ORIGINAL ARTICLE

Prevalence and Risk Factors Associated with Metabolic Syndrome among University Students in Bintulu, Sarawak, Malaysia

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ABSTRACT

Introduction: Metabolic syndrome has become a worry for health of youth in Malaysia. This study aimed to look at the prevalence of metabolic syndrome, and to assess the risk factors of metabolic syndrome among Malaysian university students. **Methods:** A cross-sectional study was conducted on 248 students aged 18-30 years using a random sampling method from two universities in Bintulu, Sarawak, Malaysia. Data on sociodemographic, dietary habits and lifestyle were collected by a pre-tested self-reported questionnaire. Biochemical measurements, blood pressure, and anthropometric measurements were measured by standard procedures. Metabolic syndrome was defined according to Harmonized Joint Interim Statement criteria. Data were analysed using IBM SPSS 23.0 version. **Results:** The overall prevalence of metabolic syndrome was 12.5% and was more prevalent in male (17.5%). Indian (15.8%) was the most prevalent ethnic group, while Chinese (4.9%) had the least prevalence. 31.5% respondents had at least one metabolic component. Low HDL (42.7%) and large waist circumference (26.2%) were the most common components. Statistically significant ($p<0.05$) independent factors for developing metabolic syndrome were male, staying time more than six hours on computer/TV/mobile phone, in smokers, taking meals more than three times per day, and high consumption of soft drinks. Besides that, with high consumption of vegetables, the prevalence of metabolic syndrome was significantly low ($p<0.05$). **Conclusion:** These study findings elicit the evidence of increasing tendency and warning on metabolic syndrome for Malaysian university students, and considerable association of the prevalence of metabolic syndrome to dietary habits and lifestyle.
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Keywords: Metabolic syndrome, Risk factors, Dietary habits, Sedentary lifestyle, University students

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INTRODUCTION

Metabolic syndrome (MetS) is defined as a cluster of cardio-metabolic risk factors, including central obesity, insulin resistance, dyslipidaemia, and hypertension (1). World Health Organization (WHO) released the first criteria of MetS in 1998 (2). At present, the most used definitions to define MetS are based on International Diabetes Federation, National Cholesterol Education Program Adult Treatment Program III, and WHO. In 2009, several organizations attempted to provide a Joint Interim Statement (JIS) of the common diagnostic criteria for MetS which is known as Harmonized Joint Scientific Statement (HJSS). According to HJSS, MetS is defined as the presence of three or more than any of the following five components: waist circumference, elevated blood pressure, elevated triglyceride, decreased High-density lipoprotein (HDL) cholesterol, and elevated fasting glucose (1).

Metabolic syndrome has increased rapidly worldwide because of the prevalence of obesity, unhealthy dietary habits, and sedentary lifestyles (3). The prevalence of MetS in the Malaysian population is high compared to other Asian countries (4). Studies have shown that according to several definitions of MetS, the overall prevalence among the Malaysian population ranges between 25% to 40% (5).

Besides that, MetS among the 18–30 years old population with a college education have increased significantly worldwide (6). Their unhealthy food habit (7), lack of physical activities (8), smoking habit (9), and alcohol consumption (10) is the contributing factors to increase MetS. Studies have reported that the prevalence

of MetS among African American university students ranged from 0% to 19.2% (11). Another study showed that according to the literature on different countries, the prevalence of MetS among university students ranged between 1.9% to 14.2% (12). Furthermore, overweight and obesity have increased rapidly among Malaysian university students because of unhealthy diet, stress, and sedentary lifestyle (7).

Early recognition of MetS and effective changes in food habits and lifestyle will help to decrease the risk of non-communicable disease series. A university population is an understudied group despite the increase in the frequency of related disorders and metabolic risk factors. In Malaysia, many studies on MetS conducted mainly on general public and children. Existed studies on university students focused only on obesity and overweight, however, there is a lack of information and research done on MetS among university students in Malaysia. Hence, this study aimed to assess the prevalence of MetS and to identify the possible associated factors that may contribute to MetS.

MATERIALS AND METHODS

Study design and study population

A cross-sectional study design was adopted for this study on university students. The study sampling was carried out from October 2020 to January 2021 in two selected institutes of higher learning at Bintulu, Sarawak, Malaysia. The study participants were selected following the simple random-sampling procedure, aged between 18 to 30 years both male and female, registered as a student at a higher institution and a Malaysian. Pregnant, physically disabled, and those who are suffering from acute and chronic disease or other illnesses were excluded from the study. To determine the required sample size, the following formula used: $N=(p(1-p))/d^2$, where N= desired sample size, p= anticipated population proportion, d= allowable error (13). The estimated prevalence of MetS in Malaysian young adult population is 20.0% [5], using a 95% confidence interval. As a result, a total of 246 respondents were required as per formula.

