ORIGINAL ARTICLE

Predictors of Coronary Heart Disease (CHD) among Malaysian Adults: Findings from MyDiet-CHD Study

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ABSTRACT

Introduction: This study aimed to determine the risk factors of CHD among the Malaysian adult population. **Methods:** Using a cross- sectional observational study design, this study involved 365 adult patients aged between 30-64 years, attending clinics from eight government hospitals and four health clinics in Terengganu, Pahang, Selangor, Putrajaya, Penang, Kedah, Johor and Sabah from February 2018 until September 2020. Sociodemographic characteristics, clinical and dietary data, physical activity and stress level were recorded using a structured questionnaire. Multiple logistic regression was used to analyse CHD risk factors. **Results:** The overall response rate was 99.2%. The adjusted odds ratio of CHD was greater for age (AOR; [%95 CI]) (1.043;[1.009,1.078]); waist circumference (1.033;[1.009, 1.057]); total fat intake (1.035;[1.021, 1.050]); full cream dairy products intake (1.004;[1.001, 1.008]); smokers vs non-smokers (4.691;[2.399, 9.176]); individual with family history of CHD vs without family history (2.705;[1.496, 4.891]); married vs single (0.434;[0.217,0.867]); and lower for HDL cholesterol (0.185;[0.052, 0.662]); Chinese vs Malays (10.619;[2.255, 49.995]); and third lowest income (0.197;[0.073, 0.532]) and forth lowest income (0.167;[0.056, 0.499]) vs lowest income. **Conclusion:** Age, race, income, smoking and marital status, family history of CHD, waist circumference, HDL cholesterol, total fat intake, full cream dairy products intake were significantly associated with CHD among this population. This finding is particularly important to the primary health carers to identify at-risk CHD individuals thus appropriate intervention could be provided.
Malaysian Journal of Medicine and Health Sciences (2022) 18(6):259-269. doi:10.47836/mjmhs18.6.34

Keywords: Coronary heart disease, Risk factor, Adult, Logistic regression, Malaysia

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INTRODUCTION

According to World Health Organization (WHO), cardiovascular diseases (CVDs) have become the primary cause of mortality globally and it was estimated that 32% of all global death were due to CVD (1). CVDs have become silent killers as many people are not aware of the presence of its symptoms until it affects the heart and arteries (2). Among all CVDs, ischaemic heart diseases (IHD) or known as coronary heart disease (CHD) was the leading cause of mortality globally in which the total number of prevalent CHD and deaths increase steadily from 1990, reaching 197 million global prevalent cases and 9.14 million deaths in 2019 (3). In Malaysia, CHD remained as the principal cause of mortality among all CVDs by 15.6% in 2019 (4). Ministry of Health of Malaysia (MOH) reported that in 2017, Disability-Adjusted Life Years (DALYs) losses from CVDs totalled RM59.85 billion and the highest proportion of the disease is attributable to CHD which is RM32.48 billion (5).

The Framingham heart study (FHS) was the first study that created the concept of risk factors in CHD, in 1957 in which the associations between cigarette smoking, blood pressure, and cholesterol levels and the incidence of CHD had contributed evidence in the medical field (6). CHD can be caused by modifiable risk factors such as smoking, hypertension, high body mass index (BMI), large waist circumference, dyslipidemia, diabetes mellitus, physical inactivity, unhealthy dietary intake, meanwhile non-modifiable risk factors are age, sex and family history (6,7). Moreover, psychosocial factors such as stress, depression, anxiety and socioeconomic status also contributed to cardiovascular health (8). In

Malaysia, there was an increasing trend for CHD risk factors such as diabetes mellitus, hypertension and dyslipidemia (9).

Malaysia is one of the developing countries that is currently experiencing fast economic growth followed by technological advancement and urbanization which have led to poor lifestyle changes (10). The National Health and Morbidity Surveys (NHMS) has estimated that 63 percent of Malaysian adults had at least one risk factor of CHD (9). Although the Malaysian Ministry of Health has implemented 'The National Strategic Plan for Non-Communicable Disease (NSP-NCD) 2016-2025 to reduce the modifiable risk factors of NCD including CHD (11), however, the incidence rate of CHD is expected to increase over the years and consequently contributes to the economic loss due to the increase of the healthcare cost (5).

Global clinical practice guidelines still advise that CHD treatments and prevention methods must be carried out based on underlying risk factors. As CHD is a multi-factorial disease, it requires continuous attention to evaluate the most significant risk factors that contribute to the disease development. The findings are important for reducing the risk of CHD by helping primary health care in identifying those who are at risk of CHD and prescribing appropriate intervention.

In Malaysia, several studies on CHD risk factors have been conducted, however, the findings were inconclusive and contradicting between studies (12,13). Moreover, it is noteworthy that dietary factors have not been adequately examined in the previous studies. In addition, there is inadequate published data on CHD risk factors among CHD patients in Malaysia. Thus, this paper aimed to determine the risk factors of CHD among Malaysian adult population.

MATERIALS AND METHODS

Study area and study population

This cross-sectional observational study was conducted at eight government hospitals and four health clinics from February 2018 until September 2020. The selection of clinics was based on purposive sampling from every region of Malaysia which were east coast, central, south, north, and Sabah/Sarawak and it involved eight states (Terengganu, Pahang, Selangor, Putrajaya, Penang, Kedah, Johor and Sabah). The selected government hospitals and health clinics were chosen as there was a high number of CHD patients who attended cardiology clinics and non-CHD patients who attended medical outpatient clinics or health clinics to receive their treatment there. Consecutive sampling was applied for the selection of participants from every clinic.

