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Comparison of Fruits and Vegetables Intake and Physical Activity between Hypercholesterolemic Adults and Non-hypercholesterolemic Adults in Malaysia

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ABSTRACT

Introduction: Hypercholesterolemia is an important modifiable risk factor for coronary heart disease. Lifestyle changes in diet and physical activity can improve cholesterol levels. This study aimed to compare the fruits and vegetables (FV) intake and physical activity (PA) between hypercholesterolemic adults and non-hypercholesterolemic adults in Malaysia, and to investigate factors associated with meeting the recommended levels of FV intake and PA in a hypercholesterolemic population. **Methods:** This study was based on 17,988 participants (response rate 98.7%) aged 18 years and above who responded to the hypercholesterolemia questionnaire in the 2011 Malaysian National Health and Morbidity Survey (NHMS), a cross-sectional study with two-stage stratified sampling design. Data were obtained by trained enumerators via face-to-face interviews and were analysed by descriptive analysis, chi-square test, and univariable and multivariable logistic regression. **Results:** Out of the total population assessed, 39.0% had hypercholesterolemia. The prevalence of consuming five or more servings of FV per day is low (7.8%) while 36.0% were physically inactive among the hypercholesterolemic adults. No significant differences were observed in FV intake and PA between hypercholesterolemic and non-hypercholesterolemic populations. Gender, age and educational levels were associated with FV intake and PA among hypercholesterolemic adults. Hypercholesterolemic adults who were underweight or obese were less likely to consume FV, while those who were former smokers and those who had diabetes and heart disease were less likely to be physically active. **Conclusion:** These findings are relevant for future health promotion strategies, suggesting that more intensive interventions are needed to increase FV intake and PA level in hypercholesterolemic population and in the general population.

Key words: Fruit and vegetable intake, hypercholesterolemia, hypercholesterolemic adults, Malaysia, physical activity

INTRODUCTION

Hypercholesterolemia is a major health concern in both developed and developing countries. It is associated with increased risk of cardiovascular diseases (CVD), particularly coronary heart disease (CHD)

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(Ueshima *et al.*, 2008). The rising prevalence of hypercholesterolemia has been implicated in the rising incidence of CHD in the Asia Pacific region (Zhang *et al.*, 2003). The relationship between lifestyles (e.g. physical activity and diet) and chronic diseases (e.g. hypercholesterolemia, hypertension and diabetes) are of increasing public health research interest. As reviewed by Roberts & Barnard (2005), overwhelming evidence from epidemiological, prospective cohort, and intervention studies, has documented that diet, physical activity, and combined physical activity and diet interventions can mitigate progression of chronic diseases and in fact reverse existing diseases. For instance, living a healthy lifestyle (i.e. staying at a healthy weight, following a healthy diet, and participating in regular exercise) not only could potentially prevent hypercholesterolemia, but is also beneficial for the management and treatment of hypercholesterolemia.

For patients with hypercholesterolemia, the National Cholesterol Education Program (NCEP) guidelines recommended therapeutic lifestyle changes (TLC) which include intensive use of heart-healthy eating, physical activity, and weight control to lower both blood cholesterol and the risk of CHD (NCEP Adult Treatment Panel III, 2002). The TLC diet is a low saturated fat, low cholesterol diet that emphasises fruits and vegetables intake (five or more servings per day) to reduce blood cholesterol level and to decrease the chance of developing heart disease for patients with hypercholesterolemia (NCEP Adult Treatment Panel III, 2002). Two meta-analyses of cohort studies have reported that increased intake of fruits and vegetables (FV) is related to a reduced risk of CHD (Dauchet *et al.*, 2006; He *et al.*, 2007). Previous studies also suggested that diet must be combined with physical activity (PA) in lowering blood cholesterol level as PA provides metabolic and cardiovascular benefits by increasing High Density Lipoprotein (HDL) cholesterol levels, lowering triglyceride levels and improving the overall lipid profile (Khan & Khan, 2004). Increasing intake of FV and enhancing levels of PA have also been shown to reduce the risk of CHD among patients with hypercholesterolemia (Centers for Disease Control and Prevention, 2005; Williams 2008).

Fruits and vegetables are specifically known to be important for health because they are naturally low in calories and provide essential nutrients and dietary fibre. The Malaysian Dietary Guidelines (MDG) 2010 recommended intake of five servings of FV (approximately 400 g), i.e. two servings of fruits and three servings of vegetables per day (Ministry of Health Malaysia, 2010). Based on the World Health Organisation (WHO) STEP-wise approach to surveillance (STEPS) criteria, the recommended intake of FV is five or more servings of combined FV per day, without differentiating between the two (WHO, 2003). Meanwhile, WHO (2010) also recommended that adults aged 18-64 years old should do at least 150 minutes of moderate-intensity aerobic PA throughout the week, or do at least 75 minutes of vigorous-intensity aerobic PA throughout the week, or an equivalent combination of moderate- and vigorous-intensity PA, which is equivalent to a total PA level of at least 600 metabolic equivalents-minutes per week (METs-min/week). However, studies in Malaysia had documented that prevalence of FV intake and PA is low among the general population (NCD, 2006; Norimah *et al.*, 2008; IPH, 2011). The majority of Malaysians are not practising healthy eating and leading an active lifestyle despite their well-known health benefits.

