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Socio-Demographic Characteristics and Nutritional Status of Individuals by Stages of Change for Dietary Fat Reduction

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Abstract: Changes in lifestyle and food habits have been implicated in the increasing rate of nutrition related chronic diseases in Malaysia. A cross-sectional study was conducted to identify socio-demographic characteristic and nutritional status of individuals by their readiness to reduce dietary fat intake. A total of 202 non-academic staff aged 18-56 years at Universiti Putra Malaysia participated in the study. Information on demographic, socio-economic and stages of change related to dietary fat reduction were collected using a pre-tested interview-administered questionnaire. Subjects were measured for weight, height and waist circumference. Fasting blood through venipuncture was obtained for triglycerides, LDL-, HDL- and total cholesterol. Energy and dietary fat intake were estimated based on two days 24 h diet recall. Chi-square test and Analysis of Covariance (ANCOVA) were used for data analysis. Of the respondents, about 12% reported reduced fat intake, 20% were not committed to change and more than half (68%) were in preparation stage. There was no significant association between stages of change and socio-demographic factors. Body mass index was highest in preparation group (Mean±SE = 24.93±0.35 kg/m^2) [F = 5.686; p<0.01]. Men in action/maintenance group (Mean±SE = 76.22±4.17 cm) had significantly lower adjusted mean waist circumference than those in preparation group (Mean±SE = 89.77±1.85 cm) [F = 5.324, p<0.01]. No significant difference across stages was observed in waist circumference for women, lipid profile, caloric and fat intake. It is important to identify characteristics of individuals by their readiness to change dietary behaviors so that effective nutrition strategies can be developed and implemented to meet their dietary needs and goals.

Key words: Food habits, fat reduction, behavioral change

INTRODUCTION

The global deaths from nutrition related non-communicable diseases such as cardiovascular diseases and cancers are projected to increase from 23.8 million in 2002 (WHO, 2003) to 34.8 million in 2030 (Mather and Loncar, 2006). Likewise, nutrition related non-communicable diseases are the major causes of morbidity and mortality in Malaysia (Information and Documentation System Unit, MOH, 1991-2004). The Malaysian National Health and Morbidity Survey showed that the prevalence of overweight and obesity have increased from 21% in 1996 (Institute of Public Health, 1997) to 43.1% in 2006 (Institute of Public Health, 2007). The prevalence of diabetes and hypertension has also increased alarmingly from 8.3% and 29.9% (Institute of Public Health, 1997) to 14.9% and 42.6% (Institute of Public Health, 2007), respectively.

High fat consumption is a risk factors for obesity (Newby *et al*., 2003), diabetes mellitus (Tuomilehto *et al*., 2001; Sonnenberg *et al*., 2005), hypertension, hypercholesterolemia, cardiovascular diseases (Jang *et al*., 2003; Nimal Ratnayake and Sarwar Gilani, 2004) and certain types of cancer (Lee and Lin, 2000; Jarvinen *et al*., 2001; Willett, 2001; Binulumar and Mayhew, 2005). Nutrition transition that occurs worldwide is characterized by the shift from traditional diets that consist of various staple grains, legumes, fruits, vegetables and limited animal food sources to diets that are high in processed food, animal food sources, fat and sugar (Popkin *et al*., 2001; Popkin, 2004). In Malaysia, the Food Balance Sheet indicates that per capita availability of fat has increased nearly double over a period of 40 years, with a high proportion of fat being derived from edible oil such as oilseeds and vegetable oil (FAOSTAT Food Balance Sheet, 1961-2003).

Dietary behaviors, such as lowering dietary fat intake, are complex as the behaviors are influenced by a number of societal, cultural and environmental factors (Shepherd, 2005). Transtheoretical Model, a health behavior change model which is also referred to as Stages of Change Model (Prochaska and DiClemente, 1983) has been frequently used to classify individuals' readiness to change and adopt healthy dietary behaviors (Greene *et al*., 1999; Henry *et al*., 2006). The model describes individual's readiness to change behavior which can be classified into 5 stages with each stage requires different strategy to meet the individuals' need and goal to change his behavior (Prochaska and DiClemente, 1983). For example, in the pre-action stages, cognitive strategies are emphasized while

action and maintenance stages focus on behavioral strategies.

