

RESEARCH ARTICLE

Open Access

Cardiovascular disease risk factors and socioeconomic variables in a nation undergoing epidemiologic transition

Rajah Rasiah^{1*}, Khalid Yusoff², Amiri Mohammadreza¹, Rishya Manikam³, Makmor Tumin¹, Sankara Kumar Chandrasekaran³, Shabnam Khademi¹ and Najmin Abu Bakar²

Abstract

Background: Cardiovascular disease (CVD) related deaths is not only the prime cause of mortality in the world, it has also continued to increase in the low and middle income countries. Hence, this study examines the relationship between CVD risk factors and socioeconomic variables in Malaysia, which is a rapidly growing middle income nation undergoing epidemiologic transition.

Methods: Using data from 11,959 adults aged 30 years and above, and living in urban and rural areas between 2007 and 2010, this study attempts to examine the prevalence of CVD risk factors, and the association between these factors, and socioeconomic and demographic variables in Malaysia. The socioeconomic and demographic, and anthropometric data was obtained with blood pressure and fasting venous blood for glucose and lipids through a community-based survey.

Results: The association between CVD risk factors, and education and income was mixed. There was a negative association between smoking and hypertension, and education and income. The association between diabetes, hypercholesterolemia and being overweight with education and income was not clear. More men than women smoked in all education and income groups. The remaining consistent results show that the relationship between smoking, and education and income was obvious and inverse among Malays, others, rural women, Western Peninsular Malaysia (WPM) and Eastern Peninsular Malaysia (EPM). Urban men showed higher prevalence of being overweight than rural men in all education and income categories. Except for those with no education more rural men smoked than urban men. Also, Malay men in all education and income categories showed the highest prevalence of smoking among the ethnic groups.

Conclusions: The association between CVD risk factors and socioeconomic variables should be considered when formulating programmes to reduce morbidity and mortality rates in low and middle income countries. While general awareness programmes should be targeted at all, specific ones should be focused on vulnerable groups, such as, men and rural inhabitants for smoking, Malays for hypertension and hypercholesterolemia, and Indians and Malays, and respondents from EPM for diabetes.

Keywords: Cardiovascular disease risk factors, Education, Income, Malaysia

* Correspondence: rajah@um.edu.my

¹Faculty of Economics and Administration, University of Malaya, 50603 Kuala Lumpur, Malaysia

Full list of author information is available at the end of the article

Background

Cardiovascular disease (CVD) is the main cause of death in the world [1-5]. However, whereas the adult CVD death rate in developed economies has declined since the 1970s [1] it has risen in the low and middle income countries [1]. Low and middle income countries contributed the highest percentage of CVD deaths worldwide, which rose from 14.4 million in 1990 to 16.5 million in 2005 [1]. In Malaysia, which was ranked as a middle income country in 2010 [6], in-hospital CVD deaths shot up from 15.7% in 2006 to 25.4% in 2009 [7,8]. The prevalence of CVD risk factors in Malaysia have also risen: the rates of diabetes, hypertension and hypercholesterolemia rose from 8.3%, 33.0% and 5.0% respectively, in 1996 to 14.9%, 42.6% and 24.0% respectively, in 2006 [7,8].

Data from the developed countries show an inverse relationship between socio-economic status (SES), and CVD risk factors of smoking [9-13], high blood pressure [11,14-17] and overweight [11,13,14]. However, past findings on Malaysia are mixed [18-24]. This study provides current evidence on the relationship between prevalence of CVD risk factors and SES variables in Malaysia. In addition, this study for the first time examines the respondents by three regional classifications, Western Peninsular Malaysia (WPM), Eastern Peninsular Malaysia (EPM and East Malaysia (EM). The advantage of this study over past studies on multiple CVD risk factors on Malaysia are, one, the sample is much larger than many other studies [21,22], two, it has a much wider geographical coverage than many other studies [19,25-27], and three, it examines more CVD risk factors than several studies [25,26,28,29].

Methods

The prevalence of CVD risk factors was derived from a community-based health survey on 11,959 adult volunteers (aged ≥ 30 years) conducted by the REDISCOVER Study team in 2007–2010. Of this number we were able to obtain complete income data only from 7,135 respondents, and hence, the analysis is based on this number. Part of the data contributed to the Prospective Urban Rural Epidemiological (PURE) study [30,31]. Volunteers were invited to attend community centres in a fasting state where demographic and anthropometric data and blood pressures, as well as, venous blood for glucose and lipid readings were screened and recorded. The community centres were from Selangor (5), Kuala Lumpur (3) and Negri Sembilan (2), all of which are urbanized and located in WPM, and from the EPM states of Pahang (4) and Kelantan (4), and the EM state of Sabah (1). The respondents gave a written consent to participate at recruitment into the study, which was approved by the institutional research ethics committee. To attract significant participation in the community survey, the

REDISCOVER team pledged to monitor their CVD risk factors over the period 2007–2016. It is for these reasons the ethnic breakdown of the sample of 71.4% Malays, 10.5% Chinese, 2.9% Indians and 15.2% others (includes non-Malay natives and other Malaysians not classified among Malays, Chinese and Indians) differs from the ethnic breakdown of the 2010 national population of, 55.1% Malays, 24.6% Chinese, 7.3% Indians and 13.0% others [32]. Given that the survey involves health screening during the study, and the large size of the sample, we believe the sample is sufficiently robust for meaningful interpretation of the results. In doing so we followed the same sampling procedure used by Yusof et al. [30].

The prevalence rates were age-adjusted using 2010 standard Malaysian population, and income was inflation adjusted using the consumer price index for the years 2007–2010. We used the jack-knifed approach by writing a module in SPSS 20 to avert biased estimates of standard errors (SEs) [33-35]. Weighted standard deviation was employed to derive the distribution of the variables. The number of observations of each CVD risk factors varies because of missing responses.

Hypercholesterolemia is defined as fasting total plasma cholesterol of ≥ 5.2 mmol/L [10], regular smokers if they smoked at least one cigarette a day [11], and hypertensive if their blood pressures were $\geq 140/90$ mmHg or were on anti-hypertensive medications or aware of being hypertensive [11,17,36,37]. Blood pressure was taken twice, and the mean value was used. The measurement of blood pressure was standardized across the sample. A body mass index (BMI, kg/m²) of 25.0 or more was considered as overweight [38-40]. Diabetes is diagnosed when fasting glucose was ≥ 126 mg/dL (or 7.0 mmol/L) [41,42]. Although the BMI thresholds vary with different ethnic groups [41], we did not take different BMI thresholds for each of them because it would complicate the inter-ethnic statistical comparison, and also because past studies on Malaysia have used the same thresholds as defined by the Ministry of Health of Malaysia [25,26,28,29].

Education was grouped into the categories of no education, primary, secondary, technical and university education. Income levels were classified as low, middle and high according to annual incomes of \leq MYR10,000, $>$ MYR10,000-MYR50,000, and $>$ MYR50,000 per annum [43,44]. Income was not adjusted for inflation because of the low increase in the consumer price index in Malaysia during the period 2007–2010. The participants were also classified according to the age-groups of 30–39, 40–49, 50–59, 60–69, ≥ 70 to obtain the most efficient jackknifed estimates. Ethnically, the participants were grouped into Malays, Chinese, Indians and others. The WPM states were more urbanized than EPM and EM [43,45]. We excluded the technically educated when examining the relationship between CVD risk factors and

education because they are of the same level as secondary education. While the sample details of each CVD risk factor are shown in Table 1, the sample details by education and income are shown in Tables 2 and 3.

Results and discussion

The association between CVD risk factors, and education and income was clear only with smoking and hypertension, and it was negative, which is consistent with most findings [9-12,21,22]. Also, more men smoked than women in all education and income categories, which is consistent with the findings on Malaysia [21,22]. The relationship between hypertension and age was positive among women in all education groups, but was only positive among men in the university, secondary and primary groups. Also, there was a positive association between hypertension and age among men and women in all income groups.

Education

The prevalence of CVD risk factors by education varied considerably (Table 4). In both sexes, the prevalence of hypertension was highest among those without education (men 60%, $p < 0.001$; women 56%, $p < 0.001$) followed by primary education (men 58%, $p < 0.001$; women 53%, $p < 0.001$), which is consistent with some findings on Malaysia [21,22]. The prevalence of diabetes in women was lower than in men. Men had higher prevalence of diabetes than women among the university, technical and secondary educated. The prevalence was similar among those with primary education, while the no education group showed the highest prevalence. Men showed higher prevalence of hypercholesterolemia than women in the

university and technical education groups. Whereas the prevalence among men and women was the same in the secondary education group, women showed higher prevalence among the primary and no education groups. Among men, the prevalence of hypercholesterolemia was highest in the secondary education (71%, $p < 0.001$) group and lowest in the no education (53%, $p < 0.001$) group. The prevalence of smoking was high among men in all categories, which is consistent with the findings from several countries [23,24,46-48]. The highest prevalence of smoking was found among men with primary or no education. The prevalence of being overweight among men was highest in the secondary (34%, $p < 0.001$), technical (34%, $p < 0.001$) and university education (34%, $p < 0.001$) groups. It was lowest among men with no education followed by primary education. The prevalence of being overweight among women was highest in the secondary (42%, $p < 0.001$) followed by the primary (35%, $p < 0.001$) education groups.

