ORIGINAL ARTICLE

The Prevalence of Metabolic Syndrome and its Components among Ethnic Dayak Community in Sarawak

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ABSTRACT

Introduction: Metabolic syndrome (MetS) is a condition that includes a cluster of risk factors, which will lead to increase risk of cardiovascular diseases. Global increase in MetS is likely to affect Malaysia as well, however there is a scarcity of data on MetS among Malaysians. Ethnicity plays a vital role on prevalence and incidence of MetS across different ethnic groups. This is important especially in a multi-ethnic country like Malaysia. However, two most notable studies on MetS across different ethic groups in Malaysia were about a decade ago in 2012 and 2016. The objective of this study is to ascertain the prevalence of MetS among the Dayak communities and the risk factors affiliated with it, and hopefully will serve as a platform for future in-depth researches on MetS across different ethinc groups in Malaysia. **Materials and methods:** SThis is a cross sectional study that is conducted in various Dayak villages, which are located in Kuching, Semarahan and Serian District in Sarawak. Using a multi-stage sampling, we recruited 353 respondents aged between 18 to 88 years old. Data was collected using questionnaires, blood samples, blood pressure monitor and anthropometric measurements. Descriptive test, chi-square test and logistic regression were conducted to analyse all the available datas. All datas are analyzed using SPSS version 25. **Results:** A total of 34.6% of the respondents fulfilled the criteria of MetS. Elevated triglyceride (TG) is the strongest predictor of MetS among the five components of MetS in our study population. The prevalence for the components of MetS is as follow: elevated fasting glucose (66.2%), high blood pressure (50.4%), elevated triglycerides (47.3%), central obesity (20.9%) and for low HDL-cholesterol (18.9%). Body mass index and waist-to-hip ratio were identified as the most important risk factors in the MetS prediction models for this population.Higher education level and higher level of physical activity appear to have protective effect against MetS. Traditional cardiovascular risk factors including gender, smoking and alcohol consumption are not related with higher prevalence of MetS in Dayak communities. **Conclusion:** Approximately one in three ethnic Dayak in Sarawak will have metabolic syndrome in their lifetime. Targetted health education particularly among communities with lower education levels as well as incorporating culturally sensitive and community based interventions can be effective in managing MetS.
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Keywords: Dayak, Metabolic syndrome, Hypertension, Hyperglycemia, Eleveted triglycerides, Low high-density lipoprotein cholesterol (HDL), Obesity, Education level, Physical activity

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INTRODUCTION

Metabolic syndrome (MetS) is condition that includes a cluster of risk factors, which are specific for cardiovascular disease. These cluster of metabolic risk factors include hypertension, dyslipidemia, central obesity and impaired fasting plasma glucose (1). It is a multifaceted and an increasingly prevalent health condition and it stands as a critical challenge in contemporary healthcare. Its emergence as a global epidemic has raised concerns among healthcare professionals, researchers and policymakers alike.

The prevalence of MetS has reached alarming proportions, affecting millions of individuals worldwide. A meta-analysis of global data from 28 million individuals in 2022 revealed that MetS global prevalence varied from 12.5% to 31.4% which showed that MetS and its related components are highly prevalent worldwide (2).

Its association with a heightened risk of cardiovascular disease, cerebral vascular disease and other metabolic disorders places a substantial burden on healthcare systems, and poses both economic and social challenges. Given its impact on public health, understanding the intricacies of MetS is paramount in designing effective prevention and treatment strategies.

Studies have shown that ethnicity plays a vital role on prevalence and incidence of MetS across different ethnic groups (3) (4). The underlying pathophysiology leading to ethnic variations in the prevalence of MetS is still poorly understood but it is possible to be due to the complex interactions from both the innate and environmental factors.

