

Food security status: It's association with inflammatory marker and lipid profile among young adult

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Abstract

Food insecurity, the inability to have sufficient, safe and nutritious food for an active and healthy life, was found to be closely associated with adverse health outcomes. However, limited studies can be found that clearly explains lipid profile and inflammatory events among food secure and insecure individuals, especially among young adults in university, thus creating the need for further research. This study investigated both groups including their gender distribution to determine lipid profile such as total cholesterol (TC), triglyceride (TG), high density lipoprotein cholesterol (HDL-C) and low density lipoprotein cholesterol (LDL-C) and inflammatory marker, high sensitivity C reactive protein (hs-CRP), with waist circumference (WC), fat mass index (FMI) and waist-to-height-ratio (WHTR). A comparative cross-sectional study was carried out among participants aged between 18 to 25 years old (N=124) who were selected through the Adults Food Security Survey Module (AFSSM) and participated in blood draw procedures. Well-established blood markers of lipid profile and inflammatory marker were measured. Percentage of food secure individuals (56.5%) was slightly higher than food insecure (43.5%). Although mean (M) of Hs-CRP for male and female (M=1.000, M=0.645) was higher in food secure group, all other variables showed higher measurements among the food insecure groups. Lipid profiles, TC (M=5.175, M=5.062) and LDL (M=3.100, M=2.914) were high for both male and female respectively, while TG is high for male (M=0.817) (p=0.037) and HDL for female (M=1.826). For body composition such as FMI (M=4.494, M=5.452), WC (M=77.46, M=76.82) and WHtR (M=0.471, M=0.497), male and female respectively, in food insecure group showed higher results but only FMI showed a significant difference (p = 0.016). Statistics showed an association between food security status and lipid profile (TG) and with FMI. However, no significant association was found with inflammatory marker. This study will continue further in depth in gene expression of peroxisome proliferator activated receptor gamma (PPAR-γ) and endothelial dysfunction to better understand this issue. Regardless, current data provides knowledge and understanding of food insecurity experienced by young adults in university campus and may help them in making healthier food choices and be appreciative of the risk of chronic illnesses.

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Keywords

Food security

Inflammatory marker

Lipid profile

Young adult

Introduction

Food security is acknowledged as an important determinant of health and it consists of a multidimensional concept, reflected in the many attempts of definition in research. The term food security status is applied to distinguish people with access to sufficient quality and quantity of nutrients needed for a healthy life (Norhasmah *et al.*, 2010). Recently, Food and Agriculture Organization of

the United Nations (FAO) defined food security as “a situation that exists when all people, at all times, have physical, social and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life. Based on the definition, four food security dimensions can be identified: food availability, economic and physical access to food, food utilization and stability over time”. Meanwhile, food insecurity is defined as “a situation that exists

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when people lack secure access to sufficient amounts of safe and nutritious food for normal growth and development and an active and healthy life. This may be caused by food unavailability, insufficient purchasing power, inappropriate distribution or inadequate use of food at the household level. Food insecurity, poor conditions of health and sanitation and inappropriate care and feeding practices are the major causes of poor nutritional status (FAO, 2014).

Food security status is divided into three categories: food security, food insecurity without hunger and food insecurity with hunger. Food insecurity without hunger occurs when there is an overconsumption of calorie dense food while food insecurity with hunger occurs when consumption of calorie dense food are overlooked. Overconsumption of sufficient quality or quantity of food can increase the risk of diseases (Micevski *et al.*, 2013). In fact, in 2005, high rate of obesity was documented in food insecure households in rural Malaysia, especially among women, that is caused by overconsumption (Zalilah and Khor, 2005). On the other hand, when consumption of food are overlooked or insufficient, malnutrition occurs (Rosier, 2011). Currently, approximately one in seven people did not know how to access protein and energy sufficiently from their diet, and even more might have problem in terms of micronutrient malnourishment (Godfray *et al.*, 2010). This issue is highlighted in another Malaysian study, that showed how poor protein intake, vitamin A intake and dietary energy intake were found to be systematically associated with malnutrition (Wong *et al.*, 2014).

