

Prevalence of Metabolic Syndrome Among Staff in a Malaysian Public University Based on Harmonised, International Diabetes Federation and National Cholesterol Education Program Definitions

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ABSTRACT

Introduction: Metabolic syndrome (MetSyn) as defined by the latest Harmonised definition and the agreement between the Harmonised definition and other definitions is poorly studied among Malaysians. This study was conducted to determine and compare the prevalence of MetSyn according to the Harmonised, International Diabetes Federation (IDF) and National Cholesterol Education Program (NCEP ATP III) definitions among Malay staff of Universiti Putra Malaysia (UPM). **Methods:** Subjects aged between 20 to 65 years were recruited by convenient sampling. Waist circumference, blood pressure, lipid profiles and fasting plasma glucose levels were assessed. The agreement between the Harmonised and other definitions was determined by Kappa statistics. **Results:** A total of 227 subjects with a mean \pm SD age of 37.9 \pm 9.6 years participated in the study. The overall prevalence of MetSyn was 38.3%, 38.8% and 33.5% according to Harmonised, IDF and NCEP ATP III definitions, respectively. Generally, men had higher prevalence of MetSyn than women. The prevalence increased with age in both genders with a more progressive trend in women. Men in the age group of 20-39 years had a high prevalence of metabolic syndrome. A strong agreement was found between the Harmonised and the IDF definitions (Kappa index=0.991), and between the Harmonised and the NCEP ATP III definitions (Kappa index=0.857). **Conclusion:** Regardless of definitions used, the prevalence of metabolic syndrome in the study, especially in young men, was high and warrants further investigation. The Harmonised definition is suitable for diagnosing metabolic syndrome in any population with similar socio-demographic characteristics.

Keywords: Prevalence of metabolic syndrome, components of metabolic syndrome, agreement between definitions

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INTRODUCTION

Metabolic syndrome (MetSyn) is a clustering of metabolic abnormalities associated with cardiovascular disease and diabetes mellitus. Those with MetSyn are at higher risk of developing impaired glucose tolerance, type 2 diabetes and cardiovascular disease (Isomaa, 2003; Lorenzo *et al.*, 2003). The risk of cardiovascular disease and all-cause mortality also increases with the development of MetSyn (Lakka *et al.*, 2002).

However, the definition of MetSyn has been debated for years. Following the first official definition of MetSyn proposed by an expert group of the World Health Organisation (Alberti & Zimmet, 1998), there have been different definitions proposed by various organisations focusing on different metabolic parameters. More recently, the Harmonised definition was proposed by a collaborative team consisting of six professional bodies (Alberti *et al.*, 2009). Based on this definition, MetSyn is manifested through any three or more of these features: central obesity, hypertriglyceridemia, reduced HDL cholesterol, elevated blood pressure and impaired fasting plasma glucose. For central obesity, ethnic-specific cut-off points of waist circumference measurement were proposed for diagnosis.

In Malaysia, a nationwide study on Malaysian adults revealed that the overall prevalence rates of MetSyn were 32.1%, 34.3%, 37.2% and 42.5% according to World Health Organisation (WHO), National Cholesterol Education Program: Adults Treatment Program III (NCEP ATP III), International Diabetes Federation (IDF) and Harmonised definitions, respectively (Mohamad *et al.*, 2012). However, little is known about the prevalence of MetSyn based on the Harmonised definition and its agreement with the other definitions of MetSyn. This study is aimed at determining the prevalence of MetSyn according to Harmonised, IDF and NCEP ATP III

definitions among the male and female Malay staff of Universiti Putra Malaysia, Serdang campus.

METHODS

Subjects

Subjects were recruited by convenience sampling from the academic and non-academic staff of Universiti Putra Malaysia (UPM) in February 2012. The inclusion criteria were male and female Malay staff, aged between 20 to 65 years, who volunteered and agreed to participate in the study. Informed consent was obtained from all eligible subjects while ethical approval was obtained from the Medical Research Ethics Committee, Faculty of Medicine and Health Sciences, UPM.