In a multiethnic country like Malaysia, understanding the prevalence and incidence of MetS among various ethnic groups is important as tailored prevention and treatment strategies can be targeted at the specific ethnic group. However there is a significant lack of data in this aspect in Malaysia. The most notable studies on ethnic differences in the prevalence of MetsS in Malaysia were done about a decade ago in 2012 (5) and 2016 (6). The study by Rampal S et al in 2012 concluded that there is marked differences of the prevalence of MetS across ethnicities in Malaysia with the ethnic Chinese had the lowest prevalence of MetS and the ethnic Indians had the highest (5). The same study also showed that the indigenous Sarawakians showed a marked increase in MetS at a younger age compared to the rest of the population in Malaysia (5). Another study by Lim KG et al in 2016 showed that MetS affects 25% to 40% of adult population in Malaysia, with Indian ethnicity having the highest prevalence of MetS, followed by ethnic Malay and Chinese (6).

Sarawak is a unique state, which is made up from 26 different ethnic groups. The Dayaks are the largest ethnic group in Sarawak, accounting for approximately 40% of total Sarawak populations. The two largest sub ethnic groups within the Dayak community are Iban and Bidayuh (7).

This research paper aim is to identify the prevalence of MetS and its associated risk factors with demographic profile and lifestyle behaviors among the Dayak community in Sarawak. By incorporating the existing knowledge of MetS and integrating recent advancements in this field, this study seeks to contribute to the broader understanding of MetS and its implications for public health especially among the Dayak communities in Sarawak. We also aim for this study to serve as a platform for further future in-depth researches into MetS within the Dayak community as well as other ethnic groups in Malaysia.

MATERIALS AND METHODS

Study design

This is a cross-sectional study. Using multistage sampling method, this study was conducted at several Dayak villages in Kuching, Samarahan and Serian District in Sarawak, Malaysia over a period of 6 months.

In total, 353 respondents aged 18 to 88 years old with no acute health problems at the time of the study were enrolled based on voluntary basis. All the respondents provided signed consent.

Data collection

(i) Special booths were set up in the community hall in the Dayak villages (with permission from the villages' head) for respondents to complete the questionnaires regarding demographic data and lifestyle practices. Research assistants were placed to assist the respondents with the questionnaires. A team of qualified healthcare professionals consists of medical doctors; nurse and nutritionist were placed in the booths for anthropometry and blood pressure measurements. Lab technologists were stationed at the blood-taking booth.

(ii) Anthropometry measurements

(a) Body Mass Index (BMI)

The height is measured with Seca 213 stadiometer. The measuring beam was lowered to the top of each respondent's head as they stood beneath the meter. The value is rounded to the closest 0.1 centimeter.

A calibrated Seca weighing scale was used to weigh respondents. We round the weight to the closest 0.1 kg.

BMI (kg/ m2) = Weight in kilogram/ (Height in meter)^2

Classification of BMI (kg/m^2) (8)

- Underweight : BMI <18.5kg/m^2
- Normal : BMI 18.5-22.9kg/m^2
- Overweight : BMI ≥ 23kg/m^2
- Obese : BMI≥ 25kg/m^2

(b) Waist-to-hip ratio (WHR) and Waist circumference (WC)

The respondents stood in a relaxed manner. The waist was measured halfway between the crest of the ilium and the inferior border of the final rib. The measurement of the hip circumference is made at the widest circumference point around the pelvis. Circumference is rounded to the nearest 0.1cm.

Waist-to-hip ratio = measurement at the waist (cm)/ measurement at the hip (cm)

Classification of waist-to-hip ratio (9)

• Low health risk: WHR of 0.95 or lower in men and WHR of 0.80 or lower in women
• Moderate and high health risk: WHR of 0.96 or higher in men and WHR of 0.81 or higher in women

(iii) Measurement of blood pressure
The respondents should not be taking medications, alcohol, caffeine and nicotine or exercise 30 minutes prior to BP measurement. The blood pressure was measured after 5 minutes of rest.

With the respondent seated and their arm lying at heart level on the examination table, a digital blood pressure monitor was used to take their blood pressure.

Two measurements were taken at an interval of one minute, from which their average value will be calculated.

