Geographical Variation of Cardiovascular Risk Factors in Malaysia

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SUMMARY

The purpose of this study was to describe differences in cardiovascular risk factor prevalences and clustering patterns among the states and federal territories of Malaysia. Risk factors considered were abdominal obesity, diabetes, hypertension, hypercholesterolemia and smoking. Using data from the third National Health and Morbidity Survey (NMHS III) in 2006, we estimated the states and federal territories risk factor prevalences and clustering patterns to map the cardiovascular burden distribution in Malaysia. There was a clear geographical variation in the distribution of the individual risk factors as well as in its clustering with remarkable impact seen in Peninsular Malaysia. Perlis, Kedah and Kelantan were the most affected states overall.

KEY WORDS:
Risk factor, Cardiovascular, cluster, Geographical variation, Malaysia

INTRODUCTION

Cardiovascular disease (CVD) is the number one cause of death worldwide. Of 17.1 million deaths of CVD reported in 2004, 82% were from low and middle income countries [1]. In Malaysia, the National Health and Morbidity Surveys (NHMS) report alarming increases in traditional cardiovascular risk factors prevalences. National prevalences of hypertension and diabetes in adults >30 years increased considerably from 29.9% to 42.6% and 8.3% to 14.9% respectively in a 10 year period [2]. A particularly sharp increase was seen in the prevalence of obesity which rose from 4.4% to 14% in the same time period. This shows more and more Malaysians are at risk of acquiring cardiovascular disease.

Presence of multiple risk factors in one patient ie clustering of risk factors has been associated with increased risk in heart related diseases [3, 4]. In the United States, the Behavioural Risk Factor Surveillance System (BRFSS) for the year 1994 reported that 18.0% of adults had at least two risk factors [5]. A higher proportion of clustering was reported in China; 45.9% of adults aged 35-74 years [6]. In 1996, Malaysia had 27.0% of cardiovascular risk factor clusters among adults aged 30 and above in one national study [7]. Recent reports from two single centre studies showed higher proportions of risk factor clustering in Malaysia; up to 93% [8, 9]. Though this might not be representative on a national level, it suggests an increased rate of risk factor clustering. With the escalating prevalence of individual risk factors, this amplifies the cardiovascular disease burden in Malaysia.

Years of research demonstrated that cardiovascular disease burden is not distributed equally. Many reports show different risk profiles exist for sub-populations with demographic variations [6, 10, 11, 12]. Geographically, evident variations in cardiovascular risk profiles were reported among provinces in Canada [10], among women in cities of United States [13] and between southern and northern populations of China [6]. In Malaysia, the cardiovascular risk profile variation and distribution is not well-reported. Many of the reports were done at the district, division [8, 14] or state level [15, 16]. Hence, they provide limited information in understanding the overall picture of cardiovascular disease burden in Malaysia.

It is important to determine the geographical variation in cardiovascular risk factor profile and its clustering in Malaysia. Such information can be used by programme planners to identify high risk regions or states that require more resources or interventions to help reduce the burden of these risk factors [13]. The goal of this study is to describe the geographical variation of the following modifiable risk factors: hypertension, diabetes, hypercholesterolemia, abdominal obesity and smoking, and its clustering in Malaysia.

MATERIALS AND METHODS

The NHMS III is a household survey conducted by the Institute of Public Health, Ministry of Health Malaysia in the year 2006. This survey involved a structured questionnaire that covered general household, socio-demographic, load of illnesses, health utilisation, cost and specific health problems. Included in the protocol also were general anthropometric measurements, blood pressure, and capillary blood measurements. All measurements were conducted by trained nurses or officers. Written informed consent forms were signed by the participants before the questionnaire was administered. NHMS III employed a multi-stage stratified sampling design proportionate to the population size throughout all states in Malaysia. A detailed account of the procedures can be found elsewhere [2].

States included were Perlis, Kedah, Kelantan, Melaka, Johor, Negeri Sembilan, Pulau Pinang, Perak, Pahang, Terengganu, Selangor, Federal Territory of Kuala Lumpur from the Peninsular and Sabah, Sarawak and Federal Territories of Labuan from East Malaysia. Where relevant, geographical variation in the Peninsular was described according to regional boundaries; West Coast (Perlis, Kedah, Pulau Pinang, Perak, Negeri Sembilan, Melaka, Selangor and Kuala Lumpur),

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East Coast (Kelantan, Terengganu and Pahang) and South (Johor).

Cardiovascular Risk Factors
Cardiovascular risk factors included in this study were hypertension, diabetes, hypercholesterolemia, abdominal obesity and smoking. Clustering was defined as co-existence of at least two cardiovascular risk factors. Relevant information for respondents aged 20 years and above was abstracted out from the NHMS III dataset for this study. The main outcomes measured were prevalence and clustering of cardiovascular risk factors among the various states.