Stages of change model has been used to identify individual's readiness to reduce fat intake. Several studies have shown that dietary fat intake decreased from pre-contemplation to maintenance stage (Hargreaves *et al*., 1999; Ounpuu *et al*., 2000). While more men were in the pre-contemplation stage, more women were in maintenance stage for dietary fat reduction (McDonell *et al*., 1998; Ounpuu *et al*., 2000). Younger women (<45 years) and individuals with less education were more likely to be in pre-contemplation, contemplation and preparation stage of fat reduction (Hargreaves *et al*., 1999). As identifying the characteristics of individuals undergoing dietary behavior change is an important initial step to understand their needs for dietary intervention, this study was conducted to identify socio-demographic characteristics of adults in stages of change for dietary fat reduction. This study also examined differences in individuals' current body mass index, waist circumferences, lipid biomarkers and dietary intakes by stages for fat reduction.

MATERIALS AND METHODS

Subjects and study design: This cross-sectional study was carried out at Universiti Putra Malaysia (UPM), Serdang. UPM which is located about 30 km south of the capital city of Kuala Lumpur. UPM is a community with an approximately 4000 employees including academic and non-academic staff (Registrar Universiti Putra Malaysia, 2006). For this study, 10 out of 16 of faculties were randomly selected. All non-academic staff who met the inclusion criteria of aged 18-56 years, not handicapped, not diagnosed with diet-related chronic diseases such as diabetes mellitus, hypertension and hyperlipidemia and not pregnant (for women) were invited to take part in the study. Information on diet related communicable diseases and pregnancy was self-reported by the respondents.

A minimum sample size of 171 respondents was calculated based on 95% confidence level, 66.4% estimated prevalence of individuals who have not taken any action to reduce fat intake (Wan Maria Nabillah, 2003), 10% error and design effect of 2. A total of 202 non-academic staff met study criteria and volunteered to participate; however, only 176 completed all measurements.

Measurement: A pre-tested interviewer-administered questionnaire was used to collect information on demographic (age, gender, ethnicity, marital status) and socioeconomic status (income, level of education), dietary intake and stages of change for dietary fat reduction.

A two-step stage of change algorithm was used to classify the respondents' readiness to reduce dietary fat intake (Kristal *et al*., 1999). First, all respondents were required to estimate their dietary fat intakes as high (almost always consuming butter, margarine, oil, salad dressing, fat meat, fried food and ice-cream) or low (almost always avoiding fat or frying of foods, modifying meat to make it lower in fat, substituting manufactured low-fat food for their higher-fat counterparts, replacing high-fat food with fruits and vegetables and replacing high-fat food with low-fat alternatives). Second, respondents with low dietary fat intake were further classified into action (reducing dietary fat and consuming low fat food for less than 6 months) or maintenance stage (consuming low fat food for more than 6 months). While those with high fat intakes were grouped into either pre-contemplation (has no intention to reduce fat intake within the next 6 months), contemplation (has thought to reduce dietary fat intakes but no attempts made within the next 6 months) or preparation stages (already taking steps or making attempts to reduce dietary fat intake within the next 30 days).

Weight (kg), height (cm) and waist circumferences (cm) were measured using SECA digital weighing scale, SECA body meter and SECA non-stretchable fiber measuring tape, respectively. Weight was measured to a precision of 0.1 kg, height and waist circumference to 0.1 cm. Each measurement was done twice and the average was recorded as final reading. Body Mass Index (BMI) was calculated from weight and height measurement. Categorization of BMI (WHO, 1995) and waist circumference (WHO, 1998) was based on World Health Organization classifications.

Venous fasting blood (5 ml) was obtained for total cholesterol, high density lipoprotein-cholesterol (HDL-cholesterol), low density lipoprotein-cholesterol (LDL-cholesterol) and triglycerides. Respondents were requested to fast (approximately 10 h) the night before blood was drawn. Plasma cholesterol and triglyceride were determined using routine enzymatic methods and plasma HDL-cholesterol using a polyethylene glycol precipitation technique. Duplicate plasma samples were analyzed and the average was recorded. LDL-cholesterol was calculated using the Friedewald equation of [(total cholesterol-HDL) - triglycerides/5]. The classifications for triglycerides, LDL-, HDL- and total cholesterol were according to the National Cholesterol Education Program (2001).

