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Lifestyle & nutritional factors influencing Metabolic Syndrome (MetS) among adults in Johor, Malaysia

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Executive Summary

Metabolic syndrome (MetS) is a cluster of metabolic abnormalities which includes central obesity, hypertension, dyslipidemia, and disturbed glucose metabolism. Its high prevalence among the Malaysian general population has been a subject of great concern to healthcare professionals. A number of studies carried out in this country over the past 10 years have identified various risk factors which appear to be associated with the development of this syndrome. However, there have been few studies evaluating the lifestyle and nutritional factors influencing MetS. Knowledge about these factors can help combat MetS and its related medical complications such as cardiovascular disease and diabetes mellitus among Malaysians.

One of the objectives of the research is to estimate the current prevalence values of MetS and its metabolic components in suburban communities of Johor, Malaysia. This includes ascertaining if there has been a change in these values since the nationwide survey in 2008, which involved a relatively reasonable proportion of the population from Johor. The second main objective was to identify major lifestyle and nutritional risk factors influencing the prevalence of MetS and its components in adult population of different major Malaysian ethnicities in Johor.

A cross sectional study was carried out on 481 Malaysian adults (18 years and above; both males and females) living in Kulai, Felda Taib Andak, Ulu Tiram, Kota Masai and Johor Bahru with informed consent. Pregnant women and subjects suffering from any major illness which may preclude their participation such as cancer, liver disease, renal

disease, etc were excluded. Recruited subjects were invited at medical camps structured in these places with the help of community elders in an 8-10-hour of fasting state. For assessment of MetS, blood pressure and waist circumference measurements were taken, along with collection of a 10-ml of fasting blood from each participant for determination of serum glucose, triglycerides and HDL- cholesterol.

Harmonized criteria were used to diagnose subjects with MetS. However, other criteria (NCEP-ATP III and IDF) were also employed for comparison of prevalence estimates with the previous Malaysian studies.

For statistical analysis of the data, IBM SPSS version 23 was used. Descriptive statistics was calculated for each variable. Statistical tests such as independent sample t-test, ANOVA or equivalent were used to compare mean differences among continuous variables, while chi square test was used to study associations among categorical variables. Logistic regression analyses were used to determine associations of nutritional and lifestyle risk factors with MetS, while adjusting for confounders. Exploratory factor analysis was used to identify common dietary patterns, with further confirmation by the Confirmatory factor analysis using IBM SPSS AMOS version 23. Dietary habits and dietary factors which include intakes of nutrients and food groups were analysed for their association with MetS and its components using logistic regression. The diet patterns were categorized into quartiles based on the participants' intake and their increasing intakes were analysed for association with MetS and its components using logistic regression.

The results show that prevalence of MetS among this population has decreased compared to the estimates reported in the nationwide survey-2008 (from 41.4% to 32.2%). Keeping in view the reported prevalence of MetS among the 3 major ethnicities in the nationwide survey-2008, it shows an increase among the Indians (from 46.9% to 51.9%) but decreased among the Malays (from 42.1% to 36.7%) and the Chinese (from 33.9% to 20.2%) in Johor. The decline among the Malays and the Chinese is attributed to decreased fasting hyperglycemia, low HDL-cholesterol and hypertriglyceridemia. Low physical activity, smoking, consumption of alcohol, low education level, frequent dining out, skipping breakfast, late dining and quick finishing of meals have been found to influence MetS and its components in the study population. Nutrition-wise, the results were variable due to diversity in the preference of food items by various ethnic communities in Johor. The Indians having the highest prevalence of MetS were consuming more cereals and cereal products and fats, oils and sugars, but had somewhat lower intakes of fruits, poultry, meat and eggs compared to the Malays and the Chinese. On the contrary, the Chinese having the lowest prevalence of MetS had the highest intake of fruits, poultry, meat and eggs and the lowest intake of cereals and cereal products, fats, oils and sugars. The Malays indicating a reasonably high prevalence of MetS had very high intakes of carbohydrates, sodium, omega-3-PUFA, fats and trans fatty acids but relatively small intakes of legumes and potassium. The Indians in Johor appear to be consuming high amounts of oils and fats including trans fatty acids which increase the odds of high fasting blood glucose, and this could be contributing to the risk of MetS and its complications among those in this ethnic group.

Though the prevalence of MetS and some of its metabolic components appear to have improved since the nationwide survey-2008, the cumulative undesirable effects of lifestyle and nutritional risk factors still pose a threat to the Johor population. The overall effect of these risk factors is of varying magnitude among the three major ethnic communities in Johor, and hence, ethnic-specific measures would be needed to further reduce the prevalence of MetS and metabolic abnormalities in this population. Increasing the awareness among the masses about the beneficial effects of healthy diet and lifestyles is likely to have the maximum impact.

Declaration

This thesis contains no material which has been accepted for the award of any other degree or diploma at any university or equivalent institution and that, to the best of my knowledge and belief, this thesis contains no material previously published or written by another person, except where due reference is made in the text of the thesis.

Signature:

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Date: March 15, 2019

Publications during enrolment

1. Sociodemographic and lifestyle factors associated with metabolic syndrome (MetS) in a multi-ethnic Asian population (*manuscript submitted*)

2. Nutrient intakes and its association with metabolic syndrome and its components among adults residing in Johor, Malaysia (*under preparation*)

Student signature: **Date: March 15, 2019**

The undersigned hereby certify that the above declaration correctly reflects the nature and extent of the student's and co-authors' contributions to this work. In instances where I am not the responsible author I have consulted with the responsible author to agree on the respective contributions of the authors.

Main Supervisor signature: **Date: March 15, 2019**

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Chapter 1: Introduction

1.1 Background

Metabolic syndrome (MetS), also termed as syndrome X and insulin resistance syndrome, is a combination of interrelated risk factors for cardiovascular disease (CVD) and diabetes. This includes hyperglycemia, raised blood pressure, elevated triglyceride levels, low high-density lipoprotein (HDL)-cholesterol levels, and abdominal obesity, and is now recognized as a disease by the World Health Organization (WHO) and other entities (1, 2). As the definition of MetS differs among various international bodies, the reported worldwide prevalence varies to a great extent (3). According to a report from Cameron et al. published in 2004, the prevalence varied from 8% (India) to 24% (United States) in men and from 7% (France) to 46% (India) in women (3).

