

## Original Article

# Food insecurity and the metabolic syndrome among women from low income communities in Malaysia

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This cross-sectional study examined the relationship between household food insecurity and the metabolic syndrome (MetS) among reproductive-aged women (n=625) in low income communities. The Radimer/Cornell Hunger and Food Insecurity instrument was utilized to assess food insecurity. Anthropometry, diet diversity, blood pressure and fasting venous blood for lipid and glucose profile were also obtained. MetS was defined as having at least 3 risk factors and is in accordance with the Harmonized criteria. The prevalence of food insecurity and MetS was 78.4% (household food insecure, 26.7%; individual food insecure, 25.3%; child hunger, 26.4%) and 25.6%, respectively. While more food secure than food insecure women had elevated glucose (food secure, 54.8% vs food insecure, 37.3-46.1%), total cholesterol (food secure, 54.1% vs food insecure, 32.1-40.7%) and LDL-cholesterol (food secure, 63.7% vs food insecure, 40.6-48.7%), the percentage of women with overweight/obesity, abdominal obesity, hypertension, high triglyceride, low HDL-cholesterol and MetS did not vary significantly by food insecurity status. However, after controlling for demographic and socioeconomic covariates, women in food insecure households were less likely to have MetS (individual food insecure and child hunger) ( $p<0.05$ ), abdominal obesity (individual food insecure and child hunger) ( $p<0.01$ ), elevated glucose (household food insecure), total cholesterol (child hunger) ( $p<0.05$ ) and LDL-cholesterol (household food insecure and child hunger) ( $p<0.05$ ) compared to food secure women. Efforts to improve food insecurity of low income households undergoing nutrition transition should address availability and accessibility to healthy food choices and nutrition education that could reduce the risk of diet-related chronic diseases.

**Key Words:** metabolic syndrome, food insecurity, harmonized criteria, low income communities, reproductive age women

## INTRODUCTION

The metabolic syndrome (MetS) is a constellation of inter-related risk factors that include central obesity, elevated triglycerides, reduced HDL-cholesterol, hypertension and raised fasting plasma glucose.<sup>1</sup> Regardless of the criteria used, the diagnosis of MetS is based on the presence of at least 3 risk factors. With the increasing prevalence of obesity worldwide and obesity as the central feature of MetS, there is a parallel increase in the number of individuals with MetS.<sup>2</sup> The current epidemic of type 2 diabetes mellitus and cardiovascular diseases in both the developed and developing countries could as well be attributed to the increasing prevalence of obesity and MetS.<sup>3,4</sup>

The rapid growth and development and improved socio-economic status in Malaysia has a profound effect on the lifestyle behaviors of its population and consequently the disease patterns. The National Health and Morbidity Survey III in 2006 indicated that the prevalence of overweight and obesity, hyperlipidemia, hypertension and diabetes among Malaysian adults has increased substan-

tially over the last 10 years.<sup>5</sup> A recent national survey showed that 42.5% of Malaysian adults were diagnosed with MetS and a higher prevalence was observed in women (43.7%) than men (40.2%). Although the prevalence was generally higher in urban (44.9%) than rural (40%) areas, the difference is relatively small.<sup>6</sup> Of concern is the observation that women tend to have similar or higher prevalence of these risk factors than men and that the gap between rural and urban or low and high income groups is diminishing.

Food insecurity is defined as having 'limited or uncertain availability of nutritionally adequate and safe foods

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or limited or uncertain ability to acquire acceptable foods in socially acceptable ways'.<sup>7</sup> It is also viewed as a potential mechanism underlying the relationship between poverty with obesity and other adverse health outcomes.<sup>8</sup> While studies on the relationship between food insecurity and obesity in adults have produced conflicting findings,<sup>9-17</sup> only few studies have examined the contribution of food insecurity to chronic diseases and chronic disease risks.<sup>14,18-23</sup>

Since independence in 1950's, Malaysia has experienced improved food security and consequently better health and nutritional status ie longer life expectancy and reduced undernutrition. Over the years, despite the rising global food prices, the country has observed increasing agricultural outputs, food supply, average household income and household food expenditure which have significantly contributed to the diversification of diets of its population.<sup>24</sup> Nevertheless, there are still pockets in the communities that are experiencing food insecurity. To date, published information on the relationship between food insecurity with metabolic risk factors or MetS in Malaysia are limited and the few published studies have produced mixed findings.<sup>25-26</sup> This study was conducted to explore such relationship in a sample of low income rural and urban women in Peninsular Malaysia. We hypothesized that being food insecure is associated with higher risk of having metabolic risk factors and subsequently MetS.