Previous studies in the US found that adults with hypercholesterolemia were less likely to practice healthy eating and to engage in regular physical activity compared to those without hypercholesterolemia (Fang, Keenan & Dai, 2011). In Malaysia, studies to compare the levels of FV intake and PA between the population with hypercholesterolemia and those without this problem are scarce. Furthermore, little is

known about the extent to which Malaysian adults who have hypercholesterolemia are following the recommendations for FV intake and PA. There is also a lack of research on the factors associated with FV intake and PA among hypercholesterolemic individuals in Malaysia. Hence, this study aimed to compare the FV intake and PA level between hypercholesterolemic adults and non-hypercholesterolemic adults in Malaysia, as well as to investigate the socio-demographic characteristics and risk factors that are associated with meeting the recommended levels of FV intake and PA in the hypercholesterolemic population.

METHODS

Study design and sampling method

The NHMS 2011 was a nationwide, cross-sectional, population-based study using a two-stage stratified sampling design to select a nationally representative sample. The stratifications were performed by states and urban/rural localities. The Primary Sampling Units (PSUs) were Enumeration Blocks (EBs) provided by the Malaysian Department of Statistics based on the 2010 census. A total of 794 EBs (484 urban and 310 rural) were systematically selected from the total EBs in Malaysia via probability-proportional-to-size sampling technique. Subsequently, 12 living quarters (LQs) or Secondary Sampling Units (SSU) were randomly selected from each selected EB and finally, all households and eligible household members within the selected LQ were included in the sample. A total of 18,231 participants aged 18 years and above were interviewed using a structured validated questionnaire. Methodology of the survey has been described in detail by Fadhli *et al.* (2013).

Data collection

Data collection was carried out by trained data collectors throughout all states in Malaysia from April to July 2011. Of the 18,231 participants, a total of 17,988 participants (response rate 98.7%) responded to the hypercholesterolemia questionnaire, and 14,843 out of 16,297 (91.1%) participants who claimed that they were not having high cholesterol consented to the finger prick test. The finger prick test was conducted by trained nurses to measure total blood cholesterol level of participants after an overnight fast. All eligible respondents had given their written consent for participation before they were interviewed. The study protocol was approved by the Malaysian Medical and Research Ethics Committee (MREC), Ministry of Health Malaysia.

Measures

Socio-demographics

Socio-demographic variables included gender, age, ethnicity, residential area (urban/rural), marital status (single, married, widow/widower/divorcee), educational level (no formal education, primary, secondary and tertiary), and monthly household income. Age was categorised into five groups: 18-29 years, 30-39 years, 40-49 years, 50-59 years, 60 years and above. Ethnicity was categorised into Malay, Chinese, Indian, other Bumiputeras (including Kadazan, Murut, Bajau, Melanau, Iban and Bidayuh) and 'Others' (including other races in Sabah and Sarawak, and the indigenous population in the Peninsula). Monthly household income was grouped into three levels: less than RM1000, RM1000-RM3999, RM4000 and above.

Fruits and vegetables intake

Fruits and vegetables (FV) intake was assessed by using four questions: i) "In a typical week, how many days do you eat fruits?" ii) "Usually on the day you eat fruits, how many servings of fruits do you eat in a day?" iii) "In a typical week, how many days do you eat vegetables" and iv) "Usually on the day you eat vegetables, how many

servings of vegetables do you eat in a day?" Food photographs were used to assist the respondent to recall the serving sizes of fruits and vegetables that they had consumed. The food photographs showed single servings of a few commonly consumed fruits and vegetables such as 1 medium sized apple, 1 medium sized banana, 1 slice of papaya, 1 slice of watermelon, 8 medium sized grapes, 1 cup of minced raw green leafy vegetables or 'ulam' and half a cup of cooked minced eggplant or tomato or carrot or green leafy vegetables.

According to the WHO STEPS criteria, responses to the four questions mentioned above are used to obtain an assessment of total average intake of combined FV per day, without differentiating between the two (WHO, 2003). Based on the WHO recommendations, FV intake was dichotomised into two groups: <5 servings of FV per day (inadequate) and ≥5 servings of FV per day (adequate). Based on Malaysian Dietary Guidelines 2010, the recommended intake of FV is five servings daily, of which two servings are for fruits and three servings for vegetables.