Malaysia is one of the developing countries that did not escape from food security issues. This is because food items are mainly imported and the country is expected to face increasing food prices within the next few years (Ahmed and Siwar, 2013). Furthermore, a study carried out by Soon (2014) stated that changes in dietary patterns among Malaysians that increase the intakes of meat, wheat-based products, fats and oil and sweeteners largely contribute to the percentage of total energy and in the decline of traditional staple food and other traditional food crops consumption such as sweet potatoes, cassava, pulses and oil seeds. In fact, this issue has been highlighted in a research more than a decade ago, which indicated that, the reduction on dietary diversity and increasing consumption of refined and processed foods are the causes of increasing obesity and nutrition related diseases among Malaysians (Tee, 1999). While obesity is a major issue, previous study has indicated how obesity will eventually increase the risk of various adverse health outcomes,

among them, cardiovascular disease (CVD). To better explain the relationship, measuring multiple indicators of related serum lipids will explain the association between food insecurity and risk of CVD (Tayie and Zizza, 2009). Once considered a simple lipid-storage disease, the risk of CVD commonly overlaps and is associated between obesity and atherosclerosis. Currently, researchers are exploring the idea of obesity and atherosclerosis as chronic inflammatory processes, which involves innate and adaptive immunity activation (Rocha and Libby, 2009). However, not every obese person is at greatest risk of having these diseases since it may also manifest among those who are lean or with normal body weight (Gowda *et al.*, 2012).

A recent study done by (Gowda *et al.* (2012) identified that food insecurity is connected to increased inflammation and is correlated with chronic disease. Additionally, immune responses also become a potential mediator in this pathway. Any shift in dietary pattern due to uncertainty and inadequacy of nutrient and calorie intake will trigger the occurrence of inflammation pathway hence becoming highly exposed to infections. At the same time, the immune response will be activated to allow body to fight possible infections. The activation of immune response will also release white blood cells and C-reactive protein (CRP), the latter of which is an acute phase protein involved in inflammation. It was triggered by pro-inflammatory cytokines such as interleukin-6 (IL-6) released by adipose tissue (Nanri *et al.*, 2011).

In this study, we would like to see if Malaysian college students (young adult populations) undergo the same occurrence of food insecurity as the populations studied in various prior researches. However, most researchers focused on food insecurity issues such as the cause, effects and ways to handle the problem. To our knowledge, there are limited studies that concentrate on the body biochemical changes and its relationship with inflammatory events in young adults. At this critical phase of life, between 18 to 25 years old, great changes often occur including dietary changes and this change will often remain until later stages in life. A previous studies agreed that is too little information on the degree, factors and outcomes of food security among college students (Chaparro *et al.*, 2009; Hughes *et al.*, 2011). Other than that, we also investigated if food insecurity incidence and gender will affect the students in terms of their inflammatory event, lipid profile and body composition.

Materials and Methods

Participants

Study included students from all departments of Universiti Teknologi MARA (UiTM) Puncak Alam, namely, Health Sciences, Pharmacy, Hotel and Tourism Management, Foundation of Basic Science, Art and Design and Business and Office Management. All participants were between the ages of 18 – 25 years old and were categorized as either food secure or food insecure based on Adult Food Security Survey Module (AFSSM) after taking into account all inclusion and exclusion criteria. Among the inclusion criteria include being free from non-chronic disease, especially one that affect nutritional status, and non-pregnant in order to avoid bias in results of participants' nutrient profile and micronutrient level that could occur due to hormone changes and demand of the nutrient needs of mother and the fetus. Meanwhile, exclusion criteria included participants with chronic diseases such as cardiovascular disease, hypercholesterolemia and a family history of hypercholesterolemia or other health-related illness that affect nutritional status. The pool of participants was selected during a health seminar where pamphlets were distributed to visitors. Those who volunteered were selected for the study based on the exclusion and inclusion criteria, yielding 124 participants from 236 who volunteered. Participants' anthropometric parameter and body composition were also measured.