Current dietary intakes of respondents were obtained through 2 non-consecutive days 24 h diet recall. Calibrated household measurements (e.g. cup, bowl, plate glass, spoon and ladle) were used to guide respondents to estimate food portions. Dietary data were analyzed for energy and total fat using the Nutritionist Pro version 2.5 (First Data Bank). Energy and nutrient values of foods were calculated based on the Nutrient Composition of Malaysia Food (Tee *et al*., 1997). Energy and percentage of energy from fat were

classified according to the Malaysia Recommended Nutrient Intakes (RNIs) (NCCFN, 2005).

Procedures: This study was approved by the Medical Research Ethics Committee of Faculty of Medicine and Health Sciences, Universiti Putra Malaysia. Permission to conduct this study was also obtained from the Registrar of Universiti Putra Malaysia. Prior to data collection, signed informed consent was obtained from all respondents.

Statistical analysis: The Statistical Package for Social Science (SPSS) version 15.0 software was used for data analysis. Descriptive data were presented in frequency, mean and standard deviation. Chi-square test was used for association between stages of change and socio-demographic factors while general linear model for Analysis of Covariance (ANCOVA) for differences in nutritional status (dietary fat intake, body mass index, waist circumferences, triglycerides, LDL-, HDL- and total cholesterol) by stages of change for dietary fat reduction with age, gender, BMI and waist circumference as covariates. Significant mean difference among groups was determined using Bonferroni *post hoc* test. A significance level was set at 0.05.

RESULTS

Majority of the respondents were (72.3%) women and in the age group of 20-49 years (91%) (Table 1). Most of the respondents had at least upper secondary education with an average of 13 years of schooling. The average individual and household monthly income were RM 1,361.66 and RM 2,454.13, respectively.

On average, respondents consumed about 1,482 kcal per day. Both men and women consumed 1,716 kcal and 1,392 kcal, respectively, which fell below the recommendation [men = 2,440-2,460 kcal; women = 2,000-2,180 kcal (NCCFN, 2005)]. These values could as well reflect under-reporting of energy intake in these respondents. The mean fat intake was 49.40±17.52 g while the percentage of fat energy was 30.03±5.60% with 51% of respondents consumed more than 30% of total calories from fat.

The mean Body Mass Index (BMI) for men (25.13±4.60 kg/m^2) was higher than that of women (24.04±4.50 kg/m^2). More men (46.3%) were overweight and obese than women (36.6%). The mean Waist Circumference (WC) for men and women was 86.29±11.95 cm and 77.78±10.98 cm respectively, with 16.6% of respondents had increased risk WC (men = 94-101 cm; women = 80-

Table 1: Demographic and socio-economic characteristic of sample (N = 202)

Variables	Men (n = 56)	Women (n = 146)	Total (N = 202)
	n (%)		
Age (years)			
Mean±SD	34.61±10.40	33.50±10.34	33.81±10.34
<20	3 (5.4)	1 (0.7)	4 (2.0)
20-29	24 (42.9)	76 (52.1)	100 (49.5)
30-39	6 (10.7)	17 (11.6)	23 (11.4)
40-49	20 (35.7)	40 (27.4)	60 (29.7)
≥50	3 (5.4)	12 (8.2)	15 (7.4)
Marital status			
Single	23 (41.1)	68 (46.6)	91 (45.0)
Married	32 (57.1)	74 (50.7)	106 (52.5)
Divorced/Widowed	1 (1.8)	4 (2.7)	5 (2.5)
Years of education			
Mean±SD	13.05±2.77	13.18±2.79	13.14±2.78
Education level			
Primary school	0 (0.0)	4 (2.7)	4 (2.0)
Secondary school	31 (55.4)	57 (39.0)	88 (43.6)
Form 6/Matriculation	4 (7.1)	8 (5.5)	12 (5.9)
Diploma/Degree	21 (37.5)	77 (52.7)	98 (48.5)
Individual income (RM/month)			
Mean±SD	1,471.62±592.18	1,319.48±516.34	1,361.66±541.25
<1,000	16 (28.6)	58 (39.7)	74 (36.6)
1,000-1,499.99	13 (23.2)	34 (23.3)	47 (23.3)
1,500-1,999.99	14 (25.0)	28 (19.2)	42 (20.8)
2,000	13 (23.2)	26 (17.8)	39 (19.3)
Household income (RM/month)			
Mean±SD	2,350.03±1,756.67	2,494.07±1,804.01	2,454.13±1,787.83
<1,000	14 (25.0)	28 (19.2)	42 (20.8)
1,000-2,499.99	20 (35.7)	55 (37.7)	75 (37.1)
2,500-4,999.99	17 (30.4)	53 (36.3)	70 (34.7)
5,000	5 (8.9)	10 (6.8)	15 (7.4)

