Prevalence of metabolic syndrome and its risk factors in adult Malaysians: Results of a nationwide survey

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ABSTRACT

Aim: To report the national prevalence of metabolic syndrome (MetS) and its risk factors among adult Malaysians (>18 years old) based on World Health Organization (WHO), the National Cholesterol Education Program Expert Panel III (ATP III), International Diabetes Federation (IDF) and the ‘Harmonized’ criteria.

Methods: A multi-stage stratified sampling method was used to select 4341 subjects from Peninsular and East Malaysia. Subjects underwent physical and clinical examinations.

Results: Based on the WHO, ATP III, IDF and Harmonized definitions, the overall crude prevalences of MetS were 32.1, 34.3, 37.1 and 42.5%, respectively. Regardless of the criteria used, MetS was higher in urban areas, in females, in the Indian population and increased significantly with age. Risk factors also increased with age; abdominal obesity was most prevalent (57.4%), was higher in females (64.2%) and was highest in Indians (68.8%). Hypertension was higher in males (56.5%) and highest among Malays (52.2%). In contrast, the Chinese had the highest prevalence of hypertriglyceridemia (47.4%).

Conclusions: Malaysia has a much higher prevalence of MetS compared with other Asian countries and, unless there is immediate intervention to reduce risk factors, this may pose serious implications on the country’s healthcare costs and services.

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1. Introduction

Metabolic syndrome (MetS) is characterized by the presence of multiple risk factors, including obesity, elevated blood pressure, atherogenic dyslipidemia and elevated plasma glucose \[1,2\]. MetS was first defined by the World Health Organization in 1998 \[3\] as insulin resistance, in addition to 2 other risk factors, being requisite for diagnosis. Subsequent-ly, other criteria were used; the National Cholesterol Education Program Expert Panel III (ATP III) \[4\] and the International Diabetes Federation (IDF) \[5\]. While diagnosis using ATP III criteria was based on the presence of any 3 out of 5 risk factors, IDF considers abdominal obesity as a mandatory component of MetS, where different cut-off points for waist circumference are used for different populations. More recently, in an effort to standardize the criteria for MetS, a joint interim statement was made by a collaborative team consisting of the IDF Task Force on Epidemiology and Prevention, National Heart, Lung and Blood Institute, American Heart Association, World Heart Federation and the International Association for the Study of Obesity. It was proposed that abdominal obesity should no longer be a prerequisite feature of MetS, and that diagnosis should be based entirely on the presence of any 3 of the 5 risk factors \[6\]. The waist measurement cut-off points, however, were to remain ethnic- and gender-specific, as previously recommended in the IDF criteria. Nonetheless, irrespective of the diagnostic criteria used, it has been clearly demonstrated that subjects with MetS are at higher risk of developing cardiovascular disease (CVD) and type 2 diabetes compared with those without the syndrome \[7,8\].

Little is known on the prevalence of MetS in Malaysia. A small survey involving 109 adults (age \(\geq 30\) years), reported a prevalence of 22.9% and 16.5% by IDF and ATP III definitions, respectively \[9\], while a hospital-based study recorded a 40.4% prevalence among patients attending an obesity clinic \[10\]. Realizing the importance of such data, a national survey was carried out from January to December 2008 to determine the prevalence of MetS among adult Malaysians. Here, we report the prevalence of MetS and its associated risk factors in Malaysia using the four definitions, namely WHO, ATP III, IDF and the recently proposed ‘Harmonized’ criteria.