Anthropometric measurements and body composition

Anthropometric measurements were calculated using individual's height (cm), weight (kg) and body composition such as body fat percentage (BF%) and waist circumference (WC). Participants' height was measured using a portable stadiometer (Seca, Model 217) while weight was measured using robusta high capacity digital floor scale (Seca, Model 813). WC was measured between the lower costal border of the last rib and the top of the iliac crest using non-elastic tape (Seca 201, ergonomic circumference measuring tapes). Cut off point for WC in men (≥ 102 cm) is different compared to women (≥ 88 cm) and it is measured to indicate risk of poor health (Lee *et al.*, 2011). Abdominal obesity occurs when men and women have WC greater than 102 cm and 88 cm respectively. Abdominal obesity increases the risk of cardiovascular (CVD) disease (Bener *et al.*, 2013). For the measurement of WHTR, results are calculated by dividing WC (cm) with height (cm) (Lee *et al.*, 2011). A measurement of WHTR above 0.5 indicates high risk of high risk of CVD (Jennings *et al.*, 2011).

BF% was measured using fat analyzer (Omron HBF 306 Body Logic Pro Body Fat Analyzer) and converted from percentage to fat mass (kg). Fat mass index (FMI) was introduced by dividing fat mass (kg) with the square of height (m^2). The introduction of height in this calculation will normalize fat mass for body size. FMI is a useful tool in measuring obesity and both male and female is divided into different quartiles (Q). For men, Q1: <4.39 , Q2: $4.39- <5.65$, Q3: $5.65- <7.03$ and Q4: ≥ 7.03 while for female, Q1: <5.25 , Q2: $5.25- <6.33$, Q3: $6.33- <7.93$ and Q4: ≥ 7.93 . Based on the quartiles Q1 and Q2 indicate lower risk for disease, while Q3 and Q4 indicate higher risk of disease. Normal fat percentage is between 18 % to 23 % for male and 25% to 30% for female.

Blood samples collection and analysis

After overnight fasting, blood samples were collected into plain tubes for the collection of plain serum [Lipid profile such as total cholesterol (TC), triglycerides (TG), low density lipoprotein cholesterol concentration (LDL-C), high density lipoprotein cholesterol concentration (HDL-C), and inflammatory marker which is high sensitivity C-reactive protein (hs-CRP)]. Lipid profiles were determined using commercially available kits on COBAS INTEGRA 400+ analyzer. Each component of lipid profiles used a different kit for total cholesterol (Cholesterol Gen.2, Roche Diagnostics GmbH, Mannheim, USA), TG (Triglycerides, Roche Diagnostics GmbH, Mannheim, USA) and HDL-C (HDL-C-Cholesterol plus 3rd generation, Roche Diagnostics GmbH, Mannheim, USA). The test principles used for the serum of total cholesterol and triglyceride were enzymatic colorimetric method while homogenous colorimetric assay was used as a test principle for HDL-C. However, since there is no specific method for LDL-C- reading, LDL-C was calculated using the classic Friedewald formula. LDL-C is an important variable because it carries cholesterol in plasma and act as a major transport protein for cholesterol. The current formula used to express the concentrations in mmol/L is:

$$\text{LDL-C (mmol/L)} = \text{total cholesterol} - (\text{HDL-C} + 0.37 \times \text{triglyceride}).$$

For inflammatory marker, hsCRP was also determined using COBAS INTEGRA 400 + analyzer and particle enhanced turbidimetric assay principle. hsCRP was measured using available kit (Cardiac C-Reactive Protein (Latex) High Sensitivity, Roche Diagnostics GmbH, Mannheim, USA).

Statistical Analysis

GPower Version 3.1 software was used for calculating the sample size for food secure and insecure group. For the calculation, α is set at 0.05, power at 0.80, medium effect size at 0.5 and ratio for the group is set at 1. Final calculation yields a sample size of 128 with additional 20% for missing data. However, due to dropouts and outliers, the final sample size for this study is 124 students, of which 70 are categorized as food secure and 54 as food insecure. Analysis was carried out using the Statistical Package for Social Science (SPSS) for Windows version 21.0. The independent t-test is used to compare the differences of lipid profile and inflammatory marker for those groups. Body composition such as WC, FMI and WHTR with demographics characteristics such as gender, education level and body type were included in comparison of those groups.