Study sample

The sample size was determined by using two independent means for the numerical independent variable (age) in Power and Sample Size Calculation (PS) software. The parameters used in sample size calculation were level of significance (0.05), power (0.80), the standard deviation of age for participants with CHD (12.2) (14), estimated difference of population means (4), and the ratio of control to case (1). The estimated sample size was 294 (147 participants per group) and after considering 20% of dropout compensation, the final sample size was 368 (184 participants per group). However, this study involved only 365 participants with a response rate of 99.2%.

The study participants for both groups were adult patients aged between 30-64 years old attending the medical outpatient clinic and have at least three metabolic syndromes (large waistline (man: >90cm; woman: >80cm), high triglyceride level, low HDL cholesterol level, high blood pressure, high fasting blood sugar). The CHD group was those who were newly diagnosed with CHD (less than two years) by medical officers or physicians. In contrast, the non-CHD group was those who had never been diagnosed with CHD. Patients who were unstable or in the intensive care unit (ICU)/coronary care unit (CCU), patients with cognitive impairment, or those who are deaf and dumb were excluded.

Data collection

Participants who were eligible according to the inclusion/exclusion criteria based on the medical record were invited to participate in the study. Each participant provided written informed consent prior to their participation. Then, the participants were interviewed face to face by two researchers using a set of questionnaires comprised of three main sections. The first section of the questionnaire was sociodemographic information and medical backgrounds such as age, marital status, race, religion, educational level, household income per month, smoking status and family history of CHD. The second section consisted of anthropometric measurement, biochemical and clinical data. The weight and height of participants were measured by using TANITA digital weighing scale and SECA stadiometer, respectively. Meanwhile, waist circumferences were measured by using a non-stretchable measuring tape. Two readings were obtained, and the mean value was calculated. The BMI was derived by dividing body weight (kg) by height (m2). Their clinical data (blood pressure) were measured by the nurse while latest biochemical data (lipid profile and blood sugar profile) were obtained from the medical record.

For the third section, the participants were interviewed on their health-related lifestyle behaviours (dietary intake, physical activity and stress level). Dietary intake prior to CHD diagnosis was assessed by researchers using a validated semi-quantitative food frequency questionnaire (FFQ) consisting of 189 food items categorized under 15 groups. The participants were

required to respond on the frequency of intake and number of servings consumed for each food item based on their usual dietary intake over the past year (15). The estimation of daily energy, macronutrient and micronutrient intake were determined by Nutritionist Pro software version 3.1, dietary analysis software (Axxya Software, USA). The nutrient composition was obtained from the Malaysian Food Composition Database.

The physical activity levels of participants was assessed by using a short-form Malay version of the International Physical Activity Questionnaire (IPAQ) which consisted of seven questions on frequency and time spent on vigorous and moderate physical activities and walking as well as time spent on sitting during the last seven days (16,17). IPAQ data were presented as the estimation of energy expenditure in metabolic equivalent-minutes per week (MET-min/week). Moderate physical activity was defined as at least 30 minutes/day of moderate-intensity activity and/or walking, ≥ 5 days or at least 20 minutes/day of vigorous-intensity activity, ≥ 3 days, or a combination of physical activity at least 600 MET-min/week. High physical activity was defined as at least 3 days achieving total physical activity ≥ 1500 MET-min/week or ≥ 7 days of a combination of physical activity achieving total physical activity ≥ 3000 MET-min/week. Low physical activity was defined as not meeting any of the criteria for either moderate or high level of physical activity. The stress level of participants was assessed by using the Malay version of the Perceived Stress Scale-10 (PSS-10) that consisted of 10 questions (18). The participants were asked about their feelings and thoughts during the last month and rated how often they had experienced these feelings on a Likert scale from 0 = never to 4 = very often. PSS was determined by reversing the scores for questions 4, 5, 7, and 8. The total scores of the PSS were classified into three categories which were low stress (0-13), moderate stress (14-26), and high perceived stress (27-40).

This study was approved by the Ministry of Health Malaysia Medical Research Ethics Committee and registered with National Medical Research Registry (NMRR- No-18- 269- 39671) and UniSZA Human Research Ethics Committee (UHREC). Information from the participants was treated as confidential and was not revealed in any report or publication.

Statistical Analysis

Data were analysed using IBM SPSS Statistics for Windows version 26.0 software. The normality of the data distribution was checked. A descriptive test was conducted to analyse data on socio-demographic, anthropometry, biochemical, clinical, physical activity, psychological stress level, nutrient intake and food group intake. Simple logistic regression analysis (SLR) was conducted before performing multiple logistic regression (MLR) to screen for important independent variables by using binary logistic analysis. Finally, MLR test was carried out to obtain the associated factors of CHD. Multicollinearity between variables and interactions were checked and the final model fit was assessed using the Hosmer-Lemeshow test, classification table and area under the Receiver Operating Characteristic (ROC) curve. The final results were presented by using adjusted odds ratio (AOR) with 95% confidence interval (CI) and p-value.