Hypertension is defined when the systolic pressure is 130mmHg or higher and/or diastolic pressure of 85mmHg or higher. (1)

(iv) Biochemical measurements
Twelve hours overnight fasting blood samples (7.0 ml) are collected under aseptic conditions by venipuncture from the antecubital vein, into sterile plain tubes.

Blood glucose and lipid profiles
An established laboratory appointed carries out analysis of blood glucose and lipid profiles. The definition for blood profiles is as below (1):
• Hyperglycemia: Fasting glucose level of 100mg/dL or greater
• Elevated Triglyceride (TG): Triglyceride level of 150mg/dL or higher
• Low High-Density Lipoprotein cholesterol (HDL-cholesterol): HDL-cholesterol of less than 40mg/dL in men and HDL less than 50mg/dL in women

(v) Measurement of physical activity level
International physical activity questionnaires (IPAQ) were used to measure the physical activity level in a typical week- at work, travel to and from work, recreational activities and sedentary behavior.

Respondents are divided into HIGH, MODERATE and LOW physical activities.

HIGH scores on the IPAQ involve in
• At least three days of vigorous intensity physical activity, acquiring a minimum physical activity of 1500 MET minutes per week (MET minutes represent the amount of energy expanded carrying out physical activity)

OR

• Seven or more days of any mixture of walking or moderate intensity activities acquiring a minimum physical activity of at least 3000 MET minutes per week.

MODERATE scores on the IPAQ involve in
• Three or more days of vigorous intensity physical activity and/or at least 30 minutes of walking per day

OR

• Five or more days of moderate intensity physical activity and/or at least 30 minutes of walking per day

OR

• Five or more days of any mixture of walking or moderate intensity activities acquiring a minimum physical activity of at least 600 MET minutes per week

A LOW scores on the IPAQ is defined when the level of physical activity does not meet the criteria for either HIGH or MODERATE levels of physical activity.

One of the researchers is stationed at this counter to explain the questionnaires.(10)

(vi) Assessment of alcohol consumption
AUDIT (Alcohol Use Disorders Identification Test) has 10 questions and the probable responses to all the questions will be scored from 0 to 4 points. The range of total probable scores is from 0 to 40 points.

According to World Health Organization (WHO) recommendations, a total score of one to seven points insinuates a low-risk consumption, a total score of eight to 14 points insinuates hazardous level of alcohol consumption and a total score of 15 or more points suggest the possibility of alcohol dependence. Those who had never consumed any alcoholic beverages will be given a score of zero point.

Research assistants are stationed at this booth to explain the questionnaires.

(vii) Metabolic syndrome
MetS is a cluster of conditions which is classified as a syndrome if the respondent has three or more of these disorder (1):
• Increased WC: defined as more than 40 inches in men and 35 inches in women
• Elevated TG level: defined as reading of 150 milligrams per deciliter of blood (mg/dL) or higher
• Low HDL-cholesterol level: defined as reading of smaller than 40mg/dL in men and smaller than 50 mg/dL in women
• Hyperglycemia: defined as reading of 100mg/dL or higher
• Hypertension: defined when the systolic value is 130mmHg or greater and/or diastolic value of 85mmHg or greater

Data analysis method
A total of three incomplete data (incomplete demographics, anthropometric and blood pressure measurements) were removed from the database. All the data were classified into different categories and were put under categorical variables (ordinal and nominal

variables). Data was analyzed via SPSS version 25.

A descriptive test was conducted to analyze data on socio-demographic profile, anthropometric measurements and lifestyle behaviors for all the respondents; as well as the respondents who were identified with MetS. Logistic regression was performed on the components of MetS to look at the likelihood of having MetS with the presence of these MetS components. Chi-square test was done to determine the strength of the relationship between MetS and its' associated risk factors. Subsequently multiple logistic regression (MLR) was performed to predict the likelihood of developing MetS with the presence of the risk factor(s).