Results

Food security status

Food security status was measured using the US Adult Food Security Survey Module (AFSSM). AFSSM is a subset of the US Household Food Security Survey Module (HFSSM). AFSSM contained ten questions and each question addressed conditions and behaviors that may have occurred in the previous 12 months. It also characterizes households that have difficulties meeting basic food needs. AFSSM results were given a score based on responses to each questions. Response of "Yes", "Often", "Sometimes", "Almost every month" and "some months but not every month" were coded as affirmative responses and the results were categorized into four food security categories (high food security, marginal food security, low food security, very low food security) (Table 1). Prior to statistical analysis, the four food security categories were then collapsed into two categories [food secured (high food security +marginal) and food insecure (low + very low food security)]. In the present study, we found that the percentage of food secure (FS) group among the UiTM Puncak Alam students is slightly higher compared to food insecure (FI) group with 56.5% and 43.5% respectively.

Demographics characteristics

Based on age, participants are considered as young adults. Changes in eating pattern were more likely to occur among university students who are within the age range of 18 and 25 years old (Pei Lin *et al.*, 2012). A total of 148 students agreed to participate, however, only 124 were included

Table 1 Food security categories based on the number of affirmative responses to food insecurity questionnaires

Affirmative responses	Food security category	Food security status
0	High food security	Food secure
1-2	Marginal food security	
3-5	Low food security	Food-insecure
>5	Very low food security	

Adapted from Nord and Hopwood (2007)

based on the exclusion and inclusion criteria. Of the 124 participants, only 15 are male (12.1%) and 109 females (87.9%). In addition, 15 of them are foundation students (12.1%), 82 diploma (66.1%), 24 bachelor students (19.4%) and 3 postgraduate (2.4%). The majority of participants were a diploma holder. Due to the distribution of education level, it stands to reason that a majority of participants are 18 years old 78 (62.9%). Demographic characteristics were shown in Table 2.

Comparison characteristic by food security status

Table 3 presents the summary of statistics for comparison of lipid profiles, inflammatory marker and body composition with food security status. An independent sample t-test was conducted to compare the food security status for inflammatory marker, lipid profile, WC, FMI and WHTR. As stated in Table 3, there is a significant difference on FMI ($p = 0.016$) in those groups. However, no significant differences were found between food security status with inflammatory marker ($p = 0.154$), lipid profile (TC, $p = 0.506$; TG, $p = 0.064$; HDL-C, $p = 0.725$; LDL-C, $p = 0.948$) and body composition (WC, $p = 0.257$, WHTR, $p = 0.428$). When compared with gender and food security status, mean (M) of inflammatory marker for both male and female showed higher result (M = 1.000, M= 0.645) in food secure group than food insecure group. However, lipid profile on male and female such as TC (M =5.175, M=5.062) and LDL-C (M =3.100, M=2.914) showed higher result in food insecure group. In contrast, result of TG (M=0.817) of the male participants was higher in food insecure group while HDL-C (M=1.800) was higher in food secure group. Females, on the other hand, recorded a higher TG (M=0.767) in food secure group while HDL-C (M=1.826) in food insecure group. Regardless, no significant difference were found when comparing all variables with gender except for TG (male p- value 0.037, female p-value <0.005).

Table 2 Demographic characteristics by food security status

Demographic characteristics	Food-secure n (%) 70 (56.5)	Food-insecure n (%) 54(43.5)	Total n (%)
Gender			
Male,	3 (4.3)	12 (22.2)	15(12.1)
Female,	67 (95.7)	42 (77.8)	109(87.9)
Education level			
Foundation	9 (12.9)	6 (11.1)	15(12.1)
Diploma	40 (57.1)	42 (77.8)	82(66.1)
Degree	19 (27.1)	5 (9.3)	24(19.4)
Postgraduate	2 (2.9)	1 (1.9)	3(2.4)
Age (years old)			
18	37(52.9)	41(75.9)	78(62.9)
19	10(14.3)	4(7.4)	14(11.3)
20	6(8.6)	3(5.6)	9(7.3)
21	7(10.0)	3(5.6)	10(8.1)
22	4(5.7)	1(1.9)	5(4.0)
23	2(2.9)	1(1.9)	3(2.4)
24	2(2.9)	1(1.9)	3(2.4)
25	2(2.9)		2(1.6)