RESULTS

Descriptive analysis

Out of 365 participants who were involved in this study, 178 (48.8%) were in the CHD group and 187 (51.2%) were in the non-CHD group. The mean age of the CHD group and non-CHD group were 52.0 ± 8.5 years and 51.3 ± 9.7 years, respectively (Table I). Men and women accounted for 46.3% and 53.7%, respectively. The majority of participants were men (53.7%), Malays (81.6%), married (75.6%), had SRP/SPM level of education (61.9%) and economically half of the participants had a monthly household income of less than RM2500. In addition, significantly higher proportion of smokers (38.8%) and participants who had family history of CHD (43.8%) were found in the CHD

Table I: Socio-demographic characteristics of study participants (n=365)

Characteristics	CHD n = 178	Non-CHD n = 187	Total, n (%)	p-value*
Age, Mean ± SD, years	52.0 ± 8.5	51.3 ± 9.7		0.466[b]
Gender				
Male, n (%)	118(66.3)	78(41.7)	196(53.7)	<0.001[a]
Female, n (%)	60(33.7)	109 (58.3)	169(46.3)	
Marital Status, n (%)				
Single	61(34.3)	28(15.0)	89(24.4)	<0.001[a]
Married	117(65.7)	159(85.0)	276(75.6)	
Race, n (%)				
Malay	126(70.8)	172(92.0)	298(81.6)	<0.001[a]
Chinese	20(11.24)	4(2.1)	24(6.6)	
India	24(13.48)	9(4.8)	33(9.0)	
Others (Kadazan Dusun, Bajau, Bidayuh)	8(4.49)	2(1.1)	10(2.7)	
Educational level, n (%)				
SRP/SPM	120(67.4)	106(56.7)	226(61.9)	0.108[a]
Diploma/ STPM	34(19.1)	47(25.1)	81(22.2)	
Degree and above	24(13.5)	34(18.2)	58(15.9)	
Monthly Income, n (%)				
<RM2500	102(7.3)	87(46.5)	189(51.8)	0.003[a]
RM2501-3170	25(14.0)	20(10.7)	45(12.3)	
RM3171-3970	16(9.0)	33(17.6)	49(13.4)	
RM3971-4850	8(4.5)	25(13.4)	33(9.0)	
RM4851-10970	25(14.0)	22(11.8)	47(12.9)	
>RM10971	2(1.1)	0	2(0.5)	
Family history of CHD, n (%)	100(56.2)	141(75.4)	241(66.0)	<0.001[a]
No	78(43.8)	46(24.6)	124(34.0)	
Yes				
Smoking status, n (%)	109(61.2)	157(84.0)	266(72.9)	<0.001[a]
Non-smoker	69(38.8)	30(16.0)	99(27.1)	
Smoker				

Notes: [a]Chi-square test; [b]Independent t-test; *Significant level at p-value <0.05; CHD = coronary heart disease; SD = standard deviation; SRP = Sijil Rendah Pelajaran; SPM = Sijil Pelajaran Malaysia; STPM = Sijil Tinggi Persekolahan Malaysia

group as compared to the non-CHD group (p<0.001).

The mean BMI of the CHD group was 28.7 ± 5.7 kg/m^2 meanwhile the mean BMI of the non-CHD group was 28.3 ± 6.3 kg/m^2 (Table II). The mean of waist circumference, total cholesterol and triglyceride were significantly higher in the CHD group compared with the non-CHD group, whilst HDL cholesterol was significantly higher in the non-CHD group (p<0.05). In addition, there was a significant difference in systolic blood pressure between the CHD group and the non-CHD group with a mean of 139.3 ± 15.7 mmHg and 134.8 ± 12.3 mmHg (p=0.003), respectively.

Table III shows the nutrient and food group intakes and dietary pattern of study participants. The mean intake of energy among the CHD group was significantly higher than the non-CHD group. Moreover, in terms of macronutrient intake, the CHD group consumed significantly more carbohydrate, protein, fat, saturated fat (SFA), monounsaturated fat (MUFA), and polyunsaturated fat (PUFA) than the non-CHD group (p<0.05). In terms

Table II: Baseline characteristics of study participants (n=365)

Characteristics	CHD n = 178	Non-CHD n = 187		p-value*
Body Mass Index, Mean ± SD, kg/m^2	28.7 ± 5.7	28.3 ± 6.3		0.736[b]
Waist circumference, Mean ± SD, kg/m^2	95.9 ± 11.2	90.1 ± 12.3		<0.001[b]
Blood lipid profile, Mean ± SD, mmol/L				
Total cholesterol Normal (<5.2 mmol/L)	5.4 ± 1.2	5.1 ± 1.1		0.016[b]
Triglyceride Normal (<1.7 mmol/L)	1.8 ± 0.6	1.5 ± 0.5		<0.001[b]
HDL cholesterol Normal (>1.1 mmol/L)	1.0 ± 0.2	1.1 ± 0.2		<0.001[b]
LDL cholesterol Normal (<2.6 mmol/L)	3.1 ± 1.0	2.9 ± 1.0		0.057[b]
Systolic blood pressure (mm/Hg)	139.3 ± 15.7	134.8 ± 12.3		0.003[b]
Diastolic blood pressure (mm/Hg)	82.9 ± 9.7	82.1 ± 7.9		0.365[b]
Physical activity, n (%)				
Low	81(45.5)	78(41.7)	159(43.6)	0.737[a]
Moderate	65(36.5)	75(40.1)	140(38.4)	
High	32(18.0)	34(18.2)	66(18.1)	
Stress level, n (%)				
Low	82(45.6)	98(54.4)	180(49.3)	0.732[a]
Moderate	96(52.2)	88(47.8)	184(50.4)	
High	0(0.0)	1(100)	1(0.3)	

Notes: [a]Chi-square test; [b]Independent t-test; *Significant level at p-value <0.05; CHD = coronary heart disease; SD = standard deviation; HDL = high-density lipoprotein; LDL = low-density lipoprotein

Table III: Nutrient and food group intakes and dietary pattern of study participants (n=365)

