The Association Between Risk Factors and Hypertension in Perak, Malaysia

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SUMMARY
Introduction: Hypertension is a major public health problem in Malaysia. A survey was initiated to examine the association of modifiable and non-modifiable risk factors for hypertension in Perak, Malaysia.

Methods: A total of 2025 respondents aged 30 years and above were recruited using a multi-stage sampling method. Hypertension was defined as self-reported hypertension and/or average of two blood pressure readings at single occasion with SBP ≥ 140mmHg or DBP ≥ 90 mmHg. Body mass index (BMI) was defined using the Asian criteria and International Physical Activity Questionnaire (IPAQ) was used to evaluate physical activity. Body weight, height and blood pressure were obtained using standard procedures. Univariate analyses were conducted to examine the associations between risk factors and hypertension. Multiple logistic regression was used to examine each significant risk factor on hypertension after adjusted for confounders.

Results: In total, 1076 (54.9%) respondents were found to be hypertensive. Significant associations (p <0.001) with hypertension were noted for increasing age, low physical activity, obese BMI, no education background and positive family history of hypertension. After adjusting for age, sex, ethnicity, education background, family history, BMI, physical activity, smoking and diet, respondents who were obese and had positive family history had higher odds for hypertension (OR:2.34; 95% CI:1.84-3.17 and 1.96 (1.59-2.42) respectively. A significant increase (p <0.001) in risk for hypertension was noted for age. Those with moderate physical activities were 1.40 (1.04-1.78) times more of having hypertension than those active. Poor diet score and smoking were not significantly associated with increased risk for hypertension.

Conclusion: In conclusion, modifiable risk factors such as BMI and physical activity are important risk factors to target in reducing the risk for hypertension.

KEY WORDS: Hypertension, obesity, BMI, IPAQ, smoking, Malaysia

INTRODUCTION
Cardiovascular disease (CVD) is responsible for one-third of all deaths worldwide. It was estimated that approximately 7.1 million deaths per year may be attributable to hypertension. The independent relation of hypertension to CVD has been well-established in many epidemiological studies over the past decades. Hypertension continues to be a major public health problem in Malaysia because of its high prevalence and an important risk factor for cardiovascular morbidity and mortality. Consequently, the management of hypertension appears to be one of the major therapeutic goals.

Epidemiological studies have identified a number of risk factors underlying hypertension, which can be collectively classified into modifiable and non-modifiable factors. Age, gender, ethnicity and heredity are notable non-modifiable risk factors. Modifiable risk factors include smoking, physical inactivity, obesity and diet high in saturated fats. A multifactorial approach to the treatment of hypertension is often indicated as these factors tend to interact with one another. A number of cohort studies and randomized clinical trials have demonstrated that the risks from hypertension can be partly reversed. Effective intervention includes weight loss, reduce sodium intake, moderate alcohol consumption, adequate potassium supplementation, increased physical activity and consume a diet rich in fruits, vegetables, and low-fat dairy products and reduced in saturated and total fat.

The aim of this study was to examine the associations of both modifiable and non-modifiable risk factors for hypertension in 5 locations in Perak, Malaysia. The findings of this study can provide important information in planning preventive measures for hypertension in the country.

PATIENTS AND METHODS

Study Population
A population-based cross-sectional household survey was initiated in Perak, Malaysia. This was a pilot study conducted at five sampling locations (Gerik, Kampar, Kuala Kangsar, Parit Buntar and Taiping). Four villages were selected from each sampling location and further, a number of households were selected from each village proportionate to their respective sizes by random sampling. For each household, the interviewer determines the household composition and identifies all adults aged 30 years and above. The eligible individuals were invited to participate in face-to-face interviews by trained interviewers after written consent was obtained.
In the event of an unsuccessful interview, the interviewer knocked on the immediate next household on the left until a successful interview was achieved. After obtaining their written consent, all respondents aged 30 years and above were interviewed by trained interviewers. Information on demographic variables, education background, cigarette-smoking habits, dietary habits, physical activity and medical history was obtained using a pre-tested standardized questionnaire.