Physical activity

The validated short version of the International Physical Activity Questionnaire (IPAQ) was used to measure the PA level in this study. The IPAQ measures the overall PA level by assessing three specific types of PA (walking, moderate-intensity and vigorous-intensity activities) undertaken across a comprehensive set of domains (work-related, transportation, leisure time and domestic/gardening). PA level was calculated in metabolic energy (MET)-minutes per week based on the IPAQ analysis protocol (IPAQ, 2002). MET for walking is 3.3, moderate activity is 4.0 and vigorous activity is 8.0. The total PA score is computed as the sum of all METs-minutes/week from walking to moderate- to -vigourous-intensity activities. An individual who performed any combination of walking, moderate- or vigourous-intensity activities in the past seven days, with at least a total PA score of 600 METs-minutes/week was considered as meeting the recommended level of PA.

Smoking status

Smoking status was classified as 'non-smokers' (those who had never smoked), 'former smokers' (those who were former daily smokers or formal occasional smokers, but currently do not smoke at the time of the survey) and 'current smokers' (those who smoke any tobacco products either daily or occasionally, at the time of the survey).

Hypercholesterolemia

Hypercholesterolemia includes 'known hypercholesterolemia' and 'undiagnosed hypercholesterolemia'. Known hypercholesterolemia is based on self-report, that is, being told to have hypercholesterolemia by a doctor or a medical assistant. Undiagnosed hypercholesterolemia is when the respondent is not known to have hypercholesterolemia and had a total blood cholesterol of ≥5.2 mmol/L measured via a finger prick test at the time of the survey. In this study, both known hypercholesterolemia and undiagnosed hypercholesterolemia were combined and defined as having hypercholesterolemia.

Medical history

Data on personal medical history was based on respondents' self-reported information on diseases (i.e. diabetes mellitus, hypertension, and heart disease) previously diagnosed by a doctor or medical assistant. Respondents were asked: "Have you ever been told by a doctor or medical assistant that you have _____?" The response options were 'yes' and 'no'.

Anthropometric measurements

Anthropometric measurements including weight, height, and waist circumference

were carried out on participants by trained medical personnel. The weight and height of participants were measured by TANITA HD319 digital weighing scale (TANITA, Japan) and SECA bodymeter 206 (SECA, Germany) to the nearest 0.1 kg and 0.1 cm respectively. SECA measuring tape 201 (SECA, Germany) was used to measure waist circumference to the nearest 0.1 cm. All measurements were taken and recorded twice. The average value was used for data analaysis. Abdominal obesity was defined as waist circumference ≥90 cm in men and ≥80 cm in women (IDF, 2006). Body mass index (BMI) was calculated as weight divided by height squared (kg/m^2). According to the World Health Organisation guidelines, BMI is categorised into four groups for both men and women: underweight (<18.5 kg/m^2), normal (18.5-24.9 kg/m^2), overweight (25.0-29.9 kg/m^2) and obese (≥30 kg/m^2).

Statistical analysis

Descriptive statistics were used to illustrate the socio-demographic characteristics and risk factors of participants according to hypercholesterolemia status. Prevalence of meeting the recommended daily intake of fruits (≥2 servings/day), vegetables (≥3 servings/day), combined FV (≥5 servings/day) and the recommended level of PA (≥600 METs-minutes/week) were determined, by hypercholesterolemia status. Relationships of the FV intake and PA with hypercholesterolemia status were tested using chi-square tests. Logistic regression analyses were performed to measure the odds ratios (ORs) of meeting the recommended daily intake of fruits, vegetables, combined FV and the recommended level of PA among participants with hypercholesterolemia compared to those without hypercholesterolemia (as reference group), before and after adjusting for other socio-demographic characteristics and risk factors. Finally, univariable and multivariable logistic regression analyses were conducted to measure the crude and adjusted ORs of meeting the recommended levels of combined FV intake and physical activity among adults with hypercholesterolemia while adjusting for potential confounding factors. All analyses took into account the complex survey design and the weighted sampling probabilities of the NHMS data source and were preformed using SPSS software for Windows version 20.0 (SPSS, Chicago, IL, USA). All statistical analyses were preformed at 95% confidence intervals (CI).

RESULTS

Table 1 shows the distribution of socio-demographic characteristics and risk factors of participants by hypercholesterolemia status. Of the 17,988 participants who responded to the questionnaires, 7,011 (39.0%) respondents were found to have hypercholesterolemia. The prevalence of hypercholesterolemia was high among females (40.2%), older adults aged 60 years and above (55.4%), widows/widowers/divorcees (55.5%), those who had no formal education (45.4%), those who were obese (45.5%), those who had abdominal obesity (45.9%), and those with a history of diabetes (57.5%), hypertension (59.6%) and heart disease (56.5%).