Data collection

Subjects provided socio-demographic information and underwent physical examination and biochemical measurements. A structured, self-administered questionnaire was used to gather socio-demographic information on age, gender and past medical history.

Waist circumference was measured with a measuring tape at the high point of the iliac crest; measurements to the nearest 0.1cm were taken at the end of normal expiration. All anthropometric measurements were performed in duplicate and an average of the two readings was used for analysis. Blood pressure was measured in duplicate using an IA2 Omron automatic blood pressure monitor (Omron, Japan) while the subjects were seated and rested.

Blood samples were collected in the morning after subjects had undergone an overnight fast. A total of 5ml of venous blood was collected with syringe and needle. Fasting plasma glucose level was determined using blood plasma while serum was used to analyse triglycerides, total cholesterol and high-density lipoprotein

(HDL) cholesterol in an accredited pathology laboratory (Gribbles Pathology (M) Sdn Bhd, Petaling Jaya, Malaysia).

Metabolic syndrome

The Harmonised, IDF and NCEP ATP III definitions of MetSyn, which are listed in Table 1, were adopted in the study.

Statistical analysis

Data were analysed using IBM SPSS for Windows version 20 (IBM, Armonk, New York). Descriptive data for continuous variables were expressed as means \pm S.D while categorical data were expressed as number (percentage). Difference between groups was determined by Pearson's Chi-Square test and independent *t*-test. Agreement between different MetSyn definitions was assessed by using Kappa

statistics. A *p*-value of <0.05 was considered statistically significant.

RESULTS

A total of 227 Malay subjects, consisting of 58 men (25.6%) and 169 women (74.4%), participated in the study. The mean age of the subjects was 37.9 ± 9.6 years, with a large proportion of 62.1% distributed in the age range of 20-39. A total of 12 (5.3%) of the subjects were smokers. Only 7 (3.1%) were previously diagnosed with hypertension while 2 (0.9%) were with type 2 diabetes.

Metabolic characteristics of the subject

The mean waist circumference of the subjects was 97.7 ± 11.4 cm without gender difference. Compared with women, men had a significantly higher mean of systolic blood

Table 1. Metabolic syndrome definitions adopted in the study

<i>Risk factors</i>	<i>NCEP ATP III (2001)</i>	<i>IDF (2005)</i>	<i>Harmonised (2009)</i>
Waist circumference (WC)	For Caucasian: Men: WC \geq 102cm Women: WC \geq 88cm	For South Asian: Men: WC \geq 90cm Women: WC \geq 80cm	For South Asian: Men: WC \geq 90cm Women: WC \geq 80cm
Triglycerides (TG)	TG \geq 1.7 mmol/L	TG \geq 1.7 mmol/L or on specific treatment for elevated TG	TG \geq 1.7 mmol/L or on drug treatment for elevated TG
HDL cholesterol	Men: HDL-C $<$ 1.03 mmol/L Women: HDL-C $<$ 1.29 mmol/L	Men: HDL-C $<$ 1.03 mmol/L Women: HDL-C $<$ 1.29 mmol/L or on specific treatment for reduced HDL-C	Men: $<$ 1.0 mmol/L Women: $<$ 1.3 mmol/L or on drug treatment for reduced HDL-C
Blood pressure	\geq 130/85 mmHg	Systolic \geq 130 mmHg or diastolic \geq 85 mmHg or on treatment for hypertension	Systolic \geq 130 mmHg and/or diastolic \geq 85 mmHg or on antihypertensive drug treatment
Blood glucose level	\geq 6.1 mmol/L or type 2 DM	\geq 5.6 mmol/L or type 2 DM	\geq 5.6 mmol/L or on drug treatment for elevated glucose
Metabolic syndrome	At least any three of the risk factors	WC + at least any two of other risk factors	At least any three of the risk factors

(NCEP, 2001; Alberti *et al.*, 2006; Alberti *et al.*, 2009)

pressure ($p<0.001$), diastolic blood pressure ($p=0.013$), triglycerides ($p=0.003$) as well as fasting plasma glucose ($p=0.021$). In contrast, the mean HDL cholesterol was significantly higher in women than in men ($p<0.001$).