Data collection procedure

The participants were addressed in their classrooms and invited to volunteer. The study to be performed was explained on individuals as well as group basis. Willing and interested students were registered and prior appointments were given. Respondents were requested to fast overnight (9-12 hours) and advised not to take any kind of medicine on the previous day. A total of 289 subjects participated during the study period. Among them 248 respondents (86% response rate) completed the study. Informed consent was obtained from each respondent of this study. The nurses of the UPM Satellite Clinic collaborated on the data collection procedure.

The questions (sociodemographic, lifestyle, dietary habits) in the study instruments were selected from previous journals (10,14,15,16,17) and proceeded for pilot test before being administered to the participants. Qualified nurses conducted the anthropometric measurements (weight, height, and waist circumference). Each measurement was conducted in duplicate. A weighing scale (Seca, 767 1321004; Germany) were used to measure body weight, which was recorded barefooted, lightly dressed while the scale was calibrated to zero marking before use. The weight was recorded in kilograms. The height of the study population was measured by height scale (Seca, 767 1321004; Germany). Each subject's height was measured in a standing position with their hands hanging by the side and their feet barefooted in a relaxed way while the vertebral column touched the scale. Height was measured in centimetres. Body mass index (BMI) was calculated and evaluated as defined by WHO (18). The waist circumference was conducted using a stretch-resistant measuring tape. The reading was taken in the middle to the abdomen in the transpyloric plane (normal breathing) at the level of the umbilicus and the nearest 0.1 centimetres. Blood pressure was taken by using an electronic blood pressure monitor (RAK 289). Systolic and diastolic pressures of the brachial artery of the respondents were measured in the sitting position after at least 5 minutes of rest.

For biochemical tests, 9-12 hour fasting blood samples were assayed by standard method for glucose, triglyceride, and high-density lipoprotein. Fasting blood glucose was directly measured by a small prick on the fingertips by using Accu-Check Active glucometer and Accu-Check glucose test strips (19). The study used an automated point-of-care portable analyzer to measure the lipid profile (8). Triglyceride and HDL were directly measured from blood collected (35 µl) at the participants' fingertip using Standard LipidoCare cholesterol analyzer (02LA20G), Sd Biosensor, and Standard LipidoCare test strip lipid profile (02LS10A). This analyzer measured the lipid profile in the blood sample within 3 minutes. The portable devices were calibrated before every use. The LipidoCare analyzer is certified by Centres for Disease Control and Prevention's (CDC), Cholesterol Reference Method Laboratory Network (CRMLN), and meets the National Cholesterol Education Program standard (20).

Diagnosis criteria

For the diagnosis of MetS, the criteria stipulated by the Harmonized Joint Scientific Statement (HJSS) definition (1).HJSS requires any three out of five components for diagnosis of metabolic syndrome. According to these criteria, MetS is diagnosis as: Central obesity (waist circumference for South Asian Male ≥ 90 cm, Female ≥ 80 cm), raised triglycerides (≥ 150 mg/dL), reduced HDL cholesterol (< 40 mg/dL in males < 50 mg/dL in females), Raised fasting plasma glucose (≥ 100 mg/dL), and raised blood pressure (systolic BP ≥ 130 or diastolic BP ≥ 85 mm Hg)

Statistical analysis

The software SPSS version 23.0 was used to perform descriptive analysis to generate all categorical variables in frequencies and percentages. Independents t-test was used to compare the means of continuous variables by gender. Chi-square test was used to assess the variables of socio-demographic, lifestyle, and dietary habits as a possible association that may contribute to MetS. Significant was set at p-value < 0.05. Further, analysis for the variable with p-value of less than 0.05 was used for simple logistic regression to estimate the crude-odd ratio (COR) and 95% confident interval (CI). Multiple logistic regression with Enter method was used to determine the strength of association of the independent factors with MetS by adjusted-odd ratio (AOR) and 95% confident interval.

Ethical Approval

Ethical approval with reference number JKEUPM-2020-035 was obtained from Universiti Putra Malaysia Research and Ethics Committee.

RESULTS

A total number of 248 respondents from two universities in Bintulu, Sarawak participated in the study. Table Ipresents the sociodemographic characteristics of study respondents.