Table 2 shows the prevalence of meeting the recommended daily intake of fruits, vegetables, combined FV and the recommended level of PA by hypercholesterolemia status. Among participants with hypercholesterolemia, the prevalence of eating two or more servings of fruits per day, three or more servings of vegetables per day, and five or more servings of combined FV per day were 17.0%, 12.8% and 7.8% respectively. There were no significant differences pertaining to intake of vegetables and intake of combined FV with hypercholesterolemia status. However, participants with hypercholesterolemia reported a significantly higher prevalence of consuming two or more servings of fruits per day (17.0%,

Table 1. Characteristics of participants according to hypercholesterolemia status

Variables	*Hypercholesterolemia*			
	Yes (n=7011)		*No (n=10977)*	
	n	*% (95% CI)*	*n*	*% (95% CI)*
Gender				
Male	2775	30.1 (28.7-31.6)	5636	69.9 (68.4-71.3)
Female	4236	40.2 (38.7-41.7)	5341	59.8 (58.3-61.3)
Age group (years)				
18-29	954	18.6 (17.2-20.2)	3976	81.4 (79.8-82.8)
30-39	1216	32.4 (30.4-34.4)	2413	67.6 (65.6-69.9)
40-49	1604	43.5 (41.4-45.6)	1996	56.5 (54.4-58.6)
50-59	1759	53.4 (51.0-55.8)	1346	46.6 (44.2-49.0)
60 and above	1478	55.4 (52.8-58.0)	1246	44.6 (42.0-47.2)
Ethnicity				
Malay	4224	38.4 (36.9-39.8)	6013	61.6 (60.2-63.1)
Chinese	1334	33.4 (31.2-35.7)	2143	66.6 (64.3-68.8)
Indian	550	35.5 (31.9-39.2)	896	64.5 (60.8-68.1)
Other Bumiputera	569	29.8 (27.1-32.6)	1141	70.2 (67.4-72.9)
Others	334	25.2 (20.9-30.2)	784	74.8 (69.8-79.1)
Residential area				
Urban	3995	34.3 (32.9-35.7)	6500	65.7 (64.3-67.1)
Rural	3016	37.0 (35.1-39.0)	4477	63.0 (61.0-64.9)
Marital status				
Single	839	19.4 (17.7-21.2)	3338	80.6 (78.8-82.3)
Married	5369	40.0 (38.7-41.4)	6991	60.0 (58.6-61.3)
Widow/widower/divorcee	802	55.5 (52.0-58.9)	645	44.5 (41.1-48.0)
Educational level				
No formal education	689	45.4 (41.5-49.3)	732	54.6 (50.7-58.5)
Primary	1974	41.0 (38.7-43.4)	2341	59.0 (56.6-61.3)
Secondary	2951	32.7 (31.2-34.3)	5245	67.3 (65.7-68.8)
Tertiary	1333	32.4 (30.4-34.5)	2488	67.6 (65.5-69.6)
Monthly household income				
Less than RM1000	1428	37.3 (35.1-39.6)	1985	62.7 (60.4-64.9)
RM1000-RM3999	3428	34.2 (32.8-35.7)	5626	65.8 (64.3-67.2)
RM4000 and above	2155	35.2 (33.1-37.2)	3366	64.8 (62.8-66.9)
BMI status (kg/m^2)				
Underweight (<18.5)	277	20.0 (17.4-23.0)	986	80.0 (77.0-82.6)
Normal (18.5-24.9)	2663	31.4 (29.8-33.0)	4879	68.6 (67.0-70.2)
Overweight (25.0-29.9)	2343	42.6 (40.7-44.5)	2765	57.4 (55.5-59.3)
Obese (≥−30)	1326	45.5 (43.1-48.0)	1394	54.5 (52.0-56.9)
Smoking status				
Non-smoker	5176	37.0 (35.7-38.4)	7381	63.0 (61.6-64.3)
Former smoker	531	41.4 (37.9-44.9)	693	58.6 (55.1-62.1)
Current smoker	1242	27.7 (25.8-29.7)	2833	72.3 (70.3-74.2)
Abdominal obesity				
Yes	3853	45.9 (44.3-47.5)	3963	54.1 (52.5-55.7)
No	2853	27.3 (25.9-28.7)	6405	72.7 (71.3-74.1)
History of diabetes				
Yes	955	57.5 (54.2-60.8)	638	42.5 (39.2-45.8)
No	5939	33.4 (32.2-34.6)	10144	66.6 (65.4-67.8)
History of hypertension				
Yes	1703	59.6 (57.1-62.0)	1075	40.4 (38.0-42.9)
No	5298	31.4 (30.3-32.6)	9884	68.6 (67.4-69.7)
History of heart disease				
Yes	345	56.5 (51.4-61.5)	274	43.5 (38.5-48.6)
No	6660	34.4 (33.2-35.6)	10692	65.6 (64.4-66.8)