## METHODS

### *Study sample*

This cross-sectional study was conducted in 3 states (Selangor, Negeri Sembilan and Kelantan) of Peninsular Malaysia between July 2005 and December 2009. Rural and urban low income households of two major ethnic groups (Malay and Indian) were purposively selected for the study. Urban Indian households were from three low cost housing areas, randomly selected within the district of Petaling, Selangor; while rural Indians were from seven palm plantations randomly selected throughout Negeri Sembilan. Malay households were located in housing areas/villages in five randomly selected urban and rural counties in Kelantan. The palm plantations and villages within the rural counties are located approximately 5-15 km from small towns while urban households were near (within 5 km) the cities of Kota Bharu (Kelantan) or Kuala Lumpur (Selangor).

As this study was part of a larger study that assessed factors associated with food insecurity, the sample size was calculated based on prevalence of food insecurity in rural (58%) and urban (65.7%) areas of Malaysia,<sup>25,27</sup> 95% confidence level ( $z$  value of 1.96) and error at 10%. All households were visited to identify those with non-pregnant, non-lactating and physically-able women in the reproductive age group (19-49 years old). Women in this age group were selected as this study was part of a larger study on the relationship between household food insecurity with health and nutrition of women and their children (<10 years old). Upon screening, a total of 827 households were eligible for participation; however only 625 households gave informed consent. The study was approved by the Medical Research Ethics Committee of Universiti Putra Malaysia. All respondents received food

items worth USD 7 (RM20) upon completion of study measurements.

### *Study measurements*

Interviewers were trained to obtain anthropometric measurements and conduct face-to-face interview using a pre-tested questionnaire in Malay or Indian language. Women were measured for weight and height using a digital SECA weighing scale and SECA body meter, respectively. Body mass index (BMI) was calculated as  $\text{kg/m}^2$  and categorized according to World Health Organization.<sup>28</sup> Waist circumference (WC) was measured using SECA measuring tape at the midway between the lowest rib margin and the iliac crest. Fasting venous blood (10 ml) and blood pressure were obtained by qualified staff nurse and analyzed for serum triglycerides (TG), total cholesterol (TC), HDL-cholesterol (HDL), LDL-cholesterol (LDL) and plasma glucose (FPG) using Chemistry Analyzer (Vitalab Model Selectra E). Blood pressure was measured using an Omron digital sphygmomanometer after a 5 minute rest. The metabolic syndrome was defined using 'Harmonized' criteria<sup>29</sup> that identified women with 3 or more of the following metabolic risk factors: WC  $\geq 80$  cm, TG  $\geq 1.7$  mmol/L, HDL  $< 1.30$  mmol/L, FPG  $\geq 5.6$  mmol/L (or diabetes), systolic/diastolic blood pressure  $\geq 130/85$  mmHg (or on medication). Elevated TC and LDL were defined as  $\geq 5.17$  mmol/L and  $\geq 3.36$  mmol/L, respectively.<sup>30</sup>

A food frequency questionnaire, adapted from the Malaysian Adults Nutrition Survey (2003) was used to obtain the number of different food groups consumed by the women in the previous 30 days. There were 29 food groups categorized into 8 major food categories (5 grain and cereals, 4 meat and meat products, 3 fish and seafood, 5 fruits, 5 vegetables, 3 milk and milk products, 2 meat alternatives, 2 beverages). Diet diversity score (DDS) was calculated as the number of food groups consumed regularly (daily or  $\geq 2$  times per week) with a maximum score of 29. A higher score reflects greater diversity of the diet. This method was previously used in our study to assess the relationship between dietary diversity and MetS in women.<sup>26</sup>

The Radimer/Cornell Hunger and Food Insecurity instrument was used to categorize households as either food secure (FS), household food insecure (HFI), individual food insecure (IFI) or child hunger (CH).<sup>31</sup> The four levels reflect increasing severity with child hunger being the worst. The categorization was based on responses to 10 items, namely, food secure: negative answer (not true) to all items (1-10); household food insecure: positive answer (sometimes true or often true) to one or more of items 1-4 but not to items 5-10; individual food insecure: positive answer to one or more of items 5-8 but not to items 9-10; child hunger: positive answer to items 9-10. The translated items have been used in previous local studies<sup>25,27</sup> and were reported to have a good internal consistency ( $\alpha=0.8-0.9$ ).