Nutrients, Food Groups & Dietary Pattern	CHD n = 178	Non-CHD n = 187	p-value
Energy (kcal/day)	2059.7 ± 557.9	1582.2 ± 605.2	<0.001
Carbohydrate (g/day)	283.3 ± 95.1	226.6 ± 93.5	<0.001
Protein (g/day)	85.1 ± 24.4	65.2 ± 25.7	<0.001
Fat (g/day)	65.1 ± 23.8	46.1 ± 21.4	<0.001
SFA (g/day)	28.8 ± 11.5	20.2 ± 9.0	<0.001
MUFA (g/day)	25.5 ± 9.3	18.3 ± 9.0	<0.001
PUFA (g/day)	10.5 ± 4.2	7.4 ± 4.0	<0.001
Fibre (g/day)	11.7 ± 7.6	7.9 ± 5.3	<0.001
Sugar (g/day)	47.2 ± 31.3	40.2 ± 25.7	0.020
Sodium, Na (mg/day)	3100.0 ± 1470.0	2362.0 ± 1316.8	<0.001
Calcium, Ca (mg/day)	664.7 ± 324.8	510.2 ± 243.4	<0.001
Phosphate, P (mg/day)	1398.1 ± 541.7	1052.4 ± 453.1	<0.001
Iron, Fe (mg/day)	20.5 ± 14.0	17.8 ± 12.6	0.046
Potassium, K (mg/day)	1893.0 ± 691.7	1490.2 ± 704.8	<0.001
Retinol (ug/day)	755.7 ± 457.0	542.5 ± 475.5	<0.001
Carotene (ug/day)	2468.9 ± 2386.3	1711.2 ± 1978.2	0.001
RE (ug/day)	1024.8 ± 557.9	737.7 ± 617.7	<0.001
B1 (mg/day)	1.1 ± 0.5	0.9 ± 0.5	<0.001
B2 (mg/day)	1.8 ± 0.8	1.3 ± 0.8	<0.001
Niacin (mg/day)	14.7 ± 5.4	10.9 ± 5.1	<0.001
C (mg/day)	112.8 ± 113.1	85.0 ± 94.3	0.011
Food Group 1 [white rice] (g/day)	250.0 ± 135.5	202.2 ± 109.5	<0.001
Food Group 2 [rice dishes] (g/day)	99.8 ± 89.6	98.7 ± 77.0	0.896
Food Group 3 [white bread] (g/day)	19.6 ± 30.9	16.2 ± 24.4	0.244
Food Group 4 [whole grains] (g/day)	11.2 ± 23.4	8.0 ± 25.0	0.212
Food Group 5 [bread with fillings] (g/day)	4.2 ± 10.3	2.9 ± 9.9	0.220
Food Group 6 [flat-bread] (g/day)	38.1 ± 74.0	25.9 ± 48.7	0.062
Food Group 7 [biscuits] (g/day)	10.6 ± 22.0	5.6 ± 8.0	0.004
Food Group 8 [noodles dishes] (g/day)	109.0 ± 122.2	74.0 ± 113.7	0.030
Food Group 9 [meat] (g/day)	17.9 ± 37.4	12.2 ± 27.9	0.100
Food Group 10 [poultry] (g/day)	77.5 ± 69.2	54.3 ± 57.3	0.001
Food Group 11 [fish and seafood] (g/day)	110.2 ± 103.8	88.8 ± 75.7	0.025

(Continue.....)

Table III: Nutrient and food group intakes and dietary pattern of study participants (n=365) (continued.....)

Nutrients, Food Groups & Dietary Pattern	CHD n = 178	Non-CHD n = 187	p-value
Food Group 12 [coconut-based dishes] (g/day)	62.8 ± 78.4	39.5 ± 40.1	<0.001
Food Group 13 [egg and egg dishes] (g/day)	29.8 ± 33.7	18.8 ± 28.4	0.001
Food Group 14 [dairy products] (g/day)	57.3 ±104.1	37.3 ± 79.6	0.039
Food Group 15 [legumes] (g/day)	30.7 ± 45.3	15.4 ± 28.3	<0.001
Food Group 16 [green leafy vegetables] (g/day)	76.8 ± 87.6	65.3 ± 70.5	0.165
Food Group 17 [cruciferous vegetables] (g/day)	20.2 ± 27.3	21.8 ± 33.5	0.611
Food Group 18 [other vegetables (pod and seed vegetables, root vegetables, marrow vegetables)] (g/day)	57.4 ± 83.7	51.0 ± 59.8	0.398
Food Group 19 [potatoes] (g/day)	19.9 ± 33.0	11.5 ± 20.4	0.004
Food Group 20 [fruits] (g/day)	165.1 ± 199.1	111.3 ± 200.7	0.011
Food Group 21 [sweet local dessert] (g/day)	23.8 ± 33.1	24.8 ± 31.9	0.762
Food Group 22 [savoury local dessert] (g/day)	24.1 ± 38.8	24.3 ± 31.2	0.943
Food Group 23 [confectionary food] (g/day)	8.6 ± 12.2	6.5 ± 13.1	0.119
Food Group 24 [fast foods and snacks] (g/day)	19.1 ± 28.2	11.4 ± 17.1	0.002
Food Group 25 [seasoning sauce] (g/day)	16.8 ± 19.6	13.3 ± 16.4	0.059
Food Group 26 [salted and processed foods] (g/day)	21.5 ± 24.8	13.6 ± 14.6	<0.001
Food Group 27 [sugar sweetened beverages and carbonated drinks] (g/day)	339.1 ± 218.7	299.8 ± 205.0	0.077
Food Group 28 [sweets (additional sugar)] (g/day)	19.5 ± 68.2	12.1 ± 22.5	0.158
Food Group 29 [fat spreads] (g/day)	3.6 ± 6.9	1.1 ± 4.0	<0.001
Food Group 30 [sweet bread spread] (g/day)	2.9 ± 6.3	1.6 ± 3.4	0.009
DP (High SFA, high DED, high sodium)	0.2 ± 1.2	-0.1 ± 1.0	0.009

Notes: All nutrient and food group intakes and dietary pattern were analysed by using independent t-test; *Significant level at p-value <0.05; CHD = coronary heart disease; SFA = saturated fat; MUFA = monounsaturated fat; PUFA = polyunsaturated fat; DP = dietary pattern; DED = dietary energy density

of micronutrient intake, the consumption of fibre, sugar, sodium, calcium, phosphate, iron, potassium, retinol, carotene, vitamin B1 and B2, and niacin were significantly higher among the CHD group than the non-CHD group (p<0.05). For food group consumption, the mean intakes of white rice, biscuits, noodle dishes, poultry, fish and seafood, coconut-based dishes, egg and egg dishes, full cream dairy products, legumes, potatoes, fruits, fast foods and snacks, salted and processed foods, fat spreads and sweet bread spread were significantly higher in the CHD group than the non-CHD group (p<0.05).

