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Hypercholesterolemia Prevalence, Awareness, Treatment and Control Among Adults in Malaysia: The 2015 National Health and Morbidity Survey, Malaysia

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Abstract

Background & Objective: Dyslipidaemia is one of the main modifiable risk factors for cardiovascular disease (CVD). Therefore, it is crucial to examine the prevalence, awareness, treatment and control of hypercholesterolemia and its associated factors among adults in Malaysia.

Methods: We used data from 19,935 respondents aged 18 years and above who responded to the cholesterol module in the National Health and Morbidity Survey (NHMS) 2015. The survey employed a two-stage stratified sampling to select a representative sample of Malaysian adults. Descriptive statistics and multivariate logistic regression were used to analyse the data.

Results: The overall prevalence of hypercholesterolemia was 47.7%. Among those who were diagnosed to have hypercholesterolemia, only 19.2% were aware of their hypercholesterolemia status. Only a mere 12.7% (95% CI: 12.4 -13.1) among those who were aware were on treatment and out of which only 53.7% (95% CI: 50.1-57.2) had their cholesterol levels controlled. The prevalence of hypercholesterolemia was associated with gender, age, ethnicity, education level, occupation, marital status, obesity, hypertension and diabetes. Awareness and treatment of hypercholesterolemia saw a similar pattern (except for gender and locality). For control of hypercholesterolemia, the female gender and secondary education levels were the only significant associated factors.

Conclusion: The overall high prevalence of hypercholesterolemia in addition to poor awareness, treatment and control are significant public health problems. Intensified health campaigns and programmes especially among high-risk groups should be implemented in order to reduce or prevent complications of hypercholesterolemia in the near future.

Keywords: adults, associated factors, dyslipidemia, hypercholesterolemia, NHMS

1. Introduction

Among all Non-Communicable Diseases (NCDs), cardiovascular disease (CVD) has been identified as the leading cause of death and disability among adults worldwide. The World Health Organization (WHO) data reveals that in the year 2012, almost half (46.2%) of NCD deaths was due to CVD (World Health Organization [WHO], 2014).

Dyslipidaemia is one of the main modifiable risk factors for CVD, apart from hypertension, hyperglycaemia, obesity, and life style factors, such as physical inactivity, smoking, excessive alcohol consumption and unhealthy dietary behaviour (Carlsson, Wändell, Gigante, Leander, Hellenius, & Faire, 2013). As a common type of dyslipidaemia, the WHO Global Health Observatory Data 2008 estimated the global prevalence of hypercholesterolemia among adults to be 39%, with South East Asia recording a prevalence of 29% (World Health Organization [WHO], n. d.).

Similarly, CVD was also the main cause of death in Malaysia from 2005 to 2014 (Department of Statistics Malaysia, 2016). In terms of hypercholesterolemia, the National Health and Morbidity Survey (NHMS) 2011

reported the prevalence of hypercholesterolemia to be 35.1% among adults 18 years and above (Institute for Public Health [IPH], 2008). In the preceding NHMS 2006 survey, the rate was 20.6%; i.e., an increase of 14.5% over a 5-year period (IPH, 2008). Several studies have shown hypercholesterolemia in Malaysia to be associated with increasing age (Wang, Xu, Jonas, You, & Wang, 2011), female gender (Roh et al., 2013; Ford, Li, Pearson, Zhao, & Mokdad, 2010), urban residence (Joshi, et al., 2014), Malay (Ahmad Faris & Ahmad Syaarani, 2008; Zaraihan, Azman, & Tariq, 1994) and Indian ethnic groups (Zaraihan , Azman , & Tariq, 1994), and lower educational levels (Ahmad Faris & Ahmad Syaarani, 2008). Other factors include bigger body size, hypertension, diabetes and smoking as stated by Ni et al. (2015).

Due to this increasing trend of hypercholesterolemia among adults in Malaysia over the past five years, it is essential for us to identify and analyse current data available on this disease. Thus, this paper discusses the prevalence, awareness, treatment and control of hypercholesterolemia in Malaysia using the latest available data. This in turn would allow us to get a comprehensive overview of the real situation of hypercholesterolemia in our country to curb its increasing prevalence.

