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The Risk Factors and Associated Co-morbidities of Obesity among Adults in Northern Borneo

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ABSTRACT

Obesity is a prevailing health issue and has been recognized as a threat in public health worldwide. Rural setting is no longer a barrier to the epidemic of obesity as previously thought. This cross-sectional study aimed to determine the risk factors and associated co-morbidities of obesity among adults aged 18 and above in rural community of Kudat, Sabah. 28.2% of respondents were found to be obese with female predominance (54.9%). Older age, formally educated, ever-drinkers and high systolic blood pressure were associated with obesity. Various forms of interventions should also involve the rural area to close the disparity of health.

Keywords: obesity, risk factors, co-morbidity

INTRODUCTION

Obesity is a prevailing health issue. It is a great threat in public health for the past few decades. The epidemic of obesity is witnessed by two-fold increase in its prevalence within two decades. In 2014, approximately 39% and 13% of adults around the globe aged 18 and above were overweight and obese respectively[1]. In National Health and Morbidity Survey (NHMS) Malaysia 2011, 15.1% of adults was found to be obese[2], being comparable with most of cross-sectional studies conducted in the past decade[3, 4]. Among the Asian countries, Malaysia was listed high on the list for obesity[5].

Primary prevention of obesity is always superior since health expenditure is 30% more in obese individuals than their leaner counterparts[6]. Multiple risk factors have been identified. Physical

activity, dietary patterns and alcohol consumption were among the risk factors most frequently studied in which significant association was found in relation to obesity[7, 8, 9, 10, 11]. Alcohol consumption exhibits unique relationship with obesity where moderate intake is associated with less risk while heavy intake is associated with higher risk[12]. Current smokers are protected from being obese. The prevalence of obesity was observed to correlate with dietary shifts particularly in regards to low dietary fiber intake and sedentariness[13, 14].

Obesity represents a gateway to multiple negative health outcomes with particular to hypertension, diabetes mellitus, dyslipidemia and cardiovascular diseases[15]. The notion that only certain exposures attribute to obesity within a given population but not for the others has led to extensive study in this field with preference for the risk factors, so that national health policy makers are able to plan for effective measure to overcome the local issue. However, most studies of this kind tend to center around the urban area. While obesity is no longer confined to urban area, there is no discrepancy found between rural and urban setting in terms of the prevalence of obesity[3]. Indeed, the prevalence of obesity has been rising in rural population and at times, it would be expected to outstrip that of urban population[16].

In Sabah, the prevalence of obesity was 10.6%, the lowest among the states[2]. Research on obesity has not been sufficiently established in Sabah, especially with the involvement of rural community. Therefore, current study aimed to determine the prevalence, risk factors and associated co-morbidities of obesity in rural community in Northern part of Sabah. It was hypothesized that female gender, older age, low educational level, white collars, non-current smoker, alcohol consumption and physically inactive individual might be associated with increased risk of obesity.

MATERIALS AND METHODS

This cross-sectional study was conducted in Kampung Matunggong and Kampung Molongkolong of Kudat in March 2015. This research was conducted as a part of compulsory medical program (Community Medicine Posting) in FMHS, UMS. Permissions were taken from Kudat Health Office, community leaders and the Department of Community and Family Medicine, FMHS, UMS. Simple random sampling method was used. Sample size was a minimum of 158 based on formula by Daniel (1999)[17] with finite population correction. Those residents who aged 18 and above were eligible to participate in this study. Individuals who were pregnant, ambulatory restricted and terminally ill were excluded.

A structured questionnaire was developed based on previous studies. Information such as socio-demographic data, smoking habits, alcohol consumption, physical activity level, dietary patterns and associated co-morbidities were obtained through face-to-face interview. Occupation was grouped