### *Statistical analysis*

Data were analyzed using SPSS version 19.0 for Windows. Based on normality test (Shapiro-Wilk test), all

continuous data were found to be normally distributed. All variables were presented first as descriptive statistics ie mean, standard deviation, frequency and percentage. The associations between continuous and categorical variables with food insecurity status were assessed using one-way ANOVA and chi-square test, respectively. Bonferroni post-hoc test was used to identify significant mean differences among groups. Factors associated with MetS and its components were assessed using univariable logistic regression. Multivariable logistic regression identified the association between food insecurity status with MetS and metabolic risk factors, adjusting for socio-demographic factors that were significantly associated with MetS and its metabolic risk factors (age, ethnicity, urban/rural strata, education, employment and income per capita). Statistical significance was set at  $p < 0.05$ .

## RESULTS

In this sample, 78.4% of women reported some forms of food insecurity (HFI, 26.7%; IFI, 25.3%; CH, 26.4%). A higher percentage of food insecure than food secure women were Indians ( $p=0.003$ ), lived in rural areas (palm plantations or villages) ( $p < 0.0001$ ) and had only primary education ( $\leq 6$  years) ( $p=0.002$ ) (Table 1). Household income and income per capita decreased significantly ( $p < 0.0001$ ) from households experiencing food security to child hunger.

Table 2 shows the distribution of diet diversity score, body mass index, waist circumference, lipid and glucose profile and MetS by food insecurity status. Food secure women had significantly higher diet diversity score than women from individual food insecure and child hunger

households ( $p=0.002$ ). A higher percentage of food insecure (TC=59.3-67.9%; LDL=51.3-59.4%; FPG=53.9-61.7) than food secure (TC=45.9%; LDL=36.3%; FPG=45.2%) women had normal TC, LDL and FPG. For other metabolic factors and MetS, the distribution of women with at-risk values did not differ significantly. Nevertheless, food secure women had the highest prevalence of MetS (29.6%) compared to women from HFI (25.7%), IFI (23.4%) and CH (24.2%) households.

Older age women were at higher risk of being overweight or obese and having MetS, abdominal obesity, hypertension and high FPG, TC as well as LDL (Table 3). Compared to Malays, Indians were more likely to have high BMI, WC and low HDL but lower odds of increased FPG, TC and LDL. Increased risk of hypertension and MetS but lower risk of high TC were observed in rural than urban women. Working women were more likely to have lower risk of high FPG, TC, TG and LDL but higher odds of being overweight or obese and centrally obese than housewives. Increased income per capita was associated with lower risk of high BP, FPG, TC and LDL but higher risk of low HDL.

After adjusting for demographic and socio-economic covariates, women with food insecurity had lower risk of abdominal obesity (IFI: OR=0.58, 95% CI: 0.35-0.98 and CH: OR=0.55, 95% CI: 0.32-0.95), elevated plasma glucose (HFI: OR=0.51, 95% CI: 0.29-0.91), cholesterol (CH: OR=0.61, 95% CI: 0.34-0.98) and LDL cholesterol (HFI: OR=0.52, 95% CI: 0.30-0.89 and CH: OR=0.49, 95% CI: 0.28-0.87) and MetS (IFI: OR=0.59, 95% CI: 0.32-0.99 and CH: OR=0.58, 95% CI: 0.33-0.95) as compared to women with food security (Table 4).

**Table 1.** Socio-demographic characteristics of women by food security status (n=625)

	Food Secure (FS) (n=135)	Household Food Insecure (HFI) (n=167)	Individual Food Insecurity (IFI) (n=158)	Child Hunger (CH) (n=165)	p value
Age (years)†	38.1 ± 7.07	38.0 ± 7.05	38.4 ± 7.18	37.7 ± 7.17	0.836
Ethnicity					0.003
Indian	53 (39.3)	83 (49.7)	94 (59.5)	94 (57.0)	
Malay	82 (60.7)	84 (50.3)	64 (40.5)	71 (43.0)	
Strata					0.000
Rural	51 (37.8)	86 (51.5)	79 (50.0)	104 (63.0)	
Urban	84 (62.2)	81 (48.5)	79 (50.0)	61 (37.0)	
Marital status					0.071
Single/Divorced/Widowed	4 (3.0)	6 (3.6)	9 (5.7)	15 (9.1)	
Married	131 (97.0)	161 (96.4)	149 (94.3)	150 (90.9)	
Education level					0.002
Low education ( $\leq 6$ years)	18 (13.3)	42 (25.1)	45 (28.5)	52 (31.5)	
High education ( $> 6$ years)	117 (86.7)	125 (74.9)	113 (71.5)	113 (68.5)	
Employment status					0.236
Working	56 (41.5)	81 (48.5)	84 (53.2)	83 (50.3)	
Housewife	79 (58.5)	86 (51.5)	74 (46.8)	82 (49.7)	
Household size	5.95 ± 2.19	6.17 ± 2.09	6.13 ± 1.96	6.29 ± 2.07	0.556
Women's income (USD)†	92 ± 71	73 ± 55	58 ± 35	53 ± 46	0.283
Household income (USD)†	497 ± 366	409 ± 286	328 ± 185	287 ± 218	0.000‡,§,¶,††,‡‡
Income per capita (USD)†	92 ± 71	73 ± 55	58 ± 35	52 ± 46	0.000‡,§,¶,††