The prevalence of this syndrome in USA among adults aged twenty years and above, using the WHO criteria was found to be 25% and between 22% - 24%, using the National Cholesterol Education Program (NCEP) – Adult Treatment Panel III (ATP III) criteria for the diagnosis of MetS (4-8). Similarly, according to a research across 7 European countries, the collected prevalence was estimated to be 23% in 2002 using the WHO criteria (9). In Canada, nearly 25% of the adult population (35 years to 75 years) was found to be afflicted with MetS using the NCEP-ATP III criteria (10). The studies mentioned above investigated the prevalence of MetS in respective regions using a single definition. In Australia, the prevalence values of MetS using the WHO, NCEP ATP III and International Diabetes Federation (IDF) criteria were 21.7%, 21.1% and 30.7%, respectively (11, 12). This points to the fact that prevalence of MetS within the same region may vary as different definitions are employed; and this could be due to the differences in the defined cut offs for its considered metabolic risk factors.

As the proportion and distribution of body fat in Asians, in general, were found to be different from Caucasians in North America and Europe, it became apparent that the definition of obesity applied to Western populations would not be applicable to Asian populations (13, 14). Therefore, the estimated prevalence values of MetS among Asians were found to be increased when Asian-adapted definitions of obesity were employed rather than the NCEP ATP III criteria (15). For example, in the Southeast Asian region, it increased from 13.1% to 20.9% for Singaporean males and for the Chinese adults, it increased from 10.1% to 26.3% (16, 17). In Taiwan, the increase was from 11.2% to 23.8% for males (18), while among Filipinos, the prevalence increased from 14.3% to 18.6% in males and from 14.1% to 19.9% in females (19). Similarly, among South Korean males and females the increase was found to be from 16% to 29% and 10.7% to 16%, respectively (20). A similar trend was observed among Malaysians and an overall prevalence of 43.4% was found using the JIS "harmonized" criteria (21). In the South Asian region, India, Turkey and Iran have been reported to have high prevalence of MetS ranging from 31% to 40% among females and between 19% to nearly 29% among males (22-25). In Pakistan, its prevalence in an urban population (Karachi) was found to be 34.8% and 49% using the IDF criteria and modified NCEP ATP III criteria, respectively (26).

The prevalence of MetS is dependent on a variety of non-modifiable (gender, age, ethnicity) and modifiable (lifestyle, diet) risk factors. These factors are known to, directly or indirectly, influence MetS among populations. For instance, Wen and colleagues reported the prevalence of Mets in rural China as 44.3% (by modified NCEP-ATP III criteria), 40.7% (by IDF criteria) and 47.7% (by Harmonized criteria), amongst a large cohort of 4748 subjects, primarily among females aged 50 years and above (27). From a study in Canada, Liu and colleagues reported MetS prevalence to be higher among Cree Indians compared to other aboriginal and non-aboriginal Canadians (28). Malaysia is no different as according to the nationwide survey (29) the prevalence was found to

be higher among older age groups, more among females, and most common among the Indians compared to other races in Malaysia (29).

Studies have shown that various lifestyle factors influence MetS. Sedentary lifestyle and physical inactivity have been shown to contribute to the development of MetS and its components (30-34). Smoking and alcohol consumption have also shown to have variable influences on MetS and its components (35-39). Furthermore, the speed of eating, dining out, skipping breakfast and late dinners have been found to be associated with increased incidence of MetS (40, 41). These factors are present in most communities and might provide some insight on how their influence on MetS may be regulated in populations to contain its life-threatening complications.

Furthermore, as suggested by research, nutrition also has a profound effect on MetS. For instance, consumption of sugars and artificially sweetened beverages is associated with increased risk of MetS, whereas, increased consumption of nuts, fruits and vegetables reduces the risk of MetS (42-45). The nationwide survey in Malaysia in 2008 indicates obesity and hypertension to be the most crucial factors constituting to MetS in the country (29). Since nutrition has a major impact in causing obesity, hypertension and dyslipidemia, a focus on nutrition and diet that is consumed by Malaysians could also provide insight to various dietary risk factors for MetS in the country.

1.2 Problem statement

A review of MetS research in Malaysia indicates the prevalence of this syndrome to be 25 – 40% among Malaysian adults (46). Rampal et al reported the prevalence estimates among Malaysian adults to be 37.1% and 34.3% using IDF and NCEP ATP III criteria, respectively (47). The prevalence of MetS has also been shown to vary across different ethnicities within the same country. In Malaysia, for example, ethnic Chinese have the lowest prevalence of MetS, while

ethnic Indians have the highest (48). In the nationwide survey in Malaysia in 2008, prevalence of MetS was found to be 42.5% (29). Moreover, abdominal obesity was reported to be the most prevalent (57.4%) and was higher in females (64.2%) compared to the males (44.9%). Its percentage was highest among the ethnic Indians (68.8%) and lowest among the Chinese (49.9%). High blood pressure was the second most common metabolic abnormality (52.3%) and was more prevalent among males compared to females (56.5% vs. 50.0%). The Malay population was most affected by high blood pressure (52.2%). Hypertriglyceridemia was most prevalent among the Chinese (47.4%) (29). Nonetheless, this survey is about 10 years old and it would be important to find out whether prevalence of MetS and its components has remained stable or has undergone a change over this period.

A large cross-sectional study carried out in the Peninsular Malaysia and West Malaysia about prevalence and complications of MetS showed high prevalence of MetS among Malaysian adults who were found to be at a high risk of developing type 2 diabetes mellitus and cardiovascular disease (29). In another study, Tan et al. have reported that the prevalence of MetS in Malaysian type 2 DM patients was 97.7%, and 98.2% of them were suffering from cardiovascular disease (49). In another report, there was a three-fold higher risk of developing colorectal cancer among Malaysian adults with MetS (50). This shows that high prevalence of the MetS is leading to a number of chronic diseases in the country resulting in high mortality and morbidity, and therefore, this problem must be addressed as a high health risk priority in the country.

In a recent study on prevalence of MetS among vegetarians in Malaysia, Ching et al have reported its prevalence among vegetarians to be 24.2% as compared to 42.5% among Malaysian adults in the country in the nationwide survey 2008 (51). This report lends further support to the hypothesis that nutrition can have a significant impact on the spread of MetS.

Limited data are available on the prevalence of MetS and/or its components from Johor. According to the National and Health Morbidity Survey 2015 by the Ministry of Health Malaysia, the prevalence of hypertension in Johor has been reported as 27.4% (30.3% in the country), while diabetes mellitus was found to be 19.8% (17.5% in the country), and hypercholesterolemia as 45.8% (47.7% in the country) and obesity as 52.8% (48.6% nationwide) (52). These estimates show a high prevalence of these diseases/metabolic abnormalities, both across the country and the state of Johor. With the reported high prevalence estimates of MetS in Malaysia, it can be deduced that the prevalence of MetS would be high in Johor as well.