Dietary pattern (DP) analysis was obtained from a previous study (unpublished data). The DP was derived from reduced rank regression (RRR) analysis by combining at least three response variables that were decided based on the researcher's clinical judgement and previous literature. There were significant differences found in the dietary pattern intake between the CHD group and the non-CHD group (p<0.05).

Simple Logistic Regression (SLR) analysis

SLR analysis was performed to identify risk factors that were associated with CHD among the CHD and the non-CHD group. In this analysis, the following significant risk factors with p-value <0.25 were identified as shown in Table IV: waist circumference, total cholesterol, triglyceride, HDL cholesterol, LDL cholesterol, systolic blood pressure, intake of energy, carbohydrate, protein, total fat, fibre, SFA, MUFA, PUFA, sodium, sugar, calcium, phosphorus, iron, potassium, retinol, carotene, RE, vitamin B1, vitamin B2, niacin, vitamin C, all food groups intake except rice dishes, cruciferous vegetables, other vegetables, sweet local dessert, savoury local dessert, dietary pattern, race, gender, marital status, education level, income status, smoking status, and family history of CHD.

Multiple logistic regression (MLR) analysis

In MLR analysis, all the variables from SLR analysis with a p-value <0.25 were simultaneously entered into the MLR analysis. However, age and diastolic blood pressure (p-value >0.25) were also selected as they were clinically important. The final step was left with ten variables that had a p-value less than 0.05 as shown in Table V.

For each year increase in age, an individual was more likely to have CHD, (AOR= 1.043; 95% CI 1.009,1.078; p=0.014). It was also interesting to find that married person had a lower chance to have CHD than single or unmarried person (AOR= 0.434; 95% CI 0.217,0.867; p=0.018). Among all ethnicities, the Chinese had the highest odds to get CHD (AOR=10.619; 95% CI 2.255, 49.995; p=0.003). In addition, smokers were 4.6 times more likely to have CHD as compared to non-smoker (AOR= 4.691; 95% CI 2.399, 9.176; p<0.001). The chance of having CHD increases among individuals with a family history of CHD (AOR=2.705; 95% CI 1.496, 4.891; p=0.001). Compared to the individual with income of <RM2500, the odds of developing CHD was lower for the individual with income of RM3171-3970 (AOR= 0.197; 95% CI 0.073, 0.532; p=0.001) and RM3971-4850 (AOR= 0.167; 95% CI 0.056, 0.499; p=0.001). Moreover, an individual with an increase in 1cm of waist circumference had 3% higher odds to have

Table IV: Associated factors of CHD by Simple Logistic Regression (n=365)

