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Frequency of Metabolic Syndrome in a Rural District Hospital in Malaysia

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Abstract

Background: Metabolic Syndrome (MetS) is a cluster of factors that increase the risk of Coronary Artery Disease (CAD) and Diabetes Mellitus (DM).

Methods: A cross-sectional analysis of data was performed from 355 patients who attended rural Malaysian district hospital outpatient clinics from January to June 2011, using the International Diabetes Federation (IDF) criteria to define MetS and identify the demographic risk factors for developing MetS.

Results: Prevalence MetS was 48.7% of which 63.6% were female. Hypertension was the most common metabolic risk factor (82.4%). Age, female sex and BMI were significant factors for developing MetS with OR=1.05 (CI=1.03-1.06), 2.53 (CI=1.51-4.26) and 1.19 (CI=1.13-1.25) respectively. Risk was significantly lower among Chinese patients compared to Indian patients p=0.01, OR=0.46 (CI=0.23-0.87).

Conclusion: Age, female gender and ethnicity were noted to be demographic factors for developing MetS.

Keywords: Metabolic syndrome; Hypertension; Fasting plasma glucose; Low HDL-C and high triglycerides

Introduction

The term 'Metabolic Syndrome' (MetS) dates back to at least the late 1950s, but came into common use in the late 1970s to describe various associations between risk factors and Diabetes Mellitus (DM) noted as early as the 1920s [1,2]. MetS is a cluster of interrelated factors that increase the risk of Cardiovascular Disease (CAD) and type 2 DM [3]. The central feature of MetS is obesity and its prevalence is increasing with the 'obesity epidemic' [3]. The increased prevalence of MetS is accompanied with three-fold and two-fold increases in type 2 DM and CAD respectively and has become a major health challenge worldwide [4]. The Third Report of the National Cholesterol Education Program Expert Panel on Detection, Evaluation, and Treatment of High Blood Cholesterol in Adults (ATP III) highlights the importance of treating patients with MetS to prevent cardiovascular disease [5]. However, there is minimal data available on the prevalence of MetS in Malaysia using most recent criteria of the International Diabetes Federation (IDF) for MetS definition [6].

The objectives of this study were to determine the frequency of MetS, to identify its risk factors and the most common co-morbidity of metabolic risk factors for developing MetS by IDF criteria, among patients who attended the general outpatient and medical consultation clinic in a rural district hospital in Malaysia.

Materials and Methods

Patients attending a rural district hospital in Malaysia were referred by medical officers and other practitioners, or referred back from secondary and tertiary level hospitals for continued care.

This was a cross sectional study with a sample size (n=355) determined using the Epi Info version 6(CDC) for population surveys. The study period was from January 15 to June 30, 2011. Samples were selected using clustered systematic randomizing. Fifteen patients were recruited every week, by randomly selecting patients from two out-patient clinics. Inclusion criterion was age above 13 years. Exclusion criteria were: patients with known causes of obesity such as Cushing's and pseudo-Cushing's syndrome, known causes of dyslipidaemia such as chronic renal failure, nephrotic syndrome, hypothyroidism, and HIV patients on antiviral drugs.

The research purpose was explained and consent obtained from patients above 18 years old and from parents for those less than 18, with patients interviewed and examined by the investigators. Questions asked included smoking history, alcohol intake, occupation, family income, exercise (mild =active with house chores, moderate activity = 30 minute walk, jog, swimming per day for three days per week, etc. Strenuous exercise= hard labourer. History also included use of contraceptive pills, knowledge of healthy food and lifestyle, hazards of being obese (BMI ≥ 30). Measurements of the BMI (kg/m^2), Waist Circumference (WC) (cm) and blood pressure (mmHg) were carried out by the same assigned staff. Measurement of WC was standardized at the midpoint between the lower costal cartilage and the highest point of iliac crest with the patient exhaling completely. Blood samples for Fasting Blood Sugar (FPG), serum Triglycerides (TG) and High-Density Lipoprotein Cholesterol (HDL-C) were taken in the early morning after an overnight fast.We chose IDF to define MetS because it is ethnic specific.