Discussions

Food security has started to become an important issue globally. It affects not only developing countries but also developed nations (Ahmed and Siwar, 2013). However, in Malaysia, most research were carried out on identified household food insecurity among low-income rural communities (Zalilah and Khor, 2008), low income household in Kuala Lumpur (Zalilah and Ang, 2001), Kelantan (Ihab *et al.*, 2012), women from low income communities (Sharif *et al.*, 2014) and mothers in Rural Malaysia (Ihab *et al.*, 2013). To our knowledge, none of the studies focused on Malaysian young adults, especially university students. With this study, we aim to identify the prevalence of food insecurity among young adult. Change in eating patterns are more likely to occur among university students, between the age of 18 to 25 years old (Pei Lin *et al.*, 2012) and will probably continue for the rest of their lives (Harker *et al.*, 2010). However, while we found that the percentage of food secure (FS) group is slightly higher compared to food insecure (FI) group with 56.5% and 43.5% respectively. The results are inadequate to demonstrate whether there is a higher prevalence of food insecure individuals than food secure individuals as highlighted in previous study carried out in rural and low income areas (Mohamadpour *et al.*, 2012). The same article highlighted the association between food insecurity, health and nutritional status among 169 Indian women where all participants were randomly selected within palm-plantation household in Malaysia. The study also divided food insecurity

into three parts; household food insecurity, individual food insecurity, and child hunger. This could explain the lack of difference between food secure and insecure among our participants since our study focus only on individual food insecurity in a single population setting. In fact, healthy foods are also easily available within the campus area with most participants having adequate monetary allowance for basic needs. Another study that investigated food security and dietary intake in Midwest Migrant Farmworker Children had also found that the prevalence of food insecurity was higher than food security (Kilanowski and Moore, 2010). The results indicate that food security depends on the availability of food since dietary intake of children participated in the research were better in bigger farms with better food option and availability.

Further analysis of our results also showed that the percentages of male in food insecure group (80%) are higher than food secure group (20%). This differed with females where results showed that food secure females (61.5%) are higher than food insecure (38.5%). A previous study had stated that gender affects consumption patterns where it was revealed that although students of all gender prefer food with high fat content, male students prefer unhealthful food that has even higher sodium and fat content, as opposed to their female counterparts (Boek *et al.*, 2012). Based on this evidence, nutrition educators need to give more attention to demographic variables such as gender as it may be important when designing intervention programs.

The next part of the analysis focus on biochemistry

Table 3 Comparison of inflammatory marker, lipid profile with food security status

Characteristic	Gender	Food Security <i>Mean ± SD</i>	Food Insecurity <i>Mean ± SD</i>	Confidence Interval (CI)		p-value _a
				Lower	Upper	
Inflammatory Marker	All	0.660 ± 0.473	0.650 ± 0.432	-0.1533	0.173	0.154
	Male	1.000±0.656	0.725±0.349	-0.299	0.849	1.790
	Female	0.645±0.464	0.629±0.454	-0.163	0.196	0.358
Lipid profile						
Total cholesterol (TC)	All	5.027 ± 0.621	5.087 ± 0.647	-0.287	0.167	0.506
	Male	5.067±0.404	5.175±0.772	-1.123	0.907	0.178
	Female	5.025±0.631	5.062±0.614	-0.280	0.207	0.818
Triglyceride (TG)	All	0.766 ± 0.235	0.731±0.181	-0.042	0.111	0.064
	Male	0.733±0.058	0.817±0.244	-0.252	0.085	0.037
	Female	0.767±0.239	0.707±0.154	-0.015	0.135	0.005
High density level (HDL)	All	1.786 ± 0.298	1.800 ± 0.299	-0.121	0.092	0.725
	Male	1.800±0.4583	1.708±0.339	-0.041	0.594	0.635
	Female	1.785±0.295	1.826±0.285	-0.155	0.073	0.746
Low density level (LDL)	All	2.900 ± 0.584	2.956 ± 0.573	-0.263	0.152	0.948
	Male	2.967±0.153	3.100±0.616	-0.929	0.662	0.068
	Female	2.897±0.596	2.914±0.561	-0.245	0.210	0.675
Waist Circumference (WC)	All	73.70±6.832	76.96±7.719	-5.851	-0.666	0.257
	Male	71.33±7.286	77.46±9.141	-18.51	6.260	0.475
	Female	73.81±6.849	76.82±7.382	-5.764	-0.257	0.517
Fat Mass Index, FMI	All	1.760 ± 0.999	1.940 ± 1.204	-0.589	0.215	0.016
	Male	2.861±0.859	4.494±1.774	-3.956	0.691	0.159
	Female	5.227±1.724	5.452±2.051	-0.949	0.499	0.213
Waist-to-height ratio, WHtR	All	0.479 ± 0.044	0.491 ± 0.048	-0.028	0.004	0.428
	Male	0.429±0.0342	0.471±0.055	-1.123	0.907	0.368
	Female	0.481±0.0436	0.497±0.045	-0.033	0.001	0.500