Table I. Sociodemographic characteristics of study subjects (n=248)

Variable		N (%)
Gender	Male	120 (48.4)
	Female	128 (51.6)
Age	18- 21 years	150 (60.5)
	22- 25 years	73 (29.4)
	26-30 years	25 (10.1)
Current education level	Diploma or equivalent	161 (64.9)
	Degree or equivalent	64 (25.8)
	Postgraduate or equivalent	23(9.3)
Race/Ethnicity	Malay	119 (48.0)
	Chinese	41 (16.5)
	Indian	19 (7.7)
	Bumiputra Sarawak	59 (23.8)
	Bumiputra Sabah	10 (4)

Table II shows that, among the study subjects (n=248), 31 respondents were found with three or more than three components of MetS according to Harmonized Joint Interim Statement, which indicate the overall prevalence was 12.5%. The prevalence of MetS was higher in males (17.5%) compared to in females (7.8%). The prevalence of individual components for MetS was high for low HDL cholesterol (40.7%), followed by the large waist (26.2%) and elevated blood pressure (18.1%) compared to elevated fasting glucose (8.9%) and elevated triglyceride (8.1%) among the respondents. The male had high triglyceride (5.6%), high blood pressure (11.7%) and large waist (14.5%) compared to female respondents. On the contrary, more females had high fasting glucose (5.1%) and low HDL (21.0%) compared

Table II: Prevalence of MetS and components in study respondents by gender (n=248)

Variable	Total N (%)	Male N (%)	Female N (%)
Metabolic syndrome	31 (12.5)	21 (17.5)	10 (7.8)
Metabolic syndrome components			
Elevated fasting glucose	22 (9.4)	10 (4.3)	12 (5.1)
Elevated triglyceride	20 (8.1)	14 (5.6)	6 (2.4)
Reduced HDL-cholesterol	101 (40.7)	49 (19.8)	52 (21.0)
Elevated Blood pressure	45 (18.1)	29 (11.7)	16 (6.5)
Elevated waist	65 (26.2)	36 (14.5)	29 (11.7)
Number of MetS components			
None	107 (43.1)	45 (18.1)	62 (25.0)
One component	78 (31.5)	38 (15.3)	40 (16.1)
Two components	33 (13.3)	17 (6.9)	16 (6.5)
Three components	20 (8.1)	15 (6.0)	5 (2.0)
Four components	5 (4.0)	5 (2.0)	5 (2.0)

to males. A total of 31.5% of the respondents had at least one metabolic component, followed by 13.3% respondents who had at least two components, 8.10% had three components and 4.0% had four components, while 43.1% had no components.

An independent sample t-test was used to compare the mean of MetS components of males and females among the study subjects. Table III shows the mean values of biochemical, anthropometric, and clinical measurements by gender. The mean values of waist circumference, systolic blood pressure, diastolic blood pressure and triglyceride were higher in male than female respondents, while the mean values of high-density lipoprotein and fasting blood glucose were higher in female than male respondents, which was statistically significant (p<0.05).

Chi-square test was used for assessing whether the sociodemographic, lifestyle and dietary habits of study respondents were related to MetS. Table IV presents

Table III: T-test on biochemical, anthropometric, clinical measurement by gender

Variable	Total Mean± SD (N=248)	Male Mean± SD (N=120)	Female Mean± SD (N= 128)	Significant (2-tailed)
Body Mass Index (kg/m2)	23.9±5.6	24.3±5.6	23.6±5.5	0.297
Waist circumference (cm)	77.9±12.8	81.5±13.8	74.5±10.7	<0.001 *
Systolic blood pressure (mmHg)	116.9±11.4	120.1±10.5	113.0±11.5	<0.001 *
Diastolic blood pressure (mmHg)	77.3±7.9	79.0±7.8	75.7±7.7	0.001 *
Triglyceride (mg/dl)	97.3±38.2	102.9±41.8	92.0±33.8	0.024 *
High density lipoprotein (mg/dl)	49.8±13.9	45.3±12.8	54.0±13.6	<0.001 *
Fasting blood glucose (mg/dl)	4.0±0.4	4.9±0.4	5.0±0.4	0.047 *

*Significant P<0.05, SD= Standard Deviation

Table IV: Association between metabolic syndrome and sociodemographic, lifestyle, and dietary habits of study subjects (n=248)