The prevalence of smoking in men was significantly higher than women in all education groups (Table 5). Also, the less educated groups showed higher prevalence of smoking than the most educated group, which corroborated with previous findings on Malaysia [23,24]. The highest prevalence of smoking was found among men with technical education in the age group of 30–39 (83%, $p < 0.001$). However, the relationship between smoking and education by ethnicity was only obvious among Malay and other ethnic groups, and it was inverse. Malay men showed the highest prevalence of smoking in all education groups, which corroborated with previous study [21]. Malays with technical education showed the highest prevalence (45%, $p < 0.001$). The relationship between smoking and education was negative among rural women. Except for respondents with no education, rural men showed higher prevalence of smoking than urban men. Also, rural women showed either higher than or equal prevalence with urban women in all education categories. The relationship between smoking and education was only clear among women in WPM and EPM, and it was inverse. Also, there was not much difference in the prevalence of smoking among the three regions in men with university, secondary and primary education. However, the prevalence of smoking was much higher among men in WPM (58%, $p < 0.001$) and EPM (57%, $p < 0.001$) than men in EM (25%, $p < 0.1$) in the technical education group. Whereas there was not much difference in the prevalence levels of women with university, secondary and primary education in the three regions, EPM showed significantly higher prevalence levels than the other regions among women with technical (13%, $p < 0.001$) and no education (17%, $p < 0.001$).

Although past studies on Malaysia showed an inverse association between hypertension and education [21,22],

Table 1 Number of men and women in sample by CVD risk factors

Risk factors	Responses	Men	Women
Hypertension*	No	2728	3969
	Yes	2509	2753
Diabetes+	No	4157	5600
	Yes	1080	1122
Hypercholesterolemia δ	No	1684	2092
	Yes	3553	4630
Regular Smoker θ	No	2451	5985
	Yes	2789	737
Overweight ψ	No	3752	4400
	Yes	1485	2322

Note:

*Mean SBP (Systolic Blood Pressure) \geq 140 mm Hg or Mean DBP (Diastolic Blood Pressure) \geq 90 mm Hg or using medication.

+Mean plasma glucose \geq 126 mg/dL or 7.0 mmol/Lit.

δ Mean Plasma cholesterol \geq 5.2 mmol/Lit.

θ Smokes at least one cigarette per day.

ψ BMI (Body Mass Index) \geq 25.0.

Table 2 Number of men and women in sample by education level, gender, age, ethnicity and location

Age/Ethnicity/ Location/Region	Men					Women				
	University	Technical	Secondary	Primary	None	University	Technical	Secondary	Primary	None
30 – 39	136	23	190	35	7	191	14	403	101	37
40 – 49	325	49	584	191	68	389	27	984	357	138
50 – 59	323	35	581	451	122	269	20	711	578	332
60 – 69	146	12	280	451	155	50	9	204	405	336
≥ 70	16	9	62	171	179	7	10	22	85	250
Malay	725	108	1305	1015	266	710	45	1835	1138	572
Chinese	171	17	190	58	24	185	28	274	99	54
Indian	51	7	52	14	9	53	4	66	25	17
Others	23	3	173	214	227	25	4	191	263	447
Urban	867	103	961	357	112	867	64	1361	452	219
Rural	104	32	760	942	422	107	17	1010	1072	876
WPM	616	92	1017	580	224	559	45	1365	699	518
EPM	272	35	551	496	216	145	16	504	440	434
EM	83	8	153	225	94	270	20	502	389	1689

our results showed a lack of association between them (Table 6), which nonetheless is consistent with some studies on other countries [45,49]. While there was no association between ethnicity and education by ethnicity among men, it was clear and inverse among women. The prevalence of hypertension was highest among other women with technical education (46%, $p > 0.1$) followed by Indian women with no (44%, $p < 0.001$), and technical (39%, $p < 0.05$) and primary (32%, $p < 0.001$) education. While there was no association between education and hypertension among urban and rural men, it

was inverse among urban women. Apart for differences among women with primary education, there were no other major rural–urban differences in the prevalence of hypertension. Urban women with primary education (42%, $p < 0.001$) followed by urban (35%, $p < 0.001$) and rural (35%, $p < 0.001$) women with no education showed the highest prevalence of hypertension. Among the three regions, the relationship between hypertension and education was clear and inverse only among women in WPM and EPM. Men from EM had higher prevalence of hypertension than men from WPM and EPM and in the university, technical and secondary education groups, while men with primary or no education from EPM had higher prevalence of hypertension than men from WPM and EM. Women with technical, secondary, primary and no education in EPM had the highest prevalence of hypertension among women. However, WPM (23%, $p < 0.001$) and EM (23%, $p < 0.001$) showed the highest prevalence of hypertension among university educated women.

An important past study showed that the relationship between diabetes and education was inverse among women, but the middle income group showed the highest prevalence among men in Malaysia [22]. However, our results show that there was no association between diabetes and education (Table 7). Also, the association between age and diabetes was only positive among women in the secondary education group. While the relationship between education and diabetes by ethnicity was positive among the Malay, Chinese and Indian women, it was not obvious among other women, and among men in all ethnic groups. The prevalence of diabetes was highest among Indian men with technical education (26%, $p < 0.1$) followed by Indian women with no education (20%, $p < 0.05$), and Indian

Table 3 Number of men and women in sample by income level, gender, age, ethnicity and location

Age/Ethnicity/ Location/Region	Men			Women		
	Low	Middle	High	Low	Middle	High
30 – 39	105	125	45	225	159	59
40 – 49	430	415	153	621	418	207
50 – 59	586	345	179	698	271	154
60 – 69	585	150	37	442	84	25
≥ 70	152	17	3	87	7	10
Malay	1379	890	305	1463	758	345
Chinese	26	70	78	23	98	68
Indian	9	38	28	17	37	26
Others	448	57	8	574	54	5
Urban	393	648	383	433	612	419
Rural	1474	408	36	1652	336	26
WPM	987	667	280	897	508	245
EPM	590	269	90	622	176	43
EM	290	120	49	566	264	157

Table 4 Age-adjusted percentage of men and women having CVD risk factors by education level

CVD risk factors	Men					Women				
	University	Technical	Secondary	Primary	None	University	Technical	Secondary	Primary	None
Hypertension*	42 (0.001)	40 (0.001)	47 (0.001)	58 (0.001)	60 (0.001)	27 (0.001)	31 (0.001)	39 (0.001)	53 (0.001)	56 (0.001)
Diabetes+	16 (0.001)	18 (0.001)	22 (0.001)	20 (0.001)	15 (0.001)	9 (0.001)	8 (0.01)	17 (0.001)	20 (0.001)	17 (0.001)
Hypercholesterolemia δ	69 (0.001)	70 (0.001)	71 (0.001)	69 (0.001)	53 (0.001)	68 (0.001)	63 (0.001)	71 (0.001)	74 (0.001)	68 (0.001)
Smoker θ	42 (0.001)	52 (0.001)	48 (0.001)	55 (0.001)	55 (0.001)	3 (0.001)	6 (0.05)	4 (0.001)	6 (0.001)	16 (0.001)
Overweight ψ	34 (0.001)	34 (0.001)	34 (0.001)	24 (0.001)	13 (0.001)	35 (0.001)	18 (0.001)	42 (0.001)	41 (0.001)	19 (0.001)

Note: Figures in parentheses refer to p-values.

*Mean SBP (Systolic Blood Pressure) \geq 140 mm Hg or Mean DBP (Diastolic Blood Pressure) \geq 90 mm Hg or using medication

+Mean plasma glucose \geq 126 mg/dL or 7.0 mmol/Lit;

δ Mean Plasma cholesterol \geq 5.2 mmol/Lit;

θ Smokes at least one cigarette per day;

ψ BMI (Body Mass Index) \geq 25.0.

women with primary education (18%, $p < 0.01$). The relationship between diabetes and education by location was significant among men and women but it was positive in the former and negative in the latter. Urban men had the highest prevalence of diabetes among respondents with primary (12%, $p < 0.001$) and no (7%, $p < 0.001$) education. However, rural men had higher prevalence among university, technical and primary categories, and rural women showed higher prevalence in the university, technical and secondary categories, though all the prevalence levels were low. There was no association between education and diabetes among men and women in the three regions. However, EPM had the highest prevalence of diabetes among men in the education categories of secondary and no education, and among women in all categories except for university education. EM (27%, $p < 0.001$) had the highest prevalence among men with primary education.