With respect to ethnicities, the National and Health Morbidity Survey 2015 also reports that the Indians are having the highest prevalence values for abdominal obesity (66.2%), diabetes mellitus (22.1%), hypertension (32.4%) and hypercholesterolemia (50.1%), while the Chinese have the lowest prevalence for these metabolic conditions (44.7%, 12.0%, 30.8% and 47.5%, respectively). This suggests that the burden of non-communicable diseases (and hence, MetS) varies among different races in Malaysia. Ethnicity-specific lifestyle and diet practices, as a cluster or alone, could be affecting this burden of disease conditions in Malaysia (52).

Two recent studies on the Malaysian population (53, 54) have indicated that the lack of physical activity and more sitting time would increase the risk of MetS in Malaysian adults. However, both studies were carried out on urban population. The study subjects were middle aged and elderly people (aged 35 years and above) who were employees of a public university in Kuala Lumpur. Those engaged in moderate to high level of physical activity had reduced odds of having MetS. Longer sitting time quartiles and insufficient physical activity were found to be associated with adverse effects on abdominal obesity, hypertriglyceridemia and hyperglycemia. Another such study was undertaken by Johari and Shahar also on elderly people (aged 60 years and above) residing in low cost flats in urban areas in Central Malaysia (55). Chee et al in a randomized

controlled trial carried out on employees of government agencies in Putrajaya having MetS, showed that regular exercise had a beneficial effect on components of MetS (56). To the best of our knowledge, there has been no detailed study on the role of physical activity on MetS apart from those mentioned above. Since engagement in physical activity has a close relationship with cultural habits of a community, an investigation to explore its effect on MetS might partly explain the variability of prevalence of this syndrome across different ethnicities in Malaysia, especially those residing in Johor.

Consumption of sugar and sweetened carbonated beverages has been identified to be a newish risk factor for MetS (57). Since these beverages are widely used in Malaysia, it would be important to find out their adverse effect towards the development of MetS in adult population in Johor area.

The Orang Asli, are the indigenous people of peninsular Malaysia. They constitute 0.6% of the population and a majority of them live among tribes in various settlements (58). A couple of recent studies carried out on them for metabolic risk factors have revealed variable prevalence of obesity, cholesterol, hypertension and diabetes compared to the main ethnic groups in this country (58, 59). Prevalence of abdominal obesity was highest in the urbanized Orang Asli (66.1 %) compared to other larger ethnic groups in Malaysia such as the Malays, Indians and Chinese. Hypertension was also found to be very common among the different tribes (58). Moreover, they were found to be having increased risk of cardiovascular disease and insulin resistance (59). Their eating pattern has also been found to be different from other ethnic groups. For example, they represent the highest proportion among Malaysians who regularly take breakfast, and lunch and the lowest proportion of those who have dinner. Conversely, the Indians have the lowest percentage of those who regularly take breakfast and lunch. Similarly, the Chinese also had the highest percentage of those who have dinner as their main meal (60). This also shows that eating patterns could be

different due to ethnic and cultural diversity among Malaysians, and this could have a bearing on the risk of MetS in these ethnic communities.

The Orang Asli diet comprises mainly hill padi with supplements of sweet potatoes, cassava, millet, maize, fish and pork. There is belief that they would be having fewer cardiac events arrests compared to other Malaysian communities (61). However, the above-mentioned studies have shown that they too are vulnerable to cardiometabolic risks. There exists a sizeable number in parts of Johor and it would be important to explore how their nutrition and lifestyle could be contributing to the risk of MetS and its components among these tribes, provided the ethical issues pertaining to their recruitment in a study could be appropriately addressed.

The information above indicates that the Johor population has not been fully studied regarding the role of various life style and dietary factors that impact the risk of MetS and associated metabolic complications. Current and updated information about the prevalence of MetS and its components and the effect of various lifestyle and nutritional risk factors would be necessary for strategizing the measures to control the spread of this syndrome among them.

1.3 Significance of the study

It is evident from the above-mentioned studies that MetS is a major health problem in this country owing to its high prevalence and variation of its prevalence by demographic factors (such as age, gender, ethnicity, etc). Literature suggests that modifiable and non-modifiable risk factors contribute towards the development of MetS and its metabolic complications. The proposed study will result in ascertaining the current prevalence values of MetS and its components and enable its comparison with the results of the nationwide survey of 2008. Furthermore, this would also provide information whether the prevalence has increased or decreased over this period of 9 years or so, and what could be the role of modifiable factors (such as lifestyle, diet) contributing to this

change (if any). Subjects at the risk of developing MetS can then be targeted by stakeholders, impressing upon them to modify their nutritional and lifestyle habits so that the progression of metabolic disease state into MetS and its associated complications could be averted.

Based on the evidence obtained through studies carried out in Malaysia, the most probable reasons for increase in the prevalence of MetS are because of rapid economic, demographic and nutritional changes. For example, there is migration of rural population to cities for economic reasons. Moreover, due to recent advances in healthcare management, the life expectancy has increased in growing economies such Malaysia, Singapore, China and India, and proportion of elderly population in these countries has been on the rise. Globalization of diet and introduction of fast food chains in this region have led to nutritional imbalance especially for the population belonging to a relatively better socio-economic class. Physical inactivity, sedentary lifestyle, and stress have further aggravated the situation and more and more people are becoming victims of metabolic abnormalities such as, diabetes mellitus, obesity, hypertension, and dyslipidemia – all components of MetS. In a review by Vassallo et al, it has been pointed out that effective lifestyle modifications can improve all five components of MetS (62).

The information/data regarding various nutritional and lifestyle risk factors for MetS and its components (mentioned above) when obtained from people of Johor area will be of help in understanding the progression of the syndrome in a better manner and enable stakeholders to take specific measures for nutritional and lifestyle modification for controlling the progression of MetS in other places of Malaysia as well. As a result, such measures will improve the quality of life, self-esteem and mental well-being of Malaysian individuals.

1.4 Research question

How the current lifestyle and nutritional habits among a sample of adult Malaysians of different ethnicities in Johor have influenced the prevalence of MetS among them?

1.5 Research objectives

1.5.1 General objective

To investigate the relationship between lifestyle and nutritional factors with MetS among Malaysian adults living in urban and semi-urban districts of Johor.