2. Methods

2.1 Sample and Sampling

We analysed data from the National Health and Morbidity Survey (NHMS) 2015 for this study. The NHMS is a series of cross-sectional, population-based surveys conducted by the Institute for Public Health, Ministry of Health Malaysia. The 2015 survey employed a two-stage stratified sampling to select a representative sample of the population in Malaysia. The primary stratum comprised all the states in Malaysia, including federal territories; and the secondary stratum comprised urban and rural localities within each primary stratum. The sampling frame was provided by the Department of Statistics Malaysia based on the population size of the gazetted area in the year 2014. The Primary Sampling Units (PSUs) were Enumeration Blocks (EBs). A total of 869 EBs, comprising of 536 urban EBs and 333 rural EBs were randomly selected from all EBs in Malaysia via a probability proportionate-to-size (PPS) sampling technique. Subsequently, 12 Living Quarters (LQs) or Secondary Sampling Units (SSUs) were randomly picked from each selected EB. Finally, all households within each selected LQ were included, and all eligible members in each household were recruited as respondents in the survey. Respondents who were 18 years and above and able to understand the Malay language or the English language were eligible to take part in this survey.

2.2 Data Collection Tools

A validated questionnaire which included socio-demographic information of the respondent was used as a tool to collect the data required for this survey. Cholesterol (mmol/L) and blood glucose (mmol/L) levels were measured via a finger prick method using CardioChek® PA. Systolic and diastolic blood pressures were measured while the respondent was in a sitting position in mmHg using Omron Digital Automated Blood Pressure Monitor Model HEM-907. Height was measured in centimetres using Seca 206 Bodymeter and weight was measured in kilograms using a digital weighing machine (TANITA HD-319).

2.3 Variable Definitions

Hypercholesterolemia was defined based on NCEP ATP III (2002) as total cholesterol (TC) ≥of 5.2 mmol/L. For respondents with hypercholesterolemia, awareness was defined as 'Yes' if they had been informed previously by medical personnel that they had high cholesterol. Treatment for hypercholesterolemia was defined as 'Yes' if they were currently receiving medication from a doctor in the past 2 weeks for high cholesterol. Controlled hypercholesterolemia was defined as having a desirable blood cholesterol level at the time of the survey among respondents who were on treatment. Desirable cholesterol level was defined as < 5.2 mmol/L. Respondents were considered hypertensive if their average reading was ≥140 mmHg for systolic blood pressure and/or ≥90 mmHg for diastolic blood pressure or if they have been told by medical personnel that they have hypertension according to the Seventh Annual Report of the Joint National Committee (National Heart, Lung, and Blood Institute Joint National Committee on Prevention, Detection, Evaluation, and Treatment of High Blood Pressure and National High Blood Pressure Education Program Coordinating Committee, 2003). Obesity was defined as having a Body Mass Index of 30 kg/m2 and above (World Health Organization [WHO], 2017). Diabetes was defined as having a fasting capillary blood glucose level of 6.1 mmol/L and above, or if medical personnel have told respondents that, they have diabetes (American Diabetes Association [ADA], 2000).

2.5 Data Analysis

SPSS version 19.0 (IBM Corp, 2010) with add-on complex sample analysis was used to analyse the data after adjustment for stratification using post-stratification weight. Descriptive statistics was used to illustrate the

prevalence, awareness, treatment and control of hypercholesterolemia by sociodemographic variables. Multivariate logistic regression was used to estimate the effect of each variable on the prevalence, awareness, treatment and control of hypercholesterolemia after controlling for potential confounders. Results of logistic regression were expressed as adjusted Odds Ratio (aOR) and 95% Confidence Interval (CI). A two-sided p value less than 0.05 was considered as statistically significant.

There are 4 models in this analysis. Model 1 (1=Hypercholesterolemia, 0=No cholesterol), Model 2 (1=Aware of hypercholesterolemia, 0=unaware of hypercholesterolemia), Model 3 (1=On treatment, 0=not treated), Model 4 (1=Controlled, 0=Not under controlled).

3. Results

3.1 Characteristics of the Respondents

A total of 19,935 respondents responded to the cholesterol module in this study with a response rate of 99.9%. Table 1 shows the socio-demographic characteristics of the respondents. The majority of the respondents were Malays (61.9%). Females (52.4%) and males (47.6%) had an almost equal proportion. Similarly, urban (57.7%) and rural (42.3%) dwellers also had an almost even proportion. Those aged between 18-39 years old made up the largest proportion of respondents (44.7%). Overall, 69.3% were married, 46.4% had secondary education and 60.9% were employed.