Hypertension
Systolic and diastolic blood pressures were measured using Omron Digital Automatic Blood Pressure Monitor Model HEM-907. Two readings were taken for both diastolic and systolic blood pressure, 15 minutes apart. The average was used as recorded blood pressure values. Respondents were considered hypertensive if their average reading was ≥140 mmHg for systolic and/or ≥90 mmHg for diastolic blood pressure [17], or were on blood pressure lowering drugs, or were self reported to be hypertensive.

Diabetes
Blood glucose was checked by the finger prick method after 8 to 10 hours overnight fast using the Accutrend GC machine. Only respondents who claimed to be non diabetics were tested for their glucose level after obtaining written consent. Diabetics were either respondents who had been diagnosed with diabetes in the past, or were taking anti-diabetic medication or had their fasting blood glucose level higher than 6.1 mmol/l [18].

Hypercholesterolemia
Blood lipid was measured with Accutrend GC machine in all respondents who agreed to be tested. Respondents were considered hypercholesterolemia if their blood total cholesterol was ≥5.2 mmol/l [19], or were previously diagnosed with hypercholesterolemic by a medical doctor or paramedic.

Abdominal Obesity
Waist circumference was measured at the midpoint between the inferior margin of the last rib and the crest of the ilium in all respondents. Measurements were done to the nearest 0.1 centimetre using a Seca 200 measuring tape following a verbal permission. Cut-off points of 80 centimetres for females and 90 centimetres for males were used to determined abdominal obesity as recommended by the International Diabetes Foundation (IDF) [20].

Smoking
Current smokers were based on the CDC definition; participants who reported to have smoked 100 or more cigarettes in a lifetime and smoked daily or some days in the past one month.

Statistical Analysis
Analysis was done using STATA 10 and accounted for the complex sampling design. Survey Sample Analysis was used to obtain means, proportions and 95% Confidence Intervals (CI) for all risk factors reported in this paper. Both crude and adjusted prevalences were presented. Prevalences were adjusted for age and gender using the Malaysian 2006 census to obtain the weights.

Crude prevalences were mapped to illustrate the cardiovascular risk factor burden distribution in Malaysia. Maps were created using Epi Map interface in Epi Info (TM) 3.5.1 software. Choropleth maps were generated for each risk factor based on state boundaries, and risk factor prevalences were divided into tertiles, each representing the first, second and third 33.3% of the prevalence values in ascending order. The tertiles were different for each risk factor, and were referred to as low, medium and high categories respectively. For hypertension, prevalence of 0 to 34.7%, 34.8 to 42.2% and above 42.2% were referred as low, medium and high categories. In case of diabetes, low, medium and high categories were 0 to 8.7%, 8.8 to 12.3% and 12.4 and above respectively. Abdominal obesity prevalence of 0 to 38.8%, 38.9 to 42.8% and above 42.8% were described as low, medium and high categories. For hypercholesterolemia 0 to 21.4%, 21.5 to 31.5% and above 31.5% were low, medium and high categories respectively. Lastly, for smoking, prevalence of 0 to 21.3%, 21.4 to 26.7% and above 26.7% were referred to as low, medium and high categories.

RESULTS

Study Sample
Overall, there were 32 796 eligible adults aged above 20 years in the NHMS III survey. Out of these, 32 789 records were obtained for diabetes, 32 172 for smoking, 32 719 for hypertension, and 32 796 for hypercholesterolemia and abdominal obesity. Baseline characteristics of the study sample are described in Table I.

National prevalences of hypertension, diabetes, hypercholesterolemia, smoking and abdominal obesity for adults aged 20 years and above were 39.6%, 11.9%, 23.7%, 22.0 % and 40.9%. Nationally, risk factor clusters were seen in 43.2% of our samples who had at least two risk factors of the five considered. Additionally, 19.1% had clustering of the drug modifiable risk factors; hypertension, diabetes and hypercholesterolemia.

Geographical distribution of cardiovascular risk factors
Prevalence of risk factors varied remarkably between states (Table II). Each risk factor had a different distribution over the 13 states and two federal territories of Malaysia. Overall, Peninsular Malaysia showed greater risk factor prevalences compared to East Malaysia.

The prevalence of hypertension ranged from 27.2% in Kuala Lumpur to 49.8% in Perlis. In addition to its high prevalence, hypertension distribution also displayed an alarming pattern as majority states were either in the high or medium category (Figure 1-A). Overall, only Kuala Lumpur and Selangor of the Malaysian Peninsular had low prevalences of hypertension. Diabetes, with lower prevalence of 5.1% in Sabah to 15.9% in N. Sembilan showed a similar high overall distribution (Figure 1-B). Geographically, for hypertension and diabetes, states of high prevalence highly overlapped. These include majority of states in the West Coast. Kuala Lumpur and

Table I: Baseline characteristics of study respondents of the third National Health and Morbidity Survey (2006).