1.5.2 Specific objectives

1. To determine the prevalence of MetS and its components based on Harmonized, NCEP-ATP III and IDF criteria among Malaysian adults living in urban and semi-urban districts of Johor.

2. To investigate the association of lifestyle factors with MetS among Malaysian adults in Johor.

3. To investigate the association of lifestyle factors with MetS components among Malaysian adults in Johor.

4. To investigate the association of nutritional factors with MetS among Malaysian adults in Johor.

5. To investigate the association of nutritional factors with MetS components among Malaysian adults in Johor.

6. To evaluate the differences in lifestyle and nutritional habits associated with MetS and its components among the three major ethnicities of Malaysian adults in Johor.

Chapter 2: Literature Review

2.1 MetS definition

Since MetS is a cluster of various metabolic abnormalities, such as hypertension, obesity, hypertriglyceridemia, low HDL-cholesterol, hyperglycemia and insulin resistance, international organizations have suggested different definitions for this syndrome (63). The Harmonized definition is the most recent one for this syndrome. Other major definitions of MetS have been listed in table 1:

Table 1: Definitions of MetS based on the NCEP-ATP III, IDF and Harmonized criteria

Risk factors		NCEP-ATP III (2001)	IDF (2005)	Harmonized (2009)
Abdominal obesity	Males	Waist circumference ≥ 102 cm	Waist circumference ≥ 90 cm	Waist circumference ≥ 90 cm
	Females	Waist circumference ≥ 88 cm	Waist circumference ≥ 80 cm	Waist circumference ≥ 80 cm
Blood pressure (systolic/diastolic)		≥ 130/85 mmHg	≥ 130/85 mmHg or on treatment	≥ 130/85 mmHg or on treatment
Fasting serum blood glucose		≥ 6.1 mmol/L	≥ 5.6 mmol/L	≥ 5.6 mmol/L
Fasting serum triglycerides		≥ 1.7 mmol/L	≥ 1.7 mmol/L	≥ 1.7 mmol/L
Fasting HDL-cholesterol	Males	< 1.03 mmol/L	< 1.0 mmol/L	< 1.0 mmol/L
	Females	< 1.29 mmol/L	< 1.3 mmol/L	< 1.29 mmol/L
Diagnosis of MetS		*At least 3 out of 5*	*At least 3 (including abdominal obesity) out of 5*	*At least 3 out of 5*

"Harmonized" Definition

In 2009, representatives of various international organizations got together and came up with a definition which could capture greater number of people at the risk of developing MetS (2). In this definition, most of the components of IDF global consensus criteria were included except the mandatory requirement of central obesity. The presence of **3 or more** of the following 5 parameters could be used to identify a person with MetS:

1. Central obesity [race and gender-specific cut-offs for WC].
2. Hypertriglyceridemia [≥ 150 mg/dl (1.7 mmol/l)].

3. Low HDL-cholesterol [< 40 mg/dl (1.03 mmol/l) for men and < 50 mg/dl (1.29 mmol/l) for women].
4. Increased blood pressure [≥ 130 mm Hg and ≥ 85 mm Hg].
5. Increased fasting serum glucose [≥ 100 mg/dl (5.55 mmol/l)].

Why 'Harmonized' definition is superior to other definitions?

A study by Ramli et al., indicated that "Harmonized" criteria were helpful in identifying maximum number of subjects with MetS among Malaysians (43.5%) (21). Moreover, in another study, Heng et al., reported that both IDF and Harmonized definitions of MetS would be suitable for Malaysian population to capture maximum number of subjects with this syndrome (64). This is due to the fact that the Harmonized criteria have an edge in terms of flexibility in identifying any of the three metabolic abnormalities, while applying specific regional cut-offs for abdominal obesity. This property was neither present in the NCEP-ATP III nor in the IDF definitions.

2.2 Pathophysiology

The mechanism is poorly understood, however, since insulin resistance and abdominal obesity are the most important components of MetS, they have been found to be associated with perturbations in plasma levels of adipokines, altered metabolism of fatty acids, endothelial dysfunction, a state of pro-coagulation and increased systemic inflammation. All these abnormalities could be playing a role in the development of MetS (65).

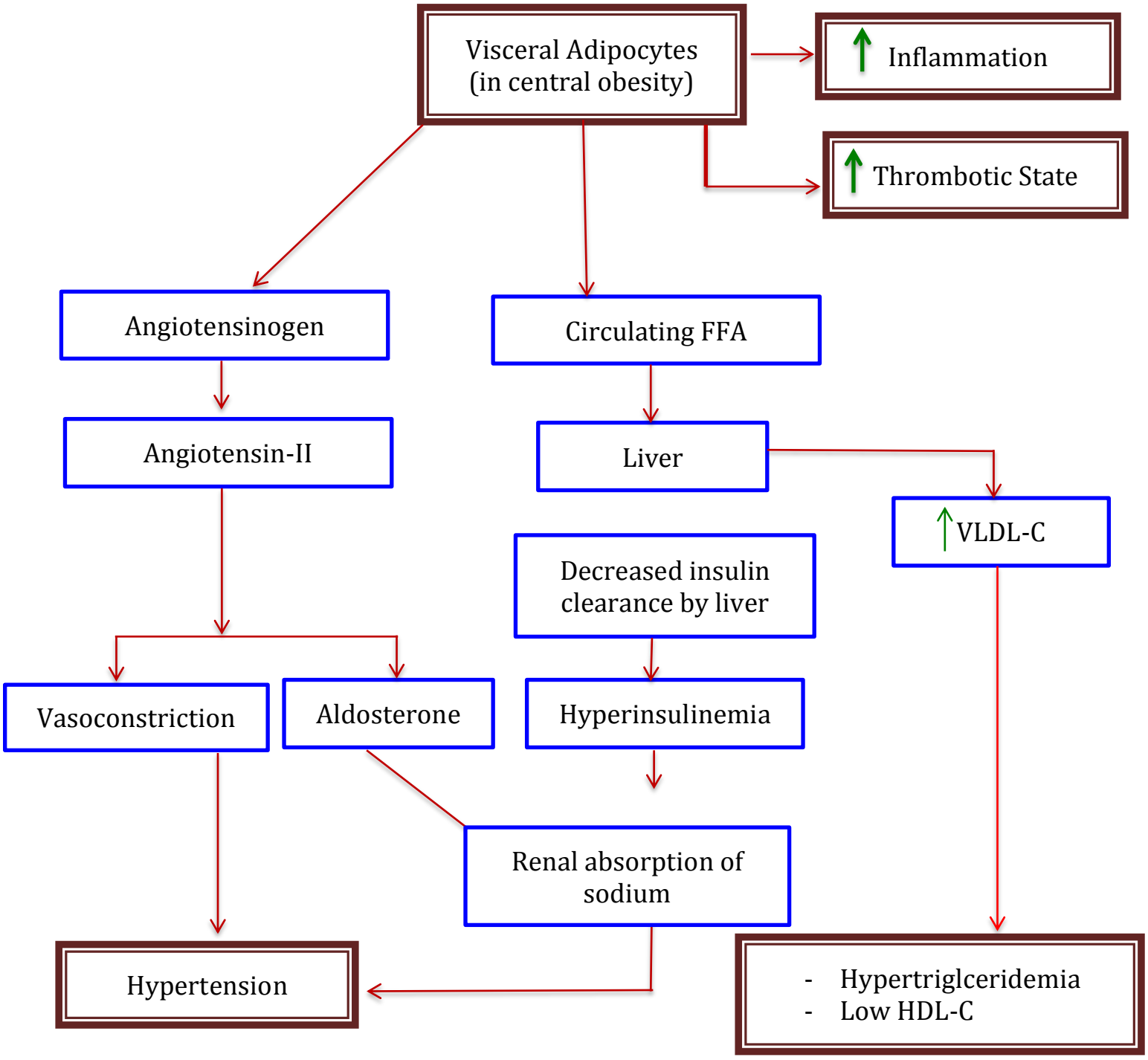
Giles and Sander have further elaborated these events (66). Visceral adipocytes or fat cells are metabolically active in central obesity. These fat cells are insulin resistant and lead to increased release of plasma free fatty acids (FFA), angiotensinogen, prostaglandins, prothrombotic plasminogen activator inhibitor-1 and inflammatory cytokines such as interleukin 6 and tumor