Variable	Metabolic syndrome		*p*-value
	Yes (N=31) N (%)	**No (N= 217) N (%)**	
Gender			0.021*
Male	21 (17.5)	99(82.5)	
Female	10 (7.8)	118(92.2)	
Age			0.934
18- 21 years	18 (12.0)	132(88.0)	
22-25 years	10(13.7)	63(86.3)	
26-30 years	3(12.0)	22(88.0)	
Current education			0.996
Diploma or equivalent	20(12.4)	141(87.6)	
Degree or equivalent	8(12.5)	56(87.5)	
Postgraduate or equivalent	3(13.0)	20(87.0)	
Race			0.526
Malay	18(15.1)	101(84.9)	
Chinese	2(4.9)	39(95.1)	
Indian	3(15.8)	16(84.2)	
Bumiputra Sarawak	7(11.9)	52(88.1)	
Bumiputra Sabah	1(10.0)	9(90.0)	
How often do you do any physical exercise?			0.001*
Regular [a]	5(4.5)	106(95.5)	
Irregular [b]	26(19.0)	111(81.0)	
How many hours do you sleep per day?			0.546
< 6 hours	7(9.1)	70(90.9)	
1-8 hours	21(14.2)	127(85.8)	
> 8 hours	3(13.0)	20(87.0)	
How many hours do you stay on computer or television per day?			<0.001*
< 6 hours	11(5.6)	185(94.4)	
≥ 6 hours	20(38.5)	32(61.5)	
Do you smoke?			<0.001*
Yes	16(30.8)	36(69.2)	
No	15(7.7)	181(92.3)	
Do you take any alcohol?			0.751
Yes	6(14.0)	37(86.0)	
No	25(12.2)	180(87.8)	
How many times do you take meals per day?			<0.001*
≤ 3 times	18(8.3)	198(91.7)	
> 3 times	13(40.6)	19(59.4)	
How often do you take any kind of vegetables in your meals?			0.001*
Regular [a]	10(6.5)	144(93.5)	
Irregular [b]	21(22.3)	73(77.7)	
How often do you take any kind of fruits in your meals?			0.954
Regular [a]	7(12.7)	48(87.3)	
Irregular [b]	24(12.4)	169(87.6)	
How often do you take fast food per week?			<0.001*
Regular [a]	17(27.0)	46(73.0)	
Irregular [b]	14(7.6)	171(92.4)	
How often do you take soft drinks per week?			<0.001*
Regular [a]	18(43.9)	23(56.1)	
Irregular [b]	13(6.3)	194(93.7)	

*Significant P<0.05; [a] Regular ≥ 3 times/week; [b] Irregular < 3 times/week

the association between MetS and sociodemographic, lifestyle, and dietary habits. There was a statistically significant (p< 0.05) association between MetS and gender. The prevalence of MetS was found to be significantly high in males (17.5%) than in female (7.8%) respondents. There was no statistically significant relationship between age group, current education level and MetS (p>0.05). In terms of race, the prevalence of MetS was found a majority in Indians (15.8%), while only 4.9% of Chinese had MetS. Hence, the relation between MetS and race was not significant (p>0.05).

Statistically significant (p<0.05) lifestyle factors for developing MetS were irregular exercise (19.0%), staying on the computer/television/mobile phone more than six hours per day (38.5%) and in smokers (30.8%) (Table V). The prevalence of MetS was found to be significantly (p<0.05) high in respondents who took meals more than three times per day (40.6%), regular intake (≥ 3 times/week) of fast food (27.0%) and soft drinks (43.9%) among respondents. Besides that, there was a statistically significant (p<0.05) relation between MetS and vegetable intake in respondents. The prevalence of MetS was low with high consumption of vegetables (6.5%) (Table IV).

Table V shows, the crude odds ratio and adjusted odds ratio of independent variables. Based on an adjusted odds ratio with 95% CI, six of the independent variables of MetS made a unique statistically significant (p<0.05) contribution to the final model included gender, staying time on computer and television, smoking habits, meals frequency per day, vegetable intake, soft drinks intake. However, in the final model, the relation between MetS and physical exercise, fast food were not statistically significant (p>0.05).

The crude and adjusted odds ratio for male students were associated with an increased odd of exhibiting the MetS. Based on crude and adjusted odds ratio, male students were 2.5 times and 3.4 times more likely to develop MetS than females, respectively. For staying time on

Table V: Crude-odd ratio (COR) and adjusted odds ratio (AOR) of sociodemographic, lifestyle, dietary habits, and probiotic and prebiotic food consumption habits of study subjects (n=248)