Body weight and height measurements were taken by trained observers according to a standard procedure using standardized equipment which was calibrated before use. Specific quality checks were conducted to ensure the quality of the data collected. Body mass index (BMI) was calculated as weight in kilograms divided by the square of height in metres. Participants’ BMI scores were categorized using the World Health Organization Asian criteria: underweight (BMI<18.5kg/m²), normal (BMI=18.5 to 22.9 kg/m²), overweight (BMI=23.0 to 26.9 kg/m²) and obese (BMI ≥ 27.0 kg/m²).

Blood pressure was taken manually using mercury sphygmomanometer and stethoscope (Littmann) in accordance to recommendations by the Joint National Committee on Prevention, Detection, Evaluation, and Treatment of High Blood Pressure. Two blood pressure measurements were obtained from each respondent in a sitting position in their respective residence. The average of these two readings was used to classify an individual. Written consent was obtained from each respondent. The study protocol was approved by the Ethical Review Board of Faculty of Medicine, University of Malaya.

Hypertension was defined as those who have reported hypertension and is currently on anti-hypertensive medication and those who were detected to be hypertensive through medical examination with an average of two blood pressure readings at single occasion with SBP ≥ 140mmHg and/or DBP ≥ 90 mmHg. Previous studies supports that self-reported hypertension is a relatively valid tool to assess the hypertensive status of study participants. The second criterion used in this screening examination has also been practiced in a national study.

The assessment of food intake practices was conducted using a set of questionnaire provided by the Ministry of Health, Malaysia. The questions ranged from frequency of food intake daily, to frequency of intake of red meat, fish, fried food and fruits. Each respondent is classified into one of 4 diet score groups: 0-3 (Poor), 4-7 (Moderate), 8-11 (Good) and 12-16 (Excellent).

Physical activity was evaluated using IPAQ (International Physical Activity Questionnaire) where METS (metabolic equivalent score) was computed. The IPAQ assesses physical activity undertaken across a comprehensive set of domains including leisure time, domestic and gardening (yard) activities, work-related and transport-related activity. Each respondent was classified into 3 categories: high, moderate or low-intensity.

Smoking is the inhalation of the smoke of burning tobacco encased in cigarettes, pipes, and cigars. In this study, we grouped the respondents into 3 categories: non-smokers for those who have never smoked or smoked a few puffs but never smoked again; smokers for those who smoke rarely, occasionally or daily; and ex-smokers for those who used to smoke but now have stopped.

**RESULTS**

The total number of respondents aged 30 years and above was 2025. The majority (69.6%) of our respondents were aged 40 to 69 years. About half (56.8%) of the respondents were females.

In total, 54.9% respondents were found to be hypertensive of which 31.5% respondents were self-reported whereas 23.4% respondents were detected during medical examination. Prevalence of obese BMI (≥27 kg/m²) was the highest (35.6%), followed closely by overweight BMI (23.0-26.9 kg/m²) (33.7%). Female respondents had higher obesity prevalence at 41.6% than men at 22.7%. A majority of respondents were non-smokers (75.9%) and practiced high physical activity (38.9%). Among those with self-reported hypertension, about one-half respondents (48.5%) reported to be hypertensive despite medication. Table I showed that the prevalence of hypertension increased with age and BMI respectively.

The adjusted odds (aOR) of hypertension increased as age increased. Obese individuals (BMI ≥ 27.0 kg/m²) had the odds of 2.3 times to have hypertension than individuals with a normal BMI (aOR: 2.34, 95% CI: 1.84-3.17). The aOR of individuals with positive family history of hypertension had nearly 2 times increased odds of having hypertension compared to those without a family history of hypertension (aOR 1.96, 95% CI: 1.59-2.42). Individuals with moderate physical activity were 1.40 times of having hypertension (aOR: 1.40, 95% CI: 1.04-1.78.). Poor diet score, smoking and education background were not statistically associated with hypertension.