necrosis factor α. Increased FFA decrease hepatic insulin clearance resulting into hyperinsulinemia which in turn would increase renal reabsorption of sodium, thereby, leading to increased blood pressure.

Angiotensinogen released by these visceral fat cells gets converted to angiotensin II, which not only produces vasoconstriction but also leads to increased production of aldosterone that would enhance renal reabsorption of sodium. Both vasoconstriction and enhanced renal absorption of sodium would cause increase in blood pressure. Circulating FFA also alters hepatic metabolism leading to increased synthesis of triglycerides and very low density lipoprotein (VLDL)-cholesterol. The increased levels of VLDL-cholesterol are often associated with decreased levels of HDL-cholesterol (67).

Figure 1 shows the schematic diagram delineating the pathophysiological mechanism of MetS.

Figure 1: Schematic diagram depicting the pathophysiologic mechanism of MetS-Modified version of Giles & Sander [J Clin Hypertens. 2005; 7(11):669-78].



2.3 Prevalence and complications

Studies indicate the worldwide prevalence of MetS to be highly variable depending on the definition and the composition of the studied population (68-70). Due to high prevalence of MetS in Asian countries, especially in Southeast Asia, there would certainly be an increased risk of metabolic complications, such as coronary heart disease, stroke and neuropathy.

Several studies have also been carried out to find out MetS associated risk of cardiometabolic outcomes in the Asian populations. In China, He et al., reported the prevalence of 30.5% and 46.3%, according to the NCEP-ATP III and IDF definitions, respectively, in 2006 (71). The authors made this assessment via a cross-sectional study, performed amongst 2334 subjects aged 60 and above in an urban setting (71). In 2015, Wen and colleagues reported the prevalence of MetS in rural China as 44.3% (by modified NCEP-ATP III criteria), 40.7% (by IDF criteria) and 47.7% (by Harmonized criteria), amongst a large cohort of 4748 subjects, primarily of age 50 years and above (27). In these studies, despite the roles played by other influencing non-modifiable and modifiable risk factors (especially old age), we can see a high prevalence of MetS in China, especially when employing definitions bearing the Asian cut-off values for central obesity (27, 71). In Japan, studies on large cohorts of subjects (more than 6300) have reported the prevalence of MetS to be between 12.8% and 13.9%, employing the NCEP-ATP III definition (72, 73). In 2007, Ninomiya et al., studied a cohort of 2452 subjects and reported a prevalence of MetS as 25.9% in Japan, following the modified NCEP-ATP III definition and employing the Asian cut-offs for abdominal obesity (74). In 2007, in Thailand, Kitiyakara et al., reported a prevalence of MetS as 13.3% by NCEP-ATP III, however by employing the modified NCEP-ATP III definition, the prevalence of MetS became 19.4% (75). Similarly, in 2011, Satirapoj and colleagues studied the prevalence of MetS amongst a large cohort of more than 15000 Thai subjects and reported a prevalence of MetS as 25.3% (by modified NCEP-ATP III criteria) and 23.6% (by IDF criteria) (76).

Since the IDF criteria, though defining central obesity according to Asian guidelines, possess a mandatory criterion of the presence of central obesity as one of the three conditions for defining MetS, hence, it would yield comparatively lower prevalence values of MetS compared to the more flexible NCEP-ATP III (modified or otherwise) and the Harmonized criteria. In China, the IDF criteria yielded a prevalence of 40.7%, lower than that reported by employing the modified NCEP-ATP III and the Harmonized definitions (27). Similar reports have been perceived from Thailand as well (76).

Malaysia is another Asian country with a high prevalence of MetS. According to its nationwide survey in 2008, the reported overall prevalence values of MetS have been found to be 32.1% (by NCEP-ATP III definition), 37.1% (by IDF definition) and 42.5% (by Harmonized definition) (29). The high prevalence estimates by the IDF and Harmonized criteria may be attributed to the high prevalence of central obesity, which is reported as 57.4% (29). In 2004, Rampal et al., studied the prevalence of MetS amongst 17211 subjects and reported a prevalence of 27.5% according to IDF definition, with the prevalence of central obesity as 36.9% (47). In 2013, Ramli and colleagues reported a prevalence as 26.5% by NCEP-ATP III, 37.4% by IDF and 43.4% by the Harmonized definitions, from a total number of 8836 subjects across East and West Malaysia (21). Here again, one can speculate the prevalence of MetS to be higher when employing the Asian cut-offs for central obesity, as these estimates of MetS are closer to that reported in the nationwide survey.