Variable	COR (95 % CI [a])	AOR (95% CI [a])
Gender		
Male	1.00	1.00
Female	2.50 (1.12-5.56) *	3.41 (1.99-11.75) *
Physical exercise		
Regular [b]	1.00	1.00
Irregular	4.96 (1.83-13.41) *	1.89 (.487-7.39)
Stayed at computer or television or mobile phone	1.00	1.00
≤ 6 hours [b]	10.51 (4.60-24.0) *	6.41 (2.05-20.01) *
> 6 hours		
Smoking status		
No [b]	1.00	1.00
Yes	5.36 (2.43-11.81) *	3.74 (1.07-13.10) *
Meal Frequency per day		
≤ 3 times [b]	1.00	1.00
> 3 times	7.52 (3.20-17.69) *	4.80 (1.23-18.70) *
Vegetable intake		
Irregular [b]	1.00	1.00
Regular	0.24 (0.10-0.53) *	0.43(0.13-0.39) *
Fast food consumption		
Irregular [b]	1.00	1.00
Regular	4.51 (2.07-9.83) *	2.32(0.75-7.17)
Soft drinks consumption		
Irregular [b]	1.00	1.00
Regular	11.67 (5.07-26.89) *	3.68 (1.16-11.65) *

* Significant P<0.05; [a] Confidence Interval; [b] Reference group

computer or television or mobile phone, according to crude and adjusted odds ratio, those who stayed more than six hours on computer/television were 10.5 times and 6.4 times higher in getting MetS than those who stayed less than six hours, respectively. The crude and adjusted odds ratio for smoker respondents were 5.3 times and 3.7 times higher to exhibit MetS than a non-smoker, respectively (Table V).

Based on crude and adjusted odds ratio, respondents who take meals more than three times per day were 7.5 times and 4.8 times higher to get MetS than those who take meals less than three times per day, respectively. Furthermore, the crude and adjusted odds ratio for regular consumption of vegetables was 0.24 times and 0.43 times less likely to exhibit MetS than irregular vegetable consumption. Besides that, the crude and adjusted odds ratio of regular consumption of soft drinks among respondents was 11.6 times and 3.6 times higher to exhibit MetS than irregular consumption, respectively (Table V).

DISCUSSION

This study was intended to investigate the prevalence of MetS, and risk factors associated with MetS among university going youth in Malaysia. The present study enrolled 248 students between the ages of 18 to 30 years from two higher education institutes in Bintulu, Sarawak.

The overall prevalence of metabolic syndrome in this study's respondents was 12.5% as per Harmonized Joint Scientific Statement criteria. The prevalence of this study was low as compared to the prevalence of 27.5%, 42.5%, and 43.4% from studies on the Malaysian population used 'Harmonized' criteria by many other authors (4,21,22). This low prevalence of metabolic syndrome might be clarified with the fact that the present study population were mostly young group aged 18 to 30 years, while those said studies subjects were all age group. On the other hand, the present study demonstrated a higher prevalence of metabolic syndrome compared to other studies with a college education. Similar studies conducted using the same Harmonized criteria among the student population in Cameroon, Ghana, Colombia, Kenya, and the United Arab emirate showed the prevalence of MetS was 11.3%, 12.4%, 8.7%, 1.9%, and 6.8%, respectively which lower than this study found. (8,19,23-25). The higher prevalence of metabolic syndrome in the present study might be attributed to a sedentary lifestyle, unhealthy diet and stress among respondents which was more common in Malaysian university students (7).

For biochemical measurements, the most prevalent components were low HDL (40.7%), and large waist (26.2%), whereas elevated triglyceride (8.1%) was the least prevalent component among respondents in this study. Low HDL (25-31) and large waist (27,32,33) were the most prevalent MetS components in previous college education studies. The higher prevalence of low-HDL and large waist can be connected to lack of physical activity and poor diet among respondents. The present study also observed that 31.5% of respondents had at least one component and 13.3% had two components, which is almost like previous student study findings [30,34]. In addition, a study has observed that the prevalence of one component was 53.2% among students in the United States which was the highest so far (27). In this study, the prevalence of individual one or two components in the respondents might indicate the risk of developing MetS later in life.