3.2 Prevalence of Hypercholesterolemia, Awareness, Treatment and Control

Table 2 shows the overall prevalence, awareness, treatment and control of hypercholesterolemia by gender, age group, locality, ethnic group, educational level, employment status, marital status, obesity status, hypertension status and diabetic status.

The overall prevalence of hypercholesterolemia among Malaysian adults was 47.7% (95% CI: 46.5-49.0). There was a significant association between hypercholesterolemia and other independent variables except for locality. (Table 2a)

Among those who were diagnosed to have hypercholesterolemia, only 19.2% (95% CI: 18.0-20.5) were aware of their hypercholesterolemia status. (Table 2b). Only a mere 12.7% (95% CI: 12.4-13.1) were on treatment (Table 2c) and out of which 53.7% (95% CI: 50.1-57.2) had their cholesterol levels controlled. (Table 2d)

For awareness and treatment, there was an association with other independent variables except for gender. (Table 2b and Table 2c). Factors associated with receiving treatment among those with controlled hypercholesterolemia were gender and ethnic groups. (Table 2d)

3.3 Factors Predictive of Hypercholesterolemia

Based on logistic regression, the factors significantly associated with the higher prevalence of hypercholesterolemia were female gender, age group 40 years and above, ethnic groups (Malays, Chinese, and Indians), marital status (married, widowed/divorced), those who were obese, hypertensive and diabetics. (Table 3)

Factors significantly associated with the higher awareness rate of hypercholesterolemia were older age groups, urban residents, ethnic groups (Other Bumiputera, Indian, Chinese, Malays), married, obese, hypertensive and diabetics. (Table 3)

For treatment rate, factors that were significantly associated with higher treatment rates were older age groups, urban residents, ethnic groups (Other Bumiputeras, Indians, Chinese, and Malays), those who were unemployed, married, obese, hypertensive and diabetics. (Table 3)

For control rates, female gender and secondary education levels were the only significant factors.

Females had 0.42 times lower control of cholesterol level compared to males and those with secondary education had 0.66 times lower control of the cholesterol level compared to those with tertiary education.

Table 1. Sociodemographics of Respondents (n=19,935)

Sociodemographic characteristics	N	(%)
Gender:		
Male	9842	47.6
Female	10453	52.4
Age group:		
18 – 39	8906	44.7
40 – 59	7239	36.3
60 & above	3790	19.0
Residence:		
Urban	11504	57.7
Rural	8431	42.3
Ethnic groups:		
Malays	12345	61.9
Chinese	3193	16.0
Indians	1410	7.1
Other bumiputeras	1750	8.8
Others	1237	6.2
Educational level:		
No formal education	1370	7.0
Primary education	4781	24.3
Secondary education	9147	46.4
Tertiary education	4397	22.3
Marital status:		
Single	4191	21.0
Married	13805	69.3
Widowed/divorced	1939	9.7
Employment status:		
Employed	12139	60.9
Unemployed	7794	39.1

Table 2a. Prevalence of hypercholesterolemia among adults in Malaysia

	Prevalence	
	% (95% CI)	p-value
Overall (National)	47.7 (46.5,49.0)	-
Gender:		
Male	43.5 (42.0,45.1)	<0.001
Female	52.2 (50.6,53.8)	
Age group:		
18 – 39	36.2 (34.7,37.8)	<0.001
40 – 59	62.3 (60.5,64.0)	
60 & above	62.4 (60.1,64.6)	
Residence:		
Urban	47.7 (46.3,49.2)	0.946
Rural	47.7 (45.6,49.8)	
Ethnic groups:		
Malays	50.1 (48.7,51.6)	<0.001
Chinese	47.5 (44.7,50.3)	
Indians	50.1 (46.2,53.9)	
Other bumiputeras	45.4 (42.0,48.8)	
Others	37.4 (33.5,41.3)	
Educational level:		
No formal education	51.3 (47.0,55.6)	<0.001
Primary education	55.5 (53.3,57.6)	
Secondary education	46.4 (44.8,48.1)	
Tertiary education	44.2 (42.1.46.3)	
Employment status:		
Employed	46.1 (44.6,47.6)	<0.001
Unemployed	50.9 (49.2,52.6)	
Marital status:		
Single	32.7 (30.6,34.8)	<0.001
Married	52.6 (51.2,54.0)	
Widowed/divorce	62.4 (59.3,65.5)	
Obesity:		
Non-Obese	47.9 (46.5,49.3)	<0.001
Obese	59.6 (57.3,61.9)	
Hypertension:		
No	40.5 (39.1,41.9)	<0.001
Yes	64.4 (62.7,66.0)	
Diabetes Mellitus:		
No	44.0 (42.6,45.3)	<0.001
Yes	65.5 (63.2,67.7)	