There was no clear relationship between hypercholesterolemia, and education and gender (Table 8), which adds to the past literature reporting varied findings from other countries [2-5,9-11,13,39,50]. However, our results show that the relationship between hypercholesterolemia and education by ethnicity was negative among Malay, Chinese and Indian women but positive among Chinese and other men. Also, our study showed that Malay men in all education categories had the highest prevalence of hypercholesterolemia, which is consistent with some findings on Malaysia and Singapore [51,52]. The highest prevalence was found in the technical education group (69%, $p < 0.001$). Women with no education had the highest prevalence of hypercholesterolemia in all ethnic groups. Malay women (55%, $p < 0.001$) showed the highest prevalence of hypercholesterolemia followed by Indian women (51%, $p < 0.001$). The relationship between

Table 5 Age-adjusted percentage of men and women smoking by education, gender, ethnicity and location

Age/Ethnicity/ Location/Region	Men					Women				
	University	Technical	Secondary	Primary	None	University	Technical	Secondary	Primary	None
30 – 39	48 (0.001)	83 (0.001)	62 (0.001)	63 (0.001)	57 (0.05)	3 (0.001)	7 (0.1)	4 (0.001)	7 (0.01)	8 (0.1)
40 – 49	44 (0.001)	43 (0.001)	53 (0.001)	56 (0.001)	50 (0.001)	2 (0.001)	7 (0.001)	3 (0.001)	4 (0.001)	9 (0.001)
50 – 59	38 (0.001)	51 (0.001)	46 (0.001)	54 (0.001)	52 (0.001)	3 (0.001)	10 (0.1)	4 (0.001)	5 (0.001)	15 (0.001)
60 – 69	41 (0.001)	33 (0.05)	45 (0.001)	55 (0.001)	55 (0.001)	6 (0.001)	5 (0.001)	4 (0.001)	3 (0.001)	17 (0.001)
\geq 70	50 (0.001)	51 (0.1)	44 (0.001)	54 (0.001)	54 (0.001)	10 (0.001)	5 (0.001)	9 (0.001)	18 (0.001)	18 (0.001)
Malay	24 (0.001)	45 (0.001)	23 (0.001)	28 (0.001)	20 (0.001)	1 (0.001)	1 (0.1)	1 (0.001)	2 (0.001)	7 (0.001)
Chinese	11 (0.001)	8 (0.05)	15 (0.001)	14 (0.001)	15 (0.001)	3 (0.001)	8 (0.05)	5 (0.001)	1 (0.001)	2 (0.1)
Indian	14 (0.001)	14 (0.001)	14 (0.001)	15 (0.001)	14 (0.001)	2 (0.001)	0 (0.05)	3 (0.001)	2 (0.001)	11 (0.1)
Others	18 (0.001)	14 (0.1)	18 (0.001)	20 (0.001)	16 (0.001)	0 (0.001)	0 (0.05)	3 (0.001)	8 (0.001)	15 (0.001)
Urban	31 (0.001)	33 (0.001)	30 (0.001)	32 (0.001)	31 (0.001)	1 (0.001)	2 (0.05)	2 (0.001)	1 (0.001)	5 (0.001)
Rural	35 (0.001)	37 (0.001)	34 (0.001)	38 (0.001)	27 (0.001)	1 (0.001)	4 (0.05)	2 (0.001)	3 (0.001)	12 (0.001)
WPM	41 (0.001)	58 (0.001)	51 (0.001)	55 (0.001)	20 (0.001)	3 (0.001)	11 (0.01)	4 (0.001)	6 (0.001)	15 (0.001)
EPM	42 (0.001)	57 (0.001)	49 (0.001)	54 (0.001)	23 (0.001)	4 (0.001)	13 (0.001)	4 (0.001)	5 (0.001)	17 (0.001)
EM	43 (0.001)	25 (0.1)	48 (0.001)	57 (0.001)	24 (0.001)	2 (0.001)	5 (0.1)	4 (0.001)	3 (0.001)	12 (0.001)

Note: Figures in parentheses refer to p-values.

Table 6 Age-adjusted percentage of men and women having hypertension by education, gender, ethnicity and location

Age/Ethnicity/ Location/Region	Men					Women				
	University	Technical	Secondary	Primary	None	University	Technical	Secondary	Primary	None
30 – 39	19 (0.001)	17 (0.05)	24 (0.001)	26 (0.01)	43 (0.1)	8 (0.001)	7 (0.1)	19 (0.001)	20 (0.001)	14 (0.001)
40 – 49	33 (0.001)	43 (0.001)	34 (0.001)	39 (0.001)	46 (0.001)	19 (0.001)	19 (0.05)	33 (0.001)	34 (0.001)	30 (0.001)
50 – 59	46 (0.001)	37 (0.001)	38 (0.001)	47 (0.001)	42 (0.001)	38 (0.001)	25 (0.05)	41 (0.001)	51 (0.001)	46 (0.001)
60 – 69	51 (0.001)	67 (0.05)	56 (0.001)	63 (0.001)	56 (0.001)	40 (0.001)	56 (0.05)	56 (0.001)	62 (0.001)	56 (0.001)
≥ 70	63 (0.001)	65 (0.001)	71 (0.001)	69 (0.001)	69 (0.001)	57 (0.05)	60 (0.1)	59 (0.001)	62 (0.001)	66 (0.001)
Malay	22 (0.001)	34 (0.001)	19 (0.001)	37 (0.001)	19 (0.001)	11 (0.001)	6 (0.05)	20 (0.001)	27 (0.001)	42 (0.001)
Chinese	16 (0.001)	23 (0.001)	21 (0.001)	35 (0.001)	14 (0.001)	12 (0.001)	7 (0.1)	26 (0.001)	35 (0.001)	36 (0.001)
Indian	15 (0.001)	36 (0.05)	18 (0.001)	20 (0.01)	10 (0.1)	8 (0.01)	39 (0.05)	19 (0.001)	32 (0.001)	44 (30.001)
Others	15 (0.01)	20 (0.001)	21 (0.001)	24 (0.001)	20 (0.001)	8 (0.05)	46 (0.1)	16 (0.001)	19 (0.001)	30 (0.001)
Urban	20 (0.001)	24 (0.001)	19 (0.001)	24 (0.001)	19 (0.001)	11 (0.001)	9 (0.001)	20 (0.001)	42 (0.001)	35 (0.001)
Rural	20 (0.001)	22 (0.001)	19 (0.001)	27 (0.001)	19 (0.001)	11 (0.001)	10 (0.001)	21 (0.001)	26 (0.001)	35 (0.001)
WPM	35 (0.001)	32 (0.001)	37 (0.001)	48 (0.001)	19 (0.001)	23 (0.001)	22 (0.001)	35 (0.001)	46 (0.001)	49 (0.001)
EPM	40 (0.001)	40 (0.001)	49 (0.001)	58 (0.001)	26 (0.001)	17 (0.001)	31 (0.05)	36 (0.001)	54 (0.001)	57 (0.001)
EM	49 (0.001)	75 (0.05)	50 (0.001)	57 (0.001)	25 (0.001)	23 (0.001)	15 (0.1)	32 (0.001)	47 (0.001)	40 (0.001)

Note: Figures in parentheses refer to p-values.

hypercholesterolemia and education was negative among rural women. Urban women had higher hypercholesterolemia than rural women in all education categories. The highest prevalence of hypercholesterolemia was recorded by urban women with no education (52%, $p < 0.001$), and in men among the technically educated (41%, $p < 0.001$). Among the three regions, the relationship between hypercholesterolemia and education was clear only among men (positive) in WPM and women (negative) in EM. EPM

showed the highest prevalence of hypercholesterolemia among men in the technical (74%, $p < 0.001$) and secondary (73%, $p < 0.001$) education groups, and among women in the no (67%, $p < 0.001$) education group. EM showed the highest prevalence among men in the university (72%, $p < 0.001$), primary (75%, $p < 0.001$) and no education (28%, $p < 0.001$) groups. WPM showed the highest prevalence among women with technical (60%, $p < 0.001$) and secondary (72%, $p < 0.001$) education.