The present study demonstrated that the prevalence of MetS was higher in males compared to females and males were 3.4 times more likely to develop MetS than females, which is statistically significant. This result agreed with several previous students' studies (10,12,26,34). The higher prevalence of MetS in males can be related to excess body weight, sedentary lifestyles such as physical inactivity and a higher rate of smoking. In contrast, several studies observed a more frequent prevalence of MetS in females (19,32,33). Nevertheless, in this study, the prevalence of elevated triglyceride (5.60% vs 2.40%), elevated blood glucose (11.70% vs 6.50%) and large waist (14.50% vs 11.70%) were higher in male respondents compared with females. In contrast, the female had a higher prevalence of elevated fasting glucose (5.1% vs 4.30%) and reduced HDL (21.0% vs 19.80%) compared to male respondents. A recent study conducted among Korean college students reported males were more prevalent with individual all MetS components except low-HDL (35). A substantial number of studies reported that the prevalence of large waist was higher in females than in males, while the study findings in this study disagree with those previous study outcomes (8,30,36). This present finding observed that male was more prevalent in large waist than female. This contradictory outcome might be due to their smoking habit and inactive lifestyle, which were very common in male than female respondents in the current study. Sedentary lifestyle is a key risk factor for developing several components of MetS (12). In addition, previous studies found a higher prevalence of elevated triglyceride and elevated blood pressure in males compared with female which is also found in the present study (8,30). Hence, the various outcome of the prevalence of MetS components by gender might be due to environmental and genes factors (37).

As for ethnicity, Indian (15.8%) and Malay (15.1%) had a higher prevalence of MetS compared to Bumiputra Sarawak (11.9%) and Bumiputra Sabah (10.0%), whereas Chinese had the least prevalence (4.9%) among the study respondents. There was no statistically significant relationship between race and MetS, which is consistent with previous studies (4,21,22,38). Previous studies

Table III: Kappa Score for relevancy of each food item (continued)

Items/Domain	Result of kappa statistics		
	Pc	Kappa statistic	Interpretation
H3. Pizza	0.016	1.00	Excellent
H4. French fries	0.016	1.00	Excellent
H5. Nugget	0.016	1.00	Excellent
H6. Mashed potatoes	0.234	0.57	Fair
H7. Coleslaw	0.234	0.57	Fair
H8. Sausage/Hotdog/Frankfurter	0.016	1.00	Excellent
H9. Instant Noodle Maggi	0.016	1.00	Excellent
I. Confectionery			
I1. Sweets/Lollipop	0.016	1.00	Excellent
I2. Jelly/Custard	0.016	1.00	Excellent
I3. Ice-cream	0.016	1.00	Excellent
I4. Pastry	0.016	1.00	Excellent
I5. Street foods	0.016	1.00	Excellent
I6. Snacks/Crackers	0.016	1.00	Excellent

Table IV: Content Validity Ratio of Food Frequency Questionnaire

Items/Domain	Result of content validity ratio		
	N_e	CVR	Interpretation
A. Fruit juice & drinks			
A1. Apple drink	6	1.00	Remained
A2. Orange drink	6	1.00	Remained
A3. Blackcurrant drink	6	1.00	Remained
A4. Soy drink	6	1.00	Remained
A5. Mango drink	6	1.00	Remained
A6. Lychee drink	6	1.00	Remained
A7. Iced lemon tea	6	1.00	Remained
A8. Chrysanthemum	5	0.67	Eliminated/Refined
A9. Various flavour cordial drink	6	1.00	Remained
B. Sweetened milk & cultured milk drinks			
B1. Strawberry flavoured	6	1.00	Remained
B2. Fresh milk	5	0.67	Eliminated/Refined
B3. Chocolate flavoured	6	1.00	Remained
B. Sweetened milk & cultured milk drinks			
B4. Full cream	5	0.67	Eliminated/Refined
B5. Yoghurt drink	6	1.00	Remained
B6. Yoghurt	5	0.67	Eliminated/Refined
C. Carbonated beverages			
C1. Cola	6	1.00	Remained
C2. Orange	5	0.67	Eliminated/Refined
C3. Isotonic drink	6	1.00	Remained
D. Sweetened chocolate malt, tea, & coffee			
D1. Malted drinks	6	1.00	Remained
D2. Ready-to-drink coffee	6	1.00	Remained
D3. Ready-to-drink tea	6	1.00	Remained
E. Vendor-made or home-prepared drinks			
E1. *Bandung*	6	1.00	Remained
E2. *Jagung*	5	0.67	Eliminated/Refined
E3. Iced chocolate	6	1.00	Remained
E4. Lychee in Syrup	6	1.00	Remained
E5. Iced tea	6	1.00	Remained
E6. Iced milk tea	6	1.00	Remained
E7. Pearl milk tea	6	1.00	Remained
E8. ABC	6	1.00	Remained
E9. Hot tea	6	1.00	Remained

Table IV: Content Validity Ratio of Food Frequency Questionnaire (continued)