2. Subjects, materials and methods

2.1. Subjects

This nationwide, cross-sectional study using a two-stage stratified sampling design was a collaborative effort of 6 institutions in Peninsular and East Malaysia. The sampling method used was comparable to that used during the National Health Morbidity Survey (NHMS III) in 2006 \[11\]. Peninsular Malaysia was divided into 4 zones, where a state was selected to represent each zone. To ensure adequate representation of the country’s population, the most populous states with adequate proportion of the major ethnic groups were chosen. The selected states were Kelantan, Selangor, Johor and Penang. East Malaysia was represented by the state of Sabah. One urban and one rural area (having the most populous and mixed ethnic groups) was then identified as the study sites. At each study site, enumeration blocks, used by the Department of Statistics Malaysia \[12\] to divide the country into contiguous geographical areas, were used to randomly select households for the survey. For each selected household, World Health Survey Kish tables were used to select one eligible subject (\(\geq 18\) years old) who was then invited by letter to participate in the study.

The main ethnic groups in Peninsular Malaysia are Malay, Chinese and Indian, while the main ethnic groups in Sabah are the Kadazan-Dusun, Bajau and Murut. For the purpose of this study, the Kadazan-Dusun, Bajau, Murut plus several other ethnic minorities were categorized as the ‘other indigenous group’ and non-citizens as ‘others’.

Ethical approval for the study was obtained from the Medical Research and Ethics Committee, the Ministry of Health, Malaysia, as well as from the ethics committee for each participating institute.

2.2. Physical and clinical examinations

Subjects fasted for 10–12 h prior to the study visit, and, after giving informed written consent, underwent physical and medical examinations and answered health-related questionnaires. Body weight was measured in light clothing without shoes (to the nearest 0.1 kg) using a pre-calibrated Seca digital scale and, using the same instrument, height was measured without shoes (to the nearest 0.1 cm). Body mass index (BMI) was calculated and expressed as kg/m\(^2\).

Waist circumference was measured at the midpoint between the lower rib margin (12th rib) and the iliac crest. Subjects were required to stand with feet together and arms in a relaxed position at either side during measurement. The tape was then held in a horizontal position and wrapped around the waist, loose enough for the recorder to place one finger between the tape and the subject’s body. Subjects were asked to breathe normally, and measurements were taken (to the nearest 0.1 cm) at the end of a normal exhalation, while making sure that the subject did not contract the abdominal muscles.

Blood pressure was measured using an Omron digital sphygmomanometer after 5 min rest, in a seated position with the arm supported at heart level, on both right and left arms of the subject. Each arm was measured twice, and measurements from the arm with the highest readings were used to calculate the average systolic and diastolic blood pressure. To minimize variability in the anthropometric measurements between recorders and study sites, the main investigators from each institution attended a special workshop, held prior to the start of the study, where procedures were standardized and appropriate training provided if necessary. Training of the remaining research team members was subsequently carried out by the main investigators at their respective institutions and the same team members were assigned to carry out the anthropometric measurements for the duration of the study.

2.3. Blood and urine sampling

Venous blood samples were taken for fasting plasma glucose (FPG) and other biochemical parameters, and each subject
provided an early morning urine specimen. Blood samples were processed on the same day for either plasma or serum, and, together with the urine samples, were transported to a central laboratory in the Institute for Medical Research, Kuala Lumpur where aliquots of the various samples were stored at −20 °C prior to further analysis.

2.4. Biochemical analysis

Fasting plasma glucose, triglyceride (TG), high density lipoprotein-cholesterol (HDL-C), low density lipoprotein-cholesterol (LDL-C), total cholesterol (T-Chol), urine creatinine and microalbumin were analyzed on Selectra XL chemistry analyzer (Vital Scientific, Netherlands), using reagents purchased from Randox Laboratories Ltd., Crumlin, Co., Antrim, United Kingdom.

