 5 schools x sample size = 655/4040 X 2480	402
School No.3	No. in school No.3/ Total students in 5 schools x sample size = 780/4040 X 2480	479
School No.4	No. in school No.4/ Total students in 5 schools x sample size = 1185/4040 X 2480	727
School No.5	No. in school No.5/ Total students in 5 schools x sample size = 1110/4040 X 2480	682
Total		2480

No. = Number

Phase II: This was the selection of classes and the students who participated in the study. The sampling frame in this phase was the list of all the classes in Forms 1, 2 and 4 from the five selected schools. Cluster sampling was done and each class was identified to be a cluster. The classes were randomly selected to achieve the sample size allocated to each school and each form. All the students from the selected classes were eligible to participate in the study.

DATA COLLECTION

The questionnaire used for the data collection consisted of three sections: Section A was the socio-demographic data (gender, age, ethnicity, religion, family income, educational level of father and mother); section B was a semi-quantitative food frequency questionnaire (FFQ) which was a modified, pretested version of Malaysian Adults Nutrition Survey FFQ, 2003.[20] Section C was anthropometric measurements of weight and height. FFQ has been shown to be valid in assessing the dietary patterns of adolescents [21] and frequency of food consumption has been shown to account for the major variance in food intake.[22] It was used to assess the food intake of the respondents and had a list of 126 commonly eaten foods in Malaysia based on the nutrient composition of Malaysian foods.[23] In this study, the food items were classified into 13 food groups. The respondents were asked to state the frequency of intake of each food item over the past one month and this was scored on a 5 point scale based on the intake: '1' for never/rarely consumed, '2' for once in a month, '3' for once in a week, '4' for 2-3 times in a week and '5' for daily intake of the particular food. The serving size for each food item was also given according to the medium serving sizes in food serving size album "*Album saiz sajian makanan Malaysia*" and household measures were used for illustration.[24]

Statistical Analysis

This was done with Statistical Package for Social Sciences version 21 (SPSS Inc, Chicago, IL, USA). Descriptive characteristics of the respondents were obtained as frequency & percentage. Independent sample t-test was used to compare means of two groups. Body mass index (BMI) was calculated as weight in kg/height in m^2 and age was approximated to the nearest month. Each of the respondents was classified as normal, severely thin, thin, overweight or obese according to WHO Growth Reference for 5 to 19 years.[25, 26] Principal component factor analysis using Varimax orthogonal transformation was done to identify the dietary pattern of the respondents. Factor analysis is a multivariate statistical method that uses information on food frequency questionnaires to identify common underlying patterns of food consumption. The food frequency data was screened by checking the correlation between items. Items that do not have correlation of ≥ 0.3 were excluded for further analysis. Following Kaiser's criterion, factors with Eigenvalues >1 were retained. In addition, the Scree plot was also examined. The number of dietary patterns was finally selected based on where the Scree plot begins to flatten out. The first factor (dietary pattern) extracted accounted for the highest possible variance while the second factor explained the largest possible

remaining variance. A factor score was also produced for each respondent which shows the degree to which each respondent's diet conform to each of the dietary patterns.[27] These factor scores were categorised into four quartiles and used to determine association between socio-demographic characteristics and obesity with each of the dietary patterns. Chi-square was used to test for the association.

Ethics

Approval to conduct the study was obtained from the Ministry of Education, Malaysia, the Selangor Education Department and the principals of each of the selected schools. Ethical approval was obtained from Medical Research Ethics Committee, Universiti Putra Malaysia. Written consent was also obtained from the students and their parents before data collection.

RESULTS

Socio-demographic Characteristics and Nutritional Status of the Respondents

Table 3 shows the socio-demographic characteristics and nutritional status of the respondents. A majority of the respondents were females (60.8%). The respondents' mean age was 14.5 (14.4-14.5) years. The mean age of males was 14.6 years (95% CI = 14.5-14.7) and significantly higher than that of females, 14. 4 years (95% CI = 14.3-14.5) (t = 3.74, df = 1823, $p < 0.001$). Most of the respondents were Malay (52.7%) and Muslim (55.1%). The overall mean family income was RM4,460 (95% CI = RM4,223- RM 4,696). The male respondents had a mean family income of RM4,545 (95% CI = RM4,137- RM 4,954) while the female respondents had a mean family income of RM4,407 (95% CI = RM4,119- RM 4,695). However, there was no significant difference in the family income between male and female (t= 0.56, df = 1093, $p = 0.578$). The educational level for the majority of the respondents' parents was higher institution (45.8% and 44.7% for father and mother, respectively). The prevalence of obesity and overweight were 13.7% and 16.7%, respectively.