Items/Domain	Result of content validity ratio		
	N_e	CVR	Interpretation
E10. Iced blend	6	1.00	Remained
E11. Pre-mixed drinks	6	1.00	Remained
E12. Coffee drinks	6	1.00	Remained
F. Biscuits, cake, & bread			
F1. Chocolate chips	6	1.00	Remained
F2. Cheese sandwich	5	0.67	Eliminated/Refined
F3. Plain biscuits	5	0.67	Eliminated/Refined
F4. Sugar Crackers	6	1.00	Remained
F5. Flavoured/cream/filled cookies	6	1.00	Remained
F6. *Kuih-muih*	6	1.00	Remained
F7. Cake	6	1.00	Remained
G. Chocolate			
G1. Chocolate rice cereal	6	1.00	Remained
G. Chocolate			
G2. Wafer bar	6	1.00	Remained
G3. Chocolate bar	6	1.00	Remained
G4. Chocolate nugget	6	1.00	Remained
H. Fast foods			
H1. Burger	6	1.00	Remained
H2. Fried chicken	6	1.00	Remained
H3. Pizza	6	1.00	Remained
H4. French fries	6	1.00	Remained
H5. Nugget	6	1.00	Remained
H6. Mashed potatoes	4	0.33	Eliminated
H7. Coleslaw	4	0.33	Eliminated
H8. Sausage/Hotdog/Frankfurter	6	1.00	Remained
H9. Instant Noodle Maggi	6	1.00	Remained
I. Confectionery			
I1. Sweets/Lollipop	6	1.00	Remained
I2. Jelly/Custard	6	1.00	Remained
I3. Ice-cream	6	1.00	Remained
I4. Pastry	6	1.00	Remained
I5. Street foods	6	1.00	Remained
I6. Snacks/Crackers	6	1.00	Remained

Table V: Experts' comments

Experts	Comments
Expert 1	1. Separate plain and flavoured yoghurt in the Sweetened milk & cultured milk drinks section. 2. Add (Others: ____) option to each section for respondents to fill the drinks that are not available in FFQ
Expert 2	1. Suggest B6 item change to flavoured yoghurt
Expert 3	1. Add another flavour other than orange in the carbonated drinks section
Expert 4	1. Suggest additional flavour for carbonated drinks including grapes, strawberry, and apple
Expert 5	1. Change orange flavoured to flavoured carbonated drinks. 2. Suggest removing the brand of the products and simplifying them in an appropriate group
Expert 6	1. Change strawberry flavoured and chocolate flavoured milk to flavoured milk only 2. Add another section for *kuih-muih*

Table VI: Food list refinement

Item groups		Items	No. of items
Sugar-sweetened beverages	Fruit juice & drinks	"apple drink", "orange drink", "blackcurrant drink", "soy drink", "mango drink", "lychee drink", "iced lemon tea", "chrysanthemum", "various cordial drink"	9
	Sweetened milk & cultured milk drinks	"flavoured milk", "fresh milk", "full cream", "yogurt drink", "plain yogurt", "flavoured yogurt"	6
	Carbonated beverages	"cola", "flavoured carbonated beverages", "isotonic drink"	3
	Sweetened chocolate malt, tea, & coffee	"malted drink", "ready to drink coffee", "ready to drink tea"	3
	Vendor-made or home-prepared drinks	"*bandung*", "*jagung*", "iced chocolate", "lychee in syrup", "iced tea", "iced milk tea", "pearl milk tea", "ABC", "hot tea", "iced blend", "pre-mixed drinks", "coffee drinks-cappuccino, mocha, latte"	12
High-energy dense food	Biscuits, cake & bread	"chocolate chips", "cheese sandwich", "plain biscuits", "sugar crackers", "flavoured/cream/filled cookies", "cake"	6
	Kuih-muih	*"donut", "karipap", "pulut bakar", "chakoi", "bahulu", "kuih keria", "pau"*	7
	Chocolate	"chocolate rice cereal", "wafer bar", "chocolate bar", "chocolate nugget"	4
	Fast foods	"burger", "fried chicken", "pizza", "French fries", "nugget", "sausage/hotdog/frankfurter", "instant noodle"	7
	Confectionery	"sweet/lollipop", "jelly/custard", "ice-cream", "pastry-pai, croissant, tart", "street foods-takoyaki, *keropok lekor*, sweetened corn", "snacks/crackers"	6

also attempted to clarify that lack of physical activity, less consumption of vegetables (38), and carbohydrate-rich diet (39) have been shown among Indian that may contribute to exhibit MetS. Besides that, Bumiputra Sarawak and Sabah ethnic showed an increasing trend for the prevalence of MetS. A study reported young indigenous Sarawakian had the highest prevalence of all MetS components compared to other young ethnic groups and young Sarawakian have a risk of developing MetS (21). There are limited data on MetS in Bumiputra Sarawak and Sabah. Therefore, further understanding of the increasing tendency of the prevalence of MetS among Bumiputra Sarawak and Sabah should be researched more.