Table 2. Prevalence of meeting the recommended daily intake of fruits, vegetables, combined FV and the recommended level of physical activity, by hypercholesterolemia status

Variables	*Hypercholesterolemia*				*P-value*
	Yes (n=7011)		*No (n=10977)*		
	n	*% (95% CI)*	*n*	*% (95% CI)*	
Based on Malaysian Dietary Guideline 2010:					
Intake of fruits					0.002
≥2 servings per day (Adequate)	1239	17.0 (15.8-18.3)	1682	14.8 (13.8-15.7)	
<2 servings per day (Inadequate)	5752	83.0 (81.7-84.2)	9265	85.2 (84.2-86.2)	
Intake of vegetables					0.052
≥3 servings per day (Adequate)	864	12.8 (11.7-14.1)	1454	14.2 (13.1-15.4)	
<3 servings per day (Inadequate)	6124	87.2 (85.9-88.3)	9492	85.8 (84.6-86.9)	
Based on WHO STEPS criteria:					
Intake of combined FV					0.675
≥5 servings per day (Adequate)	535	7.8 (6.9-8.7)	813	7.5 (6.8-8.4)	
<5 servings per day (Inadequate)	6438	92.2 (91.3-93.1)	10109	92.5 (91.6-93.2)	
Based on IPAQ definition:					
Physical activity level					0.228
≥600 METs-minutes/week (Active)	4455	64.0 (62.3-65.7)	7022	65.2 (63.7-66.7)	
<600 METs-minutes/week (Inactive)	2526	36.0 (34.3-37.7)	3877	34.8 (33.3-36.3)	

95% CI: 15.8-18.3) compared to those without hypercholesterolemia (14.8%, 95% CI: 13.8-15.7). Prevalence of meeting the recommended level of PA for those with hypercholesterolemia and those without the ailment were 64.0% and 65.2% respectively, with no statistically significant difference.

Table 3 shows the results of logistic regression analyses with participants without hypercholesterolemia as the reference group. The crude OR of consuming two or more servings of fruits per day for those with hypercholesterolemia was 1.18 (95% CI: 1.06-1.31). After adjusting for socio-demographic characteristics, participants with hypercholesterolemia were less likely to consume three or more servings of vegetables per day (OR=0.86, 95% CI: 0.76-0.97) and five or more servings of combined FV per day (OR=0.84, 95% CI: 0.72-0.98). However, after adjustment for socio-demographic characteristics and other additional risk factors, we found no significant differences in terms of meeting the recommended daily intake of fruits, vegetables, combined FV and the recommended level of PA among participants with hypercholesterolemia compared to those without hypercholesterolemia.

Table 4 shows crude and adjusted ORs of meeting the recommended daily intake of five or more servings of combined FV and the recommended level of PA among adults with hypercholesterolemia by socio-demographic characteristics and other risk factors. Multivariable logistic regression

Table 3. Odds ratios (95% CI) of meeting the recommended daily intake of fruits, vegetables, combined FV and the recommended level of physical activity among participants with hypercholesterolemia compared with those without hypercholesterolemia*

	Crude OR	*Adjusted OR*[a]	*Adjusted OR*[b]
≥2 servings of fruits per day	1.18 (1.06-1.31)	0.93 (0.83-1.04)	0.92 (0.82-1.04)
≥3 servings of vegetables per day	0.89 (0.76-1.00)	0.86 (0.76-0.97)	0.88 (0.78-1.01)
≥5 servings of combined FV per day	1.03 (0.89-1.20)	0.84 (0.72-0.98)	0.86 (0.73-1.01)
≥600 METs-minutes/week of physical activity	0.95 (0.87-1.03)	1.01 (0.92-1.10)	1.01 (0.92-1.11)

* Reference group

[a] Adjusted for gender, age group, ethnicity, residential area, marital status, educational level, and monthly household income.

[b] Adjusted for gender, age group, ethnicity, residential area, marital status, educational level, monthly household income, BMI, smoking, abdominal obesity, history of diabetes, history of hypertension, and history of heart disease.

analyses revealed that hypercholesterolemic adults who were females (OR=1.40; 95% CI: 1.02-1.93), older adults aged 60 years and above (OR=2.02; 95% CI: 1.01-4.10), and those who had a tertiary educational level (OR=4.35; 95% CI: 2.20-8.59) were more likely to consume five or more servings of combined FV per day. Being underweight or obese were both associated with being less likely to consume five or more servings of combined FV per day. Hypercholesterolemic adults aged 40-49 years of Indian, Other Bumiputera and Others ethnicity, residing in rural areas, and those who had a primary or secondary educational level were more likely to be physically active; whilst those who were females, former smokers, and those who had diabetes and heart disease were less likely to meet the recommended level of PA.