Ethical approval

The study protocols are approved by Ethic Committee, Faculty Medicine and Health Sciences, Universiti Malaysia Sarawak UNIMAS (Rujukan Etika: FAME/22/41 dated 14 April 2022).

The consent form include following information: voluntary enrollment, purpose of this study, responsibility as respondent, potential risk and benefit from enrollment in this study, funding and confidentiality of every respondents. All the respondents provided signed consent.

RESULTS

(i) Demographic data, lifestyle behavior and anthropometric measurements

The study enrolled 353 respondents from Dayak ethnic communities, which include both the Iban and Bidayuh; with the majority from ethnic Bidayuh group comprising about 91% of total population. The mean age was 50.26 ± 14.50 years being made up of mostly those in between 31-60 years old. There is a near uniformed distribution between the genders with about 56% females and 44% males. The majority of the respondents was from Bidayuh sub ethnic group (91.2%) and had secondary level of education (48.2%). In addition significantly higher proportion of non/former smokers (86.1%), those who had never consumed alcohol (64.6%) and those who were engaged in high level of physical activity (52.7%) in this study.

68.3% of the respondents are obese. 24.7% and 71.3% of the male and female respondents respectively had WHR under the category of moderate and high health risk.

The summary of the distribution of the socio-demographic data, lifestyle behaviors and anthropometric measurements are summarized in Table I.

Table I: Socio-demographic profile, anthropometric measurements and lifestyle behaviour (n=353)

	n (%)	Mean (SD)
Demographic Data		
Age		
<31	42 (11.9)	50.26
31-60	213 (60.3)	(14.50)
>60	98 (27.8)	
Gender		
Male	158 (44.8)	
Female	195 (55.2)	
Race		
Bidayuh	322 (91.2)	
Iban	31 (8.8)	
Education level		
No formal education/primary/special education	72 (20.4)	
Secondary	170 (48.2)	
Diploma/Degree/Master	111 (31.4)	
Anthropometric Measurements		
Body Mass Index (BMI)		
Underweight/Normal (BMI<23)	60 (17.0)	
Overweight (BMI 23-24.9)	52 (14.7)	27.41 (5.06)
Obese (BMI >/= 25)	241 (68.3)	
Waist-to-hip ratio		
Men		
Low health risk (0.95 or lower)	119 (75.3)	0.91 (0.08)
Moderate and high health risk (0.96 or higher)	39 (24.7)	
Women		
Low health risk (0.80 or lower)	56 (28.7)	0.85 (0.09)
Moderate and high health risk (0.81 or higher)	139 (71.3)	
Lifestyle		
Smoking		
Never/Former Smoker	304 (86.1)	
Currently still smoking	49 (13.8)	
Alcohol Consumption		
Never Consumed Alcohol	228 (64.6)	
Low Risk Drinker	99 (28.0)	
Hazardous/Dependance Drinker	26 (7.4)	
IPAQ (Physical Activity)		
Low Level of Physical Activity	50 (14.1)	
Moderate Level of Physical Activity	118 (33.2)	
High Level of Physical Activity	187 (52.7)	

(ii) Metabolic syndrome

The highest prevalence of MetS components among the Dayak communities is elevated fasting glucose level (66.2%), followed by hypertension (50.4%), elevated triglycerides (47.3%), increased WC (20.9%) and

reduced HDL-cholesterol (18.9%). The percentage of respondents that fit each of the criteria for the diagnosis of MetS is summarized in Table II.

Table II: Number/Percentage of Respondents that Fit the Criterias for Metabolic Syndrome

Criterias	n (%)
Waist circumference	
More than 40 inches in men	18 (5.1%)
More than 35 inches in women	56 (15.8%)
Fasting glucose profile	
Elevated fasting glucose of 100mg/dL or greater	235 (66.2%)
Fasting lipid profile	
Elevated Triglycerides >/= 150mg/dL (n=355)	168 (47.3)
Fasting lipid profile	
Reduced high-density lipoprotein cholesterol (HDL) less than 40mg/dL in men (n=158)	19 (5.4%)
Reduced high-density lipoprotein cholesterol (HDL less than 50 mg/dL in women	48 (13.5%)
Blood pressure	
Blood pressure values of systolic 130mmHg or higher and/or diastolic 85mmHg or higher	179 (50.4%)
Metabolic Syndrome (each respondent with at least 3 of the above criterias)	123 (34.6%)