The inter-assay coefficient of variant (CV) for glucose at 6.27 mmol/L and 15.6 mmol/L were 4.7% and 6.3%, respectively, and for lipids ranged from 3.5 to 6.4%. Inter-assay CV for urine creatinine was 7.4 and 1.6% at 131 and 295 mmol/L, respectively, and for microalbumin was 4.3 and 2.8% at 735 and 3993 mg/L, respectively. Based on the WHO criteria for MetS, presence of microalbuminuria was defined as an albumin:creatinine ratio (ACR) \( \geq 3.5 \) mg/mmol (equivalent to 30 mg/g (Table 1)). Plasma insulin was measured using DSL-10-1600 Active Insulin ELISA kits (Diagnostic System Laboratories, Inc., Webster, TX 77594-4217, USA), with an inter-assay CV of 14.6 and 8% at 9 and 28 \( \mu \)IU/mL, respectively. Insulin resistance was evaluated using the homeostasis model assessment of insulin resistance (HOMA-IR) and calculated as fasting glucose (mmol/L) \( \times \) insulin (\( \mu \)IU/mL)/22.5 [13].

2.5. Statistical analysis

EpiData version 3.1 was used for data entry at each participating site and data then exported to one center where all of the analysis was performed using Stata version 10. Data cleaning was done by means of checking the box plots for quantitative variables and bar charts for qualitative variables. Point and period prevalence of MetS and its risk factors were determined using exact binomial confidence intervals, based on the four definitions for MetS (Table 1). Where appropriate, the recommended waist circumference cut-off values for South Asians (90 and 80 cm for males and females, respectively) were used in the analysis [14].

3. Results

The socio-demographic characteristics of the study subjects are shown in Table 2. A total of 4341 adults (mean age 47.8 ± 14.5 years) participated, with equal proportions coming from both urban and rural areas. Since the study was conducted mostly during weekdays, there were more female (64.9%) than male (35.1%) participants (the former being mostly homemakers). Malaysia’s ethnic population comprises around 53.3% Malays, 26.0% Chinese and 7.7% Indians, the remaining 13% of other ethnic origin. In this study, however, we had a high proportion of Malay participants (62.5%) while the Chinese were under-represented (14.6%).

The prevalence of individual risk factors for MetS is shown in Table 3. Abdominal obesity showed the highest prevalence at 57.4%, was significantly higher in females (64.2%), increased with age, and was highest in the Indian population (68.8%). Hypertension was more prevalent in males than females (56.5% versus 50.0%), increased significantly with age, and was highest in the Malay population (52.2%). Elevated TG was most prevalent in the Chinese population (47.4%). It was also noted that the prevalence of dyslipidemia was higher in subjects from urban areas, while hypertension was more prevalent in those from rural areas. The prevalence of microalbuminuria,
Table 3 – Prevalence (95% CI) of individual risk factors for MetS based on IDF and Harmonized criteria among Malaysian adults: overall, by location, gender, age- and ethnic-specific.