Prevalence of metabolic syndrome

The overall prevalence rates of MetSyn were 38.3%, 38.8% and 33.5% according to Harmonised, IDF and NCEP ATP III criteria. Regardless of the definitions used, generally men had higher MetSyn occurrence than women. Analysed by Pearson’s Chi-Square test in women only, a combined education level category of university/college and pre-university had significantly higher prevalence of MetSyn than the combined education level category of primary, lower secondary and upper secondary, regardless of the definitions used. No significant difference was observed in the prevalence of MetSyn between academic and non-academic staff.

Figures 1 and 2 illustrate the prevalence of MetSyn by age groups in men and women respectively. An increasing trend of the prevalence by age was noted in both men

and women according to all the three definitions but more progressively for women. Women exhibited a steady increase in prevalence with age and a greater magnitude of increase across the age groups compared to men. However, men had higher prevalence of MetSyn than women up to 50 years of age regardless of the definitions used. In women, regardless of the definitions used, higher prevalence in the 50-59 age group compared to men was observed.

Among the three definitions used, both Harmonised and IDF definitions recorded a similar prevalence of MetSyn for all age groups in men and women except for the age group of 40-49 years for men where IDF definition recorded a higher prevalence with a percentage of 63.6%, which was 9.1% higher than Harmonised-defined prevalence. In men, the highest prevalence was found in the 50-59 years of age group according to Harmonised and IDF definitions with two equal percentages of 70% while the highest prevalence was recorded in the 40-49 years age group according to NCEP ATP III definition with a percentage of 54.5%. For women, the highest