Dietary Patterns of the Respondents

Three dietary patterns were identified from factor analysis, as shown in Table 4. Kaiser-Meyer-Olkin measure of sampling adequacy was 0.683, which indicated that the sample size was adequate for factor analysis. Bartlett's test of sphericity was significant ($p < 0.001$) which indicated that factor analysis was appropriate.

The factor loading is the correlation between the food items and the dietary pattern (Factor). The greater the value of loading, the more important that food item is in accounting for the variance of scores. Food items with loadings < 0.4 were suppressed because it has been suggested by Stevens (2002) that this cut-off was appropriate for interpretative purposes.[28] Hence, some food items commonly consumed by the respondents such as rice and bread had loadings < 0.4 and were suppressed. However, the suppression made interpretation easier by identifying substantial loadings only.[29] Each dietary pattern was named based on the food items that have highest loading on each factor. The food items that loaded highly on dietary pattern 1 included guava, pineapple, papaya, and cabbage. The food items that loaded highly on dietary pattern 2 included peanut butter, jam, margarine, sugar, and sweets. The food items that loaded highly on dietary pattern 3 included burger meat, hot dog, chicken and chicken egg. All factor loadings for the food items in the identified dietary patterns were positive indicating that they had a linear relationship with the dietary pattern.

Dietary pattern one was named as fruits and vegetables pattern, dietary pattern two was named as sugar and fat pattern while the third pattern was named as meat and chicken pattern. Fruit and vegetable patterns explained 12.7% of the variation in food intake, sugar and fat pattern explained 11.6% of the variation in food intake while meat and chicken pattern explained 10.7% variation in food intake. Factor analysis categorised the food items based on the degree of correlation between the food items in the data set.

Table 5 shows the association between socio-demographic factors and the dietary patterns. All the dietary patterns were found to be significantly associated with educational level of parents and religion. In addition, dietary patterns 1 and 2 were found to be associated with ethnicity while only the third dietary pattern was found to be associated with family income. However, there was no association between obesity and the three dietary patterns (Table 5).

Table 3. Socio-demographic characteristics and nutritional status of the respondents.

Factors	Frequency	Percentage
Gender		
Male	882	39.2
Female	1366	60.8
Age		
13	256	11.4
14	754	33.5
15	546	24.3
16	322	14.3
17	370	16.5
Ethnicity		
Malay	1184	52.7
Chinese	558	24.8
Indian	440	19.6
Others	66	2.9
Religion		
Islam	1238	55.1
Buddha	412	18.3
Hindu	394	17.5
Christian	188	8.4
Others	10	0.4
No religion	6	0.3
Family income		
<2000	299	13.3
2000-3999	321	14.3
≥4000	475	21.1
Information not available	1153	51.3
Educational level of father		
No formal education/Primary	156	7.0
Secondary school	916	40.7
Higher institution	1030	45.8
Information not available	146	6.5
Educational level of mother		
No formal education/Primary	54	7.0
Secondary school	964	42.8
Higher institution	1006	44.7
Information not available	124	5.5
Nutritional status		
Severe thinness	44	2.0
Thinness	184	8.2
Normal	1336	59.4
Overweight	376	16.7
Obese	308	13.7

DISCUSSION

It has been shown that a healthy dietary pattern is characterised by high consumption of vegetables, fruits, grains without added fats and low consumption of sweetened drinks, burgers and fried fruits.[30] Hence, the fruits and vegetables dietary pattern in this study was judged as the healthiest dietary pattern while the other two were judged unhealthy.

The dietary patterns identified in this study are similar to those among adolescents in some developed countries like Australia and Scotland.[7, 8] It has been documented that there has been rapid improvement in socio-economic status of the population in Malaysia ,[31], which may be responsible for the change in lifestyle and similarity in the dietary pattern with some developed countries. However, the dietary patterns are not exactly the same with those among adolescents in other developing countries like Iran.[32] The variation may be due to racial and cultural differences. The major dietary patterns identified among Iranian adolescent girls were Western pattern - high in pizza, meats and fruit juicewhile the Asian pattern was high in legumes, potato and other vegetables; sweat junk foods

Table 4. Factor matrix showing loadings on the three dietary patterns extracted.