Samples were defined as high waist circumference (WC ≥ 90 cm for male and WC ≥ 80 cm for female) and normal weight (BMI 18.5-22.9), overweight (BMI 23-29.9) and obese (BMI ≥ 30) for both female and male. Definitions were hypertension (systolic BP ≥ 130 mmHg, or diastolic BP ≥ 85 mmHg); raised fasting plasma glucose (FPG=5.6 mmol/L - 6.99 mmol/L; diabetes mellitus (FPG ≥ 7 mmol/L); low HDL-C < 1.29 mmol/L in females and HDL-C <1.03 mmol/L in males; high TG ≥ 1.7 mmol/L for both females and males.

Statistical analyses were performed using the SPSS version 11.5(SPSS Inc, Chicago, Il, USA). Student's test was used to compare means; chi-squared test to identify the associations. Any result of p value value < 0.05 was considered as significant. Wilcoxon Signed Rank test was used for non-normally distributed variables if applicable.

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Variable	Proportion (%)of whole study population (n=355)	Proportion (%) of subjects with MetS (n=172)
Age group (years)		
13-19	5.1	0.6
20-29	9.9	2.0
30-39	10.7	3.4
40-49	20.6	12.1
50-59	28.7	17.7
≥60	25.6	12.7
Gender		
Male	49	17.5
Female	51	31
Ethnicity		
Malay	39.2	18
Indian	38.3	21.1
Chinese	22.5	9.3
BMI class		
<18.5	5.6	0
18.5-23	17.5	2.8
23.1-29.9	47.3	22.8
30-60	29.6	22.8

Table 1: Demographics of study population and subjects with MetS.

Results

Table 1 shows the largest number of subjects were in the age group of 50-59, followed by age groups ≥ 60, 40-49, 30-39, 20-29 and 13-19 both overall and in subjects with MetS. There were equal numbers of male and female patients, but females were twice as likely to have MetS as males. Frequency of MetS was equal in Malay and Indian patients were comparable but less in Chinese. Overweight subjects were most common, followed by obese subjects, normal weight and underweight subjects both overall and with MetS.

Table 2a shows that all the parameters were comparable among the ethnic groups overall, apart from age which was highest in the Chinese population. Patients with MetS in any ethnic group had similar mean of age, BMI and WC, but HDL-C was lowest in Indians and normal in Chinese. Mean of systolic BP, triglycerides and fasting plasma glucose was the highest in Malays, followed by Indians and lowest in Chinese. Means of age and BMI were significantly different between females and males.

Table 2b shows means of metabolic risk factors between males and females were not significantly different except that males were significantly older than females and means of BMI was significantly higher in females. Means of physical and metabolic characteristics of subjects with MetS were significantly higher and HDL-C lower than those without MetS.

Variable	Entire Study Population			Subjects with MetS		
	Malay (n=138)	Indian (n=137)	Chinese (n=80)	Malay (n=64)	Indian (n=75)	Chinese (n=33)
Age	45.1 ± 14.5	47.6 ± 14.9	57.2 ± 13.3	51.5 ± 12.5	51.4 ± 10.6	54.9 ± 13.7
BMI	28.4 ± 7.21	27.3 ± 7.17	25.8 ± 5.39	32.7 ± 6.85	29.2 ± 5.62	28.9 ± 5.47
WC	91.8 ± 15.8	93.1 ± 13.9	90.8 ± 14.2	102 ± 10.6	97.9 ± 9.57	100 ± 9.86
SBP	134 ± 21.8	134 ± 19.4	130 ± 18.6	145 ± 18.6	142 ± 16.6	140 ± 16.4
DBP	82.5 ± 11.4	81.1 ± 10.5	79.9 ± 11.3	86.4 ± 10.3	85.1 ± 9.39	84.3 ± 10.4
TG	1.73 ± 1.52	1.69 ± 1.06	1.50 ± 0.67	2.16 ± 2.02	2.04 ± 1.22	1.88 ± 0.77
HDL-C	1.20 ± 0.49	1.08 ± 0.44	1.27 ± 0.49	1.05 ± 0.35	0.95 ± 0.24	1.24 ± 0.45
FPG	6.76 ± 2.85	6.75 ± 2.35	6.07 ± 1.92	8.14 ± 3.23	7.47 ± 2.05	6.50 ± 2.09