Variable	Regression coefficient (b)	Crude Odds Ratio (95%)	Wald statistic	p-value
Age	0.08	1.008(0.986,1.031)	0.53	0.465
BMI (kg/m2)	0.01	1.006(0.972,1.041)	0.11	0.740
Waist circumference (cm)	0.04	1.040(1.021,1.059)	17.21	<0.001
Total Cholesterol (mmol/L)	0.22	1.245(1.040,1.492)	5.67	0.017
Triglyceride (mmol/L)	1.09	2.965(1.935,4.545)	24.89	<0.001
HDL cholesterol (mmol/L)	-2.40	0.090(0.034,0.243)	22.78	<0.001
LDL cholesterol (mmol/L)	0.20	1.225(0.993,1.510)	3.60	0.058
Systolic blood pressure (mm/Hg)	0.02	1.023(1.008,1.038)	8.81	0.003
Diastolic blood pressure (mm/Hg)	0.01	1.011(0.987,1.035)	0.82	0.364
Energy (kcal/day)	0.001	1.001(1.001,1.002)	45.66	<0.001
Carbohydrate (g/day)	0.01	1.007(1.004,1.009)	27.63	<0.001
Protein (g/day)	0.03	1.032(1.022,1.041)	43.97	<0.001
Fat (g/day)	0.04	1.038(1.027,1.050)	47.08	<0.001
Fibre (g/day)	0.11	1.119(1.072,1.169)	25.92	<0.001
SFA (g/day)	0.08	1.087(1.061, 1.113)	46.06	<0.001
MUFA (g/day)	0.09	1.092(1.063,1.121)	42.46	<0.001
PUFA (g/day)	0.19	1.214(1.144,1.289)	40.40	<0.001
Sodium, Na (mg/day)	0.00	1.000(1.000,1.001)	21.38	<0.001
Sugar (g/day)	0.01	1.009(1.001,1.016)	5.27	0.022
Calcium, Ca (mg/day)	0.002	1.002(1.001,1.003)	23.50	<0.001
Phosphate, P (mg/day)	0.001	1.001(1.001,1.002)	35.08	<0.001
Iron, Fe (mg/day)	0.02	1.018(1.000,1.037)	3.66	0.053
Potassium, K (mg/day)	0.001	1.001(1.001,1.001)	21.67	<0.001
Retinol (ug/day)	0.001	1.001(1.001,1.002)	16.22	<0.001
Carotene (ug/day)	0.00	1.000(1.000,1.000)	9.65	0.002
RE (ug/day)	0.001	1.001(1.001,1.001)	18.32	<0.001
B1 (mg/day)	1.05	2.844(1.774,4.561)	18.83	<0.001
B2 (mg/day)	0.87	2.395(1.738,3.300)	28.50	<0.001
Niacin (mg/day)	0.14	1.150(1.099,1,204)	36.70	<0.001
C (mg/day)	0.003	1.003(1.001,1.005)	6.08	0.014
FG1 white rice (g/day)	0.00	1.003(1.001,1.005)	12.83	<0.001
FG2 rice dishes (g/day)	0.00	1.000(0.998,1.003)	0.02	0.896
FG3 white bread (g/day)	0.00	1.004(0.997,1.012)	1.34	0.246
FG4 whole grains (g/day)	0.01	1.006(0.997,1.015)	1.51	0.219
FG5 bread with fillings (g/day)	0.01	1.014(0.991,1.037)	1.40	0.237
FG6 flatbread (g/day)	0.00	1.003(1.000,1.007)	3.19	0.074
FG7 biscuits (g/day)	0.04	1.036(1.012,1.059)	9.06	0.003
FG8 Noodles dishes (g/day)	0.00	1.002(1.000,1.004)	4.34	0.037
FG9 Meat (g/day)	0.01	1.006(0.999,1.012)	2.54	0.111
FG10 Poultry (g/day)	0.01	1.006(1.003,1.010)	10.78	0.001
FG11 Fish and seafood (g/day)	0.003	1.003(1.000,1.005)	4.71	0.030
FG12 Coconut based dishes (g/day)	0.01	1.008(1.003,1.012)	11.79	0.001
FG13 Egg and egg dishes (g/day)	0.01	1.014(1.005,1.023)	9.89	0.002
FG14 Dairy products (g/day)	0.002	1.002(1.000,1.005)	4.10	0.043
FG15 Legumes (g/day)	0.01	1.012(1.005,1.019)	12.60	<0.001
FG16 Green leafy vegetables (g/day)	0.002	1.002(0.999,1.005)	1.90	0.168
FG17 Cruciferous vegetables (g/day)	-0.002	0.998(0.992,1.005)	0.26	0.610
FG18 Other vegetables (pod and seed vegetables, root vegetables, marrow vegetables) (g/day)	0.00	1.001(0.998,1.004)	0.702	0.402
FG19 Potatoes (g/day)	0.01	1.014(1.004,1.024)	7.50	0.006
FG20 Fruits (g/day)	0.002	1.002(1.000,1.003)	5.69	0.017
FG21 Sweet local dessert	-0.001	0.999(0.993,1.005)	0.09	0.761
FG22 Savoury local dessert (g/day)	0.00	1.000(0.994,1.006)	0.01	0.943
FG23 Confectionary food (g/day)	0.01	1.013(0.996,1.031)	2.34	0.126
FG24 Fast foods and snacks (g/day)	0.02	1.017(1.006,1.029)	8.73	0.003
FG25 Seasoning sauce (g/day)	0.01	1.012(0.999,1.024)	3.41	0.065
FG26 Salted and processed foods (g/day)	0.02	1.022(1.010,1.035)	12.27	<0.001
FG27 Sugar sweetened beverages and carbonated drinks (g/day)	0.001	1.001(1.000,1.002)	3.10	0.078
FG28 Sweets (additional sugar) (g/day)	0.01	1.005(0.997,1.012)	1.53	0.217
FG29 Fat spreads (g/day)	0.14	1.147(1.068,1.233)	14.16	<0.001
FG30 Sweet bread spread (g/day)	0.06	1.063(1.013,1.116)	6.18	0.013
DP (z score) -High SFA, high sodium, high DED	0.25	1.286(1.061,1.558)	6.58	0.010
Race				
Chinese vs Malay	1.87	6.493(2.168,19.444)	11.17	0.001
Indian vs Malay	1.24	3.463(1.558,7.695)	9.29	0.002
Gender	1.01	2.748(1.796,4.206)	21.68	<0.001
Marital status	-1.09	0.338(0.203,0.561)	17.60	<0.001
Education level				
Diploma/STPM vs Degree & above	0.03	1.025(0.517,2.031)	0.01	0.944
SRP/SPM vs Degree & above	0.47	1.604(0.894,2.876)	2.51	0.113
Income status				
RM2501-3170 vs <RM2500	0.06	1.066(0.554, 2.050)	0.04	0.848
RM3171-3970 vs <RM2500	-0.88	0.414(0.213,0.802)	6.83	0.009
RM3971-4850 vs <RM2500	-1.30	0.273(0.117,0.636)	9.05	0.003
>RM4851 vs <RM2500	1.05	1.047(0.557,1.968)	0.20	0.887
Smoking status	1.20	3.313(2.023,5.426)	22.64	<0.001
Family history of CHD	0.87	2.391(1.531,3.733)	14.71	<0.001
Physical activity level				
Moderate vs Low	-0.08	0.921(0.513,1.654)	0.08	0.783
High vs Low	0.10	1.103(0.621,1.959)	0.11	0.737
Stress category				
Moderate vs Low	0.27	1.304(0.864,1.968)	1.59	0.207
High vs Low	-21.03	0.00(0.00)	0.00	1.00

Notes: Forward LR Multiple Logistic Regression model was applied; Multicollinearity and interaction term were checked and not detected; Hosmer-Lemeshow test, (p=0.581), classification table (overall correctly classified percentage=78.2%) and area under the ROC curve (86.9%) were applied to check the model fit; CHD = coronary heart disease; SFA = saturated fat; MUFA = monounsaturated fat; PUFA = polyunsaturated fat, FG = food group; DED = dietary energy density; SRP = Sijil Rendah Pelajaran; SPM = Sijil Pelajaran Malaysia; STPM = Sijil Tinggi Persekolahan Malaysia