<table>
<thead>
<tr>
<th>Risk factor</th>
<th>Abdominal obesity</th>
<th>High BP</th>
<th>Reduced HDL-C</th>
<th>Elevated TG</th>
<th>High FPG</th>
<th>Microalbuminuria</th>
<th>HOMA-IR &gt; 2.6</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overall</td>
<td>57.4 (55.9, 58.9)</td>
<td>52.3 (50.8, 53.8)</td>
<td>42.7 (41.2, 44.2)</td>
<td>37.1 (35.6, 38.5)</td>
<td>36.7 (35.2, 38.2)</td>
<td>16.3 (15.1, 17.6)</td>
<td>49.8 (48.0, 51.6)</td>
</tr>
<tr>
<td>Location</td>
<td></td>
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<tr>
<td>Urban</td>
<td>56.5 (54.4, 58.6)</td>
<td>50.0 (47.9, 52.1)</td>
<td>48.1 (46.0, 50.2)</td>
<td>40.6 (38.9, 43.0)</td>
<td>34.9 (32.9, 37.0)</td>
<td>14.1 (12.6, 15.7)</td>
<td>51.3 (48.7, 54.0)</td>
</tr>
<tr>
<td>Rural</td>
<td>58.4 (56.2, 60.5)</td>
<td>54.6 (52.5, 56.8)</td>
<td>36.9 (34.8, 39.0)</td>
<td>33.0 (31.0, 35.1)</td>
<td>38.6 (36.4, 40.7)</td>
<td>18.7 (16.9, 20.5)</td>
<td>48.5 (46.0, 51.0)</td>
</tr>
<tr>
<td>Gender</td>
<td></td>
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</tr>
<tr>
<td>Male</td>
<td>44.9 (42.4, 47.4)</td>
<td>56.5 (53.9, 59.0)</td>
<td>32.6 (30.3, 35.1)</td>
<td>43.4 (40.8, 45.9)</td>
<td>39.2 (36.7, 41.7)</td>
<td>16.9 (15.4, 18.4)</td>
<td>48.1 (45.0, 51.3)</td>
</tr>
<tr>
<td>Female</td>
<td>64.2 (62.4, 66.0)</td>
<td>50.0 (48.1, 52.9)</td>
<td>48.1 (46.2, 50.0)</td>
<td>33.7 (31.9, 35.5)</td>
<td>35.3 (33.5, 37.1)</td>
<td>15.3 (13.4, 17.4)</td>
<td>50.7 (48.4, 53.0)</td>
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<td>Age, years</td>
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<tr>
<td>&lt;40</td>
<td>44.1 (41.3, 47.0)</td>
<td>24.7 (22.3, 27.2)</td>
<td>42.5 (39.7, 45.4)</td>
<td>23.2 (20.9, 25.7)</td>
<td>18.7 (16.5, 21.1)</td>
<td>8.7 (7.4, 10.7)</td>
<td>46.8 (43.6, 50.1)</td>
</tr>
<tr>
<td>40–49</td>
<td>60.4 (57.5, 63.3)</td>
<td>47.0 (44.1, 50.0)</td>
<td>42.2 (39.3, 45.1)</td>
<td>34.3 (31.5, 37.2)</td>
<td>34.8 (31.9, 37.7)</td>
<td>14.8 (12.6, 17.3)</td>
<td>51.0 (47.5, 54.5)</td>
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<tr>
<td>50–59</td>
<td>65.7 (62.7, 68.7)</td>
<td>64.4 (61.3, 67.3)</td>
<td>45.0 (41.9, 48.2)</td>
<td>46.6 (43.4, 49.7)</td>
<td>44.5 (41.4, 47.7)</td>
<td>18.1 (15.7, 20.9)</td>
<td>52.8 (48.8, 56.7)</td>
</tr>
<tr>
<td>≥60</td>
<td>61.9 (58.8, 64.9)</td>
<td>80.0 (77.4, 82.4)</td>
<td>41.1 (38.0, 44.2)</td>
<td>47.6 (44.5, 50.8)</td>
<td>53.0 (49.8, 56.2)</td>
<td>24.7 (21.8, 27.7)</td>
<td>49.7 (45.6, 53.9)</td>
</tr>
<tr>
<td>Ethnicity</td>
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</tr>
<tr>
<td>Malay</td>
<td>60.6 (58.7, 62.4)</td>
<td>52.2 (53.3, 57.1)</td>
<td>38.3 (36.5, 40.2)</td>
<td>36.0 (34.1, 37.8)</td>
<td>43.8 (41.9, 45.7)</td>
<td>18.8 (17.4, 20.5)</td>
<td>54.0 (51.7, 56.3)</td>
</tr>
<tr>
<td>Chinese</td>
<td>49.5 (45.6, 53.5)</td>
<td>48.4 (44.5, 52.4)</td>
<td>46.4 (42.4, 50.4)</td>
<td>47.4 (43.4, 51.4)</td>
<td>27.2 (23.8, 30.9)</td>
<td>9.7 (7.2, 12.6)</td>
<td>41.1 (36.4, 46.0)</td>
</tr>
<tr>
<td>Indian</td>
<td>68.8 (63.8, 73.5)</td>
<td>47.0 (41.8, 52.3)</td>
<td>50.4 (49.0, 57.0)</td>
<td>45.3 (40.1, 50.5)</td>
<td>45.2 (40.0, 50.5)</td>
<td>13.9 (10.3, 18.2)</td>
<td>65.6 (56.7, 73.8)</td>
</tr>
<tr>
<td>Others</td>
<td>44.9 (40.9, 48.9)</td>
<td>46.5 (42.5, 50.5)</td>
<td>53.0 (49.0, 57.0)</td>
<td>26.7 (23.3, 30.4)</td>
<td>11.0 (8.6, 13.7)</td>
<td>13.5 (10.7, 16.7)</td>
<td>38.6 (34.6, 42.9)</td>
</tr>
</tbody>
</table>