Table 7 Age-adjusted percentage of men and women having diabetes by education, gender, ethnicity and location

Age/Ethnicity/ Location/Region	Men					Women				
	University	Technical	Secondary	Primary	None	University	Technical	Secondary	Primary	None
30 – 39	15 (0.001)	26 (0.05)	21 (0.01)	23 (0.001)	14 (0.1)	7 (0.001)	14 (0.1)	14 (0.001)	23 (0.001)	11 (0.05)
40 – 49	15 (0.001)	18 (0.001)	18 (0.001)	18 (0.001)	13 (0.01)	7 (0.001)	7 (0.1)	14 (0.001)	17 (0.001)	14 (0.001)
50 – 59	14 (0.001)	9 (0.1)	24 (0.001)	21 (0.001)	20 (0.001)	12 (0.001)	5 (0.1)	16 (0.001)	22 (0.001)	14 (0.001)
60 – 69	21 (0.001)	8 (0.1)	22 (0.001)	20 (0.001)	15 (0.001)	10 (0.05)	11 (0.1)	24 (0.001)	20 (0.001)	19 (0.001)
≥ 70	13 (0.1)	25 (0.1)	24 (0.001)	22 (0.001)	13 (0.001)	20 (0.001)	23 (0.1)	27 (0.05)	18 (0.001)	18 (0.001)
Malay	9 (0.001)	24 (0.001)	10 (0.001)	10 (0.001)	5 (0.001)	5 (0.001)	2 (0.1)	10 (0.001)	11 (0.001)	12 (0.001)
Chinese	6 (0.001)	6 (0.001)	6 (0.001)	7 (0.001)	7 (0.05)	1 (0.05)	5 (0.1)	4 (0.001)	6 (0.01)	8 (0.05)
Indian	8 (0.01)	26 (0.1)	15 (0.001)	16 (0.05)	3 (0.1)	4 (0.05)	9 (0.1)	7 (0.01)	18 (0.01)	20 (0.05)
Others	10 (0.05)	9 (0.001)	10 (0.001)	8 (0.001)	6 (0.001)	6 (0.1)	12 (0.1)	12 (0.001)	11 (0.001)	11 (0.001)
Urban	8 (0.001)	10 (0.001)	9 (0.001)	12 (0.001)	7 (0.001)	4 (0.001)	3 (0.05)	9 (0.001)	12 (0.001)	12 (0.001)
Rural	9 (0.001)	12 (0.001)	9 (0.001)	9 (0.001)	5 (0.001)	8 (0.001)	5 (0.05)	10 (0.001)	10 (0.001)	11 (0.001)
WPM	16 (0.001)	17 (0.001)	20 (0.001)	19 (0.001)	6 (0.001)	8 (0.001)	2 (0.1)	15 (0.001)	20 (0.001)	15 (0.001)
EPM	17 (0.001)	17 (0.05)	23 (0.001)	19 (0.001)	8 (0.001)	8 (0.001)	31 (0.01)	18 (0.001)	21 (0.001)	20 (0.001)
EM	12 (0.001)	13 (0.1)	22 (0.001)	27 (0.001)	3 (0.05)	8 (0.001)	5 (0.1)	15 (0.001)	18 (0.001)	10 (0.001)

Note: Figures in parentheses refer to p-values.

Table 8 Age-adjusted percentage of men and women having hypercholesterolemia by education, gender, ethnicity and location

Age/Ethnicity/ Location/Region	Men					Women				
	University	Technical	Secondary	Primary	None	University	Technical	Secondary	Primary	None
30 – 39	74 (0.001)	70 (0.001)	69 (0.001)	57 (0.001)	29 (0.001)	57 (0.001)	36 (0.05)	61 (0.001)	54 (0.001)	51 (0.001)
40 – 49	72 (0.001)	61 (0.001)	73 (0.001)	65 (0.001)	62 (0.1)	63 (0.001)	67 (0.001)	67 (0.001)	61 (0.001)	57 (0.001)
50 – 59	77 (0.001)	77 (0.001)	72 (0.001)	67 (0.001)	52 (0.001)	76 (0.001)	70 (0.001)	77 (0.001)	76 (0.001)	62 (0.001)
60 – 69	61 (0.001)	67 (0.01)	69 (0.001)	71 (0.001)	54 (0.001)	82 (0.001)	78 (0.01)	74 (0.001)	77 (0.001)	72 (0.001)
≥ 70	38 (0.05)	65 (0.1)	73 (0.001)	70 (0.001)	52 (0.001)	57 (0.05)	60 (0.001)	82 (0.001)	80 (0.001)	70 (0.001)
Malay	38 (0.001)	69 (0.001)	33 (0.001)	36 (0.001)	22 (0.001)	33 (0.001)	16 (0.001)	41 (0.001)	41 (0.001)	55 (0.001)
Chinese	32 (0.001)	23 (0.001)	26 (0.001)	24 (0.001)	15 (0.001)	33 (0.001)	41 (0.001)	39 (0.001)	41 (0.001)	42 (0.001)
Indian	27 (0.001)	34 (0.01)	22 (0.001)	27 (0.001)	17 (0.01)	33 (0.001)	39 (0.05)	34 (0.001)	35 (0.001)	51 (0.001)
Others	34 (0.001)	25 (0.001)	23 (0.001)	20 (0.001)	13 (0.001)	15 (0.01)	14 (0.1)	27 (0.001)	26 (0.001)	33 (0.001)
Urban	36 (0.001)	41 (0.001)	31 (0.001)	32 (0.001)	23 (0.001)	32 (0.001)	24 (0.001)	42 (0.001)	41 (0.001)	52 (0.001)
Rural	39 (0.001)	40 (0.001)	31 (0.001)	32 (0.001)	16 (0.001)	32 (0.001)	15 (0.001)	37 (0.001)	37 (0.001)	43 (0.001)
WPM	71 (0.001)	63 (0.001)	71 (0.001)	64 (0.001)	21 (0.001)	67 (0.001)	60 (0.001)	72 (0.001)	70 (0.001)	65 (0.001)
EPM	71 (0.001)	74 (0.001)	73 (0.001)	70 (0.001)	21 (0.001)	63 (0.001)	56 (0.01)	67 (0.001)	72 (0.001)	67 (0.001)
EM	72 (0.001)	50 (0.001)	69 (0.001)	75 (0.001)	28 (0.001)	64 (0.001)	55 (0.001)	66 (0.001)	74 (0.001)	65 (0.001)

Note: Figures in parentheses refer to p-values.

The relationship between education and being overweight among men was generally inverse (Table 9), which supports most findings on Malaysia [25,26,28,29]. However, our results show no clear relationship between education levels and being overweight among women. The relationship between being overweight and education by ethnicity was clear and positive among Malay and Chinese men, while it was negative among Indian women. In

addition, except for primary education, Malays had the highest prevalence of being overweight among men, which largely supports past results on Singapore and Malaysia [26,51]. However, Indians with primary education had the highest prevalence of being overweight among men (20%, $p < 0.001$). Also, except for university and secondary education, Indians had the highest prevalence of being overweight among women. Malays had the highest prevalence

Table 9 Age-adjusted percentage of men and women being overweight by education level, gender, age, ethnicity and location

Age/Ethnicity/ Location/Region	Men					Women				
	University	Technical	Secondary	Primary	None	University	Technical	Secondary	Primary	None
30 – 39	40 (0.001)	30 (0.01)	31 (0.001)	23 (0.001)	14 (0.1)	29 (0.001)	14 (0.001)	34 (0.001)	27 (0.001)	19 (0.01)
40 – 49	38 (0.001)	47 (0.001)	34 (0.001)	31 (0.001)	19 (0.001)	34 (0.001)	26 (0.001)	43 (0.001)	41 (0.001)	27 (0.001)
50 – 59	35 (0.001)	40 (0.001)	38 (0.001)	27 (0.001)	20 (0.001)	39 (0.001)	20 (0.001)	45 (0.001)	44 (0.001)	28 (0.001)
60 – 69	29 (0.001)	17 (0.1)	32 (0.001)	26 (0.001)	12 (0.001)	40 (0.001)	11 (0.001)	44 (0.001)	43 (0.001)	21 (0.001)
≥ 70	25 (0.05)	20 (0.001)	26 (0.001)	16 (0.001)	11 (0.001)	29 (0.001)	30 (0.001)	32 (0.01)	31 (0.001)	11 (0.001)
Malay	21 (0.001)	27 (0.001)	16 (0.001)	13 (0.001)	6 (0.001)	19 (0.001)	9 (0.001)	28 (0.001)	24 (0.001)	18 (0.001)
Chinese	9 (0.001)	11 (0.05)	9 (0.001)	7 (0.001)	2 (0.1)	6 (0.001)	10 (0.001)	9 (0.001)	15 (0.001)	14 (0.001)
Indian	13 (0.001)	16 (0.1)	15 (0.001)	20 (0.001)	8 (0.1)	17 (0.001)	20 (0.001)	17 (0.001)	34 (0.001)	34 (0.01)
Others	13 (0.05)	14 (0.1)	15 (0.001)	9 (0.001)	4 (0.001)	12 (0.001)	14 (0.001)	13 (0.001)	12 (0.001)	9 (0.001)
Urban	18 (0.001)	22 (0.001)	15 (0.001)	14 (0.001)	9 (0.001)	17 (0.001)	6 (0.001)	24 (0.001)	24 (0.001)	20 (0.001)
Rural	18 (0.001)	23 (0.001)	14 (0.001)	11 (0.001)	3 (0.001)	14 (0.001)	10 (0.001)	23 (0.001)	21 (0.001)	12 (0.001)
WPM	37 (0.001)	38 (0.001)	34 (0.001)	26 (0.001)	5 (0.001)	35 (0.001)	18 (0.001)	42 (0.001)	41 (0.001)	22 (0.001)
EPM	33 (0.001)	31 (0.001)	34 (0.001)	24 (0.001)	7 (0.001)	29 (0.001)	19 (0.001)	41 (0.001)	40 (0.001)	18 (0.001)
EM	34 (0.001)	38 (0.1)	41 (0.001)	28 (0.001)	5 (0.001)	31 (0.001)	20 (0.001)	41 (0.001)	43 (0.001)	29 (0.001)