2.3.1 Significance of MetS

In the presence of cardiometabolic disease conditions, the prevalence of MetS may also vary. Tan et al., have reported that prevalence of MetS in Malaysian type 2 diabetic patients to be as high as 97.7%; and 98.2% of them were suffering from cardiovascular disease (49). In China, the prevalence of MetS increases by 2-3 folds amongst the diabetic population (77-79). Furthermore, studies among the Chinese indicate increasing odds for coronary artery disease, stroke and peripheral artery disease among people suffering from MetS (27, 71). In another study from Iran, the odds of having incident diabetes with MetS were four times higher compared to those without MetS (80). As regards to cardiovascular outcomes, in the Hisayama Study which included more than 2400 Japanese adults, the hazard ratios of cardiovascular events with MetS were 1.86 and 1.70 in men and women, respectively (74). Another study from Korea reported an increase in odds ratios of cardiovascular disease among subjects with MetS; the odds were higher among females compared to males (81). In the light of the above studies, the prevalence of MetS rises in presence of metabolic compromise, which can further aggravate morbidity and mortality from these cardiometabolic disorders.

As mentioned in the above, the association of MetS with cardiovascular disease and diabetes mellitus has been well established. In the Kuopio Ischemic Heart Disease Risk Factor Study, MetS was reported to be associated with a three-fold increased risk of death from any cardiovascular cause (82). According to a large meta-analysis of 87 studies, it was reported that MetS resulted in a 1.5-fold increase in all-cause mortality, and a two-fold increase in the risk of developing cardiovascular disease, myocardial infarction, stroke and cardiovascular mortality (83). MetS is also predictive for the risk of diabetes mellitus. According to a study on Aboriginal Canadians by Ley and colleagues, MetS was associated with two-fold increase in incident diabetes (84). Another study by Cameron et al, showed the odds of incident diabetes to be 3-4 times higher

among subjects with MetS in 2007 (85). Several other studies have also shown that the risk of diabetes is comparatively higher than that of cardiovascular disease (86, 87). According to a meta-analysis, the relative risk of incident diabetes amongst subjects with MetS was 3.5-5.2 times, whereas the relative risk of cardiovascular disease was 1.5-2.0 times among subjects with MetS (86).

Aside from the cardiovascular and diabetic outcomes, other associated complications such as cerebrovascular complications, peripheral arterial diseases, renal complications, malignancies, etc. have also been studied in many Asian countries. Studies indicate that compared to Europeans, South Asians experience a greater burden of stroke related mortality attributed to diabetes and hypertension, which are two components of MetS (88-90). Peripheral arterial disease (PAD) carries considerable morbidity and mortality, and is associated with diabetes, hypertension and dyslipidemia (89). Plenty of information is available on PAD from Western countries, however, information is limited from countries in Asia (91). Satirapoj et al., reported an odds of 1.3 of having chronic kidney disease among subjects with MetS (76). According to a recent study from India, Billow et al., found an increasing odds of retinopathy and nephropathy among subjects with MetS (92). Moreover, Asian studies have reported increasing odds of neoplastic lesions such as breast cancer and colorectal neoplasia among MetS subjects (93-95). With an increasing prevalence of MetS in Asia, the proportions of these risks and complications may also be on the rise. Knowledge of these complications is essential to strategize measures for effective prevention of MetS.

2.4 Risk factors

Apart from the risk factors listed under the three definitions of MetS (table 2-1), which include insulin resistance, abdominal obesity, dyslipidemia, hypertension and fasting hyperglycemia, there are other associated risk factors which contribute towards development of MetS. These risk

factors can be conveniently categorised to non-modifiable risk factors which include age, gender, ethnicity, while risky lifestyle behaviours (smoking, alcohol drinking, lack of physical activity, etc.) can be included among modifiable risk factors (96, 97). These are well recognized factors reported in various research studies.

2.4.1 Non-modifiable risk factors

2.4.1.1 MetS and age

The prevalence of MetS, in general, increases with age. For instance, the reported prevalence estimate of MetS among Iranian middle aged women (30-50 years) is 31%, however, it has been found to be 50.8% among Iranian elderly women (> 65 years) (98, 99).

In China, He et al., reported a comparatively higher prevalence of MetS among older males and females (70 years and above) compared to those aged between 60-69 years, using the IDF definition among a total of over two thousand Chinese subjects. (71). In the study by Rampal et al., the prevalence of MetS among Malaysians was found to be higher among subjects aged 40 years and above compared to subjects less than 40 years (44.6% vs. 16.0%) (47). Also, in the study by Ramli and colleagues, the odds of MetS, irrespective of definition applied, were found to be higher among higher age groups, and maximum among subjects aged 60 years and above (21). The nationwide survey also reported higher prevalence of MetS among higher age groups; additionally, higher age groups also had a higher prevalence of central obesity, high blood pressure, low HDL-cholesterol, elevated triglycerides and hyperglycemia (29). This suggests that higher prevalence of MetS among higher age groups may be due to the accumulated higher prevalence of its associated cardiometabolic risk factors among elderly subjects.

2.4.1.2 MetS and gender

Regarding the influence of gender on prevalence of MetS, the results are variable. In certain populations, there were higher prevalence values of MetS among women compared to men, while in some other populations in East Asia such as Taiwan and Korea, higher prevalence of MetS was observed among males (100-106).

According to the study by He et al., the Chinese females had a higher prevalence of MetS compared to the Chinese males (54.1% vs. 34.8%, by IDF criteria) (71). Moreover, females also had higher prevalence values of central obesity, low HDL-cholesterol and hypertriglyceridemia (71). Wen and colleagues also reported similar trends in prevalence across the genders; females having a higher prevalence of MetS than males (54.2% vs. 39.7% by Harmonized definition) (27). Similar to the results obtained by He et al., females had higher prevalence values of central obesity, low HDL-cholesterol and elevated triglyceride levels (27). Additionally, females also had a higher prevalence of hypertension and diabetes mellitus (27).

In Malaysia, studies have explored variability in the prevalence of MetS and its associated components with respect to gender. Rampal et al., showed that the prevalence of MetS among females was comparatively higher than among males (30.1% vs. 24.8%) (47). Similar results were also obtained by Ramli and colleagues (21). According to the nationwide survey, the prevalence of MetS among the females was higher compared to the males (43.7% vs. 40.2%, by Harmonized definition) (29). Additionally, prevalence values of abdominal obesity and low HDL-cholesterol were also higher among the females compared to the males (29).