Table 2: Nutritional status and stages of change for dietary fat reduction (N = 202)

Variables	Men (n = 56)	Women (n = 146)	Total (N = 202)
	n (%)		
Nutritional status			
Energy intake (kcal)			
Mean±SD	1,716±532	1,392±377	1,482±449
Fat intake (g)			
Mean±SD	57.26±20.11	46.39±15.46	49.40±17.52
% of fat energy			
Mean±SD	30.02±5.43	30.04±5.68	30.03±5.60
Low/Normal (≤ 30%)	24 (7.4)	75 (51.4)	99 (49.0)
High (> 30%)	32 (57.1)	71 (48.6)	103 (51.0)
Body mass index (kg/m^2) (n = 199)			
Mean±SD	25.13±4.60	24.04±4.50	24.34±4.54
Underweight (< 18.50)	4 (7.1)	12 (8.3)	16 (8.0)
Normal weight (18.50-24.99)	25 (46.3)	80 (55.2)	105 (52.8)
Overweight/Obesity (≥ 25.00)	25 (46.3)	53 (36.6)	78 (39.2)
Waist circumferences (cm) (n = 199)			
Mean±SD	86.29±11.95	77.78±10.98	80.09±11.85
Low risk (M < 94; F < 80)	40 (74.1)	89 (61.4)	129 (64.8)
Increased risk/Substantially increased risk (M = ≥94; F = ≥80)	14 (25.9)	56 (38.6)	70 (35.2)
Total cholesterol (mmol/L) (n = 179)			
Mean±SD	8.49±1.99	7.51±1.51	7.78±1.71
Desirable (≤5.17)	2 (4.1)	8 (6.2)	10 (5.6)
Borderline high/High (>5.17)	47 (95.9)	122 (93.8)	169 (94.4)
HDL cholesterol (mmol/L) (n = 179)			
Mean±SD	1.54±0.32	1.84±0.46	1.76±0.45
Low/Desirable (≤1.55)	25 (51.0)	36 (27.7)	61 (34.1)
High (>1.55)	24 (49.0)	94 (72.3)	118 (65.9)
LDL cholesterol (mmol/L) (n = 179)			
Mean±SD	5.86±1.71	5.01±1.34	5.24±1.50
Optimal/Near optimal (≤3.35)	3 (6.1)	13 (10.0)	16 (8.9)
Borderline high/High/Very high (>3.35)	46 (93.9)	117 (90.0)	163 (91.1)
Triglyceride (mmol/L) (n = 179)			
Mean±SD	2.38±1.37	1.45±0.85	1.71±1.09
Normal (<1.69)	16 (32.7)	98 (75.4)	114 (63.7)
Borderline high/High/Very high (≥1.69)	33 (67.3)	32 (24.6)	65 (36.3)
Stages of change			
Pre-contemplation	9 (16.1)	7 (4.8)	16 (7.9)
Contemplation	6 (10.7)	18 (12.3)	24 (11.9)
Preparation	34 (60.7)	104 (71.2)	138 (68.3)
Action	3 (5.4)	10 (6.8)	13 (6.4)
Maintenance	4 (7.1)	7 (4.8)	11 (5.4)

M = Male; F = Female

87 cm) and 18.6% had substantially increased risk WC (men ≥ 102 cm; women ≥ 88 cm).

Majority of men and women had border high to very high total cholesterol (men = 95.9%, women = 93.8%) and LDL-cholesterol (men = 93.9%, women = 90.0%). More than half of respondents (63.7%) had normal fasting triglycerides level, however men had higher mean triglycerides (2.38±1.37 mmol/L) than women (1.45±0.85 mmol/L). Accordingly, more men (67.3%) than women (24.6%) had border to very high triglycerides level. About 65.9% respondents had high HDL-cholesterol level, with more women (72.3%) than men (49.0%) had high HDL-cholesterol.