Note: Figures in parentheses refer to p-values.

of being overweight among university (19%, $p < 0.001$) and secondary (28%, $p < 0.001$) educated women. Whereas the relationship between being overweight and education was positive among urban and rural men, it was not clear among women. Urban men in the secondary (15%, $p < 0.001$), primary (14%, 0.001) and no education (9%, $p < 0.001$) groups showed higher prevalence of being overweight than rural men in the same education categories respectively. Except for the technically educated, urban women showed higher prevalence of being overweight than rural women in all other education groups. Among the three regions, the relationship between being overweight and education was clear and positive only in WPM. Also, WPM showed the highest prevalence among the university educated (37%, $p < 0.001$), while EM showed the highest prevalence in the secondary (41%, $p < 0.001$) and primary (28%, $p < 0.001$) education groups among men. EPM showed the highest prevalence among men with no education (7%, $p < 0.001$), though the levels were low in all three regions. Whereas WPM showed the highest prevalence among women in the university (35%, $p < 0.001$) and secondary (42%, $p < 0.001$) education groups, EM showed the highest prevalence among women in the technical (20%, $p < 0.001$) and primary (43%, $p < 0.001$) education groups.

Income

There was a positive relationship between diabetes, hypercholesterolemia and being overweight, and income among men (Table 10). These results differ from one study on Malaysia in which the relationship between diabetes and income was inverse, while the middle income had the highest prevalence of hypercholesterolemia [22]. Also, our results show that the relationship between hypertension and hypercholesterolemia, and income was negative among women, which is consistent with the findings from similar studies on Malaysia and the developed countries [11,13,22]. The relationship between income and diabetes was positive among women. Our results did not

corroborate with some studies on Malaysia that showed middle income women having the lowest prevalence of diabetes, hypertension, while high income women the lowest prevalence of hypercholesterolemia [22-24].

Our results showed that more men than women smoked in all income, age, ethnic and location categories (Table 11). Except for the age categories of 50–59 and 70 and above, the relationship between income and smoking was inverse among men, which supports some studies on Malaysia [22-24]. The relationship between smoking and income among men was positive in the 50–59 and 60–69 age groups. However, the relationship was inverse among women in the age groups of 30–39 and 50–59. Malays had the highest prevalence of smoking among men. The relationship between smoking and income in men was negative among Malays, Chinese and others. In women, the prevalence of smoking was highest among the others in the low income (15%, $p < 0.001$) and high income (10%, $p < 0.001$) groups, and Chinese among the middle income (12%, $p < 0.001$) groups. More rural men smoked than urban men in all income categories. Also, rural women (9%, $p < 0.001$) smoked more than urban women (7%, $p < 0.001$) in the low income group, while the prevalence of smoking was similar between urban and rural women among the middle and high income groups. There was no association between smoking and income between the three regions. However, EM had the highest prevalence of smoking among men in the low (43%, $p < 0.001$) and high (56%, $p < 0.001$) income groups, while EPM had the highest prevalence of smoking among women in the low (14%, $p < 0.001$) income groups.

The relationship between hypertension and income by gender was negative in the age category of 40–49 but was positive in the age categories of 50–59 and ≥ 70 years among men (Table 12), which we could not compare with past studies on Malaysia because of the use of different age intervals [21,22]. This association was inverse among women in all but the category of ≥ 70 years. The relationship between hypertension and income by ethnicity

Table 10 Age-adjusted percentage of men and women having CVD risk factors by income level

CVD risk factors	Men			Women		
	Low	Middle	High	Low	Middle	High
Hypertension*	52 (0.001)	47 (0.001)	58 (0.001)	51 (0.001)	37 (0.001)	29 (0.001)
Diabetes+	15 (0.001)	19 (0.001)	22 (0.001)	16 (0.001)	11 (0.001)	9 (0.001)
Hypercholesterolemia δ	62 (0.001)	73 (0.001)	78 (0.001)	73 (0.001)	73 (0.001)	68 (0.001)
Smoker θ	51 (0.001)	48 (0.001)	55 (0.001)	9 (0.001)	3 (0.001)	5 (0.001)
Overweight ψ	21 (0.001)	38 (0.001)	49 (0.001)	35 (0.001)	41 (0.001)	32 (0.001)

Note: Figures in parentheses refer to p-values.

*Mean SBP (Systolic Blood Pressure) ≥ 140 mm Hg or Mean DBP (Diastolic Blood Pressure) ≥ 90 mm Hg or using medication.

+Mean plasma glucose ≥ 126 mg/dL or 7.0 mmol/Lit.

δ Mean Plasma cholesterol ≥ 5.2 mmol/Lit.

θ Smokes at least one cigarette per day.

ψ BMI (Body Mass Index) ≥ 25.0 .

Table 11 Age-adjusted percentage of men and women smoking by income level, gender, age, ethnicity and location

Age/Ethnicity/ Location/Region	Men			Women		
	Low	Middle	High	Low	Middle	High
30 – 39	60 (0.001)	57 (0.001)	53 (0.001)	6 (0.001)	4 (0.01)	2 (0.1)
40 – 49	57 (0.001)	49 (0.001)	41 (0.001)	5 (0.001)	3 (0.001)	5 (0.001)
50 – 59	43 (0.001)	46 (0.001)	47 (0.001)	9 (0.001)	3 (0.01)	2 (0.1)
60 – 69	52 (0.001)	49 (0.001)	38 (0.001)	10 (0.001)	2 (0.1)	16 (0.05)
≥ 70	56 (0.001)	35 (0.01)	45 (0.1)	14 (0.001)	1 (0.001)	2 (0.001)
Malay	58 (0.001)	51 (0.001)	48 (0.001)	5 (0.001)	2 (0.001)	4 (0.001)
Chinese	42 (0.001)	31 (0.001)	10 (0.001)	4 (0.05)	12 (0.001)	6 (0.05)
Indian	11 (0.1)	34 (0.001)	29 (0.05)	2 (0.001)	3 (0.1)	4 (0.1)
Others	43 (0.001)	40 (0.001)	13 (0.1)	15 (0.001)	6 (0.001)	10 (0.001)
Urban	37 (0.001)	37 (0.001)	30 (0.001)	7 (0.001)	3 (0.001)	4 (0.001)
Rural	40 (0.001)	38 (0.001)	39 (0.001)	9 (0.001)	3 (0.001)	4 (0.001)
WPM	41 (0.001)	49 (0.001)	53 (0.001)	4 (0.001)	3 (0.001)	8 (0.001)
EPM	40 (0.001)	48 (0.001)	54 (0.001)	14 (0.001)	3 (0.05)	8 (0.01)
EM	43 (0.001)	49 (0.001)	56 (0.001)	2 (0.001)	4 (0.001)	6 (0.1)

Figures in parentheses refer to p-value.

was inverse among Indian men and women, Chinese men and Malay women. However, low income Indian women (70%, $p < 0.05$) and men (56%, $p < 0.05$) showed the highest prevalence of hypertension. Men (53%, $p < 0.001$) and women (41%, $p < 0.001$) in the others category showed the highest prevalence of hypertension among the middle income. Malay men (38%, $p < 0.001$) and other women (40%, $p > 0.1$) showed the highest prevalence of hypertension among the high income group. Whereas the relationship

between income and hypertension was inverse among urban men and women, it was only clear and inverse among rural men. Rural men and women showed higher prevalence of hypertension than urban men and women in all income groups. The relationship between hypertension and income was positive in WPM and EM among men, and in all three regions among women. Whereas EPM showed the highest prevalence of hypertension among women in all income categories, EPM showed the

Table 12 Age-adjusted percentage of men and women having hypertension by income level, gender, age, ethnicity and location