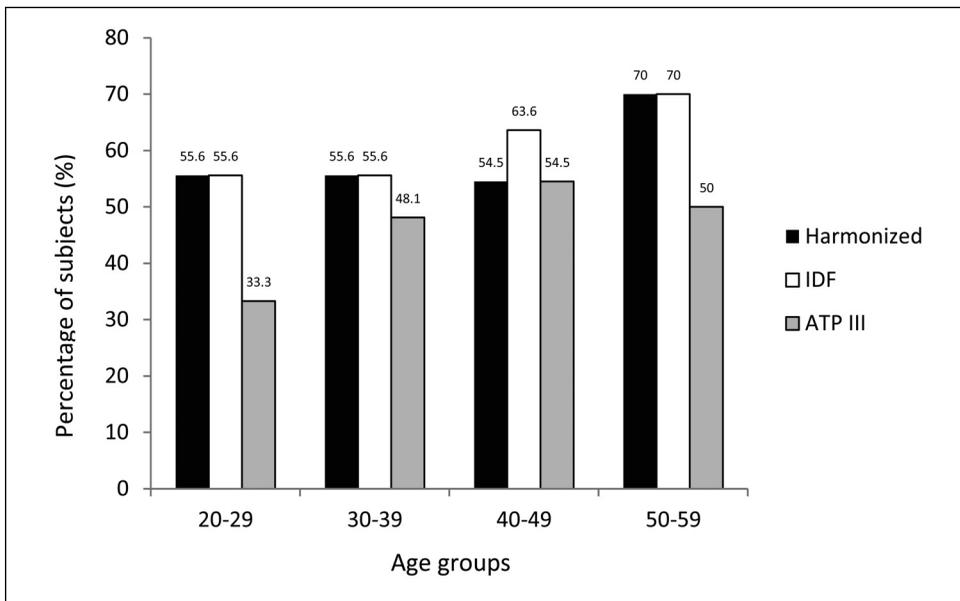


Figure 1. Prevalence of metabolic syndrome in men by age groups

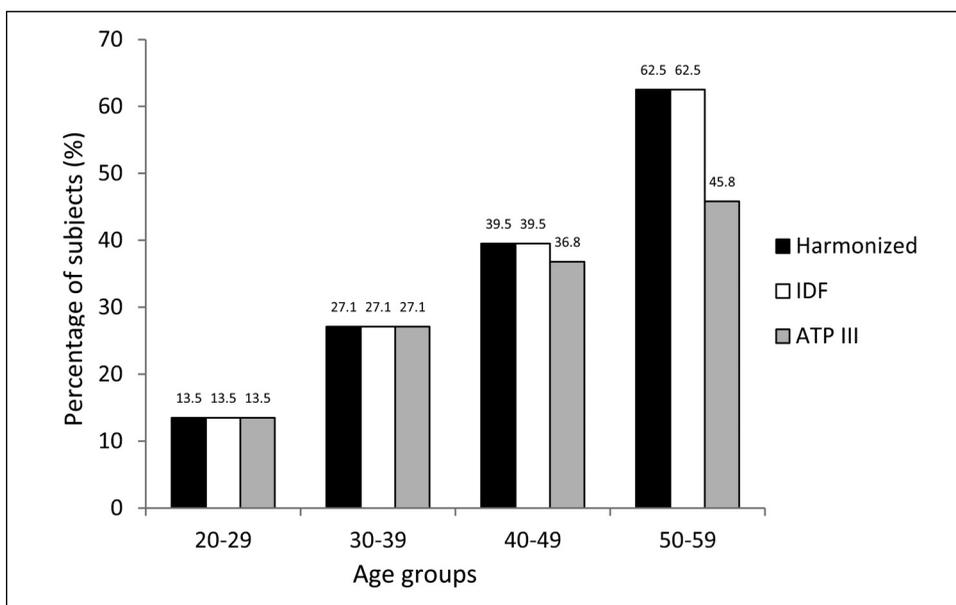


Figure 2. Prevalence of metabolic syndrome in women by age groups

prevalence was noted in 50-59 age group regardless of the definitions used.

Prevalence of components of metabolic syndrome

The prevalence of individual components of MetSyn according to the three definitions is presented in Table 2. Central obesity was the most prevalent component with a percentage of 91.6% by Harmonised or IDF definitions and 71.8% by NCEP ATP III definition while elevated fasting plasma glucose was the least prevalent component in the study subjects with a percentage of 16.3% by Harmonised or IDF definitions and 8.4% by NCEP ATP III definition. A similar pattern was observed in a stratified analysis by gender.

The prevalence of central obesity was significantly higher in women than men ($p < 0.001$) regardless of the definitions used. However, compared to women, men had a significantly higher prevalence of elevated triglycerides (32.8% vs 18.9%; $p = 0.030$) and elevated blood pressure (60.3% vs 37.3%; $p = 0.002$). Although a significant gender difference was not detected, the prevalence

of reduced HDL cholesterol and elevated fasting plasma glucose was higher in men than women regardless of the definitions used.

It is worth noting that with a lower cut-off point for waist circumference adopted as per Harmonised and IDF criteria compared to NCEP ATP III criteria, there was a marked increase in the prevalence of central obesity at a magnitude of 29.3% in men and 16.5% in women. However, there was only a slight difference between the prevalence of elevated fasting plasma glucose by Harmonised/IDF and NCEP ATP III and no obvious difference between reduced HDL as defined by Harmonised and IDF/NCEP ATP III.

Agreement among the three definitions

The agreement between the three definitions of MetSyn is depicted in Table 3. The strongest agreement was found between Harmonised and IDF definitions. Among all subjects fulfilling the Harmonised criteria of MetSyn, 98.4% also met the IDF criteria. All of the subjects classified as normal by the Harmonised definition were also categorised as normal by the IDF definitions.