By stages of change for dietary fat reduction (Table 2), more than half of the respondents (68.3%) planned to reduce their dietary fat within the next 30 days (preparation stage). Only one-fifth respondents (19.8%) were in pre-action stages (pre-contemplation stages = 7.9%; contemplation stages = 11.9%) or were not committed to reduce their dietary fat intake within the next 6 months. About 6.4% respondents reported low fat intakes for less than 6 months (action stage) while 5.4% respondents had consumed low fat food for more than 6 months (maintenance stage).

For further analysis, stages of dietary fat reduction were collapsed into three groups as Pre-Contemplation/ Contemplation (PC/C), Preparation (P) and Action/Maintenance (A/M). While more men were in PC/C stages (26.8% vs 17.1%), more women (71.2% vs 60.7%) were in preparation stage (Table 3). A higher percentage of respondents with younger age, tertiary education and lower individual income were in PC/C stages. Older age, married, primary to secondary

Table 3: Demographic and socioeconomic factors by stages of change for dietary fat reduction (N = 202)

Stages of change	Pre-contemplation/ Contemplation (n = 40)	Action/ Preparation (n = 138)	Maintenance (n = 24)	X^2
Gender				
Men	15 (26.8)	34 (60.7)	7 (12.5)	2.589
Women	25 (17.1)	104 (71.2)	17 (11.6)	
Age (years)				
(Mean±SD)	31.48±8.89	33.87±10.25	37.33±12.37	
<40	29 (22.8)	86 (67.7)	12 (9.4)	3.310
≥40	11 (14.7)	52 (69.3)	12 (16.0)	
Marital status				
Single/Divorce/Widowed	19 (19.8)	68 (70.8)	9 (9.4)	1.137
Married	21 (19.8)	70 (66.0)	15 (14.2)	
Education (years)	13.66±3.14	13.16±2.74	12.14±2.10	
Primary to secondary school	15 (16.3)	61 (66.3)	16 (17.4)	5.461
Tertiary school	26 (22.7)	77 (70.0)	8 (7.3)	
Individual income (Mean±SD) (RM/month)	1,279.01±603.70	1,372.53±498.88	1,436.88 ± 664.20	
< RM 1,499.99	29 (24.0)	78 (64.5)	14 (11.6)	3.324
≥ RM 1,500.00	11 (13.6)	60 (74.1)	10 (12.3)	
Household income (Mean±SD) (RM/month)	2,211.60±1,562.03	2,450.88±1,778.74	2,877.05 ± 2,158.94	
< RM 2,499.99	24 (20.5)	82 (70.1)	11 (9.4)	1.637
≥ RM 2,500.00	16 (18.8)	56 (65.9)	13 (15.3)	

*p<0.05

Table 4: Health and nutrition by stages of change for dietary fat reduction (N = 202)

Stages of change	Pre-contemplation/ Contemplation (n = 40)	Action/ Preparation (n = 138)	Maintenance (n = 24)	F-value
	---------- Mean ± SE ----------			
Energy intake (kcal/day)[a,b]	1,503±69.54	1,497±37.06	1,365±89.76	0.967
Dietary fat intake (g/day)[a,b]	48.38±2.74	50.50±1.46	44.87±3.54	1.145
% of fat energy[a,b]	29.12±0.90	30.39±0.48	29.35±1.16	0.949
Body Mass Index (kg/m^2) (n = 199)[a]	23.68±0.66	24.93±0.35	22.05±0.84	5.686*[z]
Waist circumferences (cm) (n = 199)[a]				
Male	83.15±2.86	89.77±1.85	76.22±4.17	5.324*[z]
Female	76.52±1.86	77.81±0.91	79.47±2.24	
Total cholesterol (mmol/L) (n = 179)[a,c]	7.43±0.26	7.85±0.14	8.09±0.37	1.306
HDL-cholesterol (mmol/L) (n = 179)[a,c]	1.67±0.07	1.77±0.04	1.93±0.09	2.654
LDL-cholesterol (mmol/L) (n = 179)[a,c]	4.99±0.23	5.30±0.13	5.44±0.32	0.886
Triglycerides (mmol/L) (n = 179)[a,c]	1.70±0.16	1.71±0.09	1.56±0.22	0.203

Mean±SE = Mean±Standard Error; [a]Adjusted for age and gender; [b]Adjusted for body mass index; [c]Adjusted for waist circumferences
*p<0.001, Bonferroni *post hoc* test for: [x] = Pre-contemplation/Contemplation vs Preparation;
[y] = Pre-contemplation/Contemplation vs Action/Maintenance; [z] = Preparation vs Action/Maintenance;
PC/C = Pre-Contemplation/Contemplation; P = Preparation; A/M = Action/Maintenance

educated respondents and those with higher household income were more likely to be in A/M stages. However, there was no significant association between stages of change and socio-demographic factor.