**DISCUSSION**

CVD has been the leading cause of death in Malaysia for nearly 5 decades. Large population-based cohort studies have demonstrated a continuous, consistent and graded relationship between blood pressure and subsequent detrimental sequelae of various atherosclerotic events. The risk of heart attack, heart failure, stroke and kidney diseases increases with rising blood pressure. This is further compounded by additional risk factors such as smoking, diabetes mellitus and dyslipidaemia. The Third National Health and Morbidity Survey (NHMS III) in Malaysia was
Table I: Bivariate analyses between risk factors for hypertension and hypertension

<table>
<thead>
<tr>
<th>Variables</th>
<th>Hypertensive n (%)</th>
<th>Non-hypertensive n (%)</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>SOCIODEMOGRAPHY</strong></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Age group</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>30-39</td>
<td>68 (26.5)</td>
<td>189 (73.5)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>40-49</td>
<td>178 (43.5)</td>
<td>231 (56.5)</td>
<td></td>
</tr>
<tr>
<td>50-59</td>
<td>286 (53.7)</td>
<td>247 (46.3)</td>
<td></td>
</tr>
<tr>
<td>60-69</td>
<td>300 (69.8)</td>
<td>130 (30.2)</td>
<td></td>
</tr>
<tr>
<td>70-79</td>
<td>189 (71.9)</td>
<td>74 (28.1)</td>
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<tr>
<td>≥80</td>
<td>55 (77.7)</td>
<td>14 (22.3)</td>
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<tr>
<td>Sex</td>
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<td></td>
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<tr>
<td>Male</td>
<td>458 (53.8)</td>
<td>393 (46.2)</td>
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</tr>
<tr>
<td>Female</td>
<td>618 (55.7)</td>
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<td>Ethnicity</td>
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<td>0.032</td>
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<tr>
<td>Malay</td>
<td>860 (55.8)</td>
<td>682 (44.2)</td>
<td></td>
</tr>
<tr>
<td>Chinese</td>
<td>163 (55.1)</td>
<td>133 (44.9)</td>
<td></td>
</tr>
<tr>
<td>India</td>
<td>38 (48.7)</td>
<td>40 (51.3)</td>
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</tr>
<tr>
<td>Others</td>
<td>15 (33.3)</td>
<td>30 (66.7)</td>
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<tr>
<td><strong>Education background</strong></td>
<td></td>
<td></td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Yes</td>
<td>875 (53.0)</td>
<td>776 (47.0)</td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>201 (65.3)</td>
<td>107 (34.7)</td>
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</tr>
<tr>
<td><strong>BMI, kg/m²</strong></td>
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<tr>
<td>Underweight</td>
<td>40 (41.7)</td>
<td>56 (58.3)</td>
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</tr>
<tr>
<td>Normal</td>
<td>240 (49.0)</td>
<td>250 (51.0)</td>
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<tr>
<td>Overweight</td>
<td>335 (51.4)</td>
<td>517 (48.6)</td>
<td></td>
</tr>
<tr>
<td>Obese</td>
<td>431 (63.0)</td>
<td>253 (37.0)</td>
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<td><strong>LIFESTYLE</strong></td>
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<tr>
<td>Physical activity (IPAQ)³</td>
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<tr>
<td>Low</td>
<td>300 (58.8)</td>
<td>210 (41.2)</td>
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</tr>
<tr>
<td>Moderate</td>
<td>309 (61.4)</td>
<td>196 (38.8)</td>
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<tr>
<td>High</td>
<td>409 (48.4)</td>
<td>436 (51.6)</td>
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<tr>
<td>Diet Score α</td>
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<tr>
<td>Excellent</td>
<td>730 (55.4)</td>
<td>588 (44.6)</td>
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</tr>
<tr>
<td>Good</td>
<td>321 (53.1)</td>
<td>284 (46.9)</td>
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<tr>
<td>Moderate</td>
<td>15 (57.7)</td>
<td>11 (42.3)</td>
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</tr>
<tr>
<td>Poor</td>
<td>4 (80)</td>
<td>1 (20)</td>
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<td><strong>Smoking</strong></td>
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<td>0.001</td>
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<tr>
<td>Non-smoker</td>
<td>825 (56.2)</td>
<td>644 (43.8)</td>
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<tr>
<td>Smoker</td>
<td>163 (46.3)</td>
<td>189 (53.7)</td>
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<tr>
<td>Ex-smoker</td>
<td>76 (61.3)</td>
<td>48 (38.7)</td>
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<tr>
<td><strong>DISEASE PREVALENCE</strong></td>
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<tr>
<td>Family history of hypertension</td>
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<tr>
<td>Yes</td>
<td>512 (61.7)</td>
<td>318 (38.3)</td>
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</tr>
<tr>
<td>No</td>
<td>536 (49.2)</td>
<td>553 (50.8)</td>
<td></td>
</tr>
</tbody>
</table>