Table 2b. Awareness of hypercholesterolemia among adults in Malaysia

	Awareness	
	% (95% CI)	p-value
Overall (National)	19.2 (18.0,20.5)	-
Gender:		
Male	19.6 (17.9,21.5)	0.398
Female	18.8 (17.5,20.2)	
Age group:		
18 – 39	7.6 (6.5,9.0)	<0.001
40 – 59	23.2 (21.4.25.1)	
60 & above	38.5 (35.6,41.6)	
Residence:		
Urban	20.5 (19.0,22.0)	<0.001
Rural	15.1 (13.5,16.8)	
Ethnic groups:		
Malays	17.5 (16.1,19.0)	<0.001
Chinese	23.3 (20.5,26.3)	
Indians	24.5 (20.2,29.4)	
Other bumiputeras	24.9 (20.5,30.0)	
Others	5.9 (3.8,8.8)	
Educational level:		
No formal education	25.1 (20.4,30.5)	<0.001
Primary education	24.5 (22.3,26.9)	
Secondary education	15.7 (14.3,17.2)	
Tertiary education	19.4 (17.1,22.0)	
Employment status:		
Employed	16.0 (14.7,17.5)	<0.001
Unemployed		
Marital status:		
Single	8.0 (6.5,9.9)	<0.001
Married	21.1 (19.7,22.6)	
Widowed/divorce	27.8 (24.5,31.3)	
Obesity:		
Non-Obese	17.2 (15.9,18.6)	<0.001
Obese	23.1 (20.9,25.4)	
Hypertension:		
No	10.6 (9.5,11.8)	<0.001
Yes	31.7 (29.6,33.8)	
Diabetes Mellitus:		
No	13.7 (12.6,14.9)	<0.001
Yes	36.6 (33.7,39.5)	

Table 2c. Treatment of hypercholesterolemia among adults in Malaysia

	Treatment	
	% (95% CI)	p-value
Overall (National)	12.7 (12.4,13.1)	-
Gender:		
Male	13.1 (11.8,14.5)	0.390
Female	12.4 (11.3,13.6)	
Age group:		
18 – 39	2.3 (1.8,3.1)	<0.001
40 – 59	14.9 (13.6,16.4)	
60 & above	33.6 (30.8.36.6)	
Residence:		
Urban	13.4 (12.3,14.6)	0.003
Rural	10.6 (9.3,12.0)	
Ethnic groups:		
Malays	11.9 (10.9,13.1)	<0.001
Chinese	15.4 (13.2,17.9)	
Indians	18.7 (15.1,23.0)	
Other bumiputeras	14.7 (11.0,19.3)	
Others	2.1 (1.1,3.9)	
Educational level:		
No formal education	22.4 (17.9,27.7)	<0.001
Primary education	19.6 (17.6,21.7)	
Secondary education	10.6 (9.5,11.8)	
Tertiary education	8.0 (6.5,9.6)	
Employment status:		
Employed	8.4 (7.5,9.3)	<0.001
Unemployed	20.5 (18.8,22.2)	
Marital status:		
Single	3.3 (2.3,4.6)	<0.001
Married	14.0 (12.9.15.2)	
Widowed/divorce	22.6 (19.6,26.0)	
Obesity:		
Non-Obese	10.9 (10.0,11.9)	<0.001
Obese	16.9 (15.0,19.1)	
Hypertension:		
No	4.6 (3.9,5.3)	<0.001
Yes	24.6 (22.8,26.5)	
Diabetes Mellitus:		
No	7.5 (6.8,8.3)	<0.001
Yes	29.3 (26.7,32.1)	