DISCUSSION

In this study, we found that the prevalence rates of meeting the recommended daily intake of fruits, vegetables, and combined FV among Malaysian adults with hypercholesterolemia as well as those without this ailment were equally low. This indicates that Malaysians are not consuming enough of FV despite having high cholesterol. With regard to PA level, though the prevalence of meeting the recommended PA level was close to 65% in both hypercholesterolemic and non-hypercholesterolemic groups, intensified efforts are still needed to increase the level of PA among the Malaysian population in order to reduce the risk of cardiovascular diseases. The low prevalence of FV intake suggests that the majority of the Malaysian population may not be aware of the dietary recommendations for FV intake as stated in the Malaysian Food Pyramid. This is a critical issue that needs to be investigated because it will help to prevent undesirable health conditions in society. The dietary guidelines and the food pyramid should be disseminated to the public to promote healthy eating and active living.

Our study showed that participants with hypercholesterolemia reported a significantly higher prevalence of consuming two or more servings of fruits per day as compared to those without hypercholesterolemia (P=0.002). Plausible explanation may be that persons with hypercholesterolemia choose to practice healthy eating by eating more fruits as fruits can often be eaten fresh and raw at anytime while vegetables is part of a typical daily meal (Yen & Tan, 2012). However, logistic regression analysis showed no significant differences pertaining to the intake of fruits,

Table 4. Crude and adjusted odds ratios (95% CI) of meeting the recommended levels of FV intake and PA among Malaysian adults with hypercholesterolemia

Variables	*≥5 servings of combined FV per day*		*≥600 METs-minutes/week of PA*	
	Crude OR (95% CI)	*Adjusted OR (95% CI)*	*Crude OR (95% CI)*	*Adjusted OR (95% CI)*
Gender				
Male	1.00	1.00	1.00	1.00
Female	1.03 (0.82-1.30)	1.40 (1.02-1.93)	0.73 (0.65-0.83)	0.78 (0.64-0.94)
Age group (years)				
18-29	1.00	1.00	1.00	1.00
30-39	1.22 (0.77-1.94)	1.14 (0.62-2.12)	1.33 (1.06-1.67)	1.13 (0.86-1.49)
40-49	1.75 (1.15-2.66)	1.49 (0.83-2.68)	1.57 (1.24-1.98)	1.35 (1.01-1.80)
50-59	1.93 (1.27-2.93)	2.09 (1.14-3.83)	1.40 (1.13-1.72)	1.32 (0.98-1.76)
≥60	1.34 (0.84-2.13)	2.02 (1.01-4.10)	0.72 (0.57-0.91)	0.92 (0.66-1.29)
Ethnicity				
Malay	1.00	1.00	1.00	1.00
Chinese	1.30 (1.00-1.70)	1.29 (0.97-1.72)	1.08 (0.89-1.30)	1.16 (0.94-1.42)
Indian	0.56 (0.31-1.00)	0.60 (0.33-1.10)	1.29 (1.00-1.66)	1.38 (1.05-1.97)
Other Bumiputera	0.63 (0.41-0.97)	0.86 (0.55-1.35)	1.44 (1.14-1.82)	1.51 (1.15-1.97)
Others	1.27 (0.67-2.41)	1.67 (0.82-3.42)	1.94 (1.30-2.90)	1.91 (1.20-3.04)
Residential area				
Urban	1.00	1.00	1.00	1.00
Rural	0.82 (0.65-1.04)	1.02 (0.79-1.30)	1.16 (1.00-1.34)	1.24 (1.04-1.48)
Marital status				
Single	1.00	1.00	1.00	1.00
Married	1.61 (1.10-2.37)	1.32 (0.76-2.29)	1.29 (1.06-1.57)	1.21 (0.94-1.56)
Widow/widower/divorcee	1.07 (0.63-1.81)	1.15 (0.59-2.27)	0.72 (0.54-0.94)	0.99 (0.70-1.40)
Educational level				
No formal education	1.00	1.00	1.00	1.00
Primary	1.86 (1.09-3.16)	2.00 (1.11-3.59)	1.82 (1.48-2.23)	1.52 (1.18-1.95)
Secondary	2.13 (1.31-3.45)	2.81 (1.56-5.09)	1.96 (1.59-2.42)	1.49 (1.14-1.97)
Tertiary	2.77 (1.66-4.63)	4.35 (2.20-8.59)	1.41 (1.11-1.79)	1.18 (0.85-1.64)