Table 2. Prevalence of components of metabolic syndrome

Components	Men n (%)	Women n (%)	Total n (%)	p-value
Central obesity				
IDF/Harmonised-defined	44 (75.9)	164 (97.0)	208 (91.6)	<0.001
ATP III-defined	27 (46.6)	136 (80.5)	163 (71.8)	<0.001
Elevated TG		19 (32.8)	32 (18.9)	51 (22.5)
0.030				
Reduced HDL-C				
Harmonised-defined IDF/	32 (55.2)	82 (48.5)	114 (50.2)	0.382
ATP III-defined	34 (58.6)	82 (48.5)	116 (51.1)	0.184
Elevated BP ^b	35 (60.3)	63 (37.3)	98 (43.2)	0.002
Elevated FPG ^c				
Harmonised/IDF-defined	12 (20.7)	25 (14.8)	37 (16.3)	0.294
ATP III-defined	7 (12.1)	12 (7.1)	19 (8.4)	0.238

^a Value from Pearson Chi-Square test to detect difference between men and women

^b or on medication

^c or known diabetes mellitus

Table 3. Sensitivity, specificity and level of agreement for metabolic syndrome defined by Harmonised definition against IDF definition and NCEP ATP III definition

Definition	Harmonised definition					
	MS (n)	Normal (n)	Sensitivity (%)	Specificity (%)	Kappa index	p-value
IDF						
MS (n)	90	1	98.4	100.0	0.991	<0.001
Normal (n)	0	139				
ATP III						
MS (n)	74	2	97.4	91.4	0.857	<0.001
Normal (n)	13	138				

An excellent agreement was found between the Harmonised and the IDF definitions (Kappa value = 0.991, sensitivity = 98.4%, specificity = 100.0%).

An excellent agreement was also observed between the Harmonised and the NCEP ATP III definitions (Kappa index = 0.857, sensitivity = 97.4%, specificity = 91.4%). Of the total subjects classified by NCEP ATP III criteria, 97.4% fulfilled the Harmonised criteria. However, of the subjects without MetSyn according to NCEP ATP III, 8.6 % were categorised as having MetSyn by the Harmonised criteria.

DISCUSSION

The overall prevalence of MetSyn in this study was high and comparable to the national prevalence of MetSyn in Malaysia which was 42.5%, 37.1% and 34.3% according to Harmonised, IDF and NCEP ATP III definitions, respectively (Mohamud *et al.*, 2012). Although this is an ethnic specific study, it shared some common characteristics with the national survey of MetSyn, particularly in the subjects' age and gender. The mean age of subjects was 37.9 years in this study compared to the mean

age of 48 years in the national survey. In addition, a relatively larger proportion of subjects were female in both of the studies. In another study involving 1494 Malay employees in Kuala Lumpur (Moy & Bulgiba, 2010), the prevalence of MetSyn was 38.2% using IDF definition, which is very similar to the 38.8% of our study. Interestingly, a higher prevalence of MetSyn was noted in women, but not in men, with higher education level (pre-university and college/university). It is generally recognised that educational level is negatively correlated with the prevalence of MetSyn (Santos, Ebrahim & Barros, 2008; Hidvegi *et al.*, 2001). The discrepancy found in this study might be due to a more affluent lifestyle practised by those women with a higher education level. Similar findings were reported among Sri Lankan adults (Katulanda *et al.*, 2012).

The overall prevalence of MetSyn was the highest in the IDF definition (38.8%), followed by the Harmonised (38.3%) and the NCEP ATP III (33.5%); however no significant difference between the three definitions was found. Previous studies showed that the Harmonised definition recorded a higher prevalence of MetSyn than IDF definition (Mohamud *et al.*, 2012; Pandey *et al.*, 2010) as central obesity is not a compulsory in the Harmonised definition. In the Harmonised definition, those non-obese subjects having other components of MetSyn can be classified as having MetSyn as long as they fulfill the minimum numbers of components defined, resulting in more people being diagnosed as having MetSyn. However, in this study, the subjects recruited were mostly with central obesity. As expected, the prevalence of MetSyn using NCEP ATP III definition was the lowest among the three, as the definition adopts higher cut-off points for central obesity and elevated fasting plasma glucose. Tan, Kantilal & Singh (2008) reported similar findings in that the prevalence of MetSyn defined by NCEP ATP III was 6.4% lower than that of IDF definition.