and biological response between both food secure and insecure groups and among males and females. Due to the uncertainty and lack of nutrients and calorie intake among food insecure individuals, their dietary pattern and food preference will change to accommodate the lack of quality food. When an individual is deprived of an important nutrient, they will be more vulnerable to infections. Adaptive and innate immunity will start to activate and will be triggered to fight the infections. It will also stimulate the body to released enormous amounts of white blood cell and C-reactive protein (CRP). CRP is one of the classic acute phase proteins to inflammatory reactions. High sensitivity C-reactive protein (hs-CRP) in cardiovascular risk assessment is a method recommended by The American Heart Associations and the Centers for Disease Control and Prevention (Pearson, 2003).

The risk of metabolic and cardiovascular disease can be modulated by early-life factors, gender and lifestyle. High sensitivity C-reactive protein (hs-CRP) and leukocyte count is one of the biomarkers that can assess low grade systemic inflammation (Pirkola *et al.*, 2001). Obesity, metabolic syndrome, impaired endothelial function and atherosclerosis have an association with low grade, systemic inflammation among children and adolescent (Pirkola *et al.*, 2001).

Concentration of hs-CRP among young adults can be a predictive indicator for a person's dietary choices later in life (Ridker, 2003). In addition, elevated levels of hs-CRP in childhood and adolescence have been demonstrated to cause problems once an individual reaches adulthood (Juonala *et al.*, 2006). Prevention of metabolic and cardiovascular disease in adulthood can be carried out by identifying modifiable risk factors for a pro-inflammatory state in adolescence. Contrary to expectations, we found that there are no significant difference between inflammatory marker and food security status ($p = 0.154$). Additionally, the mean of inflammatory marker on food security group ($M = 0.660$) is slightly higher than food insecurity ($M = 0.650$). This could be due to the high consumption of simple carbohydrate which can lead to the increase of after-meal hyperglycemia thus resulting in elevated levels of circulating free radicals, pro-inflammatory cytokines and CRP (Shen and Ordovas, 2009).

Since food security is usually defined as the availability of adequate, safe and nutritious foods at all times, food security is also associated with consumption of safe and nutrient-dense food. Previous research has stated that a Western dietary pattern (diet high in meat, simple carbohydrates and fat intakes) is classified as pro-inflammatory diet. It's associated

with higher levels of CRP which contradicted with our findings that showed lower hs-CRP levels in food insecure group (Nanri *et al.*, 2008). Nonetheless, the difference is not significant due to the possibility of low intakes of healthy foods such as fruits and vegetables among college students regardless of food security status. hs-CRP levels among the participants were within the normal range in both food secure and insecure groups. This could be due to the food choices made by young adults when living independently. For most young adults, attending university is one of the factors for leaving home. Once they moved away from parental guidance, they have a better freedom of choice regarding their dietary patterns and most have the tendency to not observe the dietary guidelines and recommended intakes for most of the food groups (Harker *et al.*, 2010). Therefore, the findings indicated that this transitional phase of dietary intakes among students in our sample population might not significantly affect the biochemical values, especially hs-CRP levels even in the early stage of life (young adults).

Since measurement of lipid profiles of each participant were also taken, a comparative statistical analysis was carried out among food secure and food insecure group with lipid profile (TC, TG, HDL-C and LDL-C) and no significant difference were found in any of the lipid profile pairings. However, when comparison was made based on gender, TG showed significant difference with male having ($p = 0.037$) and female ($p < 0.005$).