into white collars and non-white collars. White collars included managers, professionals, technicians and associate professionals and clerical support workers. The rest was otherwise non-white collars. Smoking meant the use of manufactured cigarettes in this study and current smokers were those who have smoked at least 100 cigarettes in their lifetime and continue to smoke daily or some days in the past one month. Alcohol consumption status was classified into lifetime abstainers (those who reported to have never consumed alcohol beverages in their lifetime) and ever-drinkers (those who have either stopped or consumed alcohol beverages for the past twelve months). Physical activity level was acquired using validated International Physical Activity Questionnaire Malay version (IPAQ-M) and was classified into inactive (low activity level) and active (moderate or high activity levels). To avoid subjective variation, only certain physical activities were chosen to represent vigorous (hoeing, manual ploughing, lifting heavy object and playing sports) and moderate (doing household chores, gardening) intensity works which were considered appropriate for rural setting. Dietary fiber intake was represented by daily serving of vegetables and fruits. Associated co-morbidities (hypertension, diabetes mellitus and hypercholesterolemia) were self-reported in concert with the medical records.

Height and weight were recorded. Waist and hip circumferences were registered using measuring tape, to the nearest 0.1 cm. Waist circumference was identified as midpoint between the lower margin of the last palpable rib and the tip of the iliac crest. Hip circumference was taken from the widest portion of the buttocks. Each measurement was carried out twice and the average was taken as the final reading.

Body mass index (BMI) was calculated using formula of weight (in kg)/ squared height (in m). Obesity for Asian is defined as BMI of 27.5 kg/m^2 or higher[18]. Waist-hip ratio was obtained by dividing average waist circumference over average hip circumference. A person is at high risk category when waist circumference is $\geq$ 90 cm and $\geq$ 80 cm for men and women respectively while the cut-off for waist-hip ratio is 0.90 for men and 0.85 for women[18].

Blood pressure was measured on the right arm using standard cuff. The participants were instructed to rest for at least 30 minutes before the first reading and second reading was taken at an interval of 5 minutes. The average was taken as the final reading.

Statistical analysis was done using Statistical Package for the Social Science version 17 (SPSS Inc, Chicago, IL, USA). Descriptive analysis was carried out for socio-demographic data by means of frequency and percentage. Chi-square was used for categorical variables to look for statistical significance of association. Binary logistic regression was used for risk estimation. A p-value of < 0.05 was considered as statistically significant.

RESULTS

Sociodemographic background of the respondents

A total of 181 respondents participated in the study. The mean age of the respondents was 44.7 ± 16.2. More than half (54.1%) of the respondents were female. Rungus was predominant ethnicity (54.7%) followed by Sino (21.0%). 89.5% of respondents practiced Christianity. More than two-third of respondents (69.6%) were married. 22.7% of respondents reported that they have never received formal education. Majority (32.0%) were housewife while 25.4% of respondents worked as farmer. More than half (65.2%) lived in poverty.

Prevalence of obesity

The prevalence of obesity was 28.2% while 35.9% were pre-obese, with mean BMI of 25.29 ± 5.22. Women (54.9%) registered higher rate of obesity compared to men (45.1%) but was not statistically significant. 66.7% of women belonged to high risk group based on their waist circumference and was statistically significant ($p < 0.05$) to be higher than men. Men had higher mean waist to hip ratio compared to women (0.93 ± 0.07 vs 0.88 ± 0.07; $p < 0.05$) (Table 1).

Table 1: Prevalence of obesity, high-risk waist circumference and waist-hip ratio by gender

	All (n=181)	**Men (n=83)**	**Women (n=98)**	**P-value***
BMI[a]: mean (SD)	25.29 (5.22)	25.72 (5.90)	24.92 (4.56)	0.305
Obese	51 (28.2%)	23 (45.1%)	28 (54.9%)	
Pre-obese	65 (35.9%)	28 (43.1%)	37 (56.9%)	
Non-obese	65 (35.9%)	32 (49.2%)	33 (50.8%)	0.774
Waist circumference: mean (SD)	87.10 (12.93)	89.04 (14.67)	85.46 (11.07)	0.070
High risk[b]	99 (54.7%)	33 (33.3%)	66 (66.7%)	
Normal	82 (45.3%)	50 (61.0%)	32 (39.0%)	0.000
Waist-hip ratio: mean (SD)	0.90 (0.07)	0.93 (0.07)	0.88 (0.07)	0.000
High risk[c]	110 (60.8%)	48 (43.6%)	62 (56.4%)	
Normal	71 (39.2%)	35 (49.3%)	36 (50.7%)	0.456

[a] body mass index: obese ≥ 27.5; pre-obese 23.0-27.4; non-obese < 23.0
[b] waist circumference cut-off: men ≥ 90cm; women ≥ 80cm
[c] waist to hip ratio cut-off: men > 0.90; women > 0.85
* chi square or t-test was used. Significant statistically when $p < 0.05$.