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Table V: Associated factors of CHD by Multiple Logistic Regression (n=365)

Variable	Multiple Logistic Regression		
	b	Adjusted OR[a] (95% CI)	p-value
Age	0.04	1.043(1.009,1.078)	0.014
Smoking status			
Non smoker	0	1	-
Smoker	1.55	4.691(2.399,9.176)	<0.001
Family history of CHD			
No	0	1	-
Yes	1.00	2.705(1.496,4.891)	0.001
Race			
Malay	0	1	-
Chinese	2.36	10.619(2.255,49.995)	0.003
Indian	0.68	1.975(0.635,6.146)	0.240
Income status			
<RM2500	0	1	-
RM2501-3170	0.38	1.468(0.624,3.452)	0.379
RM3171-3970	-1.63	0.197(0.073,0.532)	0.001
RM3971-4850	-1.79	0.167(0.056,0.499)	0.001
>RM4851	-0.08	0.926(0.389,2.203)	0.862
Marital status			
Single	0	1	-
Married	-0.84	0.434(0.217,0.867)	0.018
Waist circumference (cm)	0.03	1.033(1.009,1.057)	0.007
HDL cholesterol (mmol/L)	-1.69	0.185(0.052,0.662)	0.009
Total fat intake (g/day)	0.04	1.035(1.021,1.050)	<0.001
Full cream dairy products (g/day)	0.00	1.004(1.001,1.008)	0.021

Notes: [a]Adjusted for total cholesterol, triglyceride, LDL cholesterol, systolic blood pressure, intake of energy, carbohydrate, protein, fiber, SFA, MUFA, PUFA, sodium, sugar, calcium, phosphorus, iron, potassium, retinol, carotene, RE, vitamin B1, vitamin B2, niacin, vitamin C, all food groups intake except dairy products, rice dishes, cruciferous vegetables, other vegetables, sweet local dessert, savoury local dessert, dietary pattern, gender and education level; Forward LR Multiple Logistic Regression model was applied; Multicollinearity and interaction term were checked and not detected; Hosmer-Lemeshow test, (p=0.581), classification table (overall correctly classified percentage=78.2%) and area under the ROC curve (86.9%) were applied to check the model fit; CHD = coronary heart disease; OR = odd ratio; CI = confidence interval; HDL = high- density cholesterol

CHD (AOR=1.033; 95% CI 1.009, 1.057; p=0.007). However, the chance of developing CHD decreases with increasing HDL cholesterol (AOR=0.185; 95% CI 0.052, 0.662; p=0.009). It was also found that an increases intake of 1g of total fat and 1g of full cream dairy products increased CHD risk (AOR= 1.035; 95% CI 1.021, 1.050; p<0.001)(1.004; 95% CI 1.001, 1.008; p=0.021), respectively.

DISCUSSION

The increasing prevalence and complications of CHD have caused a major economic burden on the health care system in Malaysia. Therefore, the present study investigated the predictors of CHD among the CHD group and the non-CHD group. Based on the result of the MLR analysis of this study, ten variables were identified as CHD determinants. Age, waist circumference, total fat intake, full cream dairy products, race, smoking status, and family history of CHD were positively associated with CHD, meanwhile, HDL cholesterol level, income status and marital status were inversely associated with CHD. Compared with our study, the findings from Framingham Study revealed that high blood pressure, high cholesterol level, smoking, obesity, diabetes, low physical activity, high triglyceride, low HDL level, age, sex and psychosocial issues were the major risk factors related to CHD (6).

In general, few findings from our study are very well-known associated factors that increase the risk of getting CHD. Our result tallied with data from the National Health and Nutrition Examination Survey 2015 to 2018, which showed that the prevalence of CHD increases with age for both men and women and the prevalence in the >80 years age group was the highest compared to other age groups (19). Moreover, the risk of CHD development increases with age including an age >45 years for men and >55 years for women (6). Evidence has proven that aging has been linked to increased oxidative stress, which leads to an increased proneness of functional and electrical abnormalities that might promote CVD (20).

We also found that smoker has 4.7 times higher odds compared to non-smoker to have CHD. This was supported by earlier studies which identified that smoking remained as the major risk factor for CHD (6,21,22). A systematic review and meta-analysis found that men who smoke about one cigarette each day had 48% of higher risk to develop heart disease than those who never smoke (23). There was evidence suggesting that heavy smoking tend to have other behavioural risk factor such as consuming less fruits and vegetables and drink more alcohol, particularly at risky levels (24). A study that was conducted in Perak, Malaysia showed that the HDL level among CHD patients were more reduced in smokers than former smokers and non-smokers, which revealed that cigarette smoking itself predisposed to higher risk of CHD development (25).

Moreover, we found that patients with a family history of CHD have higher odds to have CHD disease compared with patients without a family history of CHD in our study. This result is in line with the finding from a previous study, which revealed CHD incidence was significantly higher in those with a family history compared to those without (21). The relationship between CHD and family history could be explained by the complex interactions between genetic, environmental and behavioral factors (26). Therefore, incorporating family history as part of intervention strategies might help to prevent future CHD events.