Out of the 353 respondents who were involved in this study, 123 respondents (34.6%) fulfill the criteria of MetS (having at least three of the MetS components). The mean age of the respondents with MetS was 53.36 +/- 11.91. The youngest person with MetS in this study population is 24 years old, and the oldest to have MetS is 78 years old.

Logistic regression analysis was used to study the commonest components of the MetS among the respondents (Table III). According to the results, elevated TG (OR =11.169; 95% CI 6.497, 19.201; p<0/0001), elevated fasting blood sugar (OR =8.857; 95% CI 4.526, 17.332; p<0/0001), hypertension (OR =7.734; 95% CI 4.589, 13.036; p<0/0001), increased WC (OR =6.375; 95% CI 3.639, 11.167; p<0/0001) and reduced HDL-cholesterol (OR =0.122; 95% CI 0.044, 0.335; p<0/0001) are observed.

Table III: Logistic regression analysis for respondents with components of MetS with MetS

Components of MetS	MetS		OR (95% CI)	p-value
	Yes	No		
Increased WC	51	23	6.375 (3.639,11.167)	p<0.0001
Normal WC	72	207		
Eleveated FBS	112	123	8.857 (4.526,17.332)	p<0.0001
Normal FBS	11	107		
Elevated TG	101	67	11.169 (6.497,19.201)	p<0.0001
Normal TG	22	163		
Reduced HDL-c	104	225	0.122 (0.044,0.335)	p<0.0001
Normal HDL-c	19	5		
Hypertension	99	80	7.734 (4.589,13.036)	p<0.0001
Normal BP	24	150		

Logistic regression analysis model is used. MetS = Metabolic Syndrome; WC = waist circumference; FBS = fasting blood sugar; TG = triglycerides; HDL-c = HDL- cholesterol; BP = blood pressure; OR = odd ratio; CI = confidence interval

The majority of the respondents with MetS was female (56.1%), Bidayuh sub ethnic group (95.9%) and had secondary level of education (52%). In addition significantly higher proportion of non/former smokers (83.7%) and those who had never consumed alcohol (62.6%) were found in those with MetS. (Table IV)

Table IV: Socio-demographic profile, lifestyle behaviour and health profile of respondents with metabolic syndrome (n=123)

	n (%)	Mean(SD)
Age		
< 30 years old	5 (4.1)	53.36 (11.91)
31- 60 years old	78 (63.4)	
>60 years old	40 (32.5)	
Gender		
Male	54 (43.9)	
Female	69 (56.1)	
Race		
Bidayuh	118 (95.9)	
Iban	5 (4.1)	
Education level		
No formal school/Primary level	33 (26.8)	
Secondary level	64 (52)	
Diploma/Degree/Master	26 (21.1)	
Lifestyle		
Smoking		
Never/Former Smoker	103 (83.7)	
Currently still smoking	20 (16.3)	
Alcohol Consumption		
Never consumed alcohol	77 (62.6)	
Low risk drinker	34 (27.6)	
Hazardous/Dependance drinker	12 (9.8)	
IPAQ (Physical activity)		
Low level of physical activity	19 (15.4)	
Moderate level of physical activity	46 (37.4)	
High level of physical activity	58 (47.2)	
Health profile		
Body Mass Index (BMI)		
Underweight/Normal	9 (7.3)	29.96 (5.20)
Overweight	8 (6.5)	
Pre-obese/Obese	106 (86.2)	

The mean age of the respondents with MetS is 53.36+/- 11.91 with highest percentage between 31 to 60 years old (63.4%). 43.9% and 56.1% of the respondents were male and female respectively. Majority of the respondents with MetS had secondary level of education (52%). Only 16.3% of the respondents were still smoking at the time of study, and 9.8% of the respondents fell under hazardous and dependence drinker category. 15.4% of the respondents had low level of physical activity, while 37.4% and 47.2% had moderate and high level of physical activity respectively. The mean BMI of the respondents with MetS was 29.96 +/- 5.20. The socio-demographic profile, lifestyle behaviors and health profile of respondents with MetS are summarized in Table IV.