WC=Waist Circumference; SBP= Systolic BP; DBP=Diastolic BP; TG=Triglycerides; FPG=Fasting Plasma Glucose

Table 2a: Physical and metabolic characteristics of whole study population and subjects with MetS by ethnicity.

Variable	Female (n=181)	Male (n=174)	P-value	95% CI
Age (yr)	46.7 ± 1.13	51.0 ± 16.3	0.03	-6.86 - 0.27
BMI(Body weight kg/height by cm)	28.9 ± 7.44	25.9 ± 5.98	0.00	1.67 - 4.48
WC (cm)	92.50 ± 16.0	91.2 ± 13.1	0.47	-1.96 - 4.19
Systolic BP (mmHg)	132 ± 20.1	132 ± 20.4	0.36	-.05 - -0.15
Diastolic BP (mmHg)	81.0 ± 10.7	81.6 ± 11.1	0.98	-0.10 - 0.10
FBG (mmol/L)	6.50 ± 2.29	6.66 ± 2.77	0.66	-0.66 - 0.40
HDL-C (mmol/L)	1.23 ± 0.51	1.12 ± 0.52	0.24	-0.64 - - 0.40
TG (mmol/L)	1.68 ± 1.02	1.73 ± 1.42	0.51	-0.34 - 0.17
	MetS (n=173)	**Non-MetS (n=182)**	**P value**	**95% CI interval**
Age(yr)	52.4 ± 11.7	45.5 ± 18.3	0.00	3.45-9.94
BMI(Body weight kg/height by cm)	30.5 ± 6.27	24.7±6.27	0.00	4.50-7.10
WC(cm)	100 ± 9.77	84.0±13.0	0.00	13.7-18.8
Systolic BP (mmHg)	142.9 ± 17.3	123 ± 18.3	0.00	0.34-0.53
Diastolic BP (mmHg)	88.5 ± 9.89	77.5 ± 10.7	0.00	0.20-0.39
FBG (mmol/L)	7.58 ± 2.60	5.70 ± 1.99	0.00	1.33-2.29
TG (mmol/L)	2.06 ± 1.52	1.3 ± 0.63	0.00	0.52-0.99
HDLC (mmol/L)	1.07 ± 0.46	1.3 ± 0.59	0.00	0.31-0.72

BMI=Body Mass Index; WC= Waist Circumference; SBP=Systolic Blood Pressure; DBP=Diastolic Blood Pressure; FBG=Fasting Blood Glucose; RFBG=Raised Fasting Blood Glucose; TG=Triglycerides; HDLC=High Density Lipoprotein Cholesterol

Table 2b: Physical and metabolic characteristics and prevalence of metabolic risk factors in entire population by gender and subjects with and without MetS.

Table 3 shows that prevalence of metabolic risk factors and MetS were higher in females than males except that DM was similar.

Table 4 shows that the trend of prevalence of all metabolic risk factors increased with age until age group 50- 59 and then declined after age 60.

Table 5 shows that hypertension was the most common associated risk factor with MetS, followed by raised FPG, obesity (BMI ≥ 30), high TG, with low HDL-C the least common factor of MetS in this study population.

Table 6a shows that there were no significant differences of means of age, BMI, WC, systolic and diastolic BP, FPG, TG and HDL-C between females and males with MetS.