*Education background is defined as Yes if a respondent has had previous exposure to formal education (Primary education, secondary education or tertiary education).
³Physical activity was evaluated using IPAQ; the international physical activity questionnaire, where metabolic equivalent score (METS) was computed.
αThe assessment of food intake practices was conducted using a set of questionnaire provided by the Ministry of Health, Malaysia. The questions ranged from frequency of food intake daily, to frequency of intake of red meat, fish, fried food and fruits.

The present study used the similar methods for blood pressure taking as the NHMS in 2006, and found that the prevalence of hypertension in the same group is relatively higher in Perak at 54.9% in 2011. This could be attributed to a larger sample of elderly participants in the study sample.

Data from the NHMS III study showed that the prevalence of obese category was 17.4% (95% CI: 16.7–18.0) for women and 10.0% (95% CI: 9.5–10.5) for men. Our study showed a higher prevalence at 41.6% for woman and 22.7% for men. This difference could be attributed to different age population of our sample and different BMI cut-off figures adopted. The NHMS III used the higher conventional BMI cut-off figures whereas our study followed the revised cut-off points recommended by the WHO Expert Consultation for Asians 17. Recent studies have shown that many Asian populations have higher percentage of body fat compared to Caucasians of the same age, gender and BMI18. Hence, the risk factors for cardiovascular diseases at a given BMI are generally higher among Asian populations.

The prevalence estimates of hypertension were slightly higher among females (56%) than males (54%). This study concurs with the NHMS III in 2006 that women were more likely to be
The NHMS III in 2006 reported the prevalence of hypertension was highest among the Malays (45.4%), followed by Chinese (40.6%) and Indian (40.0%). In this study, there was a similar estimated prevalence of hypertension between the different ethnic groups; however these differences were not statistically significant. The differences in prevalence between ethnic groups are most likely an interplay between their different genetic and environmental factors. There is clinical evidence to suggest that normotensive Malays may have higher sensitivity of beta-adrenergic receptor compared with Chinese and Indians. Higher beta-adrenergic receptor sensitivity has been linked with increased risk for hypertension in several studies.

Individuals with a family history of hypertension are twice as likely to have hypertension. Family history of hypertension has been recognized as among the strongest predictors for developing hypertension in later life. Previous studies have confirmed that elevated insulin level, higher insulin resistance and higher LDL cholesterol were all associated with family history of hypertension. These findings underscores the importance of screening family members for hypertension when an index case is found. In addition, identification of individuals at risk for hypertension allows early intervention through diet and lifestyle changes. Thus, future incidence of cardiovascular diseases may be reduced as well.

Among individuals with an education background, 53.0% were hypertensive compared to the corresponding value reported in NHMS III which was 58.6%, although no significant association between hypertension and education background was noted in our study. However, in some studies, low education level was significantly associated with increased risk of hypertension, potential consequences of hypertension and knowledge regarding nonmedical treatment options, but not all.