† Mean (SD)

‡ FS vs HFI; § FS vs IFI; ¶ FS vs CH; †† HFI vs IFI; ‡‡ HFI vs CH)

1 USD = RM 3.2

**Table 2.** Diet diversity and metabolic factors of women by food security status (n=625)

	Food Secure (FS) (n=135)	Household Food Insecure (HFI) (n=167)	Individual Food Insecurity (IFI) (n=158)	Child Hunger (CH) (n=165)	p value
Diet diversity score <sup>†</sup>	10.7 ± 4.36	9.82 ± 3.43	9.47 ± 3.66	9.07 ± 3.70	0.002 <sup>§,¶</sup>
1 <sup>st</sup> tertile (0-8)	44 (32.6)	59 (35.3)	59 (37.3)	76 (46.1)	0.021
2 <sup>nd</sup> tertile (9-11)	36 (26.7)	62 (37.1)	53 (33.5)	50 (30.3)	
3 <sup>rd</sup> tertile (12-21)	55 (40.7)	46 (27.5)	46 (29.1)	39 (23.6)	
BMI (kg/m <sup>2</sup> )	26.7 ± 5.09	26.6 ± 5.65	26.8 ± 5.34	26.0 ± 5.04	0.549
Underweight/Normal (<25)	57 (42.2)	67 (40.1)	64 (40.5)	73 (44.2)	0.146
Overweight (≥25-29.9)	42 (31.1)	56 (33.5)	60 (38.0)	61 (37.0)	
Obesity (≥30.0)	36 (26.7)	44 (26.3)	34 (21.5)	31 (18.8)	
Waist circumference (WC) (cm) <sup>†</sup>	83.2 ± 11.7	83.4 ± 14.1	83.7 ± 14.1	83.6 ± 13.6	0.989
Normal (<80 cm)	81 (60.0)	100 (59.9)	95 (60.1)	101 (61.2)	0.994
At risk (≥80 cm)	54 (40.9)	67 (40.1)	63 (39.9)	64 (38.8)	
Blood pressure (BP) (mmHg)					
Normal (<130/85 mmHg)	91 (67.4)	115 (68.9)	104 (65.8)	110 (66.7)	0.947
At risk (≥130/85 mmHg)	44 (32.6)	52 (31.1)	54 (34.2)	55 (33.3)	
Fasting plasma glucose (FPG)(mmol/L) <sup>†</sup>	6.12 ± 2.61	5.86 ± 2.41	5.61 ± 2.23	5.74 ± 2.34	0.311
Normal (<5.6)	61 (45.2)	103 (61.7)	99 (62.7)	89 (53.9)	0.008
At risk (≥5.6)	74 (54.8)	64 (38.3)	59 (37.3)	76 (46.1)	
Total cholesterol (TC) (mmol/L) <sup>†</sup>	5.22 ± 0.91	4.97 ± 1.107	4.98 ± 1.17	4.98 ± 1.07	0.142
Normal (<5.17)	62 (45.9)	99 (59.3)	96 (60.8)	112 (67.9)	0.002
At risk (≥5.17)	73 (54.1)	68 (40.7)	62 (39.2)	53 (32.1)	
Triglyceride (TG) (mmol/L) <sup>†</sup>	1.31 ± 0.59	1.20 ± 0.70	1.18 ± 0.71	1.18 ± 0.65	0.299
Normal (<1.7)	18 (13.3)	42 (25.1)	45 (28.5)	52 (31.5)	0.650
At risk (≥1.7)	117 (86.7)	125 (74.9)	113 (71.5)	113 (68.5)	
HDL-cholesterol (HDL) (mmol/L) <sup>†</sup>	1.25 ± 0.28	1.25 ± 0.32	1.22 ± 0.30	1.26 ± 0.38	0.585
Normal (≥1.3)	50 (37.0)	67 (40.1)	55 (34.8)	70 (42.4)	0.879
At risk (<1.3)	85 (63.0)	199 (59.9)	103 (65.2)	95 (57.6)	
LDL-cholesterol (LDL) (mmol/L) <sup>†</sup>	3.82 ± 1.06	3.39 ± 1.13	3.40 ± 1.16	3.25 ± 0.94	0.000 <sup>‡,§,¶</sup>
Normal (<3.36)	49 (36.3)	90 (53.9)	81 (51.3)	98 (59.4)	0.001
At risk (≥3.36)	86 (63.7)	77 (46.1)	77 (48.7)	67 (40.6)	
Number of metabolic risks					
0	14 (10.4)	27 (16.2)	21 (13.3)	15 (9.1)	0.461
1	40 (29.6)	44 (26.3)	45 (28.5)	63 (38.2)	
2	41 (30.4)	53 (31.7)	55 (34.8)	47 (28.5)	
3	31 (23.0)	32 (19.2)	28 (17.7)	27 (16.4)	
>3	9 (6.6)	11 (6.6)	9 (5.7)	13 (7.8)	
The metabolic syndrome (MetS)					
No	95 (70.4)	124 (74.3)	121 (76.6)	125 (75.8)	0.635
Yes <sup>§§</sup>	40 (29.6)	43 (25.7)	37 (23.4)	40 (24.2)	