Table 6b shows that prevalence of risk factors for MetS was similar for hypertension, raised FPG, and high TG, but low HDL-C was significantly more common in females. Prevalence of DM and obesity with MetS were similar between females and males.

Metabolic risk factors	Female	Male	P-value	Odd ratios and 95% CI interval
High waist circumference	78.6%	45.7%	0.00	OR= 4.23 (2.69-6.79)
Obesity (BMI ≥ 30)	20.4%	9.2%	0.00	OR= 2.78 (1.73-4.44)
Hypertension	56.3%	43.8%	0.04	OR= 1.55(1.02-2.36)
Low HDLC	61.5%	36.4%	0.00	OR= 2.72(1.77-4.19)
Raised FBG	54.9%	53.2%	0.81	OR= 1.05(0.69-1.59)
High triglyceride	45.6%	45.7%	0.93	OR= 1.02(0.67-1.55)
MetS	63.7%	36.3%	0.00	OR= 2.79(1.82-4.30)
Diabetes mellitus	41.8%	40.5%	0.75	OR= 0.93(0.61-1.42)

Table 3: Prevalence of metabolic risk factors in the study population by gender.

Age groups	Elevated WC n=222	High BP n=193	High Triglycerides n=162	Low HDL-C n=175	Raised Fasting Plasma Glucose n=192
< 20	16.7	27.8	27.8	38.9	27.8
20-29	48.6	28.6	20.0	42.9	25.7
30-39	42.1	42.1	42.1	60.5	26.3
40-49	78.1	58.9	52.1	53.4	54.8
50-59	73.0	66.0	53.0	54.0	73.0
≥ 60	61.5	58.2	47.3	40.7	60.4

The trend of prevalence of all metabolic risk factors is raised by increasing age until age group 50- 59 but declines at age ≥ 60

Table 4: Distribution of prevalence of metabolic risk factors by age groups.

Variable	MetS	P-value	OR	95% CI
Hypertension	74.1%	0.00	12.6	7.55-20.9
Non-Hypertension	17.9%			
Raised FBG	68.2%	0.00	5.94	3.72-9.49
Normal FBG	25.2%			
Obesity	76.6%	0.00	5.23	2.99-9.14
Non-obese	35.8%			
High TG	57.3%	0.00	4.15	2.66-6.47
Normal TG	32.6%			
Low HDLC	64.6%	0.00	3.75	2.42-5.83
Normal HDLC	32.8%			

Data expressed as means ± standard deviation, Biochemistry results as mmol/L

BMI: Body Mass Index; WC: Waist Circumference; SBP: Systolic Blood Pressure; DBP: Diastolic Blood Pressure; FBG: Fasting Blood Glucose; FBG: Fasting Blood Glucose; Raised FBG : Raised Fasting Blood Glucose; TG: Triglycerides; HDLC: High Density Lipoprotein Cholesterol

Table 5: Association of MetS with risk factors.

Variable	Female (n= 105)	Male (n=68)	P-value	95% CI
Age	51.3 ± 10.2	52.2 ±11.9	0.58	-4.81 - -2.72
BMI	31.1 ± 6.24	29.1 ± 6.21	0.09	-0.28 - 3.65
WC	99.8 ± 9.84	100.9 ± 9.71	0.08	-6.02 - 3.64
SBP (mmHg)	143.2 ± 17.6	143.2 ± 17.4	0.56	-0.18 - 1.00
DBP(mmHg)	84.4 ± 9.57	86.9 ± 9.33	0.28	-0.24 - 0.07
FBG	7.5 ± 2.43	7.82 ± 3.13	0.40	-1.17 - 0.47
HDLC	1.08 ± 0.54	1.06 ± 0.48	0.42	-0.64 - 0.15
TG	1.9 ± 1.02	2.2 ± 2.04	0.24	-0.77 - 0.19

Data expressed as means ± standard deviation, Biochemistry results asmmol/L

BMI: Body Mass Index; WC: Waist Circumference; SBP: Systolic Blood Pressure; DBP: Diastolic Blood Pressure; FBG: Fasting Blood Glucose; FBG: Fasting Blood Glucose; Raised FBG : Raised Fasing Blood Glucose; DM: Fasting Blood Glucose ≥ 7mmol/L; TG: Triglycerides; HDLC: High Density Lipoprotein Cholesterol

Table 6a: Physical and metabolic characteristics of patients by gender with MetS.