Table 2d. Control of hypercholesterolemia among adults in Malaysia

	Controlled	
	% (95% CI)	p-value
Overall (National)	53.7 (50.1,57.2)	-
Gender:		
Male	63.9 (58.9,68.6)	<0.001
Female	44.1 (39.7,48.6)	
Age group:		
18 – 39	61.7 (47.4,74.2)	0.114
40 – 59	50.1 (45.4,54.8)	
60 & above	56.1 (51.3,60.9)	
Residence:		
Urban	55.0 (50.7,59.1)	0.068
Rural	48.5 (43.0,54.0)	
Ethnic groups:		
Malays	48.7 (44.2,53.1)	0.002
Chinese	58.5 (51.5,65.2)	
Indians	47.7 (37.4,58.3)	
Other bumiputeras	68.5 (59.5,76.4)	
Others	48.0 (21.7,75.5)	
Educational level:		
No formal education	52.4 (42.8,61.8)	0.075
Primary education	54.1 (48.6,59.5)	
Secondary education	49.8 (44.4,55.2)	
Tertiary education	63.0 (54.0,71.2)	
Employment status:		
Employed	56.2 (50.8,61.4)	0.197
Unemployed	51.9 (47.5,56.2)	
Marital status:		
Single	62.9 (45.3,77.6)	0.416
Married	53.8 (49.8,57.8)	
Widowed/divorce	50.2 (41.6,58.8)	
Obesity:		
Non-Obese	51.6 (47.5,55.7)	0.444
Obese	54.4 (48.1,60.6)	
Hypertension:		
No	58.5 (50.9,65.6)	0.122
Yes	52.4 (48.8,56.0)	
Diabetes Mellitus:		
No	53.3 (48.0,58.6)	0.859
Yes	54.0 (49.3,58.5)	

Table 3. Factors associated with Prevalence, Awareness, Treatment and Controlled hypercholesterolemia among adults in Malaysia

	Prevalence		Awareness		Treatment		Controlled	
	aOR (95% CI)	p-value	aOR (95% CI)	p-value	aOR (95% CI)	p-value	aOR (95% CI)	p-value
Gender:								
Male	1.00	-	1.00	-	1.00	-	1.00	-
Female	1.55 (1.40,1.71)	<0.001*	0.95 (0.84,1.07)	0.389	0.94 (0.82,1.08)	0.390	0.42 (0.30,0.59)	<0.001*
Age group:								
18 – 39	1.00	-	1.00	-	1.00	-	1.00	-
40 – 59	1.99 (1.80,2.21)	<0.001*	2.70 (2.14,3.41)	<0.001*	4.07 (2.89,5.73)	<0.001*	1.03 (0.49,2.16)	0.930
60 & above	1.78 (1.51,2.09)	<0.001*	4.98 (3.73.6.65)	<0.001*	8.30 (5.72,12.1)	<0.001*	1.24 (0.57,2.72)	0.586
Residence:								
Urban	1.00 (0.90, 1.11)	0.946	1.55 (1.28,1.86)	<0.001*	1.58 (1.28,1.95)	<0.001*	1.22 (0.92,1.63)	0.166
Rural	1.00	-	1.00	-	1.00	-	1.00	-
Ethnic groups:								
Malays	1.47 (1.21,1.77)	<0.001*	1.78 (1.09,2.89)	0.021*	3.04 (1.59,5.83)	0.001*	0.92 (0.27,3.18)	0.899
Chinese	1.29 (1.03,1.62)	0.029*	2.28 (1.35,3.83)	0.002*	3.59 (1.80,7.13)	<0.001*	1.17 (0.33,4.20)	0.810
Indians	1.28 (1.01,1.63)	0.048*	2.49 (1.46,4.25)	0.001*	4.60 (2.29,9.22)	<0.001*	0.83 (0.21,3.21)	0.786
Other bumiputeras	1.18 (0.96,1.45)	0.113	4.05 (2.42,6.79)	<0.001*	5.64 (2.75,11.5)	<0.001*	2.51 (0.68,9.20)	0.166
Others	1.00	-	1.00	-	1.00	-	1.00	-
Educational level:								
No formal education	0.80 (0.64,0.99)	0.047*	0.42 (0.30,0.60)	<0.001*	0.84 (0.57,1.24)	0.378	0.60 (0.32,1.11)	0.101
Primary education	1.01 (0.87,1.16)	0.923	0.53 (0.42,0.69)	<0.001*	0.91 (0.69,1.20)	0.529	0.77 (0.47,1.26)	0.294
Secondary education	0.93 (0.83,1.03)	0.167	0.50 (0.41,).61)	<0.001*	0.82 (0.64.1.04)	0.108	0.63 (0.40,0.98)	0.043*
Tertiary education	1.00	-	1.00	-	1.00	-	1.00	-
Employment status:								
Employed	1.00	-	1.00	-	1.00	-	1.00	-
Unemployed	0.85 (0.77,0.94)	0.001*	0.83 (0.87,1.19)	0.831	1.32 (1.01,1.58)	0.003*	1.14 (0.80,1.61)	0.478
Marital status:								
Single	1.00	-	1.00	-	1.00	-	1.00	-
Married	1.54 (1.37,1.73)	<0.001*	1.46 (1.10,1.95)	0.010*	1.55 (1.03,2.32)	0.037*	0.69 (0.30,1.58)	0.379
Widow/widower/divorcee	1.56 (1.28,1.91)	<0.001*	1.28 (0.91,1.81)	0.153	1.29 (0.82,2.04)	0.271	0.89 (0.36.2.20)	0.808
Obesity:								
Non-Obese	1.00	-	1.00	-	1.00	-	1.00	-
Obese	1.23 (1.11,1.37)	<0.001*	1.22 (1.04,1.44)	0.014*	1.42 (1.18,1.71)	<0.001*	1.25 (0.92,1.71)	0.158
Hypertension:								
No	1.00	-	1.00	-	1.00	-	1.00	-
Yes	1.64 (1.45,1.77)	<0.001*	2.34 (2.00,2.73)	<0.001*	3.12 (2.56,3.79)	<0.001*	0.76 (0.53,1.07)	0.114
Diabetes Mellitus:								
No	1.00	-	1.00	-	1.00	-	1.00	-
Yes	1.47 (1.31,1.66)	<0.001*	2.35 (2.01.2.71)	<0.001*	2.84 (2.39.3.74)	<0.001*	1.18 (0.87,1.62)	0.288