Age/Ethnicity/ Location/Region	Men			Women		
	Low	Middle	High	Low	Middle	High
30 – 39	20 (0.001)	27 (0.001)	18 (0.01)	20 (0.001)	16 (0.001)	8 (0.01)
40 – 49	38 (0.001)	33 (0.001)	33 (0.001)	35 (0.001)	27 (0.001)	22 (0.001)
50 – 59	39 (0.001)	45 (0.001)	50 (0.001)	57 (0.001)	44 (0.001)	32 (0.001)
60 – 69	60 (0.001)	64 (0.001)	57 (0.001)	57 (0.001)	57 (0.001)	56 (0.001)
≥ 70	68 (0.001)	88 (0.001)	89 (0.1)	66 (0.001)	71 (0.05)	76 (0.001)
Malay	45 (0.001)	37 (0.001)	38 (0.001)	44 (0.001)	33 (0.001)	26 (0.001)
Chinese	50 (0.001)	43 (0.001)	27 (0.001)	43 (0.01)	22 (0.001)	26 (0.001)
Indian	56 (0.05)	32 (0.001)	32 (0.01)	70 (0.05)	35 (0.001)	19 (0.01)
Others	51 (0.001)	53 (0.001)	13 (0.1)	40 (0.001)	41 (0.001)	40 (0.1)
Urban	48 (0.001)	39 (0.001)	39 (0.001)	39 (0.001)	29 (0.001)	25 (0.001)
Rural	49 (0.001)	46 (0.001)	44 (0.001)	44 (0.001)	40 (0.001)	42 (0.001)
WPM	36 (0.001)	37 (0.001)	44 (0.001)	24 (0.001)	30 (0.001)	40 (0.001)
EPM	47 (0.001)	46 (0.001)	55 (0.001)	28 (0.001)	41 (0.001)	49 (0.001)
EM	43 (0.001)	54 (0.001)	57 (0.001)	27 (0.001)	32 (0.001)	42 (0.001)

Figures in parentheses refer to p-value.

highest prevalence of hypertension among low income men. EM had the highest prevalence among middle and high income men.

While one study showed an inverse relationship between diabetes and income among men, and the middle income showing the lowest prevalence among women in Malaysia [22], our study showed that the association between diabetes and income was positive in the age groups of 50–59 and 60–69, negative in the age group of ≥ 70 (Table 13). However, the relationship between diabetes and income was negative among women in the age groups of 40–49, 50–59 and ≥ 70 . The relationship between income and diabetes by ethnicity was inverse among women but was not clear among men in all ethnic groups. Indian women (18%, $p < 0.001$) and Malay men (16%, $p < 0.001$) had the highest prevalence of diabetes among the low income. Indian men (29%, $p < 0.001$) and other women (17%, $p < 0.01$) had the highest prevalence of diabetes among the middle income. Chinese men (18%, $p < 0.001$) and other women (20%, $p > 0.1$) had the highest prevalence of diabetes among the high income. The relationship between diabetes and income was positive among rural men and women, and negative among urban women. The relationship between diabetes and income was negative in rural women, while it was positive in urban women. The relationship between income and diabetes was positive among women but it was not obvious among men in all the three regions. EPM showed the highest prevalence among low (14%, $p < 0.001$) and middle (14%, $p < 0.001$) income women, and among middle income men (21%, $p < 0.001$). EM

showed the highest prevalence among low income (22%, $p < 0.001$) men.

Although there was no obvious relationship reported between hypercholesterolemia and income by one study on Malaysia [22], our study showed that the prevalence of hypercholesterolemia increased with income in the age categories of 30–39, 50–59, 60–69 and ≥ 70 years among men, and ≥ 70 among women (Table 14)). Hypercholesterolemia increased with age among middle income men and women. However, the relationship between hypercholesterolemia and income by ethnicity was only obvious and positive among Chinese and other men, and negative among Malay, Indian and other women. Indian women (82%, $p < 0.001$) and men (78%, $p < 0.001$) showed the highest prevalence of hypercholesterolemia among the low income. Malay men (67%, $p < 0.001$) and women (73%, $p < 0.001$) showed the highest prevalence of hypercholesterolemia among the middle income. Other men (88%, $p < 0.001$) and Malay women (67%, $p < 0.001$) showed the highest prevalence of hypercholesterolemia among the high income. There was no association between hypercholesterolemia and income among urban and rural women, but it was negative among urban and rural men. Among the three regions, the relationship between hypercholesterolemia and income was clear and positive only among men in WPM while it was negative among women in EM. However, EPM showed the highest prevalence among the low (77%, $p < 0.001$) and middle (76%, $p < 0.001$) income groups. Among women, WPM and EPM had the highest prevalence in the middle (71%, $p < 0.001$) and high (67%, $p < 0.001$) income groups. EM showed the highest

Table 13 Age-adjusted percentage of men and women having diabetes by income level, gender, age, ethnicity and location

Age/Ethnicity/ Location/Region	Men			Women		
	Low	Middle	High	Low	Middle	High
30 – 39	11 (0.001)	23 (0.001)	13 (0.01)	8 (0.001)	11 (0.001)	7 (0.01)
40 – 49	14 (0.001)	18 (0.001)	16 (0.001)	14 (0.001)	8 (0.001)	6 (0.001)
50 – 59	13 (0.001)	20 (0.001)	38 (0.001)	20 (0.001)	15 (0.001)	10 (0.001)
60 – 69	17 (0.001)	18 (0.001)	19 (0.01)	16 (0.001)	14 (0.001)	20 (0.01)
≥ 70	13 (0.001)	12 (0.1)	11 (0.001)	15 (0.001)	8 (0.001)	1 (0.001)
Malay	16 (0.001)	20 (0.001)	17 (0.001)	16 (0.001)	11 (0.001)	8 (0.001)
Chinese	12 (0.1)	5 (0.01)	18 (0.001)	4 (0.1)	4 (0.01)	6 (0.01)
Indian	11 (0.1)	29 (0.001)	11 (0.1)	18 (0.001)	14 (0.01)	12 (0.1)
Others	7 (0.001)	18 (0.1)	12 (0.001)	11 (0.001)	17 (0.01)	20 (0.1)
Urban	20 (0.001)	21 (0.001)	18 (0.001)	18 (0.001)	9 (0.001)	8 (0.001)
Rural	14 (0.001)	17 (0.001)	25 (0.001)	14 (0.001)	15 (0.001)	15 (0.001)
WPM	15 (0.001)	19 (0.001)	15 (0.001)	7 (0.001)	9 (0.001)	14 (0.001)
EPM	17 (0.001)	21 (0.001)	13 (0.001)	14 (0.001)	14 (0.001)	19 (0.01)
EM	22 (0.001)	17 (0.001)	19 (0.001)	9 (0.001)	13 (0.001)	19 (0.001)

Figures in parentheses refer to p-value.

Table 14 Age-adjusted percentage of men and women having hypercholesterolemia by income level, gender, age, ethnicity and location

Age/Ethnicity/ Location/Region	Men			Women		
	Low	Middle	High	Low	Middle	High
30 – 39	49 (0.001)	75 (0.001)	76 (0.001)	53 (0.001)	60 (0.001)	51 (0.001)
40 – 49	66 (0.001)	75 (0.001)	73 (0.001)	61 (0.001)	69 (0.001)	62 (0.001)
50 – 59	54 (0.001)	75 (0.001)	86 (0.001)	87 (0.001)	76 (0.001)	76 (0.001)
60 – 69	66 (0.001)	67 (0.001)	73 (0.001)	73 (0.001)	81 (0.001)	68 (0.001)
≥ 70	61 (0.001)	76 (0.001)	80 (0.001)	70 (0.001)	86 (0.01)	88 (0.001)
Malay	63 (0.001)	67 (0.001)	66 (0.001)	75 (0.001)	73 (0.001)	67 (0.001)
Chinese	54 (0.001)	64 (0.001)	68 (0.001)	65 (0.001)	63 (0.001)	66 (0.001)
Indian	78 (0.01)	58 (0.001)	61 (0.001)	82 (0.001)	65 (0.001)	62 (0.001)
Others	37 (0.001)	56 (0.001)	88 (0.01)	46 (0.001)	46 (0.001)	20 (0.1)
Urban	76 (0.001)	74 (0.001)	73 (0.001)	75 (0.001)	72 (0.001)	54 (0.001)
Rural	61 (0.001)	74 (0.001)	81 (0.001)	65 (0.001)	67 (0.001)	62 (0.001)
WPM	73 (0.001)	74 (0.001)	62 (0.001)	63 (0.001)	71 (0.001)	67 (0.001)
EPM	77 (0.001)	76 (0.001)	65 (0.001)	51 (0.001)	71 (0.001)	67 (0.001)
EM	73 (0.001)	69 (0.001)	71 (0.001)	74 (0.001)	69 (0.001)	66 (0.001)

Figures in parentheses refer to p-value.

prevalence among low income men (73%, $p < 0.001$) and women (74%, $p < 0.001$).