Based on Chi-Square Test, there is significant association between higher prevalence of MetS in the Dayak communities with age group, Bidayuh sub ethnic group, education level, Body Mass Index (BMI) and Waist-

to-hip ratio. No significant association demonstrated between MetS with gender, smoking, level of physical activeness and alcohol consumption. The results are summarized in Table V.

Table V: Chi Square Test for risk factors with metabolic syndrome

	Metabolic Syndrome		Chi-Square Value	Asymptomatic Significance (2-sided)
	Yes	No		
Age				
<30	5	37		
31-60	78	136	11.349	0.003
>60	40	59		
Race				
Iban	5	27	5.621	0.018
Bidayuh	118	205		
Education level				
No formal/Primary	33	41	10.085	0.006
Secondary	64	106		
Diploma/Degree/Master	26	85		
Weight				
Normal/Underweight (BMI <23)	9	52	28.705	0.001
Overweight (BMI 23-24.9)	8	44		
Obese (BMI>/= 25)	106	134		
Waist to Hip Ratio				
Low risk	48	129	9.083	0.003
Moderate/High risk	75	102		

Note p<0.05

In MLR, categorical variables for age, gender, race, education level, BMI, WHR, smoking status, alcohol consumption and level of physical activity (total 9 variables) were selected as covariates, with the result shown in Table VI.

TABLE VI: Associated factors of MetS by Multiple Logistic Regression

Variable	Multiple Logistic Regression		
	B	AOR (95% CI)	p-value
Age			
<30 years old			0.151
31-60 years old	0.957	2.603 (0.907, 7.467)	0.075
>60 years old	1.153	3.168. (0.097, 10.285)	0.055
Gender			
Male			
Female	0.129	1.138 (0.587, 2.207)	0.702
Race			
Bidayuh			
Iban	-0.899	0.407 (0.139, 1.188)	0.100
Education level			
No/Primary/Special			0.084
Secondary	-0.369	0.691 (0.345, 1.387)	0.298
Diploma/Degree/Master	-0.904	0.405 (0.178, 0.923)	0.031
BMI			
Underweight/Normal			0.00
Overweight	-0.035	0.966 (0.324, 2.877)	0.950
Obese	1.496	4.464 (1.964, 10.144)	0.000
WHR ratio			
Low health risk			
Moderate and high health risk	0.589	1.802 (1.011, 3.213)	0.046
Smoking			
Never/Former smoker			
Currently still smoking	0.435	1.545 (0.685, 3.488)	0.295
Alcohol consumption			
Never consumed alcohol			0.118
Low risk drinker	0.544	1.724 (0.910, 3.263)	0.095
Hazardous/Dependance drinker	0.859	2.360 (0.877, 6.350)	0.089
IPAQ Score			
Low level of physical activity			0.077
Moderate level of physical activity	-0.322	0.725 (0.335, 1.566)	0.413
High level of physical activity	-0.763	0.46 (0.222, 0.981)	0.044

Multiple Logistic Regression model was applied. Classification table (overall classified percentage = 70.8%); MetS = Metabolic Syndrome; BMI = Body Mass Index; WHR ratio = Waist-to-Hip Ratio; IPAQ Score = International Physical Activity Questionnaire Score; AOR = Adjusted odd ratio; CI = confidence interval

Those respondents with higher education level (diploma/degree/master) had significantly lower odds of having MetS compared to those with lower education level (AOR=0.405; 95% CI 0.178, 0.923; p=0.031). Compared to the respondents with lower BMI, the odds of developing MetS was higher for the respondents with BMI >/= 25 (AOR=4.464; 95% CI 1.964, 10.144; p=0.000). In addition, respondents with WHR, which fell under moderate and high health risk group, were 1.8 times more likely to have MetS as compared to those with lower WHR (AOR=1.802; 95% CI 1.011, 3.213; p=0.046). The chance of developing MetS decreases with higher-level physical activity compared to lower level of physical activity (AOR=0.466; 95% CI 0.222, 0.981; p=0.044).