Note: * Significant differences were set at p <0.05. The Forward LR and Backward LR was done. Gender, age group, residence, ethnic groups, educational level, employment status, marital status, obesity, hypertension and diabetes status were significant in the main effect model.

4. Discussion

In line with the increasing trend of NCDs around the world, it is no surprise that Malaysia has also been keeping up with that increase particularly in the rise of the prevalence of hypercholesterolemia over the years. Comparing findings from the National Health and Morbidity Surveys over the last decade, hypercholesterolemia prevalence has increased dramatically from 20.6% (IPH, 2008) in 2006 to 35.1% (IPH, 2011) in 2011 and to the most recent 47.7% in 2015. It has indeed surpassed the global average collated by the Word Health Organization in 2008, which was 39% (World Health Organization [WHO], n. d.). Contrarily, other countries in Asia namely, China (Huang, Gao, Xie, & Tan, 2014) and India, had lower prevalence of hypercholesterolemia; 7.9% and 13.9% respectively in 2014 (Joshi, et al., 2014).

From this study, among those who were diagnosed to have hypercholesterolemia only 19.2% were aware about their disease. This was lower compared to a study in China (24.4%) (Huang et al., 2014) in 2014 but higher than a study in Korea (13.7%) in 2013 (Roh et al., 2013).

The treatment rate in the study was 12.7%, which was higher compared to studies in China (Huang et al., 2014) in the year 2014 which was 8.8% and in Korea(7.4%) in 2013 (Roh et al., 2013). This could be due to the accessibility and heavily subsidised health care in Malaysia.

The control rate for hypercholesterolemia was much higher (53.7%) compared to the study done in China (2014) which was 19.9% (Huang et al., 2014). Only female gender and secondary educational levels were the significant associated factors for control of hypercholesterolemia.

We have found that women had a significantly higher prevalence of hypercholesterolemia in Malaysia. This finding was consistent with findings from other studies around Asia, namely-Indonesia (Hussain, 2016) and India (Joshi et al., 2014). On the contrary, in China (Huang et al., 2014), the hypercholesterolemia was more common among men compared to women. We also concluded that women had significantly poorer control, lesser awareness and had a lower treatment rate of their cholesterol levels. The findings for control of hypercholesterolemia was supported by a study done by Tappia and Dhalla (2012) which stated that women were more likely to have poor lipid control than men.

Older age was significantly associated with higher prevalence of hypercholesterolemia. Those aged above 40 years had a greater prevalence of hypercholesterolemia. Other studies also revealed that older age was related to hypercholesterolemia (Ni et al., 2015; Bayram et al., 2014). The effect of age on serum lipids is not certainly known. It may be related to hereditary characteristics, degenerative process, weight gain and progressive insulin resistance development (Bayram et al., 2014). Older age was also significantly associated with higher awareness of hypercholesterolemia in this study. Those aged 60 years and above were five times more likely to be aware of their hypercholesterolemia status compared to those aged 18 to 39 years. This is supported by previous studies (Huang et al., 2014; He et al., 2014) which stated that older participants are more concerned about their health as compared to younger participants.