In our study, the prevalence of MetSyn increased with age regardless of gender and the definitions used. The findings were in accordance with other studies conducted in Malaysia and other countries (Mohamud *et al.*, 2012; Tan *et al.*, 2008; Ford, Giles & Mokdad, 2004). Increasing age has been linked to an increase in metabolic risk following long term cumulative effects of an unhealthy lifestyle, imbalanced diet and aging process. However, women showed a larger magnitude of increase in the MetSyn occurrence by age compared to men, most likely due to lower MetSyn prevalence at the younger age categories. In the age group of 20-29, men recorded more than 4-fold MetSyn prevalence than women by the Harmonised and the IDF definitions (55.6% vs 13.5%) and by nearly 2.5-fold by the NCEP ATP III definition (33.3% vs 13.5%). For the age group of 30-39, it was double in men than in women in the three MetSyn definitions (48.1%-55.6% vs 27.1%). The difference was smaller in the age group of 40-49 years (54.5% - 63.6% vs 36.8% - 39.5%). Two issues arose from these findings. Firstly, in this study, men in the age group of 20-39 years had a high prevalence of MetSyn and were not significantly different from men of older age. Therefore, a relatively small magnitude of increase by age was observed. A closer inspection on each component of MetSyn in men may explain this phenomenon. Men who were aged 20-39 years in this study had a high prevalence of elevated blood pressure (ranging from 51.9% - 55.6% by age groups), reduced HDL cholesterol (ranging from 55.6% - 66.7% by MetSyn definitions) and triglycerides (44.4%). It has been known that younger adults with MetSyn will have prolonged exposure to metabolic risk factors. Therefore, it is crucial to determine any socio-demographic, lifestyle and dietary factors associated with a high prevalence of MetSyn in male subjects of the study. Secondly, higher prevalence of MetSyn in men than in women regardless of age was found. The findings were in contrast with other local

studies (Mohamud *et al.*, 2012; Laila Ruwaida *et al.*, 2011). The national survey by Mohamud *et al.* (2012) reported a higher prevalence of MetSyn ranging from 32.2% - 43.7% in women compared to only 31.1% - 40.2% in men by different definitions. Laila Ruwaida *et al.* (2011) attributed the higher prevalence of MetSyn to physiological and socio-economic factors among women. However, the results from this study were in accordance with another local study (Moy & Bulgiba, 2010) which found female subjects from an urban area to have a lower prevalence of MetSyn than their counterparts in a rural area due to their higher employment status. A previous study in the same university cohort (Heng *et al.*, 2011) also found similar results. In that study, the prevalence of MetSyn by IDF definition in obese UPM staff was double in men compared to women (59.2% vs 23.1%). The staff involved in the university study lived in an urban area while subjects from the national study were from a mixed rural and urban population. Women subjects from the rural area were mostly housewives (Mohamud *et al.*, 2012) while in the urban area, women subjects were employed. They tend to have higher self-esteem and body image which were possibly linked to a lower prevalence of MetSyn. The low prevalence of MetSyn in women was more obvious at a younger age category. Interestingly, at the age of 50-59, the prevalence of MetSyn in women surmounted men of the same age category. One possible explanation is the onset of menopause in women at this age. Prevalence of MetSyn increased in post-menopausal women (Lobo, 2008) due to hormonal change.