<sup>†</sup> Mean (SD)

<sup>‡</sup> FS vs HFI; <sup>§</sup> FS vs IFI; <sup>¶</sup> FS vs CH; <sup>††</sup> HFI vs IFI; <sup>‡‡</sup> HFI vs CH; <sup>†</sup> Mean (SD)

<sup>§§</sup>MetS = at least 3 of the followings - WC ≥ 80 cm, BP ≥ 130/85 mmHG, FPG ≥ 5.6 mmol/L, TG ≥ 1.7 mmol/L, HDL-C < 1.3 mmol/L

## DISCUSSION

While previous studies in either low income or general populations reported that food insecurity is a risk factor for metabolic abnormalities,<sup>14,18-23</sup> our study in low income communities did not support the positive association between food insecurity with MetS and its individual metabolic risk factors. Instead, women experiencing food insecurity, particularly child hunger, were less likely to have MetS, abdominal obesity, elevated FPG, TC and LDL compared to food secure women. There was however, no significant association between food insecurity and other metabolic risk factors, suggesting that the association between food insecurity and MetS could be based on the combination rather than individual risk factors.<sup>14,19</sup> It is also important to note that although other metabolic risk factors did not show significant association with food insecurity status, the odds of having metabolic risks were generally lower in food insecure than food secure women.

The positive association between food insecurity with obesity and chronic diseases observed in previous studies could be explained by the cyclic or episodic nature of food insecurity experienced by food insecure households.<sup>32</sup> Food insecure households may often experience both periods of food scarcity and food availability. When household food supply is limited, eating patterns are disrupted and food intakes are usually reduced. However, when resources and eventually food supply are adequate, individuals may overeat due to concern about future food scarcity. Food insecure households may also experience alterations in the types of food served and consumed.<sup>33-34</sup> Healthy foods, which are relatively expensive to food insecure households may be substituted with cheaper and energy-dense foods that are also satisfying due to high fat and sugar content.<sup>35</sup> The cycling of food restriction and overeating as well as greater dependence on high energy dense foods can put food insecure individuals at risk of