DISCUSSION

MetS is a cluster of diseases occurring together, overall increasing the risk of developing cardiovascular diseases. The incidence of MetS has shown global increasing trend over the recent years and this is a major cause for concern. Based on systemic review by Ranasinghe et al (2017), the incidence of MetS in the Asia-Pacific regions lies between 11.9 to 37.1% with Malaysian having the highest numbers of people with MetS with the incidence of 37.1% (11). Another study in 2016 showed that

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the incidence of MetS among Malaysian adult ranges between 25-40% and the incidence of MetS in Malaysia is higher than other countries in Asia (6).

Research has indicated that ethnicity significantly influence the prevalence of MetS in various ethnic groups (3) (4). With more than 26 different ethnic groups in Sarawak, knowing the prevalence and the risk factors of MetS across different ethnic groups is crucial as it allows for the development of preventative plans that are specifically targeted to that specific ethnic group. In this study, we focus on the Dayak community, which accounted for 30-40% of the population in Sarawak.

Our result shows that the prevalence of MetS among the Dayak population in Sarawak stands at 34.6%. This is comparable to the prevalence rate of MetS in Morocco, with prevalence of 35.73%, Northwestern Nigeria, with prevalence of 35.1% and Dschang Health District in West Cameroon with prevalence of 38.98% (12). However it is relatively high compared to the prevalence of MetS in Eastern Cape, South Africa with the prevalence of 21.8% (12). Our findings show that the prevalence of MetS varies greatly depending on the communities group. This is likely to be due to the lifestyle behaviors practice by the different communities as well as genetic factors.

The most prevalent component of MetS is elevated fasting glucose profile (66.2%), followed by hypertension (50.4%), elevated triglycerides (47.3%), increased WC (20.9%) and reduced HDL-cholesterol (18.9%). Compared to a study in an Iranian population, the most prevalent component of MetS among the Iranian is increased WC (73.6%), followed by reduced HDL-cholesterol levels (44.8%), elevated TG (28.3), elevated fasting glucose (35.3%), and hypertension (32.6%) (13). Another study on Cameroon population showed that the most prevalent component of MetS in their population is reduced HDL-cholesterol (82.8%) followed by elevated triglycerides (54.0%) (13). These indicate that the prevalence of the component of MetS differ across different ethnic or population groups. Thus, it is vital to identify the prevalence of each component of the MetS in different population group so targeted preventive methods can be formulated specific to that population or ethnic group.

However, among the five components of MetS, respondents with elevated TG were observed to have highest odds of having MetS; with those with elevated TG having approximately 11 times higher risk of having MetS. Those with hyperglycemia, hypertension and increased WC will have about 6 to 9 times chances of having MetS. In contrast with many literatures, low HDL-cholesterol level does not appear to have higher predictive value for MetS.

Several risk factors that are significantly associated with the risk of developing MetS among Dayak community are age, sub ethnic group of Bidayuh, education level, BMI and WHR. Using multiple logistic regressions to analyze the predictive values of these risk factors, the respondents with higher education level (diploma/degree/master) and higher-level physical activity had significantly lower odds of having MetS. The odds of developing MetS was higher for the respondents with BMI >/= 25 and WHR of 0.96 or higher in men and WHR of 0.81 or higher in women. Several traditional cardiovascular risk factors such as gender, history of smoking, and alcohol consumption, which are known to have strong association of MetS, are not significantly associated with MetS among the Dayak communities in this study.