In our study, although men appeared leaner than women by waist circumference ($p < 0.001$), they had more metabolic risk factors than their gender counterparts. For example, the prevalence of elevated triglycerides and blood pressure was significantly higher in men than women (Table 2). When NCEP ATP III waist circumference cut-off point was applied, in

men, elevated blood pressure became the commonest risk factor, followed by reduced HDL-C. In women, regardless of definition used, central obesity was still the most prevalent risk factor. However, half of the women had reduced HDL-C while more than one third had elevated blood pressure.

All of the 12 subjects who smoked were men. Smoking has been known to be an independent risk factor for MetSyn. The findings suggest that intervention targeting at gender-specific risk factors may be more appropriate in combating MetSyn. For example, reduction of abdominal fat should be the primary target in women but for men, elevated triglycerides, elevated blood pressure and smoking cessation should be given due attention.

Central obesity as defined by Harmonised and IDF criteria was the commonest MetSyn component regardless of gender. Two-thirds of men and nearly all women had central obesity, which is much higher than the national prevalence. Malaysia Non-Communicable Diseases Surveillance 2005/06 reported that 48.6% of Malaysians aged 25-64 years were classified under central obesity according to the IDF cut-off point (MOH, 2006). In another nationwide study (Rampal *et al.*, 2012), the prevalence of central obesity using Harmonised definition of MetSyn among Malay adults was 36.7% which is much lower than ours. The higher prevalence of obesity in the present study may be due to a sedentary lifestyle among UPM staff. Heng *et al.* (2011) who used step counts to quantify physical activity level reported that UPM staff with central obesity were relatively sedentary. The study also showed that physical activity among the staff was inversely associated with the prevalence of MetSyn.

There was a strong agreement between Harmonised and IDF definitions of MetSyn (Kappa index = 0.991). The results were expected as Harmonised and IDF definition shared common components of MetSyn with the difference being only the pre-requisite of

central obesity in IDF definition and a slight difference in HDL cholesterol cut-off points between the definitions. Moreover, a large proportion of the study subjects had central obesity. Therefore, it was of higher probability that subjects who fall into MetSyn category by Harmonised definition will also fulfill the IDF criteria of MetSyn.

The agreement between Harmonised and NCEP ATP III definitions remains strong (Kappa index = 0.857) although it was weaker than the agreement between Harmonised and IDF definition. Although NCEP ATP III shared some of the components of MetSyn as in the Harmonised definition, the higher cut-off points in determining central obesity and elevated fasting plasma glucose resulted in less subjects being classified as having MetSyn. Taken together, the Harmonised definition of MetSyn yielded similar and compatible results as compared to the IDF and the NCEP ATP III definitions. This latest definition of MetSyn is suitable for diagnosing MetSyn in any population with similar socio-demographic characteristics.

There are some limitations in the present study. As convenient sampling was used in the recruitment of subjects, the study was not representative of the entire population in the university. The sample size was relatively small while the subjects were all Malay. Therefore, the study findings cannot be generalised to the Malaysian adult population.

Also, the NCEP-ATPIII definition of MetSyn used in this study was the version released in 2001. There is a more recent version released in 2005, which is similar to the Harmonised definition, and the results might be different if the 2005 version had been used.

CONCLUSION

The prevalence of MetSyn in the study was alarmingly high regardless of the definitions used. IDF definition of MetSyn diagnosed

the highest prevalence of MetSyn, followed by Harmonised and NCEP ATP III definitions. The prevalence of MetSyn increased with age but the increase was more prominent in women. Men from young age categories recorded alarmingly high prevalence of MetSyn. Central obesity was the most common risk factors prevalent among the subjects. Strong agreement was found between Harmonised and IDF definitions, and Harmonised and NCEP ATP III definitions, indicating that the Harmonised definition is suitable for diagnosing MetSyn in any population with similar socio-demographic characteristics. A significantly high prevalence of central obesity regardless of gender and high prevalence of MetSyn in young men should be further studied. These findings provide alarming data for policy-makers as well as health professionals in combating MetSyn in the country.

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