Characteristic	Mean	
Age (year)[a]	42.88	(0.50)
Gender[b]		
Male	44.6	(43.7,45.4)
Female	55.4	(54.6,56.3)
Ethnicity[b]		
Malay	54.7	(45.6,63.6)
Chinese	20.6	(16.4,25.5)
Indian	8.3	(05.4,12.6)
Other Bumiputera	11.4	(04.6,25.3)
Others	5.1	(03.5,07.3)
Residence[b]		
Urban	59.4	(45.1,72.4)
Rural	40.6	(27.6,54.9)
Education Level[b]		
None	11.4	(08.3,14.4)
Primary	29.9	(27.2,32.6)
Secondary	48.5	(46.0,51.0)
Tertiary	10.3	(06.8,13.7)
Waist Circumference[a]	82.12	(0.30)
Male	84.19	(0.40)
Female	80.45	(0.27)
Blood Pressure (mmHg)[a]		
Systolic	133.02	(0.87)
Diastolic	80.95	(0.31)
Total Cholesterol[a]	4.64	(0.05)

a Continuous variable reported as means and standard errors
b Categorical variable reported as means and 95% confidence interval

Table II: Prevalence of cardiovascular risk factors in 15 states and federal territories of Malaysia

States	% (95% CI‡) Prevalence				
	Hypertension	Diabetes	Abdominal Obesity	Hypercholesterolemia	Smoking
Crude					
Johor	37.0 (29.4,45.3)	11.7 (10.2,13.5)	39.7 (39.5,39.9)	24.6 (23.2,25.9)	20.9 (20.0,21.8)
Kedah	47.0 (42.3,51.8)	14.3 (13.5,15.1)	41.2 (38.5,44.0)	31.9 (29.4,34.4)	26.1 (20.8,32.3)
Kelantan	45.6 (43.2,48.0)	12.2 (09.0,16.4)	36.6 (31.4,42.0)	32.8 (32.2,33.3)	28.0 (24.1,32.2)
Melaka	46.7 (40.1,53.4)	15.4 (13.3,17.7)	46.8 (40.9,52.7)	28.1 (27.8,28.5)	20.0 (18.8,21.3)
N.Sembilan	43.5 (36.6,50.8)	15.9 (15.4,16.3)	44.4 (42.4,46.4)	25.6 (25.0,26.2)	23.8 (17.7,31.1)
Pahang	41.7 (34.6,49.1)	12.6 (12.4,12.8)	40.5 (39.2,41.8)	27.5 (23.8,31.5)	27.4 (21.7,34.0)
Pulau Pinang	43.5 (39.9,47.1)	15.2 (15.1,15.4)	42.0 (39.7,44.3)	22.0 (21.9,22.2)	18.6 (16.6,21.0)
Perak	47.4 (42.3,52.5)	13.1 (12.0,14.3)	40.7 (39.5,42.0)	26.9 (25.4,28.5)	21.4 (16.4,27.5)
Perlis	49.8 (46.1,53.6)	14.3 (12.5,16.3)	45.7 (40.8,50.7)	41.7 (40.3,43.2)	32.2 (30.9,33.5)
Selangor	34.0 (32.2,35.8)	12.5 (12.4,12.7)	44.3 (43.2,45.4)	23.0 (22.1,23.9)	18.3 (17.2,19.5)
Terengganu	38.5 (33.7,43.6)	11.6 (10.1,13.4)	41.6 (36.9,46.3)	32.5 (31.3,33.7)	27.3 (24.0,30.7)
Sabah	36.8 (31.9,41.9)	05.1 (03.7,07.1)	34.9 (29.3,41.1)	11.3 (08.2,15.4)	24.5 (20.4,29.0)
Sarawak	40.3 (39.5,41.0)	10.2 (07.8,13.2)	40.2 (35.9,44.6)	19.7 (19.1,20.3)	19.7 (16.3,23.6)
Kuala Lumpur	27.2 (27.2,27.2)	13.0 (13.0,13.0)	43.8 (43.8,43.8)	18.5 (18.5,18.5)	15.9 (15.9,15.9)
Labuan	37.7 (37.6,37.8)	08.3 (08.2,08.4)	39.9 (35.5,45.1)	19.0 (12.5,27.8)	22.0 (20.1,24.1)
Adjusted*					
Johor	31.8 (28.5,35.2)	09.9 (09.4,10.5)	36.5 (34.9,38.1)	22.5 (22.0,23.0)	25.1 (24.0,26.2)
Kedah	38.9 (36.5,41.4)	11.2 (10.5,12.0)	37.0 (34.7,39.3)	28.2 (26.6,29.8)	30.4 (26.3,34.9)
Kelantan	37.9 (35.4,40.6)	09.9 (07.7,12.7)	32.7 (28.4,37.4)	29.8 (29.8,29.9)	31.8 (28.3,35.4)
Melaka	40.1 (36.4,44.0)	12.5(09.7,16.0)	42.7 (37.1,48.6)	25.1 (24.2,26.0)	25.5 (23.3,27.8)
N.Sembilan	35.7 (31.4,40.2)	12.8 (11.2,14.5)	39.1 (37.0,41.3)	22.5 (21.8,23.2)	28.3 (22.2,35.4)
Pahang	36.9 (34.8,39.0)	11.0 (09.7,12.4)	37.4 (35.0,39.9)	25.8 (23.7,28.1)	29.2 (23.8,35.2)
Pulau Pinang	38.2 (34.6,41.9)	12.5 (12.3,12.6)	38.4 (36.4,40.5)	19.5 (19.2,19.9)	22.5 (19.8,25.5)
Perak	37.2 (33.1,41.5)	09.8 (08.8,10.8)	34.3 (32.5,36.2)	22.8 (22.7,22.8)	25.3 (21.5,29.6)
Perlis	41.8 (40.7,42.9)	11.8 (11.6,12.0)	42.4 (38.1,46.8)	38.8 (35.3,42.5)	35.2 (35.0,35.5)
Selangor	32.2 (30.6,33.9)	11.5 (11.4,11.7)	41.8 (40.5,43.0)	21.7 (20.9,22.5)	22.4 (21.7,23.1)
Terengganu	33.6 (32.1,35.1)	09.9 (08.0,12.2)	38.1 (32.8,43.7)	29.4 (29.2,29.5)	30.6 (27.7,33.7)
Sabah	37.5 (33.4,41.8)	05.2 (03.6,07.6)	33.9 (28.7,39.6)	11.4 (08.3,15.5)	28.1 (25.8,30.4)
Sarawak	35.6 (32.1,39.2)	09.0 (06.2,13.0)	37.3 (32.4,42.5)	18.0 (17.8,18.1)	23.5 (19.9,27.6)
Kuala Lumpur	26.8 (26.8,26.8)	12.9 (12.9,12.9)	42.3 (42.3,42.3)	17.6 (17.6,17.6)	18.2 (18.2,18.2)
Labuan	39.6 (39.6,39.6)	08.4 (07.2,09.7)	40.5 (36.2,45.0)	19.3 (12.9,27.7)	23.2 (21.3,25.2)