* Or on medication.

b ≥3.5 mg/mmol (equivalent to 30 mg/g).
as defined by ACR ≥ 3.5 mg/mmol, was 16.3%. This was higher in subjects from rural areas, increased with age, and was highest in Malays (the lowest prevalence was seen in the Chinese). There were significant ethnic differences in the prevalence of insulin resistance (arbitrarily defined as HOMA-IR ≥ 2.6); the highest prevalence was seen in Indians followed by Malays (Table 3). Prevalence between male and female subjects was comparable and increased with age.

The unadjusted overall prevalence of MetS among adult Malaysians using the WHO, ATP III, IDF and Harmonized definitions were 32.1, 34.3, 37.1 and 42.5%, respectively (Table 4). In order to standardize the risk factors used to determine the prevalence of MetS using the different definitions, data on microalbuminuria and insulin resistance (HOMA-IR) (based on WHO criteria) were not used to calculate the prevalence. The highest prevalence was obtained when using the proposed ‘Harmonized’ criteria, where diagnosis was based on the presence of any 3 out of 5 risk factors, in contrast to the IDF criteria which requires central obesity as a mandatory component. Although central obesity was the most prevalent among the risk factors (Table 3), there were equally large numbers of subjects (notably those of 50 years old and above) with other risk factors, such as hypertension, reduced HDL-C, elevated TG and elevated glucose. On the other hand, the lowest prevalence rate, obtained when using ATP III definition, was due to the higher recommended cut-off values for waist circumference (102 and 88 cm for male and female, respectively) and fasting glucose (≥6.1 mmol/L) [4]. Nevertheless, regardless of the criteria used, prevalence of MetS was generally higher in urban areas, was higher in females, increased with age, and was highest among the Indian population.

4. Discussion

In this first nationwide survey, the crude prevalence of MetS among Malaysian adults was found to be 32.1, 34.3 and 37.1% based on WHO, ATP III and IDF definitions, respectively. Irrespective of the definition used, Malaysia seemed to record a much higher prevalence of MetS compared with other Asian countries, such as India [15], Hong Kong [16] and China [17], where prevalence ranged from 6.1 to 18.3%, when based on ATP III definition, and increased to 9.6 to 25.8%, when data were analyzed using IDF criteria. Our prevalence rate, based on the ATP III criteria, was comparable to that seen in other non-Asian populations, such as the United States (34.4%) [18] and Iran (35.6%) [19]. However, this is likely to be an underestimation as the waist circumference cut-off values used in ATP III were established using Western populations, whereas the WHO/IASO/IOTF [14]-recommended waist circumference cut-off values for South Asians were used in the IDF and ‘Harmonized’ criteria. Importantly, it may be the ‘Harmonized’ criteria that have the advantage of identifying more people with MetS who might subsequently benefit from prevention-based intervention programs targeted to reduce their risk of developing diabetes and cardiovascular disease. Furthermore, using the IDF criteria, which includes central obesity as a requisite feature, may underestimate the number of people with MetS, as waist circumference has been shown to have a low predictive value for detecting hypertension in different populations and age groups [20]. In the Aerobics Center Longitudinal Study [21], a large proportion of the male participants were found to still be at high risk of CVD mortality due to the presence of other multiple risk factors, despite having waist circumference of less than 94 cm (and hence not classified as having MetS by IDF criteria). Moreover, because of the difficulty and impracticality to perform insulin resistance and microalbumin measurements in clinical practice and in large epidemiologic studies (required for the WHO definition), most reports on MetS are based either on the ATP III or IDF definitions [16–19].