**Table 3.** Metabolic syndrome and its risk factors by socio-demographic factors (n=625)

Factor	Crude OR (95% CI)								
	Overweight/ Obesity	At risk WC	At risk BP	At risk FPG	At risk TC	At risk TG	At risk HDL	At risk LDL	MetS <sup>§§</sup>
Age	1.039 (1.016-1.063)	1.051 (1.027-1.076)	1.072 (1.045-1.500)	1.038 (1.015-1.062)	1.038 (1.015-1.063)	1.030 (0.997-1.065)	1.012 (0.990-1.035)	1.041 (1.018-1.065)	1.077 (1.048-1.108)
<i>p</i> value	0.001	0.000	0.000	0.001	0.001	0.075	0.295	0.000	0.000
Ethnicity (ref: Malay)	1.623 (1.178-2.235)	4.757 (3.365-6.724)	0.809 (0.579-0.131)	0.075 (0.051-0.110)	0.135 (0.094-0.194)	1.263 (0.802-1.990)	3.349 (2.389-4.694)	0.122 (0.086-0.175)	1.072 (0.748-1.536)
<i>p</i> value	0.003	0.000	0.215	0.000	0.000	0.314	0.000	0.000	0.706
Strata (ref: Urban)	1.017 (0.740-1.397)	1.083 (0.787-1.492)	1.421 (1.015-1.989)	1.207 (0.879-1.657)	0.512 (0.370-0.707)	1.233 (0.784-1.941)	0.825 (0.598-1.140)	0.790 (0.577-1.082)	1.923 (1.329-2.782)
<i>p</i> value	0.918	0.624	0.041	0.244	0.000	0.365	0.244	0.142	0.001
Education (ref: High)	1.406 (0.916-2.044)	1.865 (1.263-2.752)	0.981 (0.667-1.443)	0.980 (0.681-1.412)	1.263 (0.877-1.819)	0.859 (0.503-1.466)	0.924 (0.639-1.337)	0.840 (0.585-1.207)	1.132 (0.752-1.702)
<i>p</i> value	0.074	0.002	0.922	0.914	0.210	0.577	0.676	0.345	0.553
Employment (ref: Housewife)	1.408 (1.023-1.938)	1.479 (1.072-2.042)	0.847 (0.606-1.184)	0.535 (0.388-0.737)	0.452 (0.326-0.626)	0.623 (0.393-0.988)	1.336 (0.967-1.846)	0.640 (0.467-0.878)	0.794 (0.554-1.140)
<i>p</i> value	0.036	0.017	0.330	0.000	0.000	0.044	0.079	0.006	0.211
Income per capita	1.000 (0.999-1.001)	1.000 (0.999-1.001)	0.999 (0.998-1.000)	0.998 (0.996-0.999)	0.999 (0.998-1.000)	1.000 (0.999-1.001)	1.001 (1.000-1.002)	0.999 (0.998-1.000)	0.999 (0.998-1.000)
<i>p</i> value	0.624	0.530	0.042	0.000	0.016	0.726	0.007	0.004	0.138

BMI, body mass index ( $\geq 25$  kg/m<sup>2</sup>); WC, waist circumference ( $\geq 80$  cm); BP, blood pressure ( $\geq 130/85$  mmHg); FPG, fasting plasma glucose ( $\geq 5.6$  mmol/L); TC, total cholesterol ( $\geq 5.17$  mmol/L); TG, triglyceride ( $\geq 1.7$  mmol/L); HDL, HDL cholesterol ( $< 1.3$  mmol/L); LDL, LDL cholesterol ( $\geq 3.36$  mmol/L)

<sup>§§</sup>MetS = at least 3 of the followings, WC  $\geq 80$  cm, BP  $\geq 130/85$  mmHg, FPG  $\geq 5.6$  mmol/L, TG  $\geq 1.7$  mmol/L, HDL-C  $< .3$  mmol/L

**Table 4.** Metabolic syndrome and its risk factors by food insecurity status (n=625)

Factor	Adjusted OR <sup>†‡</sup> (95% CI)								
	Overweight/ Obesity	At risk WC	At risk BP	At risk FPG	At risk TC	At risk TG	At risk HDL	At risk LDL	MetS <sup>§§</sup>
HFI (n=167)	0.974 (0.603-1.573)	0.591 (0.340-1.027)	0.990 (0.541-1.502)	0.511 (0.288-0.907)	0.734 (0.428-1.259)	0.931 (0.491-1.764)	0.816 (0.495-1.346)	0.520 (0.300-0.899)	0.712 (0.415-1.223)
<i>p</i> value	0.914	0.062	0.687	0.022	0.261	0.826	0.426	0.019	0.219
IFI (n=158)	0.838 (0.507-1.385)	0.582 (0.346-0.979)	1.011 (0.595-1.716)	0.685 (0.377-1.248)	0.843 (0.478-1.489)	0.724 (0.360-1.454)	0.914 (0.538-1.551)	0.745 (0.422-1.315)	0.590 (0.321-0.989)
<i>p</i> value	0.490	0.042	0.969	0.217	0.557	0.364	0.941	0.310	0.031
CH (n=165)	0.746 (0.451-1.232)	0.550 (0.317-0.953)	0.968 (0.567-1.651)	1.081 (0.585-1.998)	0.608 (0.343-0.976)	0.675 (0.334-1.360)	0.701 (0.412-1.193)	0.495 (0.276-0.869)	0.579 (0.333-0.948)
<i>p</i> value	0.252	0.033	0.904	0.803	0.028	0.271	0.191	0.015	0.024
FS (ref) (n=135)	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000

HFI, Household Food Insecure; IFI, Individual Food Insecure; CH, Child Hunger; FS, Food Secure