Correlation of BMI with waist circumference and waist-hip ratio

BMI correlated significantly and positively with waist circumference (r=0.901) and waist-hip ratio (r=0.502) regardless of gender. The correlation of BMI with waist circumference and waist-hip

ratio was higher in men (*r*=0.923 and *r*= 0.572 respectively) while it was moderate in women (*r*=0.872 and *r*=0.443 respectively) (Figure 1 and Figure 2).

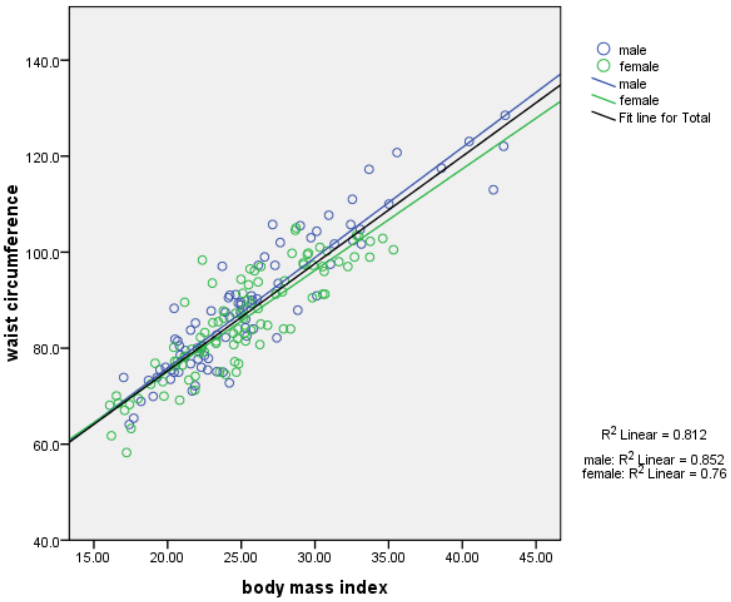

Figure 1: Correlation of BMI and waist circumference. [Total (r=0.901; p < 0.001), men (r=0.923; p < 0.001), women (r=0.872; p < 0.001)]

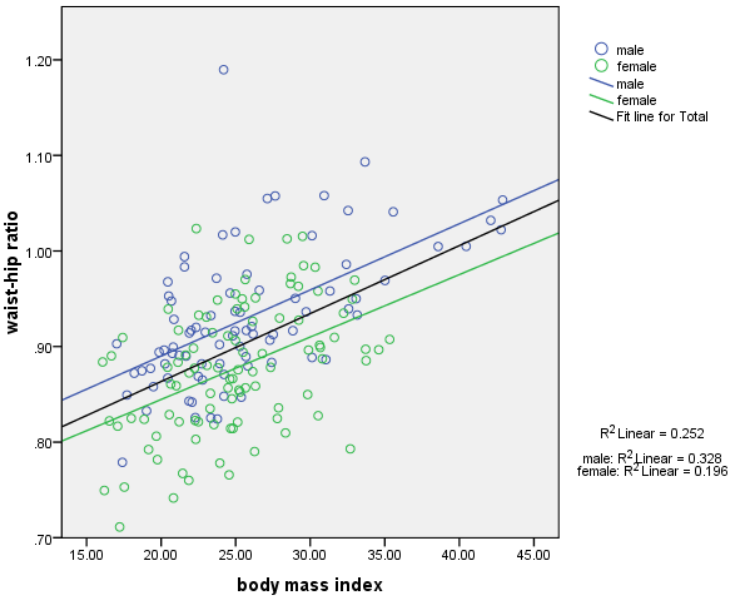

Figure 2: Correlation of BMI and waist-hip ratio. [Total (r=0.502; p < 0.001), men (r=0.572; p < 0.001), women (r=0.443; p < 0.001)]

Non-modifiable risk factors

The respondents aged 45-60 years had higher odds (OR 7.59; 95%CI 1.60-35.94) of being obese compared to young adults. Compared to men, women were more likely to be obese (OR 1.04;

95%CI 0.54-2.00). Sino was 2.24 times (95%CI 1.06-4.74) more prone to obesity compared to other ethnicities (Table 2).