Continued next page

Table 4: From previous page

Monthly household income				
<RM1000	1.00	1.00	1.00	1.00
RM1000-RM3999	1.46 (1.05-2.03)	1.30 (0.92-1.84)	1.28 (1.08-1.52)	1.15 (0.96-1.39)
≥RM4000	1.58 (1.10-2.27)	1.20 (0.78-1.84)	1.13 (0.93-1.37)	1.02 (0.82-1.27)
BMI status (kg/m^2)				
Underweight (<18.5)	0.35 (0.17-0.72)	0.41 (0.20-0.86)	0.76 (0.56-1.04)	0.86 (0.63-1.19)
Normal (18.5-24.9)	1.00	1.00	1.00	1.00
Overweight (25.0-29.9)	0.97 (0.76-1.24)	1.01 (0.76-1.33)	1.08 (0.93-1.25)	1.12 (0.94-1.33)
Obese (≥30)	0.64 (0.47-0.87)	0.74 (0.50-1.09)	1.05 (0.88-1.26)	1.15 (0.92-1.44)
Smoking status				
Non-smoker	1.00	1.00	1.00	1.00
Former smoker	1.11 (0.74-1.66)	1.24 (0.77-2.01)	0.76 (0.61-0.96)	0.67 (0.51-0.88)
Current smoker	1.04 (0.76-1.42)	1.18 (0.80-1.75)	1.51 (1.27-1.80)	1.14 (0.90-1.44)
Abdominal obesity				
Yes	0.92 (0.74-1.15)	0.92 (0.68-1.23)	0.96 (0.85-1.09)	0.97 (0.81-1.15)
No	1.00	1.00	1.00	1.00
History of diabetes				
Yes	1.12 (0.80-1.56)	1.12 (0.77-1.62)	0.64 (0.54-0.77)	0.76 (0.61-0.95)
No	1.00	1.00	1.00	1.00
History of hypertension				
Yes	1.03 (0.79-1.35)	1.06 (0.76-1.47)	0.73 (0.64-0.84)	0.89 (0.74-1.06)
No	1.00	1.00	1.00	1.00
History of heart disease				
Yes	1.13 (0.72-1.77)	1.24 (0.76-2.03)	0.49 (0.37-0.66)	0.64 (0.45-0.91)
No	1.00	1.00	1.00	1.00

vegetables, combined FV, and level of PA in hypercholesterolemic group with reference to the non-hypercholesterolemic group, after adjustment for socio-demographic characteristics and other risk factors. On the whole, these findings indicate that the situation in Malaysia is bad as almost 90% of the population did not consume enough FV and about 40% of the population did not meet the recommended PA level despite having high blood cholesterol.

Of note, the prevalence of hypercholesterolemia (known and undiagnosed) among Malaysian adults aged 18 years and above in NHMS 2011 was 35.1%, in which 26.6% were not known to have hypercholesterolemia (undiagnosed) until they were found to have a total blood cholesterol of ≥5.2 mmol/L through a finger prick test during the survey. Only 8.4% of respondents were known to have hypercholesterolemia, as told by a health care provider (IPH, 2011). Therefore, it should be noted that the majority of Malaysian adults with hypercholesterolemia were undiagnosed and unaware of their cholesterol levels at the time of the survey. The lack of awareness on cholesterol level among participants with hypercholesterolemia may be a possible reason for not meeting the recommendations for FV intake and PA. The awareness and knowledge of one's cholesterol level is crucial and should be emphasised as it would be the initial step to prompt the patient to seek medical care as well as to adopt a healthy lifestyle (Fang *et al.*, 2011).

In terms of identifying factors related to consuming adequate servings of FV per day among Malaysian adults with hypercholesterolemia, our findings indicated that socio-demographic factors such as gender, age and educational level were significantly asssociated with FV intake. These findings were consistent with a previous study conducted by Yen & Tan (2012) among the Malaysian general population that females, older people and those with a higher educational level were more likely to consume five or more servings of FV per day. Females tend to consume more FV possibly due to women's higher health consciousness compared with men (Brannon, 2006). Intake of FV increases as one becomes older as the health condition of an older individual is highly critical and hence they are more concerned with their dietary intake (Khairunnisa Izzati *et al.*, 2012). In addition, our results showed that a higher educational level led to a higher FV intake among Malaysian adults with hypercholesterolemia. Education may influence dietary knowledge (Turrell & Kavanagh, 2006) and the motivation to have a healthy diet (Worsley, 2002). Moreover, those individuals with a higher educational level may be more health conscious and aware of the health benefits of taking adequate FV (Robinson & Smith, 2003).

Among adults with hypercholesterolemia, BMI was found to be associated with FV intake. Hypercholesterolemic adults who were underweight or obese were less likely to consume five or more servings of FV per day. Epidemiological studies showed inconsistent results in assessing the association between higher intake of FV and lower body weight. A review by Tohill *et al.* (2004) to evaluate epidemiologic evidence in supporting an association between intake of FV and body weight concluded that the few studies addressing this relationship did not consistently support an association. The contradictory findings across different studies may be due to differences in the definitions used, different sample characteristics, variations in questions and survey methods. Future studies are needed to further investigate the relationship between FV intake and BMI.