BMI, body mass index ( $\geq 25$  kg/m<sup>2</sup>); WC, waist circumference ( $\geq 80$  cm); BP, blood pressure ( $\geq 130/85$  mmHg); FPG, fasting plasma glucose ( $\geq 5.6$  mmol/L); TC, total cholesterol ( $\geq 5.17$  mmol/L); TG, triglyceride ( $\geq 1.7$  mmol/L); HDL, HDL cholesterol ( $< 1.3$  mmol/L); LDL, LDL cholesterol ( $\geq 3.36$  mmol/L)

<sup>§§</sup>MetS = at least 3 of the followings, WC  $\geq 80$  cm, BP  $\geq 130/85$  mmHG, FPG  $\geq 5.6$  mmol/L, TG  $\geq 1.7$  mmol/L, HDL-C  $< 1.3$  mmol/L

<sup>†‡</sup>Adjusted for age, ethnicity, urban/rural strata, education, employment and income per capita

weight gain and subsequently obesity and chronic diseases.

In our study, the explanation for women living in food insecure households had reduced risk of MetS could be that food insecurity experienced by the households was chronic rather than recurrent or episodic. Within these low income communities, normal eating patterns of women with child hunger and individual food insecure could be altered due to lack of money for food which subsequently reduces the variety of food choices and overall energy and nutrient intakes. Although we did not report adequacy of energy and nutrient intakes, we showed that diet diversity score decreased as food insecurity worsened. However as the severity of food insecurity improves from child hunger to household food insecure (still with income or resource constraint), households might adopt strategies to increase energy intake by choosing a less varied diet and lower nutritional quality foods that are less expensive. For food secure households, despite the access to a variety of food choices, the increasing food prices could also force them to avoid relatively expensive foods (ie fruits, vegetables, fish and lean meats) in order to maintain food variety and higher energy intake at a lower cost.<sup>35</sup> In the urban and rural areas of Malaysia, this demand could be met through a wide array of relatively cheap but high energy dense foods that are easily accessible.

Poverty and low socioeconomic status are related to obesity and chronic diseases.<sup>36</sup> Poverty can limit household's access and control of resources for food acquisition which may negatively impact health and nutrition. As food insecurity is associated with low socioeconomic status and poor health, it is important to isolate the relationship between food insecurity and disease outcomes by controlling potentially confounding socioeconomic factors.<sup>8</sup> Previous studies that examined food insecurity and obesity have produced mixed findings when socioeconomic covariates are controlled. While some studies showed that the relationship between food insecurity and obesity was accounted for by socioeconomic factors,<sup>13,14,17,18</sup> others found that food insecurity has an independent relationship with obesity.<sup>9-12</sup> Food insecurity has been found to be an independent risk factor for MeS, diabetes mellitus, hyperlipidemia, hypertension and heart disease.<sup>18-22</sup> In our study, controlling for important socioeconomic covariates did not yield significant association between food insecurity and BMI but contributed to significant inverse relationship between food insecurity with MetS and several of its metabolic components. Nevertheless, it is important to highlight that regardless of food insecurity status, women in these low income communities were more likely to be overweight/obese and had metabolic risks.

Within 5 years, Malaysia has seen an increased in the national prevalence of obesity, hypertension, hypercholesterolemia and diabetes among adults from 14%, 32.2%, 20.7% and 11.6% (NHMS, 2006)<sup>5</sup> to 15.1%, 32.7%, 35.1 and 15.2% (NHMS, 2011),<sup>37</sup> respectively. In a recent nationwide study, prevalence of MetS (Harmonized criteria) and metabolic risks among females was 43.7% (MetS), 64.2% (abdominal obesity), 50% (hypertension), 48.1% (reduced HDL-C), 33.7% (elevated TG) and

35.3% (high FPG).<sup>6</sup> In comparison to other Asian populations such as Korea,<sup>38</sup> Hong Kong,<sup>39</sup> China<sup>40</sup> and India,<sup>41</sup> Malaysia seems to record a much higher prevalence of MetS, irrespective of the criteria used. In our study, the prevalence of Mets, abdominal obesity, hypertension, low HDL-C, elevated TG and high FPG and were 25.6%, 39.7%, 32.8%, 59%, 14.1% and 33%, respectively. It is worthwhile to note that only 12.3% of the women did not have any metabolic risk factor while 30.7% and 31.4% had 1 and 2 risk factors, respectively. As MetS increases the risk for cardiovascular disease and diabetes, the high prevalence of MetS among Malaysian adults could burden the country with high health care costs.<sup>42</sup>

Demographic and socioeconomic factors are associated with prevalence of MetS,<sup>43-48</sup> with several studies reported a stronger association for women than men.<sup>44,46,48</sup> Our study is similar to previous national surveys<sup>6,37</sup> in that increased age was consistently associated with Mets and most metabolic risks; lower income was related to higher prevalence of hypertension, diabetes mellitus and hypercholesterolemia; Indians were more likely to have central obesity and reduced HDL; and hypertension was more prevalent in rural than urban areas. The national survey<sup>6</sup> also reported that MetS was generally higher in urban areas and Indian population. In contrast, we showed that Mets was more prevalent in rural (32%) than urban (19%) areas and that Malay (25%) and Indian (26%) women had similar Mets prevalence. However, it is important to note that while the national surveys included representative sample of adult men and women of various ethnic groups, our study was limited to only women in reproductive ages and of two major ethnic groups.