Table 2: Statistical analysis of risk factors and obesity

Variable	BMI[a]		Odds ratio	95% CI
	Non-obese	Obese		
Age group				
18-25	22 (91.7)	2 (8.3)	1	Reference
26-44	51 (69.9)	22 (30.1)	4.75	1.03-21.95
45-60	29 (59.2)	20 (40.8)	7.59	1.60-35.94
>60	28 (80.0)	7 (20.0)	2.75	0.52-14.58
Gender				
Men	60 (72.3)	23 (27.7)	1	Reference
Women	70 (71.4)	28 (28.6)	1.04	0.54-2.00
Ethnicity				
Others	108 (75.5)	35 (24.5)	1	Reference
Sino	22 (57.9)	16 (42.1)	2.24	1.06-4.74

[a] Body Mass Index: obese BMI ≥ 27.5; non-obese BMI < 27.5

Socioeconomic status and obesity

Respondents who were formally educated were associated with obesity (OR 3.52; 95% CI 1.30-9.58). Being white collars had higher risk of being obese (OR 2.43; 95% CI 1.12-5.28). Monthly household income of ≥ RM950 was associated with higher risk to obesity (OR 1.86; 95% CI 0.97-3.58) (Table 3).

Table 3: Statistical analysis between socioeconomic status and obesity

Variable	BMI[a]		Odds ratio	95% CI
	Non-obese	Obese		
Formal education				
No	36 (87.8)	5 (12.2)	1	Reference
Yes	94 (67.1)	46 (32.9)	3.52	1.30-9.58
White collars				
No	111 (75.5)	36 (24.5)	1	Reference
Yes	19 (55.9)	15 (44.1)	2.43	1.12-5.28
Monthly household income				
< RM950	81 (77.1)	24 (22.9)	1	Reference
≥ RM950	49 (64.5)	27 (35.5)	1.86	0.97-3.58

[a] Body Mass Index: obese BMI ≥ 27.5; non-obese BMI < 27.5

Behavioral risk factors and obesity

While current smokers had protective risk against obesity (OR 0.55; 95%CI 0.23-1.28), ever-drinkers were more likely to be found obese (OR 2.07; 95%CI 0.92-4.67). Physically inactive

respondents were associated with obesity (OR 1.37; 95%CI 0.70-2.67). Consumption of vegetable and fruit five or more servings per day was less likely to get obese (OR 0.77; 95%CI 0.32-1.81) (Table 4).

Table 4: Association analysis between behavioral risk factors and obesity

Variable	BMI[a]		Odds ratio	95% CI
	Non-obese	Obese		
Current smoking status				
No	97 (69.3)	43 (30.7)	1	Reference
Yes	33 (80.5)	8 (19.5)	0.55	0.23-1.28
Drinking status				
Lifetime abstainer	40 (81.6)	9 (18.4)	1	Reference
Ever drinker	90 (68.2)	42 (31.8)	2.07	0.92-4.67
Physical activity				
Active	86 (74.1)	30 (25.9)	1	Reference
Inactive	44 (67.7)	21 (32.3)	1.37	0.70-2.67
Vegetable and fruit daily serving				
< 5	104 (70.3)	44 (29.7)	1	Reference
≥ 5	25 (75.8)	8 (24.2)	0.77	0.32-1.81

[a] Body Mass Index: obese BMI ≥ 27.5; non-obese BMI < 27.5

Associated co-morbidities and obesity

Both hypertension (OR 1.67; 95%CI 0.81-3.44) and diabetes mellitus (OR 2.68; 95%CI 0.64-11.16) were associated with increased odds of getting obese. Respondents with hypercholesterolemia was found to be obese (OR 2.55; 95%CI 1.09-5.98). High systolic blood pressure was found in obese individuals (OR 2.55; 95%CI 1.27-5.12) while no association was seen in diastolic blood pressure (OR 1.34; 95%CI 0.66-2.74) (Table 5).