Table 4 presents the differences in nutritional status across stages of change, adjusting for covariates. Energy intake decreased across stages of change groups; however, there was no significant adjusted mean difference across groups. Similarly, the adjusted mean fat intake and adjusted mean percentage of fat energy did not differ significantly by stages of change groups. The adjusted mean BMI for P group (24.93±0.35 kg/m^2) was significantly higher than that of A/M group (22.05±0.84 kg/m^2) [F = 5.686; p<0.01]. In addition, there was a statistically significant difference in adjusted mean waist circumference for men between P group (89.77±1.85 cm) and A/M group (76.22±4.17 cm) [F = 5.324; p<0.01]. For women, no significant difference in waist circumference by stages of change groups. All groups had high adjusted mean total cholesterol with highest value observed in A/M group. The A/M group also had the highest adjusted mean HDL-cholesterol and LDL-cholesterol but lowest adjusted mean triglycerides. However, there were no significant differences in total cholesterol, HDL-cholesterol, LDL-cholesterol and triglycerides by stages of change groups.

DISCUSSION

A high proportion of respondents (68%) had intention to lower their dietary fat intake (preparation stage) while

only 12% were at action and maintenance stage. Previous studies reported that majority respondents (44-66%) were more likely to be in action and maintenance stage (Brug *et al*., 1997; Laforge *et al*., 1999; Ounpuu *et al*., 2000; Oh and Cho, 2002; Pullen and Walker, 2002; Plotnikoff *et al*., 2009). In a national survey of Spanish adult population, Lopez-Azpiazu *et al*. (2000) found that 56% and 28.3% were in pre-contemplation and maintenance stages, respectively. The differences in these findings could be due to the different algorithms used to categorize respondents into stages as there is no standard stage algorithm available. It could also be that there are different levels of awareness and motivation between countries or populations in that some are more amenable than others to changes in health and dietary behaviors (Etter *et al*., 1997; Campbell *et al*., 1999). Perhaps, the trends in awareness of nutrition and disease link in developed nations have contributed to the populations to be more inclined to adopt dietary recommendations.

Although we did not find any significant association between stages of change and socio-demographic factors, adults in pre-action stages were more likely to be men, younger and have higher education level and individual income. Many studies reported that compared to men, women were more conscious of their health and more responsive to health and nutrition issues and information (Laforge *et al*., 1999; Lopez-Azpiazu *et al*., 2000; Kristal *et al*., 2001; Nothwehr *et al*., 2006), specifically concerning fat and cholesterol intakes (Lahmann and Kumanyika, 1999). While several studies found that older individuals were significantly more likely to be in post-action stages (Glanz *et al*., 1994; Hargreaves *et al*., 1999; Oh and Cho, 2002; Nothwehr *et al*., 2006), Lopez-Azpiazu *et al*. (2000) showed that majority of older people remained in the pre-contemplation stage. Individuals may be aware of health and nutrition issues; however, they may become disillusioned about their ability to change after experiencing repeated failures (Prochaska, 2005). Similar to age, conflicting results on the association between education level and stages of change have been reported (Hargreaves *et al*., 1999; Lopez-Azpiazu *et al*., 2000; Kristal *et al*., 2001; Nothwehr *et al*., 2006) which suggested that education may not necessarily promote awareness and motivation to eat healthfully even though higher educated individuals may have better access to and understanding of diet and health information (Hammond, 2003).

Our data that showed no significant group differences in energy intake and percentage of fat energy corroborate the findings of Nothwehr *et al*. (2006) and Oh and Cho (2002). However, several studies reported that individuals at the later stages had significantly lower percentage of fat energy than individuals in earlier stages (Hargreaves *et al*., 1999; Ounpuu *et al*., 2000). Different findings could be due to different dietary assessment being used these studies. Besides, the absence of significant difference in the present study may suggest limitation in self-reported dietary assessment. Under-reporting using diet recall has been estimated to be 88% (Black and Cole, 2001) and in this present study, approximately 71% of respondents under-reported their energy intakes. Moreover, we could not exclude the possibility of under-reporting among women and overweight/obese individuals since the majority of respondents in this study were women (73%) and 39% were overweight and obese (Macdiarmid and Blundell, 1998; Goris *et al*., 2000; Johansson *et al*., 2001). The respondents may omit high fat food or snacks during the diet recall as excessive fat intake is perceived as a less desirable behavior.