The relationship between being overweight and income was positive among men in the age category of ≥ 70 (Table 15), which does not support some of the findings on Malaysia [25,26,28,52]. However, the relationship between being overweight and income among women was negative in the age categories of 50–59 and ≥ 70 . The association

between being overweight and income by ethnicity was positive among Malay and other men, while it was negative among Chinese women. Chinese men (27%, $p < 0.01$) had the highest prevalence of being overweight among the low income, while Malay men had the highest prevalence of being overweight among the middle (40%, $p < 0.001$) and high (43%, $p < 0.001$) income. Malay women had the highest prevalence of being overweight in all income

Table 15 Age-adjusted percentage of men and women being overweight by income level, gender, age, ethnicity and location

Age/Ethnicity/ Location/Region	Men			Women		
	Low	Middle	High	Low	Middle	High
30 – 39	28 (0.001)	34 (0.001)	29 (0.001)	27 (0.001)	32 (0.001)	27 (0.001)
40 – 49	24 (0.001)	42 (0.001)	37 (0.001)	39 (0.001)	43 (0.001)	33 (0.001)
50 – 59	24 (0.001)	40 (0.001)	39 (0.001)	45 (0.001)	43 (0.001)	31 (0.001)
60 – 69	22 (0.001)	37 (0.001)	30 (0.001)	33 (0.001)	42 (0.001)	36 (0.01)
≥ 70	14 (0.001)	18 (0.1)	33 (0.1)	15 (0.001)	29 (0.1)	31 (0.001)
Malay	26 (0.001)	40 (0.001)	43 (0.001)	42 (0.001)	36 (0.001)	37 (0.001)
Chinese	27 (0.01)	29 (0.001)	19 (0.001)	13 (0.1)	12 (0.001)	9 (0.01)
Indian	22 (0.1)	34 (0.001)	21 (0.01)	18 (0.1)	35 (0.001)	31 (0.01)
Others	17 (0.001)	37 (0.001)	38 (0.1)	18 (0.001)	26 (0.001)	20 (0.001)
Urban	32 (0.001)	39 (0.001)	38 (0.001)	45 (0.001)	42 (0.001)	31 (0.001)
Rural	22 (0.001)	39 (0.001)	31 (0.001)	32 (0.001)	39 (0.001)	42 (0.001)
WPM	37 (0.001)	38 (0.001)	23 (0.001)	32 (0.001)	42 (0.001)	36 (0.001)
EPM	39 (0.001)	42 (0.001)	23 (0.001)	40 (0.001)	39 (0.001)	31 (0.001)
EM	35 (0.001)	39 (0.001)	29 (0.001)	29 (0.001)	40 (0.001)	37 (0.001)

Figures in parentheses refer to p-value.

groups. The relationship between being overweight and income by location was clear only among women: it was negative among urban women and positive among rural women. Urban men showed higher prevalence of being overweight than rural men in all income categories. Whereas urban women showed higher prevalence of being overweight than rural women in the low and middle income groups, it was the reverse in the high income group. Among the three regions, there was a clear and negative association between being overweight and income only among women in EPM. Also, EPM showed the highest prevalence among low (39%, $p < 0.001$) and middle income (42%, $p < 0.01$) men. EM had the highest prevalence among high income (29%, $p < 0.001$) men. The results were mixed among women, with EPM, WPM and EM showing the highest prevalence among the low, middle and high income groups respectively.

Conclusions

The results generally tallied with the findings from the developed countries with smoking where men consistently smoked more than women in all education and income categories [9-11]. Smoking and hypertension showed an inverse relationship with education among men and women. However, while income showed a negative relationship with hypertension among women, it did not have an association with hypertension among men, and with smoking among both men and women. Also, the relationship between income, and diabetes and hypercholesterolemia was positive among men, while it was negative among women. There was also a positive association between income and being overweight among men. In addition, the relationship between the CVD risk factors, and education and income varied by ethnicity, age and location. Hence, policy makers and administrators should take account of the CVD risk factors by socioeconomic, demographic and geographic characteristics of the population in the country when devising programmes to reduce deaths caused by CVD-related diseases.

This study has some limitations that future studies should avoid. Firstly, the use of education and income provide only a crude estimate of SES. Secondly, it will be good to find local consumer prices to adjust for inflation effects on income. Thirdly, panel data, which refers to data collected from multiple but the same respondents over time, is superior when analysing causal factors [53].

Nevertheless, the prevalence of CVD risk factors between high and low levels of SES is still obvious, and the results show a need to address them when formulating preventive programmes.

Abbreviations

CVD: Cardiovascular disease; WPM: Western Peninsular Malaysia; EPM: Eastern Peninsular Malaysia; EM: East Malaysia; SES: Socioeconomic status; MYR: Malaysian Ringgit; PURE: Prospective Urban Rural Epidemiology;

REDISCOVER: Responding to Increasing Cardiovascular Disease Prevalence; SEE: Socioeconomic epidemiology; LRGS: Long-term Research Grant Scheme.

Competing interests

The authors declare that they have no competing interests.

Authors' contributions

RR: Is the head of the socioeconomic epidemiology (SEE) component of the REDISCOVER Project. He conceived the paper, the literature review, the methodology to be used, directed the processing of data and statistical analysis, and took charge of the writing of the paper, as well as, the final revisions. YK: Is the head of the REDISCOVER Project, which is a component of the PURE project. He conceived the project, defined the parameters of the cardiovascular risk factors, obtained approval from the ethics committee and coordinated the collection of the data, and commented on the paper. AM: Is a research assistant with the SEE. He undertook the age adjustment and statistical analysis used in the paper. RM: Is a member of SEE. He contributed to the literature review used in the paper, and commented on the paper. TM: Is a member with SEE. He assisted with the logistics involved in the project, and commented on the drafts. SKC: Is a member of SEE. He commented on the drafts. KS: Is a research assistant with the SEE. She assisted with the statistical analysis used in the paper. All authors read and approved the final manuscript. ABN: Is a research assistant with the REDISCOVER Project. She coordinated the collection and processing of the data used in the paper.

Acknowledgements

The authors thank the leader of the PURE project based in McMaster University, Salim Yusof. We are also grateful to the referees for constructive comments. Funding for this project was provided by the Ministry of Higher Education of Malaysia under the program, Long-term Research Grant Scheme (LRGS) (Project Title: Heart Disease, Consumption Patterns and Socioeconomic Background; Project No: LR005-2011A). The study was approved by the ethics committee of Universiti Teknologi Mara (UiTM) in 2007.

Author details

¹Faculty of Economics and Administration, University of Malaya, 50603 Kuala Lumpur, Malaysia. ²Faculty of Medicine, Universiti Teknologi Mara, Shah Alam 40450, Selangor, Malaysia. ³Faculty of Medicine, University of Malaya, 50603 Kuala Lumpur, Malaysia.

Received: 19 March 2013 Accepted: 16 September 2013

Published: 25 September 2013

References

1. World Health Organization: *World health statistics*. Geneva: World Health Organization; 2009. Available at: <http://www.who.int/whosis/whostat/2009/en/index.html>. Accessed: January 8, 2012.
2. Ezzati M, Lopez AD, Rodgers A, Vander Hoorn S, Murray CJL: **Selected major risk factors and global and regional burden of disease**. *Lancet* 2002, **360**:1347-1360.
3. Kearney PM, Whelton M, Reynolds K, Muntner P, Whelton PK, He J: **Global burden of hypertension: analysis of worldwide data**. *Lancet* 2005, **365**:217-223.
4. Bovet P, Shamlaye C, Gabriel A, Riesen W, Paccaud F: **Prevalence of cardiovascular risk factors in a middle-income country and estimated cost of a treatment strategy**. *BMC Public Health* 2006, **6**:9.
5. Damiani G, Federico B, Bianchi CB, Ronconi A, Basso D, Fiorenza S, Sassi F: **Socio-economic status and prevention of cardiovascular disease in Italy: evidence from a national health survey**. *Eur J Public Health* 2010, **21**(5):591-596.
6. World Bank: *How we classify countries*. <http://data.worldbank.org/about/country-classifications> (accessed May 19, 2011).
7. Ministry of Health Malaysia: *Report of the Second National Health and Morbidity Survey (NHMS II)*. Kuala Lumpur: Institute for Public Health, Ministry of Health Malaysia; 1996.
8. Ministry of Health Malaysia: *Report of the Third National Health and Morbidity Survey (NHMS III)*. Kuala Lumpur: Institute for Public Health, Ministry of Health Malaysia; 2006.
9. Nair C, Colburn H, McLean D, Petrasovits A: **Cardiovascular disease in Canada**. *Health Rep* 1989, **1**(1):1-22.