Table 5: Association between co-morbidities and obesity

Variable	BMI[a]		Odds ratio	95% CI
	Non-obese	Obese		
Hypertension				
Yes	28 (21.5)	16 (32.7)	1.67	0.81-3.44
No	102 (78.5)	35 (67.3)	1	Reference
Diabetes mellitus				
Yes	4 (3.1)	4 (7.8)	2.68	0.64-11.16
No	126 (96.9)	47 (92.2)	1	Reference
Hypercholesterolemia				
Yes	14 (10.8)	12 (23.5)	2.55	1.09-5.98
No	116 (89.2)	39 (76.5)	1	Reference
Systolic blood pressure				
High	28 (57.1)	21 (42.9)	2.55	1.27-5.12
Normal	102 (77.3)	30 (22.7)	1	Reference
Diastolic blood pressure				
High	33 (67.3)	16 (32.7)	1.34	0.66-2.74
Normal	97 (73.5)	24 (26.5)	1	Reference

[a] Body Mass Index: obese BMI ≥ 27.5; non-obese BMI < 27.5

Factors associated with obesity

Statistical analysis of predictors of obesity resulted in only three factors. Middle age adults (adjusted OR 7.66; 95%CI 1.61-36.39), formally educated (adjusted OR 2.92; 95%CI 1.05-8.15) and ever drinkers (adjusted OR 2.70; 95%CI 1.12-6.51) were associated with obesity after adjustment from potential confounders. In addition, associated co-morbidities of obesity were related with high systolic blood pressure (adjusted OR 3.11; 95%CI 1.22-7.92) (Table 6).

Table 6: Predictors and associated co-morbidity of obesity using binary logistic regression

Variable	Adjusted OR	P value	95% CI
Age[ł]			
26-44	4.80	0.045	1.03-22.25
45-60	7.66	0.010	1.61-36.39
> 60	2.80	0.228	0.53-14.92
Formal education[Δ]	2.92	0.040	1.05-8.15
Ever drinkers[ϕ]	2.70	0.027	1.12-6.51
High systolic blood pressure[ŝ]	3.11	0.017	1.22-7.92

[ł]The age group of 18-25 years was used as the reference group.
[Δ]The group without formal education was used as the reference group.
[ϕ]Lifetime abstainer group was used as the reference group.
[ŝ]Normal systolic blood pressure was used as the reference group.

DISCUSSION

This community is composed predominantly of Rungus ethnicity and Christians. Low educational level and high poverty rate are disadvantageous characteristics. Farmer is the main occupation and most women are housewife.

Several key findings are worth to be discussed here: (1) high prevalence of obesity in the community, (2) significant positive correlation of BMI with waist circumference and waist-hip ratio, (3) older age, formally educated and ever-drinkers were identified as significant risk factors of obesity, and (4) high systolic blood pressure was associated co-morbidity of obesity in the community.

The prevalence of obesity found in this study (28.2%) was much higher than that of being reported by NHMS in Sabah (21.1%) while the margin was not much in the pre-obese (35.9% vs 34.5%)[2]. Generally, obesity was seen more (54.9%) in women in this study, probably due to the fact that majority of women were playing role of housewife or child rearing which is sedentary. Binary logistic regression study also produced slightly increased risk of obesity in women (OR 1.04; 95%CI 0.54-2.00). Similar trend was observed in both waist circumference and waist-hip ratio which categorized more women into high-risk group. Like previous studies done in Malaysia[3, 4], women

were more likely to be obese compared to men. On the other hand, to be able to compare the prevalence of obesity in current study with others, BMI cut-off as defined by WHO (1998) was used for reclassification. The reclassified prevalence of obesity was 18.2%, being consistent with previous studies which clustered in the range of 10-20%[3, 4].