Adjusted for other variables, Malays, Chinese and Indian ethnic groups were associated with a significantly higher risk of hypercholesterolemia compared to other ethnic groups. Comparing prevalence by ethnic background, the highest rates were, in fact, of equal magnitude (50.1%) for Malays and Indians, followed by a slightly lower rate for Chinese (47.5%). In a study done by Ahmad Faris and Ahmad Syaarani (2008) on a smaller sample in Kelantan and a study using NHMS (2006) data, Malays had the highest prevalence of hypercholesterolemia (IPH, 2008).

For Malays and Indians, higher risk of hypercholesterolemia maybe due to genetic factors (Al-Khateeb, Mohamed, Imran, Ibrahim, Zilfalil, & Yusof, 2011) which also contribute to the higher prevalence of CVD among Malays and Indians. Others factors may be due to dietary habits or lifestyle (Al-Khateeb et al., 2011).

Our study revealed that being married and widowed/divorced were significantly associated with a higher prevalence of hypercholesterolemia compared to being single. Being married was also significantly associated with a higher awareness rate of hypercholesterolemia compared to being single. Married individuals may be more concerned about their health due to influence from their partners and responsibility towards their families (Fu, Yu, Wang, Sun, Liu, & Hu, 2010).

Other co-morbidities such as diabetes, hypertension and obesity were significantly associated with a higher prevalence of hypercholesterolemia in our study. This is supported by a study (Ni et al., 2015) which stated that central obesity, hypertension and diabetes were significantly associated with higher prevalence of dyslipidaemia overall. In this study also, obese, hypertensive and diabetic respondents were more likely to be more aware of their hypercholesterolemia status. These might be due to increased health screening among these groups due to the presence of their other comorbidities (Yen, Tan, & Mustapha, 2016). In agreement with the study by Rodriguez et

al. (2015), our study also found that those who had comorbidities: hypertension and diabetes mellitus, they were more likely to have their cholesterol levels treated and controlled. Community intervention is needed to combat hypercholesterolemia through amplifying existing screening and awareness programmes, such as KOSPEN (Strengthening communities, empowering the Nation) which was introduced by the Ministry of Health Malaysia in October 2013.

Another example is the *Kelab Doktor Muda* and *Progam Siswa Sihat* (PROSIS) which is currently being implemented in schools and universities aiming at promoting health care awareness among the younger population. More health programmes and health campaigns focusing on the younger population are needed in order to increase awareness on health. Ten thousand (10,000) steps campaign, Communication for Behavioural Impact (COMBI) and community health centre promotions are other examples of interventions to reach these target populations in order to create the awareness.

Nevertheless, people should take responsibility towards their own health to reduce their cholesterol levels by participating in programmes organised by the government. However, the Government must identify and strengthen policies on healthcare in order to improve the general health of the population and thus reduce the burden of the CVDs later.

There were some limitations and strengths in our study. Since our study was cross sectional, it could only reflect the association between hypercholesterolemia and risk factors without establishing the temporal sequence. Another limitation was that only fingerpick blood lipids were taken (not venous blood) since the study involved a large sample. Thus, this may affect the accuracy of the cholesterol measurements (Foltz, 2013). On the other hand, the large sample size and high survey response rate strengthened the external validity of the findings.

The overall high prevalence of hypercholesterolemia with poor awareness, treatment and control of hypercholesterolemia in our study are important public health findings, which are beneficial to the local healthcare system. Since hypercholesterolemia is a silent disease and one of the major CVD risk factor, it is a serious concern that the public might only seek treatment at a later stage of the disease. This problem leads to increased healthcare services utilization and costs, risk of premature death, and ultimately impact the productivity and economy of the nation (Scholze, Alegria, Langham, Stevens, Jeffries, & Uhl- Hochgraeber, 2010). A comprehensive public health commitment is required at every level in order to ensure that hypercholesterolemia screening, prevention, treatment and control programmes and campaigns run effectively, especially for high risk groups to reduce the risk of CVDs in the future.

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Competing Interests Statement

The authors declare that there are no competing or potential conflicts of interest.

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