The association between physical exercise and MetS was not statistically significant. A number of previous studies also agreed with this finding that there is no significant relationship between MetS and physical exercise (10,12,19). In contrast, a previous study found sedentary lifestyle is significantly associated with MetS (8). The observed differences may be explained by the fact that other risk factors such as smoking habits, staying time on TV/mobile and dietary habits, may have more influence on the respondents to exhibit MetS. The present study found that sedentary activity by staying on the computer or television or mobile phone for more than six hours per day were 6.4 times more likely to exhibit MetS than less than six hours, which was statistically significant. A study in Cameroon students agreed with this finding and reported that MetS was significantly associated with those who watched television more than six hours per day (4.9 times more likely) (19). It is understandable that nowadays youth spent a large time on device which has effect on their health. However, the present study found no significant association between sleeping duration and MetS.

Moreover, in this study, there is a statistically significant positive association established between smoking habits and MetS. Smokers were 3.7 times more likely to get MetS than non-smokers. A study observed the same outcome that smokers were 6 times more likely to exhibit MetS (10). The same finding also concurred with the present study outcome that smoking habit has a significant association with MetS (12). In contrast, a study on Egyptian students, and a study on Palestinian students observed no significant relationship between smokers and MetS (32,40). However, the present study observed no statistically significant relationship between alcohol consumption and MetS. This is similar to the observation made in a study of Turkey students (12).

As for meals per day, there was a significantly higher prevalence of MetS in respondents who take more than three times meal per day compared to those less than three times per day. Respondents who take more than three times meal per day were 4.8 times more likely to develop MetS than those who take meals three or less than three times per day. A previous study was reported the same outcome, in which a higher number of meals were 5.1 times more likely to contribute to MetS and showed statistically significant association (19).

In addition, a low intake of fruits and vegetables along with a high intake of fast food and soft drinks is common among university students (16,17,41). Such tendency was also observed in the present study's respondents. There is a significant relationship observed between vegetable intake and metabolic syndrome, while there is no significant association between fruits intake and MetS. Regular (≥3 times/week) intake of vegetables was associated with a reduction in the likelihood (0.43 times) of exhibiting MetS. The previous study was consistent with this finding and showed that significantly high frequently intake of green vegetables was 0.4 times less

likely to exhibit MetS (19). The present study observed a statistically significant positive association between soft drinks intake and MetS, however, there is no significant relationship between fast food intake and metabolic syndrome among study respondents. Regular (≥3 times/ week) consumption of soft drinks was 3.68 times more likely to develop metabolic syndrome than irregular (<3 times/week) consumption of soft drinks in respondents. This result was in line with a study (32). This finding might be attributable to the fact that frequent consumption of soft drinks is associated with elevated triglyceride, elevated blood glucose and decreased HDL.

In the past few decades, consumption of fast food and soft drinks lead to increased calorie intake in university students (15).Unhealthy dietary habits such as fast food (42) and soft drinks (8) consumption, low intake of vegetables (19) lead to the increased risk of obesity and MetS components among university students. Moreover, consumption of soft drinks and fast food exhibited a significant role to enlarge the prevalence of overweight and obesity for Malaysian university students (7).

The health quality of the next generation is directly dependent on the prevalence of metabolic syndrome of today's generation. This present study findings will contribute to filling the data gap and facilitate in knowing the baseline of the issue. This is essential for the public health agencies and government for the future development of health, educational awareness, and intervention programs for the public, especially for young adults in Malaysia. There were some limitations in the present study that future research could take note on MetS concerning university students in Malaysia. This research was a cross-sectional study. It is suggested to conduct the proposed model with longitudinal data. It would provide more assurance outcomes. More higher education institutions could be included to expand the view on MetS among youth in Malaysia.

CONCLUSION

This study is the first known study to account for the prevalence of MetS and their associated risk factors in Malaysian university students in Bintulu, Sarawak. The overall prevalence of MetS was 12.5% which was alarmingly high. Statistically significant independent factors for developing MetS include males, staying time more than six hours on computer/television/mobile phone, smokers, intake of meals more than three times per day, and high consumption of soft drinks. Besides that, the prevalence of metabolic syndrome was significantly low with high consumption of vegetables. Well recognized recommendations regarding adequate physical activity and intake of vegetables and fruits should be emphasized in this targeted population. In addition, soft drinks, fast food consumption and smoking habits should be discouraged to decrease metabolic syndrome among university students.

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