Surrogate of body adiposity has been represented by various anthropometric measurements which are considered rapid, cheap and reproducible. Compared with more advanced means of estimation of body fat contents, BMI, waist circumference and waist-hip ratio are commonly used to predict the major cardiovascular outcomes and other obesity related diseases in most epidemiological studies. Recent studies have also shifted focus towards waist circumference in which it becomes preferable anthropometric indicator to predict major cardio-metabolic outcomes[19]. BMI was used in this study to define obesity. Correlation study has found that BMI pronouncedly correlated with both waist circumference and waist-hip ratio in positive direction particularly being stronger in men. The distribution of fat is known to be different in men from women due to hormonal influence. Men display tendency towards abdominal or central adiposity which is markedly accompanied by girth expansion. In contrast, fat accumulation in hip and thigh is characteristic of women, at least during their pre-menopausal life. This natural disparity renders men to get exposed to wide range of cardiovascular and metabolic risks. While both waist circumference and waist-hip ratio are determinant of central adiposity, it is not surprising that BMI of men correlated well with both anthropometric parameters.

Older age was associated with obesity in increasing manner from young (26-44 years of age) (adjusted OR 4.80; 95%CI 1.03-22.25) to middle-age (45-60 years of age) (adjusted OR 7.66; 95%CI 1.61-36.39) population. Thereafter, the risk is reduced in elderly group. The trend was consistent with the studies conducted within Malaysia as well as the rest of the world[3, 4, 7, 8, 20]. It is probably due to transition of body composition from lean mass to fat mass in older age group in men and postmenopausal women.

Surprisingly, educated individuals showed tendency to obesity in present study (adjusted OR 2.92; 95%CI 1.05-8.15). It was in violation with the conventional thought, as supported by Pan et al. (2011)[8] and Mohd Sidik et al. (2009)[21] that they were less likely to get obese due to healthier lifestyle and greater health awareness. Though higher education level may promote understanding of health knowledge, but it does not correspond to the actual practice of healthy lifestyle.

Ever-drinkers (adjusted OR 2.70; 95%CI 1.12-6.51) were found to be more prone to obesity. Ever-drinkers included both former and current alcohol consumers. Previous studies demonstrated alcohol to have contradictorily protective effect towards obesity[8, 12]. Our study showed that former drinkers still did get exposed to obesity even after abstinence. It is however not known that abstinence from alcohol alone can lead to reversal of weight gain previously. Higher frequency and quantity of

alcohol drinks might explain the link to obesity as moderate alcohol intake can paradoxically reduce the potential to obesity[11, 12]. It appears that the underlying mechanism for the relationship between alcohol consumption and obesity is complex. Nonetheless, Suter et al. (1997)[22] stated that it is the metabolism of alcohol in the body which suppresses the lipolytic process. Therefore, alcohol does not directly provide calorie though it has as much calories as fat (7 kCal/g).

Interestingly, systolic blood pressure was higher in obese group compared to leaner one (adjusted OR 3.11; 95%CI 1.22-7.92). Previous studies also found similar finding of relationship between obesity and blood pressure[7, 9]. This phenomenon is possibly due to arteriosclerotic consequence which leads to hardening of the blood vessel. This will eventually result in a lot of cardiovascular diseases in obese individuals. The process could be accelerated in the obese where concurrent dyslipidemia plays a role[23] as dyslipidemia is invariably found in obese population[7, 9, 20]. However, hypercholesterolemia did not show significant association with obesity. Small number of individuals with hypercholesterolemia due to small sample size may be the reason for it.

This study contained several limitations and biases. The results did not represent the whole population in northern Borneo as the sample size was small and convenience sampling was used. Association study might not be found statistically significant in some of the risk factors and co-morbidities due to similar reason. Since physical activity is major determinant of obesity, our study failed to establish the association. Since only selected types of physical activity are included during interview and they may not represent as exact total physical activity level as it should be. More studies should be carried out to ascertain the epidemiology of obesity in Sabah, which has totally different demographic characteristics.

CONCLUSION

The prevalence of obesity in rural population is on the rise. Various forms of intervention should not be focused merely in urban area, but also involve the rural area to close the disparity of health. While the epidemiology of obesity in rural is distinct than that in the urban, interventional program should be designed in such a way that it is appropriate for rural setting which has educational and financial disadvantages. Therefore, health promotion to impart health awareness or knowledge is beneficial move to combating obesity in rural population targeting at those identified risk factors.

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CONFLICT OF INTEREST

The authors declare that they have no competing interests.

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