2.4.1.3 MetS and ethnicity

The prevalence of MetS could also vary across different ethnicities within the same country. For example, from a study in Canada, MetS prevalence was reported to be higher among the Cree Indians compared to other aboriginal and non-aboriginal Canadians (28). The Cree Indians also had a higher prevalence of central obesity and hyperglycemia compared to other races in the country (28). Similarly, from a study in Suriname, South America, MetS prevalence was reported as the highest among the Hindustanis (descendent of Indians), compared to other Suriname races (107). The prevalence values of high blood pressure, low HDL-cholesterol and hyperglycemia were also high among the Suriname Hindustanis (107). In Malaysia, the ethnic Chinese have the lowest prevalence of this syndrome, while the ethnic Indians have the highest (29, 47). Furthermore, according to the nationwide survey, the Indians have the highest prevalence of abdominal obesity, low HDL-cholesterol and hyperglycemia (29). The Malays had the highest prevalence of high blood pressure, while among the Chinese, hypertriglyceridemia was the most prominent metabolic abnormality(29). In light of the evidence above, it is evident that racial differences, directly or indirectly influence the prevalence of MetS in the country.

2.4.2 Modifiable risk factors

2.4.2.1 Physical activity and MetS

Sedentary lifestyle and physical inactivity have been shown to be established risk factors contributing to the development of MetS and its components (30-34). For instance, in a study by Gardiner et al., the authors showed that older subjects who spent more than three hours while sitting had increased odds of having MetS, compared to less sedentary individuals (108). Another study showed that the longer duration spent in sedentary habits increased the risk of having MetS, whereas breaks in sedentary time throughout the day protected them against MetS (109).

Literature suggests that excess energy accumulated in the adipose tissues causes metabolic abnormalities, leading to high blood pressure, hyperglycemia, hypertriglyceridemia and inflammation, hence, regular physical activity enhances energy consumption leading to a reduced prevalence of obesity, hypertension, diabetes mellitus and also MetS (110, 111).

Modifying these factors would be important for reducing cardiovascular and metabolic health risks. Studies from Malaysia have shown that longer sitting time and insufficient physical activity result in an almost four-fold increase in MetS risk (53, 54). Moreover, the risk of MetS in moderate and high physical activities gets reduced by 50% compared to being physically inactive (54). This indicates that modification of such habits can control the risk of MetS development in this country and interventions would be needed to promote such modifications in habits.

Malaysia is a multi-ethnic country, and it would be important to consider the ethnic variation with respect to lifestyle factors, especially in the physical activity. Tan et al., found that the Indians were less likely to engage in physical activity compared to the Malays and the Chinese (112). This may partly explain the higher prevalence of MetS and MetS components among the Indians, hence improved intervention programs would require to be tailored across the different races of the country for addressing the behaviour modifications.

2.4.2.2 Alcohol intake and MetS

Literature indicates that high alcohol consumption is associated with unfavourable effects on abdominal obesity, serum triglyceride levels, insulin sensitivity and blood pressure, all of which are components of MetS (36-39). Moreover, light to moderate intake of alcohol has been found to have a favourable metabolic effect. According to a meta-analysis, a responsible intake of alcohol

(< 20 g/day for women; < 40 g/day for men) appeared to be associated with a reduced prevalence of MetS (113).

Aside from amounts of liquor consumption, different types of alcoholic beverages may have different effects on the overall metabolic profile. For instance, red wine has been shown to have a more protective effect compared to beer. This can be attributed to the richness of red wine with polyphenols that improve carbohydrate metabolism and blood pressure (114-116).

In Malaysia, reports suggest that the proportion of subjects taking alcohol is pretty low. For instance, according to a short communication among school teachers in Malaysia, only 3.2% of the participants were alcohol consumers (117). Despite ethnic breakdown of population base available in these reports, data on alcohol consumption with respect to ethnicity is limited. In this context, the role of alcohol intake with MetS and / or its components requires to be explored, overall and across the races in the country.

2.4.2.3 Smoking and MetS

According to a meta-analysis, active smokers have a 26% increased risk of MetS compared to non-smokers (35). Smoking leads to an increased release of free fatty acids, hence, disrupting the lipoprotein synthesis and increasing triglyceride levels and reducing HDL-cholesterol levels (118). Among current smokers, there is also increased cortisol production, that leads to accumulation of abdominal fat (119, 120).

Considering the information above, smoking cessation may be necessary to prevent the cardiometabolic sequelae from MetS and its components. However, smoking cessation may take time to completely alleviate the risk of MetS. According to a study in Puerto Rico, MetS was more

prevalent among former smokers compared to non-smokers and current smokers (121). According to another study, the risk of MetS after cessation remained high for 10 years for subjects who smoked ≥ 20 cigarettes per day, while for those, who smoked ≥ 40 cigarettes per day, their risk for MetS upon cessation remained high for > 20 years (122). Furthermore, a meta-analysis explored the effect of smoking cessation on diabetes. It concluded that the risk of diabetes increased among recent quitters, but decreased with time (123).

According to Filozof et al., smoking cessation results in weight gain that is attributed to increased energy intake, decreased resting metabolic rate, decreased physical activity and increased lipoprotein lipase activity (124). Hence, it can be conceived that both smoking and smoking cessation may still influence the risk of MetS and its components.

Like alcohol consumption, data on smoking patterns reveal the proportion of smokers among Malaysians to be small. According to Tan et al., approximately 19% of Malaysian participants were smokers, predominantly among Malay males (50%) (112). In this report, the male gender and ethnic minorities were probably under-represented; hence the effect of smoking to MetS and / or its components could be questionable. However, in light of this evidence, the influence of smoking might still play some role in modulating the prevalence of MetS in Malaysia.

2.4.2.4 Diet habits and MetS

Recently, eating speed, eating out, skipping breakfast and late dinners have been found to be associated with increased incidence of MetS (40, 41). These lifestyle habits have been shown to have adverse effects on MetS and its components in many countries. For instance, in a study from Japan, fast eaters had higher hazard ratios for MetS, increased abdominal obesity and low HDL-cholesterol (40). Rapid ingestion of food results in eating too much before the stomach

senses fullness, resulting in an increase in waist circumference and insulin resistance (125, 126). Eating out is associated with increased energy intake and may result in considerable weight gain (127, 128). According to a large Korean study, increased frequency of dining out was found to increase the odds of high blood pressure, abdominal obesity, high fasting serum glucose and low HDL-cholesterol (129). With respect to the role of skipping breakfast with MetS or its components, Tajima et al., did not find an association with MetS, however, from a study in Korea, skipping of breakfast was associated with MetS, along with frequent overeating and eating out (130).