Metabolic risk factors	Female	Male	P-value	Odd ratios	95% CI interval
Low HDLC	80%	39.7%	0.00	6.08	3.06-12.1
Hypertension	83.6%	81.6%	0.65	1.20	0.54-2.69
Raised FBG	75.5%	77.8%	0.73	0.88	0.42-1.83
High Triglycerides	60.9%	66.7%	0.45	0.78	0.41-1.83
Obesity (BMI ≥30)	54.5%	41.3%	0.09	1.7	0.91-3.19
Diabetes	62.7%	60.3%	0.75	0.90	0.48-1.71

Table 6b: Prevalence of Metabolic risk factors by gender in subjects with MetS.

Variable	p-value	OR	95% C I
Age	0.00	1.05	1.03-1.06
Female	0.00	2.53	1.51- 4.26
BMI	0.00	1.19	1.13-1.25
Chinese	0.01	0.46	0.23-0 .87
Malay	0.15	0.65	0.36-1.17
Indian		1	

Table 7: Multivariable logistic regression analysis of demographic risk factors for developing MetS.

Table 7, a multivariate analysis, shows that age, BMI and female gender were found to be risk factors for developing MetS with risk significantly lower in Chinese than Indians. Overall females had much higher number of risk factors than males (Figures 1 and 2).

Discussion

The frequency of MetS was high, possibly because this was a hospital based population with most of the patients in medical consultation clinics diagnosed with hypertension and DM. Our MetS prevalence was higher than a hospital based study in Bangladeshi using NCEFATPIII criteria [7]. Prevalence of MetS depends on definitions used as well as the ethnic group studied [8-11]. We found prevalence of MetS in Chinese was significantly lower than Indians. Other also has reported that MetS disproportionately affects Indians and Malays in Malaysia and also, FBG rates differ dramatically among ethnic groups [12]. There is a significant ethnic difference of MetS prevalence even using the same diagnostic criteria [9].

Higher prevalence of MetS in females is consistent with hospital based and general population studies in different countries (56.7% vs. 51.9%), (31.9% vs. 20.5%), (28.7% vs. 16.5%) and (8.3% vs. 7.3%) [8,13-16]. This could be explained by the prevalence of high waist circumference (78.6 vs. 45.7), and obesity (20.4 vs. 9.2) that were higher in females than males in this study (Table 3). The World

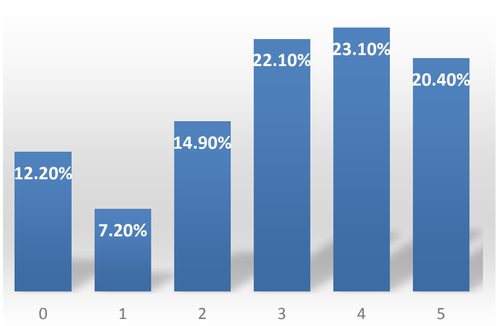

Figure 1: Percentages of number of metabolic risks in females in the whole study population (n=181).

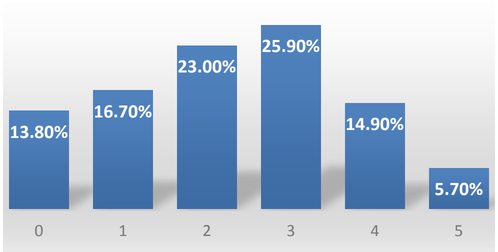

Figure 2: Percentages of number of metabolic risk factors in males in the entire study population.