Respondents in the preparation stage had significantly higher mean BMI and waist circumference (only in men) than those in the action/maintenance stages. This finding was supported by several studies, which found that contemplators and preparators had highest mean BMI and were actively attempting weight loss through reduction in dietary fat intakes (Glanz *et al*., 1994; McDonell *et al*., 1998; Oh and Cho, 2002; Plotnikoff *et al*., 2009). In another study (Nothwehr *et al*., 2006), the mean BMI of adults in later stages was lower than those at earlier stages even though all means were above acceptable cut-off point. These findings could imply that individuals in preparation stage may be aware of their unhealthy body weights and were ready to make dietary changes i.e. reduce fat intakes.

In the present study, fasting triglycerides, LDL-, HDL- and total cholesterol did not differ significantly among stages of change groups. This could be due to the fact that majority of respondents had high levels of total cholesterol and LDL-cholesterol. However, the respondents in later stages had better mean triglyceride and HDL-cholesterol compared to those at earlier stages. It could be that respondents in later stages are more physically active as several studies have shown that exercise or active lifestyle has beneficial effect on HDL-cholesterol and triglyceride, and only little effect on total cholesterol and LDL-cholesterol (Karus *et al*., 2002; Bernstein *et al*., 2002). However, data on physical activity were not obtained in this study.

We found that a high proportion of adults in this study were overweight/obese and hypercholesterolemic. While the percentage of overweight and obesity in this present study is lower than the percentages reported by several local studies (Hejar *et al*., 2003; Norimah and Haja Mohaideen, 2003; Lim *et al*., 2003; Narayan and Abdul Rashid, 2007), this study reported a higher percentage of individuals with hypercholesterolemia (Norimah and Haja Mohaideen, 2003) and low HDL-cholesterol (Moy *et*

al., 2008). The high proportion of overweight/obese and hypercholesterolemic adults reported in these studies could be due to many reasons including consumption of high energy-dense diets, types of fat consumed, low fruit and vegetable intakes, physical inactivity and abdominal adiposity. For example, in this present study, despite a high percentage of under-reporting, about half (51%) of the respondents had more than 30% of fat energy.

This study has several limitations. Misclassification of individuals into stages could occur since the staging algorithm used in this study was based on subjective estimates of dietary fat intake (Kristal *et al*., 1999). Although stage of change algorithm has been shown to be a useful tool to classify individuals' readiness to change, there is lack of strong supportive evidence on the dietary application of stage of change model in nutrition and health promotion. Therefore, a validated staging algorithm is imperative. As with other self-reported dietary assessments, 24 h diet recall is also subjected to under-reporting of energy and fat intake. This could be due to reliance on memory or respondents might intentionally omit high caloric and fat food in their diet recalls. Third, due to limited nutrient values in the Malaysian Food Composition Tables, this study was not able to provide information on dietary fat components such as cholesterol, saturated and *trans* fatty acids intakes which could elucidate better the association between stage of change and biochemical parameters. Self-selection bias might have occurred in that since the respondents were volunteers, they were more health conscious or health motivated. The lack of significant differences in demographic, socioeconomic and nutrition variables by stages of change could be due to the small sample size for comparison as well as homogeneity of the sample in relation to several variables e.g. lipids. Finally, the cross-sectional design of this study did not allow for cause and effect inference between stages of change and nutritional status.

Conclusion: As people are at various stages of behavioral change, intervention strategies in health and nutrition promotion should match the individuals' readiness to change. This study reported a high proportion of respondents were in preparation stage for dietary fat reduction. Thus, more intensive cognitive strategy interventions that emphasize on pros and cons of low fat and high fat diets, respectively as well as self efficacy and skills to realize behavioral change and cope with relapse are required to help the respondents to move towards action. In addition, knowledge on the characteristics of individuals in the various stages of change could facilitate the development of personalized information that eventually would be more effective to promote behavioral change.

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