10. Winkleby MA, Jatulis DE, Frank E, Fortmann SP: **Socioeconomic status and health: how education, income, and occupation contribute to risk factors for cardiovascular disease.** *Am J Public Health* 1992, **82**:816–820.
11. Choinière R, Lafontaine P, Edwards AC: **Distribution of cardiovascular disease risk factors by socioeconomic status among Canadian adults.** *CMAJ* 2000, **162**(Suppl 9):S13–S24.
12. Huff N, Gray D: **Coronary: heart disease inequalities: deaths and the socio-economic environment in Nottingham, England.** *Health Place* 2001, **7**:57–61.
13. Pocock SJ, Shaper AG, Cook DG, Phillips AN, Walker M: **Social class differences in ischaemic heart disease in British men.** *Lancet* 1987, **2**:197–201.
14. Millar WJ, Wigle DT: **Socioeconomic disparities in risk factors for cardiovascular disease.** *CMAJ* 1986, **134**:127–132.
15. Reynes JF, Lasater TM, Feldman H: **Education and risk factors for coronary heart disease: results from a New England community.** *Am J Prev Med* 1993, **9**:365–371.
16. Kucharska-Newton AM, Harald K, Rosamond WD, Rose KM, Rea TD, Salomaa V: **Socioeconomic Indicators and the Risk of Acute Coronary Heart Disease Events: Comparison of Population-Based Data from the United States and Finland.** *Ann Epidemiol* 2011, **21**:572–579.
17. Joffres MR, Hamet P, Rabkin SW, Gelskey D, Hogan K, Fodor G: **Prevalence, control and awareness of high blood pressure among Canadian adults.** *CMAJ* 1992, **146**:1997–2005.
18. Tan AKG, Dunn RA, Samad MIA, Feisul MI: **Sociodemographic and health-lifestyle determinants of obesity risks in Malaysia.** *Asia Pac J Publ Health* 2011, **23**(2):192–202.
19. Amplavanar NT, Gurpreet K, Salmiah MS, Odhayakumar N: **Prevalence of cardiovascular disease risk factors among attendees of the Batu 9, Cheras Health Centre, Selangor, Malaysia.** *Med J Malaysia* 2010, **65**:166–172.
20. Zaini A: **Where is Malaysia in the midst of the Asian epidemic of diabetes mellitus?** *Diabetes Res Clin Pract* 2000, **50**:23.
21. Rampil L, Rampil S, Azhar MZ, Rahman AR: **Prevalence, awareness, treatment and control of hypertension in Malaysia.** *Public Health* 2008, **122**:11–18.
22. WHO: **Noncommunicable disease risk factors and socioeconomic inequalities – what are the links? A multicountry analysis of noncommunicable disease surveillance data. Report to the WHO Regional Office of the Western Pacific.** Geneva: World Health Organization; 2010.
23. Tan AKG, Yen ST, Nayga RM: **Role of education in cigarette smoking: an analysis of Malaysian household survey data.** *Asian Econ J* 2009, **23**:1–17.
24. Cheah YKA, Naidu BM: **Exploring factors influencing smoking behaviour in Malaysia.** *Asia Pacific J Cancer Prev* 2012, **13**:1125–1130.
25. Chee HL, Kandiah K, Khalid M, Shamsuddin K, Jamaluddin J, Megat Mohd Nordin NA, Shuib R, Osman I: **Body mass index and factors related to overweight among women workers in electronic factories in Peninsular Malaysia.** *Asia Pac J Clin Nutr* 2004, **13**:248–254.
26. Sidek SM, Rampil L: **The prevalence and factors associated with obesity among adult women in Selangor, Malaysia.** *Asia Pac Family Med* 2009, **8**:1–6.
27. Hong C, Chia K, Hughes K, Ling S: **Ethnic differences among Chinese, Malay and Indian patients with type 2 diabetes mellitus in Singapore.** *Singapore Med J* 2004, **45**:154–160.
28. Tan AKG, Yen ST, Feisul MI: **Determinants of body weight status in Malaysia: an ethnic comparison.** *Int J Public Health* 2012, **57**:279–288.
29. Ismail MN, Zawiah H, Chee SS: **Prevalence of obesity and chronic energy deficiency (CED) in adult Malaysians.** *Mal J Nutr* 1995, **1**:1–9.
30. Yusuf S, Islam S, Chow CK, Rangarajan S, Dagenais G, Diaz R, Gupta R, Kelishadi R, Iqbal R, Avezum A, Kruger A, Raman K, Lanas F, Liu L, Li W, Lopez-Jaramillo P, Oguz A, Rahman O, Swidan H, Yusuf K, Zatonski W, Rosengren A, Teo KK: **Use of secondary prevention drugs for cardiovascular disease in the community in high-income, middle-income, and low-income countries (the PURE Study): a prospective epidemiological survey.** *Lancet* 2011, **378**:1231–1243.
31. Teo K, Chow CK, Vaz M, Rangarajan S, Yusuf S, PURE Investigators-Writing Group: **The Prospective Urban Rural Epidemiology (PURE) study: examining the impact of societal influences on chronic non-communicable diseases in low, middle- and high-income countries.** *Am Heart J* 2009, **158**:1–7.
32. Malaysia: **Population Breakdown by ethnicity, Malaysia.** Malaysia: Department of Statistics; 2011.
33. Skinner CJ, Holt D, Smith TMF: *Analysis of complex surveys.* West Sussex (UK): John Wiley and Sons; 1989.
34. Thomas DR: **Inference using complex data from surveys and experiments.** *Can J Psychol* 1993, **34**:415–431.
35. Ramsey F, Schafer D: *The statistical sleuth: a course in methods of data analysis.* 2nd edition. New York: Duxbury; 2002.
36. MacDonald S, Joffres MR, Stachenko S, Horlick L, Fodor G: **Multiple cardiovascular disease risk factors in Canadian adults.** *CMAJ* 1992, **146**:2021–2029.
37. Fortmann SP, Marcuson R, Bitter PH, Haskell WL: **A comparison of the Sphygmometrics SR-2 automatic blood pressure recorder to the mercury sphygmomanometer in population studies.** *Am J Epidemiol* 1981, **114**:836–884.
38. World Health Organization: **BMI classification.** Available at http://apps.who.int/bmi/index.jsp?introPage=intro_3.html. Accessed May 10, 2012.
39. Finucane MM, Stevens GA, Cowan MJ, Danaei G, Lin JK, Paciorek CJ, Singh GM, Gutierrez HR, Lu Y, Bahalim AN, Farzadfar F, Riley LM, Ezzati M: **National, regional, and global trends in body-mass index since 1980: systematic analysis of health examination surveys and epidemiological studies with 960 country-years and 9·1 million participants.** *Lancet* 2011, **37**:557–567.
40. WHO Expert Consultation: **Appropriate body-mass index for Asian populations and its implications for policy and intervention strategies.** *Lancet* 2004, **363**:157.
41. American Diabetes Association: **Standards of medical care in diabetes.** *Diabetes Care* 2011, **34**(Suppl 1):S11–S61.
42. Nolan CJ, Damm P, Prentki M: **Type 2 diabetes across generations: from pathophysiology to prevention and management.** *Lancet* 2011, **378**:169–181.
43. Haaga J, DaVanzo J, Peterson CE, Peng TN, Ann TB: *The Second Malaysian Family Life Survey. Overview and Technical Report.* Santa Monica, CA: RAND; 1993. MR-106-NICHD/NIA.
44. Tan CE, Emmanuel S, Tan B, Jacob E: **Prevalence of diabetes and ethnic differences in cardiovascular risk factors. The 1992 Singapore National Health Survey.** *Diabetes Care* 1999, **22**:241–247.
45. *Malaysia: Population Distribution and Basic Demographic Characteristics Report.* Putra Jaya, Malaysia: Department of Statistics; 2010.
46. Cooper R, Cutler J, Desvigne-Nickens P, Fortmann SP, Friedman L, Havlik R, Morosco G: **Trends and disparities in coronary heart disease, stroke, and other cardiovascular diseases in the United States: findings of the national conference on cardiovascular disease prevention.** *Circ* 2000, **102**:3137–3147.
47. Millar WJ, Franks P: **The social origin of cardiovascular risk: an investigation in a rural community.** *Int J Health Serv* 1990, **20**:405–416.
48. Castanho VS, Oliveira LS, Pinheiro HP, Oliveira HCF, De Faria EC: **Sex differences in risk factors for coronary heart disease: a study in a Brazilian population.** *BMC Public Health* 2001, **1**:3.
49. Tomijaj M, Gentleman JF: **Risk factors for hypertension as measured by the Canada Health Survey.** *Health Rep* 1993, **5**:419–419.
50. Khor GL: **Cardiovascular epidemiology in the Asia-Pacific region.** *Asia Pacific J Clin Nutr* 2001, **10**:76–80.
51. Cutter J, Tan BY, Chew SK: **Levels of cardiovascular disease risk factors in Singapore following a national intervention programme.** *Bull World Health Organiz* 2001, **79**:908–915.
52. Liew Y, Zulkifli A, Tan H, Ho Y, Khoo K: **Health status of senior civil servants in Kuala Lumpur.** *Med J Malaysia* 1997, **52**:348.
53. Engle RF, Granger CWJ: **Co-integration and error correction: representation, estimation and testing.** *Econometrica* 1987, **55**:251–276.

doi:10.1186/1471-2458-13-886

Cite this article as: Rasiah et al.: Cardiovascular disease risk factors and socioeconomic variables in a nation undergoing epidemiologic transition. *BMC Public Health* 2013 **13**:886.