Socio-demographic factors related to meeting the recommended level of physical activity (PA) among adults with hypercholesterolemia included gender, those aged 40-49 years, Indian, Other Bumiputera and Others ethnicities, rural residents, and those who had primary and

secondary educational level. Our results showed that females were less likely to be physically active than males, which was consistent with previous population-based studies (NCD, 2006; Bauman *et al.*, 2009; Shibata *et al.*, 2009). Hypercholesterolemic adults aged 40-49 years were more likely to be physically active compared to those aged 18-24 years probably due to greater concerns about their health conditions and realisation of the importance of practising an active lifestyle when entering late-middle age. Indian, Other Bumiputera and Other ethnicities were associated with a higher odds of meeting the recommended total PA level compared to Malay. The differences in levels of PA across different ethnicities could be a result of the complex interaction between socio-economic, cultural and physical environmental factors (Gordon-Larsen, Adair & Popkin, 2002). On the other hand, rural residents tend to be involved in labour intensive routine work activities and thus more likely to meet the recommended level of total PA compared to urban residents who tend to be more sedentary due to computerisation and automation of daily work activities (Wardle & Steptoe, 2003). Similarly, those who had primary or secondary educational level were more likely to be physically active probably due to occupational differences as individuals with lower educational level often perform more physically demanding jobs (Jurakic, Pedisie & Andrijasevic, 2009).

In this study, it was observed that hypercholesterolemic adults who were former smokers were less likely to meet the recommended PA level compared to non-smokers. It is plausible that former smokers stopped smoking due to personal health concerns (e.g. lung function impairment or other smoking-related clinical symptoms, such as dyspnoea) which may discourage them to engage in PA in a progressive manner (Siatkowska, Jastrzebski & Kozielski, 2010). In addition, hypercholesterolemic individuals who had diabetes and heart disease were significantly less likely to meet the recommended level of PA. This could have been due to their physical condition making them less inclined to engage in PA or physical inactivity and consequently contributing to the development of diseases. The causal effect relationships among these variables remain unclear.

To our knowledge, this is the first study to explore the FV intake and PA level among Malaysian adults with hypercholesterolemia and its associated socio-demographic attributes and risk factors. Our results were partly in line with a similar study conducted in the US (Fang *et al.*, 2011) which reported that hypercholesterolemic adults of higher educational level in the US were positively associated with FV intake, while being overweight or obese was associated with being less likely to consume FV.

The major strength of this study is its population-based design involving a large sample which is representative of the Malaysian population. Evidence derived from this study is useful for future health promotion strategies and may have public health policy implications. Interventions to increase FV intake and PA are needed for the adult population particularly those with hypercholesterolemia, which in turn should lower their risks of cardiovascular diseases.

Nevertheless, the present study has several limitations. Firstly, the study design was cross-sectional, thus only associations can be measured and not causation. Secondly, information concerning lifestyle and behavioural characteristics (e.g. FV intake, physical activity and smoking) was based upon self-reports. Therefore, we cannot exclude the possibility of recall bias and some over- or under-estimation of the data. Thirdly, detailed information on FV intake (e.g. types of FV consumed, portion size of FV consumed, weekly or monthly intake of FV) was not available as dietary measurement tools such as 24-hour dietary recall and food frequency questionnaires were not employed in this study. Fourthly, the finger

prick screening tests performed in this study only detects the total cholesterol level and does not give an accurate assessment of lipid profile. Lastly, other factors such as personal factors (e.g. personal health status, self-awareness, knowledge and perceptions on healthy lifestyle), social support, and environmental factors (e.g. availability of fresh FV, availability of recreational physical activity facilities) were not investigated in this study and may influence the likelihood of FV intake and PA among adults with hypercholesterolemia. Future studies are needed to further investigate the wide range of factors affecting intake of FV and level of PA.

CONCLUSION

A large proportion of Malaysian adults with hypercholesterolemia did not consume FV as recommended, and approximately 40% of the population was physically inactive. There is a need for a comprehensive and integrated intervention to enhance FV intake and PA level among Malaysian adults with hypercholesterolemia, including those who had comorbidity of diabetes and heart disease in order to lower their cholesterol levels which will ultimately reduce the future burden of cardiovascular diseases. The Ministry of Health Malaysia should continue its efforts to promote a healthy lifestyle and in creating awareness and providing health education to the community, particularly targeted towards hypercholesterolemic individuals who are less educated and have weight problems.

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Conflict of Interest

The authors declare that they have no conflict of interest.

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