‡ CI = Confidence Interval
* Crude prevalence was adjusted for age and sex with reference to 2006 Malaysian census.

Table III: Prevalence of cardiovascular risk factor clustering in 15 states and federal territories of Malaysia

States	% (95% CI‡) Prevalence		
	RF§ = 0	RF§ =1	RF§ ≥2
Crude			
Johor	24.7 (21.7,28.0)	34.7 (33.4,36.0)	40.6 (36.2,45.1)
Kedah	18.9 (17.0,21.1)	30.0 (28.7,31.4)	51.1 (47.7,54.4)
Kelantan	18.9 (17.7,20.1)	32.3 (30.1,34.5)	48.9 (47.9,49.8)
Melaka	20.0 (14.9,26.4)	29.9 (28.9,30.9)	50.1 (45.4,54.9)
N.Sembilan	20.6 (17.3,24.4)	30.5 (29.6,31.5)	48.9 (44.4,53.4)
Pahang	21.2 (15.8,27.9)	32.9 (32.5,33.3)	45.9 (39.5,52.3)
Pulau Pinang	24.4 (21.8,27.2)	31.8 (30.8,32.8)	43.8 (40.1,47.5)
Perak	20.6 (17.0,24.8)	32.5 (32.0,32.9)	46.9 (43.5,50.4)
Perlis	13.5 (12.7,14.8)	26.4 (24.8,28.1)	60.1 (59.3,60.8)
Selangor	27.0 (26.2,27.9)	33.3 (32.8,33.7)	39.7 (39.3,40.2)
Terengganu	19.8 (18.2,21.5)	34.4 (32.9,36.0)	45.8 (42.6,49.0)
Sabah	29.9 (28.7,31.1)	38.2 (36.1,40.4)	31.9 (30.9,32.9)
Sarawak	24.6 (23.4,25.8)	36.1 (34.0,38.3)	39.3 (38.4,40.3)
Kuala Lumpur	30.7 (30.7,30.7)	35.3 (35.3,35.3)	34.0 (34.0,34.0)
Labuan	25.4 (23.7,27.3)	37.8 (35.5,40.1)	36.8 (36.3,37.3)
Adjusted*			
Johor	26.6 (25.6,27.5)	36.5 (36.4,36.7)	36.9 (36.2,37.7)
Kedah	22.6 (21.4,23.8)	32.4 (32.1,32.8)	45.0 (43.5,46.6)
Kelantan	21.5 (20.4,22.7)	35.5 (34.1,36.9)	43.0 (42.8,43.2)
Melaka	22.0 (18.2,26.4)	32.7 (31.2,34.3)	45.2 (42.7,47.8)
N.Sembilan	24.1 (21.1,27.2)	33.6 (32.9,34.3)	42.4 (40.1,44.7)
Pahang	23.5 (20.4,27.0)	34.6 (33.4,35.8)	41.9 (39.8,44.1)
Pulau Pinang	26.9 (23.8,30.4)	33.6 (33.5,33.7)	39.5 (36.2,43.0)
Perak	25.8 (23.6,28.2)	36.0 (35.7,36.2)	38.2 (36.2,40.3)
Perlis	16.2 (15.0,17.5)	29.9 (27.9,31.9)	54.0 (50.7,57.2)
Selangor	27.3 (26.6,28.1)	34.1 (33.4,34.7)	38.6 (38.6,38.7)
Terengganu	21.5 (21.3,21.8)	37.1 (36.6,37.7)	41.4 (41.1,41.7)
Sabah	27.7 (27.4,27.9)	39.0 (37.2,40.9)	33.3 (31.7,35.0)
Sarawak	26.5 (25.3,27.6)	37.3 (34.9,39.6)	36.3 (32.9,39.9)
Kuala Lumpur	30.9 (30.9,30.9)	35.4 (35.4,35.4)	33.7 (33.7,33.7)
Labuan	23.8 (21.1,26.8)	37.9 (35.3,40.6)	38.3 (38.1,38.5)