Health Organisation (WHO) has stated Waist Circumference (WC) is the easiest and most efficient anthropometric index for obesity and fat location [17]. Elevated WC is a well-accepted cause of insulin resistance, hypertension, dyslipidaemia, impaired fasting glucose and diabetes [18-20]. In this study, females had higher WC, hypertension, TG and lower HCL-C causing more MetS (Table 3). However, the only statistically significantly association between the sexes and MetS was low HDL-C (Table 6b). We found that 92% of subjects in this study had no knowledge of healthy life style and effects of obesity on health. Men were more active than females in this study as most men were laborers and females were housewives. Lack of exercise and post-menopausal hormonal changes in females were other contributing factors to obesity and MetS in this study as was a significant association with marital status, low educational status, less physical activity at home and work and postmenopausal status in this and other studies [21-24].

The risk of developing MetS rises rapidly with weight and increases progressively with increasing BMI that is, there is a parallel rise of prevalence of MetS with obesity and BMI, also seen by many others (Table 1) [3,13,24,25].

Age was also found to be a risk factors for developing MetS, 1.04 fold higher for each year of age consistent with others who found MetS increased by 1.49 (95% CI 1.32-1.56) for every ten year age increment in Italy, and also studies in US, Iran, Taiwan, and Norway (Table 1) [5,10,12,25-27]. The increasing trend of MetS with age is probably due to increasing trend of metabolic components or risk factors with increasing age [28]. This is supported by our study and other has shown that abdominal obesity and triglycerides increase with age (Table 4) [10].

Hyperglycemia, impaired glucose tolerance and noninsulin dependent diabetes become progressively more common with advancing age due to insensitivity to insulin at the postreceptor level [29]. Decreased secretion of insulin and decreased hepatic sensitivity to insulin also occur. These age-related changes may be enhanced by obesity, renal failure, ingestion of certain drugs, or may be lowered by increased physical activity. This is supported by our study showing all risk components of MetS had increasing trend with age except for the age group ≥ 60 consistent with finding by others who assumed metabolic risks factors decreased after age ≥ 60 (Table 4) [14,30]. Other possibilities may be that most of them are on treatment for hypertension, diabetes and dyslipidaemia and may be aware of healthy life style.

Hypertension was the most common co-morbidity, followed by raised fasting plasma glucose, reduced HDL-C and high TG. Hypertension was also the highest co-morbidity of MetS in other studies worldwide [12,31,32]. Obesity is seen to be an independent cause of hypertension and our study showed 30% of subjects with obesity but without MetS had hypertension [30]. Hypertension is the most common chronic condition in many countries including Malaysia [33,34]. In the hospital where this study was performed, hypertension and DM were the most common diseases seen in a yearly census. Low HDL-C, noted to be a third highest ranking morbidity in our study, different from others where low HDL-C was the second highest abnormality and the most common abnormality in both males and females in the study in urban population in Iran [10,11]. This could be attributed to environmental and genetic factors [35].

Being a hospital based study, this population is not necessarily comparable to a random sample of the general population. Also, there could be some errors in measurement of WC, blood pressure and weight. To overcome these potential errors we assigned a nurse specifically trained for these measurements. As most of the patients were treated for hypertension and dyslipidemia and/or DM, we obtained data before therapy was initiated. Our study had a low number of youngest age group patients (13-18 years), because of difficulty in obtaining informed consent, anxiety of needles and refusal to fast.

Conclusion

The prevalence of MetS was found to be high. Female gender, age, and ethnicity were found to be statistically significant risk factors for MetS. The most common metabolic co-morbidity was hypertension. Preventive measures should be undertaken to avoid MetS and subsequent development of type 2 DM and CAD.