Meanwhile, food insecure groups recorded higher results of TC and LDL-C for both male and female. Nevertheless, TG and HDL-C recorded higher results only among males, in which HDL-C high in food secure group ($M = 1.800$), while TG higher in food insecure ($M=0.817$). TG for female ($M=0.767$) was also found to be higher in food secure group and HDL-C ($M=1.826$) in food insecure group. According to (Tayie and Zizza, 2009), level of serum cholesterol will have a strong link with food insecure individuals. In addition, food insecure individuals will also experience increasing level of LDL-C and depressed levels of HDL-C, which supports our findings. The reason for the elevation of TC, LDL-C and declining HDL-C among food insecure individuals is attributed to poor dietary intake. Among our participants, we surmised that food insecure groups would usually increase dietary intake by consuming high-calorie dense foods, which are easily accessible and inexpensive, rather than nutritionally dense foods such as fruits and vegetables. Furthermore, previous study also stated that most food insecure individual will experience problems

such as socio-economic deprivation, psychosocial distress as well as limitations performing physical activity, all of which could explain the imbalance of lipid profile (Tayie and Zizza, 2009).

Another explanation for the difference in TC and LDL-C levels is the influence of gender. TC and LDL-C concentration level is usually similar for men and women until they reach 20 years of age. Following that, cholesterol levels will increase more sharply in men than in women. According to (Roeters, *et al.* (2002), presence of low level endogenous estrogens will reduce LDL-C receptor activity, hence leading to elevated LDL-C concentration. This was observed among postmenopausal women. While our participants are far from menopause, our results did indicate a lower concentration of LDL-C among female.

As mentioned before, abdominal obesity occurs when waist circumference (WC) exceeded 102 cm (40 inches) in men or 88 cm (35 inches) in women. High WC is associated with lipid abnormalities and insulin concentration and it becomes a specific marker for upper body fat accumulation. WC also provides a more sensitive mean than BMI for identifying overweight and obesity (McCarthy and Ashwell, 2006) and in predicting increase risk of cardiovascular disease (CVD) (Bener *et al.*, 2013). Based on our WC measurements, while participants in food insecure group of both gender have higher WC compared to food secure, none reached the abdominal obesity limit of 102 cm (male) and 88 cm (female). As mentioned before, food insecure individuals tend to consume high calorie dense food and low quality diet. This phenomena affects cardiometabolic risk factors which will increase the risk of CVD (Ford, 2003). In fact, food insecure individuals have a higher obesity risk due to consumption of low quality food. This is because to cope with insecurity and unavailability of food, food insecure individuals may overcompensate their dietary intake by consuming not only cheaper, energy-dense foods but also overeat when food resources are available (Wilde *et al.*, 2012). In this instance, our findings are supported by previous research on WC.

Another measurement of body composition, WHtR and FMI, were also taken and scrutinized. Both gender in food insecure group showed higher results than their counterparts in the food secure group. While WHtR is a measure of central antibody and is a superior predictor of CVD risk factors (McCarthy and Ashwell, 2006), FMI are not only positively associated with the presence of metabolic syndrome (MetS) and CVD, but also overweight, hyperinsulinemia, hypertension, hyperlipidemia,

hypertension, fasting hyperglucose and obesity (particularly central obesity) (Liu *et al.*, 2013). In general, food insecure group have higher mean of WHtR for male (M=0.471) and female (M=0.497) and FMI for male (M=4.4941) and female (M=5.452).

Conclusion

As a conclusion, our results indicated that since only FMI and TG male and female showed a significant difference, the issue of food security among university students is yet to be a major concern. However, this does not disregard food security as an issue, since there are students who are categorized as insecure. Our results only indicate that the biological characteristics such as lipid profile, inflammatory marker and body composition showed little variation between the two groups. However, if the situation is left unattended, food security status will become a major problem. Therefore, intervention needs to be carried out immediately while the gap between these two groups of students is still small enough. In addition, to better understand this issue, this research will continue to investigate molecular gene expression of peroxisome proliferator activated gamma (PPAR- γ), which is originally identified by virtue of its role in adipocyte differentiation and changes of endothelial dysfunction.

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