‡CI = Confidence Interval
§RF = any of Hypertension, Hypercholesterolemia, Diabetes, Abdominal Obesity and Smoking.
* Crude prevalence was adjusted for age and sex with reference to 2006 Malaysian census.

Selangor however, had high prevalence of diabetes but low prevalence of hypertension. The East Coast states were less affected by both risk factors.

Smoking, hypercholesterolemia and abdominal obesity demonstrated less severe overall burden. However, the crude prevalences of these risk factors were high. Abdominal obesity especially, showed high proportions ranged from 34.9% in Sabah to 46.8% in Melaka. Especially affected by abdominal obesity were Kuala Lumpur, Selangor, Melaka and N. Sembilan and Perlis from the West Coast (Figure 1-C). Hypercholesterolemia prevalence arrayed in a wide continuum of 11.3% in Sabah to 41.7% in Perlis. High prevalence states were Perlis, Kedah and Kelantan and Terengganu from the East Coast region (Figure 1-D). The rest of the Peninsular were in the medium category. For smoking, prevalences were relatively low, ranging from 15.9% in Kuala Lumpur to 32.2% in Perlis. The East Coast region and Perlis showed high prevalence of smoking (Figure 1-E). Perlis as an individual state was highly prevalent in all five risk factors.

After adjusting for age and sex, a general reduction by 2-5% for prevalences were observed in all risk factors except smoking. Instead, smoking prevalences increased for majority of the states by 1-5% (Table II, lower panel).

Geographical variation in cardiovascular risk factor clusters
The prevalence of having at least one risk factor was high among the respondents. About 69% in Kuala Lumpur to 87% in Perlis had at least one risk factor; smoking, diabetes, hypertension, hypercholesterolemia or abdominal obesity (Table III).

Cardiovascular risk factor clusters were consistently seen in all states and federal territories. Again, the Peninsular showed higher overall prevalence of clustering. The prevalences varied across the states ranging from the lowest of 31.9 % in Sabah to the highest of 60.1% in Perlis. Of all 15 states and federal territories considered, Perlis (60.1%) and Kedah (51.1%) had high prevalence of cardiovascular risk factor clusters (Figure 2). Melaka was in the medium category, but had a prevalence of 50.1% that was at the border of high and medium category.
Adjusting for age and sex reduced the prevalence of clusters by 1-9%.

Geographical variation in drug-modifiable risk factors
Drug modifiable risk factors were a combination of diabetes, hypertension or hypercholesterolemia. High proportions, ranging from 32.2% in Perlis to 70.4% in Kuala Lumpur had at least diabetes, hypertension or hypercholesterolemia (Table IV).