MetS should be screened in routine practice when females and males have BMI ≥ 23 and ≥ 25 respectively, or WC is ≥ 80 cm in females and ≥ 90 in males (regardless of BMI) [36]. Obesity and MetS should be recognized as one of the causes of both juvenile and adult hypertension.

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Reference

1. Joslin EP (1921) The prevention of diabetes mellitus. JAMA 76: 79-84.
2. Kylin E (1923) Studies of the hypertension- hyperglycemia-hyperuricemia (German). Zentralbllnn Med 44: 105-127.
3. Liberopoulos EN, Mikhailidis DP, Elisaf MS (2005) Diagnosis and management of MS in obesity. Obes Rev 6: 283-296.
4. Zimmet P, Magliano D, Matsuzawa Y, Alberti G, Shaw J (2005) The metabolic syndrome: a global public health problem and a new definition. J Atheroscler Thromb 12: 295-300.
5. Ford ES, Gilles WH, Dietz WH (2002) Prevalence of metabolic syndrome among US adults findings from the Third National Health and Nutrition Examination Survey. JAMA 3: 356-359.

6. International Diabetes Federation (2005) Rationale for new IDF worldwide definition of metabolic syndrome.

7. Rahman Khan MM, Jalil Chowdhury MA, Zahirul Haque M, Hoque Chowdhury MM, Khalilur Rahman M, et al. (2009) Demographic profile of patients with metabolic syndrome in Bangladeshi population. TAJ 22: 36-42.

8. Wasir JS, Misra A, Vikram NK, Pandey RM, Gupta R (2008) Comparison of Definitions of the Metabolic Syndrome in Adult Asian Indians. J Assoc Physicians India 56: 158-164.

9. Nestel P, Lyu R, Low LP, Sheu WH, Nityanant W, et al. (2007) Metabolic syndrome: recent prevalence in East and Southeast Asian populations. Asia Pac J Clin Nutr 16: 362-367.

10. Mohd Zainuddin LR, Isa NF, Wan Muda WM, Jan Mohamed H (2011) The Prevalence of Metabolic Syndrome According to Various Definitions and Hypertriglyceridemic- Waist in Malaysian Adults. Int J Prev Med 2: 229-237.

11. Sharifi F, Mousavinasab SN, Saeini M, Dinmohammadi M (2009) Prevalence of metabolic syndrome in an adult urban population of the West of Iran. Exp Diabetes Res.

12. Rampal S, Mahadeva S, Guallar E, Bulgiba A, Mohamed R, et al. (2012) Ethnic Differences in the Prevalence of Metabolic Syndrome: Results from a Multi-Ethnic Population-Based Survey in Malaysia. PLoS ONE 7: e46365.

13. Marchesini G, Melchionda N, Apolone G, Cuzzolaro M, Mannucci E, et al. (2004) The metabolic syndrome in treatment- seeking obese persons. Metabolism 53: 435-440.

14. Lee WJ, Chen HH, Wang W, Wei PL, LIN CM, et al. (2003) Metabolic syndrome in obese patients referred for weight reduction surgery in Taiwan. J Formos Med Assoc 102: 459-464.

15. Kim HM, Kim DJ, Jung IH, Park C, Park J (2007) Prevalence of the metabolic syndrome among Korean adults using the new abdominal obesity criteria for the Korean people. Diabetes Res Clin Pract 77:99-106.

16. Ko GT, Cocknam CS, Chow CC, Yeung VT, Chan BW, et al. (2006) Metabolic syndrome by the international diabetes federation definition in Hong Kong Chinese. Diabetes Res Clin Pract 73: 58-64.

17. Defining the problem of overweight and obesity. Preventing and Managing the Global Epidemic (1997) Report of a WHO consultation on Obesity. World Health Organization, Geneva, 7-16.