Only 4.1% of the participants who are less than 30 years old fulfilled the criteria for MetS, whereas 32.5% of the participants above 60 years old fulfilled the criteria for MetS. These results are in agreement with previous studies showing that the prevalence of MetS increased strongly with age (14), (15), (16). Hormonal changes during the aging process are identified as the key component to the evolution and advancement of MetS in the elderly group (17). Several hormones that may affect the development of MetS are insulin secretions, estrogen, testosterone, adipokines, cortisol and thyroid hormones. As part of the aging process, the production as well as the sensitivity of the cells to these hormones may vary leading to a complex mechanism that ultimately cause MetS.

Higher incidence of MetS in the Bidayuh sub ethnic group of Dayak as compared to Iban maybe related to their genetic predisposition and their dietary habit. The Bidayuh and Iban communities traditionally have different dietary practices, mainly influenced by their different cultural background. This factor was proven to be not statistically significant predictive value from MLR, most likely due to significantly smaller number of respondents from the Iban sub ethnic group.

Studies worldwide are showing growing evidence that education level plays a significant role in reducing the incidence of MetS in a community (18). This is in tandem with our results, which shows that those who have higher education level are less likely to develop MetS. Disparities in health awareness are most likely to contribute to the differences in prevalence of MetS within these communities. On top of that, education level can also influence lifestyle choices such as dietary habits, health awareness and prevention. This is crucial information as it underscores the importance of targeted health education and promotion efforts especially among communities with lower education levels.

Both obesity and central obesity refer to excess accumulation of fat; however the distribution of fat in the body differentiates these two terms. Obesity

generally refers to excess body fat that leads to an overall increase in body weight primarily determined from BMI measurement; whereas central obesity refers to excessive accumulation of fat around the abdomen or trunk (19) based on the measurement of waist circumference and waist to hip ratio. Previous literatures had shown that WHR is the most sensitive and specific predictor for MetS. Savva et al in their publication highlighted that waist-to-hip ratio is a good predictor of cardio metabolic risk especially in the Asian population (20)(21). Our results showed significant association between BMI and WHR with MetS; however BMI has higher predictive value as compared to WHR measurement in predicting the risk for MetS. Obesity by itself is strongly associated with insulin resistance. Adipose tissue secretes various bioactive substances leading to chronic inflammation, which promote the progression of insulin resistance, which ultimately contribute to the development of MetS (22).

Our study shows that those who are engaged in high level of physical activity according to the IPAQ score have nearly 0.5 times less risk of developing MetS compared to those who are engaged in lower and moderate level of physical activity. Most of the literatures are in accordance with our findings, showing that the level of physical activity is associated with the prevalence of MetS (23) (24). Increasing physical activity was shown to have effect on reducing the probability of developing MetS (25). This implies that interventions to reduce the risk of MetS should include increasing the time and intensity of physical activity.

Traditional cardiovascular risk factors such as gender, history of smoking and alcohol consumption, which are known to be strong predictors of MetS, are not significantly associated with MetS among the Dayak communities in this study. This suggests their relative importance as predictors for MetS as these factors tend to vary depending on the population taking into consideration on individual characteristics such as ethnicity and genetic predisposition.

CONCLUSION

Approximately one in three ethnic Dayak in Sarawak will have MetS in their lifetime. Among the five components of MetS, those with hypertriglyceridemia will have higher chances of having MetS. One of the key findings in this study shows that lower education level and low level of physical activity predispose the Dayak community to MetS and the main risk factor that is significantly associated with MetS is obesity. Traditionally recognized risk factors such as gender, smoking, physical inactivity and alcohol consumption may not be as important risk factor for MetS as previously thought, at least among the Dayak community.

Targeted health education and the educational needs of the Dayak communities should be systematically included into clinical practice. We hope that the findings from this study can serve as a platform for future in-depth researches on MetS across different ethnic groups in Malaysia. MetS is a complex etiology, encompassing genetic, lifestyle, and environmental factors, making it a delicate puzzle that demands comprehensive research efforts for elucidation.

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