Table IV: Prevalence of diabetes, hypertension or hypercholesterolemia clustering in 15 states and federal territories of Malaysia

States	% (95% CI‡) Prevalence		
	RF§ = 0	RF§ =1	RF§≥2
Crude			
Johor	47.2 (41.5,53.0)	35.0 (33.2,36.8)	17.8 (14.2,22.2)
Kedah	37.6 (35.4,39.9)	35.5 (34.5,36.5)	26.9 (23.8,30.3)
Kelantan	38.3 (37.0,39.7)	36.7 (33.8,39.8)	25.0 (23.4,26.6)
Melaka	39.9 (35.4,44.6)	34.7 (30.3,39.4)	25.4 (25.4,25.4)
N.Sembilan	41.4 (36.2,46.7)	35.9 (33.2,38.7)	22.7 (20.4,25.3)
Pahang	43.2 (36.7,50.0)	35.1 (32.1,38.2)	21.7 (18.3,25.6)
Pulau Pinang	43.6 (41.7,45.5)	35.0 (34.3,35.6)	21.5 (20.2,22.8)
Perak	39.9 (34.8,45.3)	36.7 (32.2,41.5)	23.4 (22.8,24.1)
Perlis	29.6 (26.0,33.4)	38.2 (28.4,49.1)	32.2 (25.8,39.4)
Selangor	50.5 (48.5,52.5)	32.1 (30.9,33.4)	17.4 (16.6,18.1)
Terengganu	44.0 (40.0,48.1)	33.4 (31.1,35.9)	22.6 (20.9,24.3)
Sabah	56.7 (54.6,58.7)	34.4 (30.7,38.4)	08.9 (07.2,10.9)
Sarawak	47.3 (46.9,47.7)	37.1 (37.1,37.2)	15.6 (15.2,15.9)
Kuala Lumpur	56.8 (56.8,56.8)	29.9 (29.9,29.9)	13.3 (13.3,13.3)
Labuan	51.8 (47.4,56.2)	32.8 (30.8,34.8)	15.4 (13.2,18.0)
Adjusted*			
Johor	52.3 (50.7,53.9)	33.3 (32.8,35.1)	14.4 (13.3,15.5)
Kedah	45.3 (44.7,46.0)	33.9 (32.8,35.1)	20.7 (19.0,22.6)
Kelantan	45.4 (43.6,47.1)	34.7 (32.4,37.0)	20.0 (19.5,20.5)
Melaka	46.2 (43.9,48.5)	33.4 (29.6,37.4)	20.4 (18.8,22.1)
N.Sembilan	49.2 (46.4,52.0)	33.3 (31.8,34.9)	17.5 (16.3,18.8)
Pahang	47.5 (45.5,49.6)	33.9 (32.2,35.7)	18.6 (18.2,18.9)
Pulau Pinang	45.0 (47.3,50.6)	34.1 (33.6,34.5)	16.9 (15.8,18.2)
Perak	49.6 (45.6,53.5)	33.9 (29.8,38.2)	16.6 (16.3,16.9)
Perlis	35.1 (27.4,43.7)	38.9 (29.3,49.4)	26.0 (24.1,28.0)
Selangor	52.7 (50.8,54.5)	31.5 (30.2,32.7)	15.9 (15.3,16.5)
Terengganu	49.2 (48.2,50.2)	32.1 (30.8,33.4)	18.7 (18.4,19.0)
Sabah	55.9 (54.6,57.3)	35.0 (31.6,38.5)	09.1 (07.2,11.5)
Sarawak	52.1 (47.7,56.4)	34.8 (32.3,37.4)	13.1 (11.4,15.1)
Kuala Lumpur	57.6 (57.6,57.6)	29.6 (29.6,29.6)	12.9 (12.9,12.9)
Labuan	49.9 (45.2,54.6)	34.5 (33.0,36.0)	15.7 (12.7,19.1)

‡CI = Confidence Interval
§RF = any of Hypertension, Hypercholesterolemia, Diabetes.
* Crude prevalence was adjusted for age and sex with reference to 2006 Malaysian census.

The Peninsular showed greater prevalence of hypertension, hypercholesterolemia or diabetes cluster overall. Perlis led by 32.2%, followed by Kedah, Kelantan and Melaka (Figure 3). Lowest prevalence was seen in Sabah at 8.9%. It is interesting to note that Melaka and Kelantan were highly prevalent in hypertension, hypercholesterolemia or diabetes, but not for all five risk factor clustering (Figure 2 and 3).

Among all states, Melaka had the highest prevalence of having all three drug-modifiable risk factors at 4.8%, followed by Terengganu 4.2%, Kelantan 4.0%, Kedah and Perak 3.9%. Adjusting for age and sex reduced the drug-modifiable cluster prevalence by 1-9%.

DISCUSSION

Results from our study illustrate a worrying pattern of cardiovascular risk factor distribution at the national, regional and state levels. The Malaysian Peninsular is highly burdened by risk factor clustering, driven largely by drug-modifiable risk factors. Considering only the high prevalence states; at least one-fifth of the Peninsular population need social, lifestyle or medical interventions to control their cardiovascular risk factors. Moreover, this high burden was mainly seen in the poorer states of the Peninsular, including Perlis, Kedah and Kelantan.