The high prevalence of CVD risk factors recorded in this study is expected. As reported in the NHMS III in 2006 [11], the prevalence of obesity, hypertension and diabetes has escalated tremendously over the last 10 years, in tandem with the country’s rapid urbanization and improved socioeconomic

### Table 4 – Prevalence (95% CI) of MetS based on WHO, ATP III, IDF and Harmonized criteria among Malaysian adults: overall, by location, gender-, age- and ethnic-specific.

<table>
<thead>
<tr>
<th></th>
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<tbody>
<tr>
<td><strong>Overall</strong></td>
<td>32.1 (30.7, 33.5)</td>
<td>34.3 (32.9, 35.8)</td>
<td>37.1 (35.6,38.5)</td>
<td>42.5 (41.0, 44.0)</td>
</tr>
<tr>
<td><strong>Location</strong></td>
<td></td>
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<td></td>
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<tr>
<td>Urban</td>
<td>32.8 (30.9, 34.8)</td>
<td>36.0 (33.9, 38.0)</td>
<td>39.1 (37.1,41.2)</td>
<td>44.9 (42.8, 46.9)</td>
</tr>
<tr>
<td>Rural</td>
<td>31.3 (29.3, 33.3)</td>
<td>32.6 (30.6,34.6)</td>
<td>35.0 (33.0,37.4)</td>
<td>40.0 (37.9, 42.2)</td>
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<tr>
<td><strong>Gender</strong></td>
<td></td>
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</tr>
<tr>
<td>Male</td>
<td>31.8 (29.4, 34.2)</td>
<td>31.1 (28.8, 33.5)</td>
<td>32.1 (29.8,34.5)</td>
<td>40.2 (37.7, 42.8)</td>
</tr>
<tr>
<td>Female</td>
<td>32.2 (30.5, 34.0)</td>
<td>36.1 (34.3, 37.9)</td>
<td>39.8 (38.0,41.6)</td>
<td>43.7 (41.9, 45.6)</td>
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<tr>
<td><strong>Age, years</strong></td>
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<tr>
<td>&lt;40 (1217)</td>
<td>12.7 (10.8, 14.7)</td>
<td>16.7 (14.6,18.9)</td>
<td>20.3 (18.1,22.7)</td>
<td>22.4 (20.0, 24.8)</td>
</tr>
<tr>
<td>40–49 (1131)</td>
<td>29.4 (26.8, 32.2)</td>
<td>32.1 (29.3,34.9)</td>
<td>36.6 (33.8,39.5)</td>
<td>40.1 (37.2, 43.0)</td>
</tr>
<tr>
<td>50–59 (1002)</td>
<td>40.7 (37.7, 43.8)</td>
<td>44.1 (40.9,47.2)</td>
<td>47.5 (44.4,50.7)</td>
<td>54.1 (50.9, 57.2)</td>
</tr>
<tr>
<td>≥60 (991)</td>
<td>50.2 (47.0, 53.4)</td>
<td>48.7 (45.5,51.9)</td>
<td>48.3 (45.1,51.4)</td>
<td>58.4 (55.2, 61.5)</td>
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<tr>
<td><strong>Ethnicity</strong></td>
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<tr>
<td>Indian</td>
<td>44.6 (39.5, 49.8)</td>
<td>44.8 (39.7,50.1)</td>
<td>47.3 (42.1,52.5)</td>
<td>51.9 (46.7, 57.1)</td>
</tr>
<tr>
<td>Malay</td>
<td>35.3 (33.5, 37.1)</td>
<td>35.9 (34.1,37.7)</td>
<td>38.8 (37.1,40.7)</td>
<td>43.9 (42.0, 45.8)</td>
</tr>
<tr>
<td>Chinese</td>
<td>26.7 (23.3, 30.4)</td>
<td>31.8 (28.1,35.6)</td>
<td>32.9 (29.3,36.7)</td>
<td>42.1 (38.2, 46.0)</td>
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<tr>
<td>Others</td>
<td>16.0 (13.2, 19.1)</td>
<td>23.9 (20.6,27.4)</td>
<td>27.5 (24.1,31.3)</td>
<td>31.4 (27.8, 35.2)</td>
</tr>
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</table>
status. Nevertheless, this is not exclusive to Malaysia, as such observations have also been reported in many other economically developing countries such as China [17] and India [22]. Although BMI has most often been used to define overweight and obesity, studies have shown that abdominal obesity, represented by waist circumference, is a strong independent risk factor for CVD [23–25]. The recommended waist circumference cut-off values for South Asians (90 cm for men and 80 cm for women) [14] to define abdominal obesity have been adopted by many Asian countries, including China [17], Hong Kong [26] and Singapore [27]. Unfortunately, in Malaysia, the previous WHO cut-off values of 102 and 88 cm in men and women [28] are still being widely used. This could result in underestimating the health burden associated with central obesity and, as shown in the current study; the prevalence was much higher at 44.9 and 64.2% in men and women, respectively, when based on the recommended South-Asian cut-off values, compared with only 7.2 and 26.0% in men and women, respectively, reported in NHMS III [29]. Based on the current study, Malaysia has the highest prevalence of abdominal obesity compared with other countries with similar ethnic populations, such as China [17], Hong Kong [26] and India [30], where the overall prevalence is reported to be 7.7, 25.2 and 31.4%, respectively.