This study is not without limitations. The cross-sectional design of the study did not permit any cause-effect inference of food insecurity and MetS. There could be potentially two way relationship between food security and disease conditions. While food insecurity may contribute to poor health outcomes, Seligman *et al*<sup>22</sup> proposed that individuals with diabetes may preferentially allocate limited resources towards medical treatment, resulting in worsening of food insecurity. The use of small sample size, restricted study locations and low income communities could limit the generalization of study findings to Malaysian population. Nevertheless, this study provides important information on determinants and potential health outcomes of communities at risk of food insecurity. Diet and physical activity are important determinants of metabolic risks and are associated with food insecurity. Although we reported diet diversity in relation to food security status, additional information on energy and nutrients, food group serving and physical activity level of women could provide insight to the relationship between food insecurity and metabolic risks. Finally, we only examined such relationship among women of reproductive age and not men or other age groups. As overweight and obesity is on the rise in Malaysia and its prevalence seems to be higher in women than men and highest in women of 40-49 years of age, this study could enhance our understanding of the association between food insecurity with obesity and risk of chronic diseases, particularly in women of reproductive age.

In conclusion, this study did not find any positive asso-

ciation between food insecurity and MetS. Instead, there were inverse relationships between food insecurity with Mets and several metabolic risk factors independent of socio-economic status. In general, the risk of having metabolic abnormalities increased as food insecurity improved. This could suggest that as household income increases within these low income communities, the adopted strategies to cope with food insecurity may include adjustments to food expenses and procurement that favor relatively cheaper energy dense foods which could put the women at risk of diet-related chronic diseases. Strategies to improve household food insecurity in low income communities should focus on having healthy foods available and accessible to the households and nutrition education to promote healthy food choices and lifestyle. It is also important to ensure that strategies to address poverty and food insecurity do not put households at risk of obesity and chronic diseases.

#### AUTHOR DISCLOSURES

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## Original Article

## Food insecurity and the metabolic syndrome among women from low income communities in Malaysia

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### 馬來西亞低收入社區婦女之糧食不安全與代謝症候群

這個橫斷性研究評估在低收入地區的育齡婦女(625 位)，其家戶糧食不安全性與代謝症候群的相關性。利用 Radimer/Cornell 飢餓及糧食不安全指南以評估糧食不安全性。並取得體位測量值、飲食多樣性、血壓及禁食靜脈血脂及血糖值。依據國際統一分類標準(Harmonized criteria)，代謝症候群的定義為至少有 3 項危險因子。糧食不安全(家戶糧食不安全 26.7%；個人糧食不安全 25.3%；孩童飢餓 26.4%)及代謝症候群的盛行率分別是 78.4%及 25.6%。雖然糧食安全比起有糧食不安全的婦女有較高的血糖(糧食安全 54.8%比上糧食不安全 37.3-46.1%)、總膽固醇(54.1%比上 32.1-40.7%)及低密度脂蛋白膽固醇(63.7%比上 40.6-48.7%)，但是依糧食不安全程度來看，婦女體重過重/肥胖、腹部肥胖、高血壓、高三酸甘油酯、低的高密度脂蛋白-膽固醇及代謝症候群的百分比，都沒有顯著的差異。然而，在控制人口學及社經地位變項後，家戶糧食不安全的婦女比起糧食安全的婦女有較少比率的代謝症候群(個人糧食不安全及孩童飢餓)( $p < 0.05$ )、腹部肥胖(個人糧食不安全及孩童飢餓)( $p < 0.01$ )、高血糖(家戶糧食不安全)、高總膽固醇(孩童飢餓)( $p < 0.05$ )及高的低密度脂蛋白膽固醇(家戶糧食不安全及孩童飢餓)。低收入家戶處於營養轉型之際，致力於改善他們的糧食不安全，應該著重健康食物選擇的可用性及可獲性與營養教育，以降低飲食相關慢性疾病的風險。

**關鍵字：**代謝症候群、糧食不安全、國際統一標準、低收入社區、育齡婦女