Our results suggest that cardiovascular risk factor clustering is very common. Concerted efforts of the policy makers, public health professionals and clinicians are needed to cope with this health burden. Prevention, detection and treatment of cardiovascular risk factor clustering should be an important component of the national strategy. National strategic health planning should also consider the overall higher cardiovascular risk factor burden in the Peninsular, and account for the higher risks seen in the poorer states. This is essential because the prevalence of clustering is high and has increased. In 1996, 27% of adults aged 30 and above had at least two risk factors of obesity, hypertension, diabetes or hypercholesterolemia[7]. The higher prevalence of clusters seen in our younger sample makes it necessary to address this issue to reduce the future burden of CVD nationally.

Additionally, allocation of healthcare resources should be fully utilised to cater to the communities' needs. As such, institution of public health measures in accordance to the demand is an important aspect. From our study, by the burden of risk factors, Perlis, Kedah, Kelantan and Melaka appear to be the most in need compared to other states. Previously, the EUROASPIRE II study showed similar geographical variation in burden distribution and attributed it to differential access of the communities to comprehensive prevention and treatment programmes[21]. It may be likely that these four states are facing similar issues. Hence, improved

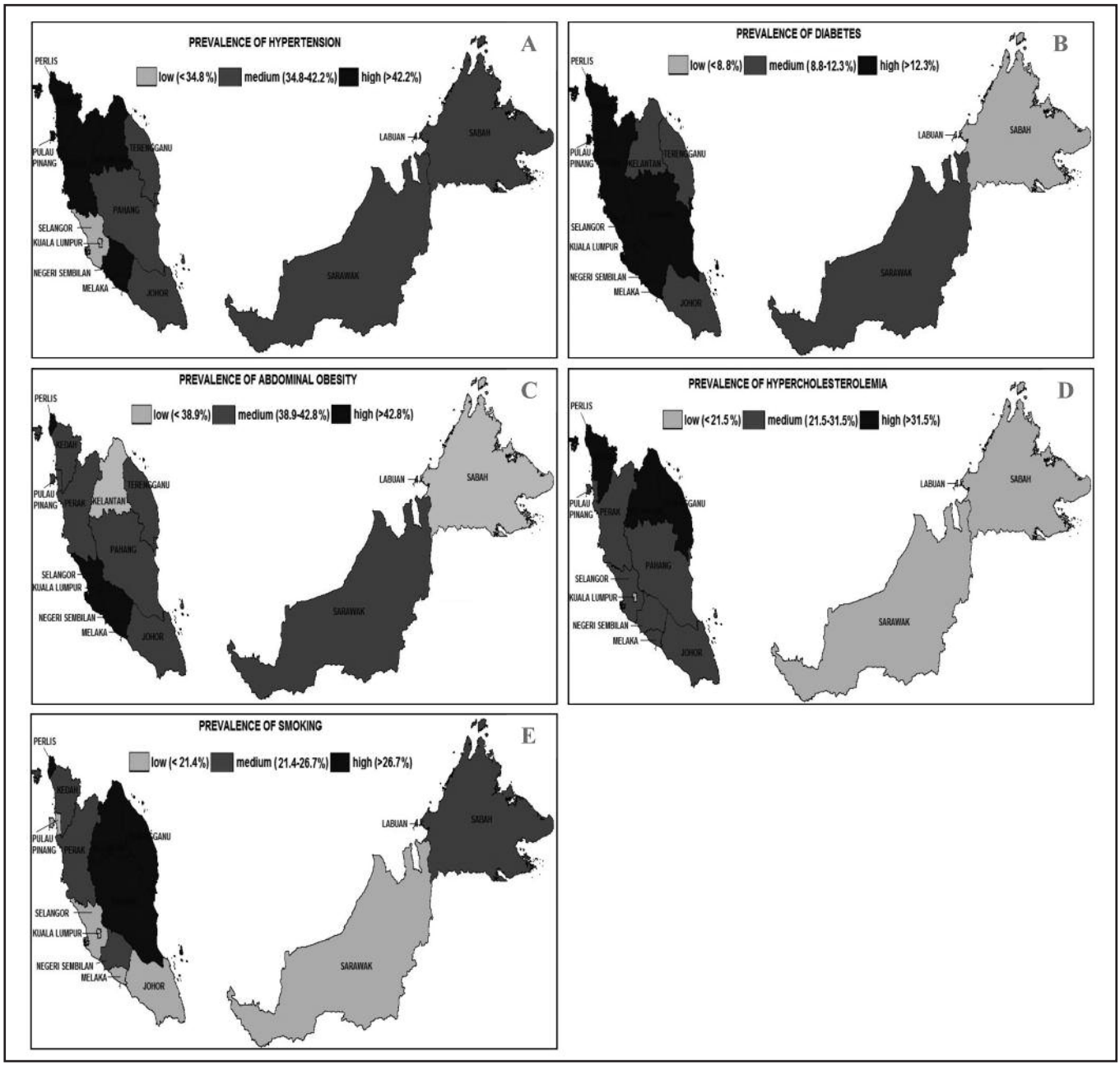

Fig. 1: Geographical distribution of cardiovascular risk factors in states and federal territories of Malaysia.