Malaysia is a multi-ethnic country consisting of three main ethnic communities which are Malays, Chinese and Indians. In our study, the Chinese appeared to have a higher risk of getting CHD as compared to the Malay. This is contradicted with the finding from Malaysia

statistics in 2019 indicated that the Chinese had a lower CHD mortality rate which is 14.0% as compared to the Malay (14.5%) (4). The possible explanation for the differences in the findings might be due to the Chinese were more health-conscious compared to other ethnic groups. Others have shown that the Chinese were more likely to undergo medical check-ups and had the highest prevalence of treatment of hypertension (27,28). In addition, an epidemiological study showed that every ethnic group living in the same area have different cardio-metabolic risk factors which lead to different incident and prevalence among them (29). However, the pathophysiology that causes differences in risk factors between ethnicity is still unclear. Differences in dietary, lifestyle and cultural factors might influence the difference in CHD risk between the ethnic groups.

Besides, our study found that the middle-income group has a lower risk of CHD compared to the participants in the lowest income group. In agreement, a previous study suggested that people from the lower social classes were at greater CHD risk than higher social classes (30). There was a strong association between socioeconomic status and CHD, especially through their dietary intake. Data suggested that low-income families purchased more low-cost items and unhealthy food which contain higher saturated fats and sugars, and less healthy food such as fruits, fish or lean meat (31). Moreover, an earlier study indicated that low-income people would rather spend on inexpensive staples food such as rice and bread than buying non-staples food such as fruits and vegetables. However, this dietary pattern reduces the intake of micronutrients which are essential for health and heart protection (32).

A married person was found to have a lower risk of getting CHD compared with a single or unmarried individual in our study. This finding was supported by a previous systematic review which revealed that unmarried persons had a slight increase in the odds of developing CHD (33). This might be linked with the benefit of social support obtained from the partner and family on the overall wellbeing mainly the quality of life which prevents psychosocial health problems such as depression and stress. Besides, having a good spouse may encourage them to practice a healthy lifestyle including dietary intake and physical activity which improves cardiovascular health (34). In contrast, another study found that an unmarried person was prone to be nonadherent to medication and was two times higher risk of getting a cardiac event as compared to married person (35).

Waist circumference is a better indicator for abdominal obesity than waist-hip ratio (36). This study showed that waist circumference is positively associated with CHD. The findings are directly in line with previous findings which demonstrated that waist circumference was associated with increased morbidity and mortality of CHD (37,38). The causal relationship between waist circumference remained unclear, however, the association between waist circumference and other risk factors such as hypertension, diabetes, high cholesterol, smoking status and low physical activity might indirectly increase CHD risk (39).

HDL-cholesterol level is one of the established risk factors of CHD and it is considered as 'good cholesterol' for its protective role against atherosclerosis and is well known to be inversely correlated with CHD risk (6,40). An inverse relationship between HDL cholesterol and CHD shown from this study seems to be consistent with other research that found adults with low HDL-C and high TG had a 1.32-fold greater hazard ratio for CHD compared with people with normal TG and normal HDL levels (41). In addition, a study revealed that isolated low HDL-C with the absence of any associated other lipids abnormality, had 20% additional risk of getting CHD than in those with normal HDL-C level, and isolated low level of HDL-C is a phenotype that most frequently occur among Asian populations, which might be due to the variations in diet, alcohol consumption and physical activity (42).

Another important finding from this study is that total fat intake was positively associated with CHD. Although this result differs from a previous meta-analysis of cohort studies that suggested total fat was not associated with CHD (43), however, our result is in agreement with a finding from another study that revealed total fat, SFA, and MUFA intake were the strong predictors of CHD mortality in American Indians aged 47-59 years old (44). Additionally, a recent study demonstrated the correlation between high fat intake with increase total cholesterol levels in CHD patients (45). Moreover, Wang et al. (2020) reported that increased fat intake was positively associated with body weight, BMI, risk of overweight and obesity (46). Notably, obesity has been associated with atherosclerosis and CHD and it might lead to structural and functional changes of the heart, which causes heart failure (47).

Interestingly, our findings also revealed a positive association between full cream dairy products with increased CVD risk. The potential reason is linked to the content of SFA as the major source of fatty acids in full cream milk and LDL cholesterol which is responsible for atherosclerosis in CHD (48). However, a previous study showed a contrary result in which, milk and dairy products intake was inversely associated with CVD mortality among women in Japan (49). Meanwhile, another study reviewed that total dairy intake had no significant association with CHD (50). Thus, further large-scale epidemiologic studies indicating the true association between full cream dairy products and CHD risk are warranted.

This study had several limitations. Firstly, this study

was a hospital and health clinic-based study, thus the patients might not be representative of the general population. Secondly, the sample size of this study was considerably small and our study population was not evenly distributed among all ethnicities which has limited our findings. Another limitation of this study was the participants' ability to accurately recall their food intake in FFQ which might increase the risk of bias, under-or misreporting. The risk of recall bias and underreporting has been minimised through interview sessions by the trained researchers using FFQ. Nevertheless, this study added to the evidence on risk factors associated with CHD among Malaysian population. This study involved every region of Malaysia to truly represent Malaysian adult population. Future prospective longitudinal studies are required to determine the actual causes of CHD among Malaysian population.

CONCLUSION

In conclusion, this study identified ten risk factors of CHD among Malaysian population. Age, waist circumference, total fat intake, full cream dairy products, race, smoking status, family history of CHD were positively associated with CHD, meanwhile, HDL cholesterol level, income status and marital status were inversely associated with CHD. It is important to create awareness and provide education about the importance of healthy lifestyle among the public to reduce the individual risk of developing CHD. However, the findings should be interpreted with cautions due to many limitations. Regardless, future longitudinal studies using larger sample size could fruitfully explore actual risk factors that may contribute to CHD.

ACKNOWLEDGEMENT

We would like to express our gratitude to all participants, enumerators and Ministry of Health staffs for their valuable contribution to this study. The result of this study has been published at a conference. This article was supported by a research grant (UniSZA/2017/SRGS/13) Universiti Sultan Zainal Abidin.

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