Many studies have shown that the prevalence of MetS varies among different ethnic populations living in the same country and is postulated to be associated with environmental and genetic factors [31,32]. Similarly, our study showed that the prevalence of MetS among Indians was 51.9%, much higher compared with 43.9% in Malays and 42.1% in Chinese. Although the pattern was similar, there is no doubt that MetS is going to be a more challenging public health issue in Malaysia than in Singapore, where the prevalence, based on modified ATP III criteria, was only 28.8% in Asian Indians, 24.2% in Malays and 14.8% in Chinese [27]. It is a well-known fact that Asians, in particular of South Asian origin, have an ethnic predisposition to abdominal obesity, hypertension, dyslipidemia and hyperinsulinemia and glucose intolerance and, as such, have a higher incidence of MetS, resulting in increased morbidity and mortality rates due to diabetes and cardiovascular disease (CVD) [33,34]. In contrast, our study showed that there was no significant ethnic-specific clustering of MetS or CVD risk factors. Although the highest prevalence of abdominal obesity and elevated glucose was indeed observed in Indian subjects, hypertension and elevated TG were more prevalent in Malay and Chinese, respectively. This implies that, except for genetics, environmental factors are equally important, and are likely to be the main contributing factors to the high prevalence of MetS and CVD risk profiles seen among Malaysians.

In conclusion, this study has generated important public health data and enough evidence to show that, regardless of the criteria used, the prevalence of MetS and its associated risk factors is alarmingly high among the adult population in Malaysia. Since MetS is known to be associated with an increased risk for CVD and type 2 diabetes [7,8], this will have serious implications on the country’s health care costs. There is indeed an urgent need to further improve the current health intervention programs. It is also timely that the cut-off points for waist circumference, as well as body mass index, are revised to more appropriate values in line with the recommendation of the expert groups [35] and hence standardize reporting for the whole country.

Conflict of interest

The authors have no conflicts of interest to declare.

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