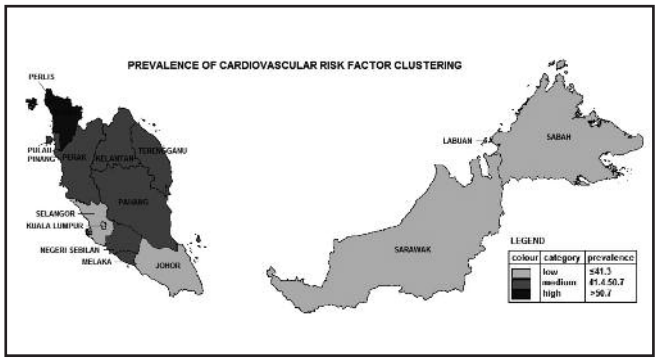

Fig. 2: Geographical distribution of cardiovascular risk factor clusters in states and federal territories of Malaysia.

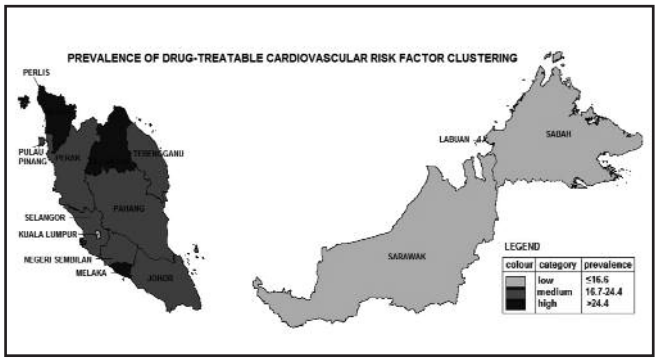

Fig. 3: Geographical distribution of diabetes, hypertension or hypercholesterolemia clusters in states and federal territories of Malaysia.

public health strategies that tailor to the needs would improve the populations of Perlis, Kedah, Kelantan and Melaka's access to better prevention and treatment programmes.

Maximum support should be given to primary prevention effort at all levels. This is important as effective prevention programmes can potentially reduce the future burden of intensive and expensive pharmacotherapies for hypertension, diabetes and hypercholesterolemia in the population [22]. Emphasis on risk factor screening as a public health strategy is important, because at least half of the hypertensive and hypercholesterolemic participants in NHMS III were not aware of their diagnosis [2]. Consequently, accessibility to early screening in the four states should be evaluated and improved if found lacking. In addition, effective behavioural preventive strategies should be established. Interventions of healthy lifestyle, diet and exercise have shown improved coronary heart disease risk and reduced incidence rate of diabetes [23,24]. Involvement of communities' institutions and agencies at the district and state level are important in the implementation of these strategies. Their participation will allow prevention strategies to be tailored to specific community needs. Besides, it facilitates community wide behavioural change [22]. Encouraging results have been described with involvement of religious organizations [25], schools [26] and worksite [27] in such intervention programmes.

Primary care clinicians are encouraged to be proactive in detecting and treating global cardiovascular risk factors. Screening for hypertension, hypercholesterolemia and diabetes should be practiced routinely among asymptomatic, high risk adult patients regardless of age. Especially in states where clustering are high, regular health check-ups should be promoted to patients. Aggressive treatment of blood pressure and blood glucose control should be considered in patients with risk factor clustering.

Limitations of this study need mentioning. Firstly, it should be considered that results reported here may not strictly represent each state's performance as only general Malaysian age and sex weight were used for standardization, not each state-specific age and sex weight. Secondly, measurements of blood pressure, and glucose and cholesterol levels were captured in one day. No measures were taken to ensure reading consistency after the one day period. In this study, glucose level was measured in respondents following an instruction of fasting 8-10 hours. However, it cannot be guaranteed all respondents adhered to the instructions given. In conclusion, this study provides a glimpse of the geographical mapping of cardiovascular risk factor burden nationally, conferred by the five risk factors mentioned. It shows that variation in cardiovascular risk factor distribution exists among the states and federal territories of Malaysia. Drastic measures at policy, community and clinical levels should be taken to address the rising burden seen in the country.

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NHMS Cohort Study group

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