### Table II: Crude & Adjusted Odds Ratio of Risk Factor associated with Hypertension

<table>
<thead>
<tr>
<th>Risk Factor</th>
<th>Crude OR</th>
<th>95% CI</th>
<th>Adjusted OR</th>
<th>95% CI</th>
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<td><strong>Age group</strong></td>
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<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
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<tr>
<td>40-49</td>
<td>2.14</td>
<td>1.53-3.01</td>
<td>2.26</td>
<td>1.56-3.29</td>
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<tr>
<td>50-59</td>
<td>3.22</td>
<td>2.33-4.46</td>
<td>3.37</td>
<td>2.35-4.83</td>
</tr>
<tr>
<td>60-69</td>
<td>6.41</td>
<td>4.54-9.06</td>
<td>7.91</td>
<td>5.35-11.69</td>
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<tr>
<td>70-79</td>
<td>7.10</td>
<td>4.83-10.44</td>
<td>9.17</td>
<td>5.86-14.33</td>
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<tr>
<td>≥ 80</td>
<td>10.92</td>
<td>5.71-20.89</td>
<td>12.42</td>
<td>6.01-25.67</td>
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<td><strong>Sex</strong></td>
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<tr>
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<td>1.00</td>
<td>1.00</td>
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<tr>
<td>Female</td>
<td>1.08</td>
<td>0.90-1.29</td>
<td>0.82</td>
<td>0.64-1.06</td>
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<td>1.48</td>
<td>0.72-3.04</td>
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<td>1.25</td>
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</tr>
<tr>
<td>India</td>
<td>1.90</td>
<td>0.89-4.07</td>
<td>1.13</td>
<td>0.47-2.70</td>
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<td>Others</td>
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<td>1.00</td>
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<td></td>
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<td><strong>Education background</strong></td>
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<td></td>
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<tr>
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<tr>
<td>No</td>
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<td>1.29-2.15</td>
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<td>0.92-1.71</td>
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<td>1.66</td>
<td>1.38-2.00</td>
<td>1.96</td>
<td>1.59-2.42</td>
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<tr>
<td>No</td>
<td>1.00</td>
<td>1.00</td>
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<tr>
<td><strong>BMI, kg/m²</strong></td>
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</tr>
<tr>
<td>Underweight</td>
<td>0.75</td>
<td>0.48-1.16</td>
<td>0.63</td>
<td>0.36-0.98</td>
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<td>1</td>
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<tr>
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<td>Obese</td>
<td>1.78</td>
<td>1.40-2.25</td>
<td>2.34</td>
<td>1.84-3.17</td>
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<td><strong>Physical activity</strong></td>
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</tr>
<tr>
<td>Low</td>
<td>1.52</td>
<td>1.34-2.10</td>
<td>1.14</td>
<td>0.88-1.47</td>
</tr>
<tr>
<td>Moderate</td>
<td>1.68</td>
<td>1.27-1.95</td>
<td>1.40</td>
<td>1.04-1.78</td>
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<td>High</td>
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<td>1.00</td>
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<tr>
<td><strong>Smoke</strong></td>
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</tr>
<tr>
<td>Non-smoker</td>
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<tr>
<td>Smoker</td>
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<td>0.53-0.85</td>
<td>0.75</td>
<td>0.55-1.04</td>
</tr>
<tr>
<td>Ex-smoker</td>
<td>1.24</td>
<td>0.85-1.80</td>
<td>0.83</td>
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<tr>
<td><strong>Diet Score</strong></td>
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</tr>
<tr>
<td>Excellent</td>
<td>1.00</td>
<td>1.00</td>
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<tr>
<td>Good</td>
<td>0.91</td>
<td>0.75-1.10</td>
<td>0.93</td>
<td>0.75-1.17</td>
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<tr>
<td>Moderate</td>
<td>1.10</td>
<td>0.50-2.41</td>
<td>1.47</td>
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<tr>
<td>Poor</td>
<td>3.22</td>
<td>0.36-28.90</td>
<td>3.10</td>
<td>0.28-33.91</td>
</tr>
</tbody>
</table>

BMI = Body mass index  
CI = Confidence interval  
OR = Odds ratio
Physical inactivity has been associated with an increased risk of cardiovascular disease in epidemiologic studies. Our study revealed significantly lower odds for hypertension among individuals with high level of physical activity as compared to moderate and low level of physical activity. Interestingly, those with moderate physical activities have additional of 40% odds of getting hypertension when compared to those with high physical activity. There was no significant association observed between low physical activity and hypertension. A possible reason is that the IPAQ questionnaire may not be sensitive enough to measure low physical activity. Substantial evidence by Sobngwi et al. suggested that walking and vigorous exercises were associated with substantial reductions in cardiovascular events like hypertension. It was found that increasing level of physical activity improves blood flow and helps to reduce the resting heart rate and blood pressure.