Food items	Fruit & vegetable	Sugar & fat	Meat & chicken
Guava	0.716		
Pineapple	0.690		
Papaya	0.681		
Water melon	0.546		
Mixed ice drink lollipop	0.527		0.443
Cabbage	0.523		
Soy beverages			
Vegetable tuberous	0.491		
0.479			
Jack fruit	0.463		
Liquid milk	0.444		
Ice cream	0.439		
Porridge	0.430		
Peanut butter		0.723	
Jam		0.675	
Butter		0.655	
Margarine		0.634	
Tomato/ chilli sauce		0.611	
Sugar		0.565	
Sweets		0.534	
Creamed cheese		0.516	
Legume		0.403	
Burger meat			0.707
Sausage/hotdog			0.703
Chicken egg			0.576
Roti canai			0.559
Cake			0.536
Local cake		0.414	0.503
Chicken balls			0.493
Chicken			0.422
Biscuits			0.411
Variance explained (%)	12.7%	11.6%	10.7%

pattern high in dried fruits, jams, honey and sugar. The Iranian traditional dietary pattern is high in hydrogenated fats, garlic and broth and salty junk foods pattern high in carrot, puffs and potato chips.[32]

The significant association between educational level of parents and dietary patterns may indicate that educational level of parents could be a strong determinant of the dietary pattern of adolescents. Higher educational level of parents can play an important role in guiding the adolescents on a healthy dietary pattern. Family income was found to be associated with only the meat and chicken dietary pattern. Individuals with high family income were more likely to conform to unhealthy meat and chicken pattern. A previous study among adolescents in Scotland has found significant association between socio-economic indicators and dietary patters.[8] The association between ethnicity and dietary patterns may be due to the variation in food choices and food preparation between ethnic groups.

Since it has been well established that diet plays a significant role in the development of obesity, [6] the non-significant association found between obesity and dietary patterns in this study may indicate that the non-obese could be at risk of developing obesity due to similar dietary patterns with the obese. A systematic review article on thirty observational studies has reported that most studies found a dietary pattern rich in meat, sweet, fatty or energy dense foods was positively associated with obesity, a few found an inverse association while some found no association between dietary pattern and obesity.[2] A dietary pattern rich in fruit, salad, cereals, and fish pattern was found to be associated with low diastolic blood pressure in adolescents more than 16 years old.[7] Ritchie *et al* have also found that dietary patterns rich in energy-dense, snack-type food is associated with weight gain after a 10-year follow up among black and white girls.[30]

The dietary pattern during adolescence is likely to continue up to adulthood and this is supported by longitudinal studies among adolescents in Minnesota and Finland that found consistent dietary patterns after a 5- and 21-year follow up, respectively.[1, 33]

Table 5. Association socio-demographic characteristics, obesity and the three dietary patterns.

	Dietary pattern 1 (Fruits & Vegetables)			Dietary pattern 2 (Sugar & Fat)			Dietary pattern 3 (Meat & Chicken)		
Characteristic	$\chi 2$	df	p-value	$\chi 2$	df	p-value	$\chi 2$	df	p-value
Gender	4.29	3	0.232	11.09	3	0.110	0.72	3	0.869
Age	21.19	12	0.058	16.98	12	0.150	17.75	12	0.124
Ethnicity	17.31	9	0.044*	18.77	9	0.027*	14.94	9	0.092
Religion	39.81	15	< 0.001*	38.0	15	0.001*	28.61	15	0.018*
Family income	8.31	6	0.217	7.46	6	0.280	17.53	6	0.008*
Educational level of father	27.80	9	0.001*	18.03	9	0.035*	19.11	9	0.024*
Educational level of mother	19.46	9	0.021*	23.60	9	0.005*	19.65	9	0.020*
Obesity	5.919	3	0.116	7.73	3	0.052	5.92	3	0.115

*Significant association

The findings in this study may give an idea about the commonly consumed foods that may lead to development of diet related diseases. It may be more comprehensible to describe a healthy diet using results of dietary pattern analysis in public health intervention than describing single food items or nutrients.

In conclusion, this study has identified one healthy and two unhealthy dietary patterns among adolescents and their associations with some socio-demographic characteristics. The information could be an easier and clearer approach for nutrition education and intervention. It is recommended that nutrition education programmes be implemented in schools so as to prevent the development of obesity in the non-obese.

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