18. Bjorntorp P (1997) Body fat distribution, insulin resistance, and metabolic diseases. Nutrition 13: 795-803.

19. Seppala-Lindroos A, Vehkavaara S, Hakkinen AM, Goto T, Westerbacka J, et al. (2002) Fat accumulation in the liver is associated with defects in insulin suppression of glucose production and serum free fatty acids independent of obesity in normal men. J Clin Endocrinol Metab 87: 3023-3028.

20. 20. Sinha R, Dufour S, Petersen KF, Lebon V, Enoksson S, et al. (2002) Assessment of skeletal muscle triglyceride content by (1) H nuclear magnetic resonance spectroscopy in lean and obese adolescent: relationship to insulin sensitivity, total body fat, and central adiposity. Diabetes 51: 1022-1027

21. Klein S, Allison DB, Heymsfield SB, Kelly DE, Leibel RL, et al. (2007) Waist circumference and cardiometabolic risk: a consensus statement from Shaping America's Health: Association for weight Management and Obesity Prevention; NAASO, The Obesity Society; the American Society for Nutrition; and the American Diabetes Association. Am J Clin Nutr 85: 1197-1202.

22. Lidfeldt J, Nyberg P, Nerbrand C, Samsioe G, Schersten B, et al. (2003) Socio-demographic and psychological factors are associated with features of metabolic syndrome. The women's health in the Lund area (WHILA) study. Diabetes Obes Metab 5: 106-112.

23. Camethon MR, Loria CM, Hill JO, Sidney S, Savage PJ, et al. (2004) Risk factors for metabolic syndrome. The coronary artery risk development in young adults (CARDIA) study. Diabetes Care 27: 2707-2715.

24. Park YW, Zhu S, Palaniappan L, Heshka S, Carnethon MR, et al. (2003) Prevalence and associated factor findings in the US population from the third national health and nutrition examination survey 1988-1994. Arch Intern Med 163: 427-436.

25. National Institutes of Health. Metabolic Syndrome.

26. Ismail MN, Chee SS, Nawawi H, Yussoff K, Lim TO (2002) Obesity in Malaysia. Obes Rev 3: 203-208.

27. Lin CH, Lai SW, Liu CS (2006) Prevalence of metabolic syndrome in Taiwanese adults. Ann Saudi Med 26: 46-48.

28. Son le NT, Kunii D, Hung NT, Sakai T, Yamamoto S (2005) The metabolic syndrome: prevalence and risk factors in the urban population of Ho Chi Minh City. Diabetes Res Clin Pract 67: 243-250.

29. Stout RW (1994) Glucose tolerance and aging. J R Soc Med 87: 608-609.

30. Termizy HM, Mafauzy M (2009) Metabolic syndrome and its characteristics among obese patients attending an obesity clinic. Singapore Med J 50: 390-394.

31. Hildrum B, Mykletun A, Hole T, Midthjell K, Dahl AA (2007) Age-specific prevalence of the metabolic syndrome defined by the International Diabetes Federation and the National Cholesterol Education Program: the Norwegian HUNT 2 study. BMC Public Health 7: 220.

32. Ying Tan B, Kantilal HK, Singh R (2008) Prevalence of Metabolic Syndrome among Malaysians using the International Diabetes Federal, National Cholesterol Education Program and Modified World Health Organization Definitions. Mal J Nutr 14: 65-77.

33. Meigs JB, Wilson PWF, Caroline SF, Ramachandran SV, David MN, et al. (2006) Body Mass Index, Metabolic Syndrome and Risk of Type 2 Diabetes or Cardiovascular Disease. J Clin End & Metab 91: 2906-2912.

34. Ibrahim H, Yusoff MM (2007) Plant-based ethnic remedies for hypertension from Malaysia. Planta Med.

35. Tall AR (1992) Metabolic and genetic control of HDL cholesterol levels. J Intern Med 231: 661-668.

36. Aye M, Sazali M (2012) Study of Waist Circumference and BMI; Their cut-off points to predict metabolic risk factors and metabolic syndrome among outpatients in a district hospital. Singapore Med J 53: 546-550.