Smoking is associated with chronic low-grade inflammation and arterial stiffness, which are associated with hypertension. In our study, smoking was not significantly and independently related to hypertension. Some population studies in the literature reported similar findings, but some others do not. The distribution pattern of prevalence of non-smokers, smokers and ex-smokers in our survey mirrored that of the data from NHMS III, whereby non-smokers are highest at 72.9%, followed by smokers (21.6%) and ex-smokers (5.5%).

In our study, smokers had lower odds of having hypertension (OR 0.67, 95% CI 0.53-0.85) as compared to non-smokers in the univariate analysis, which was later proven to be insignificant (OR 0.75, 95% CI 0.55-1.04) in the multivariate analysis. This could be attributed to a larger proportion of smokers in the younger age population (67.3% aged 30-59) which may not have significant side effect to cause hypertension. After adjustment was made, it appears that effect of smoking on hypertension is not significant.

There was a change in direction of association among the ex-smokers in the univariate analysis (OR 1.24; 95% CI 0.85-1.80) and in the final model (OR 0.83, 95% CI 0.53-1.30). We believe that ex-smokers were likely to stop smoking due to health reasons, and as such, they faced a higher risk for comorbidity, which explains the higher odds for having hypertension. However, as the proportion of ex-smoker is very low (6.2%), the change in direction of association in the multivariate analysis were most likely attributed to the effect of BMI as 67.2% of ex-smokers were overweight or obese. A prospective cohort study suggested that cigarette smoking may be a modest but important risk factor for the development of hypertension however this being a cross-sectional study, it becomes our limitation in associating smoking with hypertension.

Poor diet score was not significantly associated with increased risk for hypertension. The failure of our study to support findings relating dietary intake to the development of hypertension may be attributable to imprecision in the measurement of dietary data and unavailability of a validated food frequency questionnaire. The dietary score used in our study was mainly to assess general diet but not hypertension per se.

Hypertension is projected to be a serious public health challenge well into 2025, with an estimated 1.56 billion people (29% of world’s adult population) suffering from it. It has been suggested that men and women have similar overall prevalence of hypertension, and that such prevalences increased with age were found to be consistent in all world regions. Although improvements have been made in detection and treatment in some countries, the global rates of blood pressure control were found to be generally poor and even worse in the developing nations.

As Malaysia is a developing country, epidemiological transition is taking place with a decline in communicable diseases and an increase in non-communicable disease, thus facing the daunting prospects of even higher prevalence in the future. A study previously done in Malaysia has shown that levels of awareness, treatment and control were low.

There is an urgent need for a comprehensive awareness campaigns with concerted effort that focuses on several modifiable risks to health, in particular physical inactivity and high body-mass index. Improvement in access to medical care may also lead to better control of hypertension.

LIMITATION
A potential limitation of our study was that its cross-sectional design may limit our ability to infer a causal relationship between significant risk factors and hypertension. The instrument has not yet been formally translated. Although interviewers were able to translate it during the interviews as required, misinterpretation of the questions by the respondents may lead to information bias. An interpersonal variance may occur during measurement. The standardized assessment of food intake practices provided by the Ministry of Health, Malaysia did not include information about dietary salt intake, which was known to increase the risk of hypertension.

CONCLUSION
Modifiable risk factors such as BMI and physical activity are important factors to target in reducing the risk for hypertension. Effective preventive programs include educating the public on the dangers of hypertension, encourage weight reduction and exercise, promoting healthy lifestyle consisting of a balanced diet that follows the food pyramid, increase awareness on the effects of smoking and promote regular medical checkups for those with positive history of hypertension and of older age group should be implemented.

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