In Malaysia, only a few studies have evaluated the role of the above-mentioned habits with MetS. Abdullah and colleagues in 2016, explored the ethnic differences with a few diet habits, and concluded that Chinese adolescents were eating out more compared to the Malays, and the diet pattern among the Malays was more similar to the Western diet pattern (131). This study was performed amongst adolescent age groups, and ethnic differences were explored among the Malays and the Chinese only, but it did show that the socio-cultural diversities influence diet preferences and habits which might further influence the risk of MetS.

2.4.2.5 Nutrition and MetS

One of the most plausible hypotheses for the pathogenesis of MetS is that due to over-nutrition there is excessive accumulation of lipids in tissues or organs and this would derange the metabolic processes. This thereby leads to increased vulnerability to metabolic risk factors (132). Obesity is indeed a reflection of over-nutrition and imbalanced caloric intake with expenditure. Prevention of the lipid overload is likely to be one of the major steps in the control of MetS (133).

Diet, therefore, has a profound effect on components of MetS. Researchers often examine the association of nutrient intake or individual food item intake (such as fish, mushrooms, alcohol,

dairy products, sugar-sweetened beverages etc.) with MetS. For example, fish consumption has been found to be inversely associated with MetS among the Iranians (134). Daily consumption of white button mushrooms (a rich source of vitamin D) has been shown to have anti-inflammatory and antioxidant health benefits among adults having predisposition to type 2 diabetes mellitus (135). Among the Mediterranean population, consumption of yogurt, low fat milk and other low fat dairy products was associated with reduced risk of MetS (136). Similarly, consumption of more than five servings per week of sugar and artificially sweetened beverages was found to be associated with increased risk of MetS (42). Nut consumption was significantly associated with reduced risk of developing MetS over a follow-up of six years among Spanish graduates (43). A number of investigators have reported inverse association between increased consumption of fruits and vegetables and decreased blood pressure (44, 45), and reduced incidence of cardiovascular disease (137). The Framingham Heart Study showed a positive association between soft drinks consumption and higher prevalence of MetS (138). This was further substantiated in the Oslo Health Study, where soft drinks' intake especially COLA was found to be adversely associated with the risk of MetS (139).

As mentioned earlier, the most likely hypothesis for pathogenesis of MetS, as described by Scott Grundy, is that over-nutrition leads to excessive accumulation of lipids in the body, especially in the adipose tissue and this in turn could lead to derangement of metabolic processes and predisposition to metabolic risk factors (140). However, it is important to emphasize that nutritional factors have a "clustering" effect, which may increase or even decrease the risk of MetS and its components in a population.

From the literature, it is apparent that central obesity and hypertension are the major components associated with MetS among Malaysian adults (29). The prevalence of central obesity was 57.4%; and was highest among the Indians (68.8%). This was followed by hypertension (52.3%), which

was most common among the Malays (52.2%). Hypertriglyceridemia was most common among the Chinese (47.4%). This shows that the reduction in central obesity, high blood pressure and hypertriglyceridemia could play a central role in the control of MetS among Malaysian adults. Since nutrition has a key role in causing obesity, hypertension and dyslipidemia, a focus on over-nutrition and the diet that is consumed by Malaysians could provide important clues to major dietary risk factors for MetS in this population.

2.4.2.5.1 Dietary patterns and MetS

Food consumption is a complex phenomenon with most individuals consuming a mix of food items in their daily diet with both protective and harmful effects towards the development of MetS. Hence, nutritionists prefer to study association of dietary patterns with the risk of a disease in a particular population.

Several studies have been carried out to investigate the association of dietary patterns with the risk of MetS among different populations. Baxter et al., have reported that dietary patterns with high amounts of fruits and vegetables and dairy products and minimally processed cereals are frequently associated with lower prevalence of MetS. On the other hand, diet patterns with high intakes of meat and highly processed cereals with high glycemic index are generally associated with higher risk of the components of this syndrome (141). In another systematic review and meta-analysis, healthy dietary patterns rich in fruits and vegetables, whole grains, legumes, seeds, nuts, fish and dairy, and low in meat, sweets and alcohol have been found to reduce blood pressure (142).

Recent reports have indicated that dietary patterns' effect on components of MetS could be different in males and females (143). In a study on a Chinese population, the "animal and dried

food" dietary pattern was related to higher risk of MetS in men, while "high-salt and energy" dietary pattern was associated with increased risk of this syndrome in women (143).

Similarly, findings have been reported by Suliga et al., who identified four dietary patterns - "healthy'', "fat, meat and alcohol", "prudent" and "Coca Cola, hard cheese and French fries" across a population of 2479 subjects with a normal body mass index (BMI) in Poland (144). The dietary pattern characterized by high consumption of fish and whole grains and low consumption of refined grains, sugar, sweets and cold cured meat was found to be associated with lower risk of metabolic obesity normal weight (defined as the presence of 3 out of 5 components of MetS and a normal BMI), low HDL-cholesterol and hyperglycemia (144).

In a review by Calton et al., three dietary patterns (a Mediterranean dietary pattern, Dietary approaches to stop hypertension (DASH) diet, and the Nordic diet) were identified to be associated with MetS (145). These diet patterns consisting of food items having beneficial effects on MetS components included fruits and vegetables, whole grain, dairy and dairy products, calcium, vitamin D, whey protein, monounsaturated fatty acids and omega-3-polyunsaturated fatty acids (145).

Recently, a study on a USA population has shown that heart-healthy weight-loss dietary patterns that emphasize on either animal or plant protein improve components of MetS (146). Similarly, Western Australian Pregnancy (Raine) Cohort Study showed that an "energy dense, high fat and low fibre" dietary pattern was directly associated with metabolic risk factors (147). On the other hand, vegetarian dietary patterns have been found to be associated with lower prevalence of MetS and its component factors (148, 149).

In the Southeast Asian region, at least four studies on the association of dietary patterns with MetS have been published on the South Korean population during the past three years. Data on dietary intake of subjects who participated in the fifth Korean Health and Nutrition Examination Survey (KHANES) indicated that three major dietary patterns (Traditional, Westernized, Healthy) were identified in this population. The Traditional dietary pattern (white rice and kimchi) was found to be associated with MetS in women, while Healthy dietary pattern (whole grains, legumes, nuts and fruits) was protective against abdominal obesity among females. The Westernized dietary pattern (oils, sugar, sweets, vegetables, meat and fish) was not found to be associated with MetS in either men or women (150). Similar findings were obtained in another large cross-sectional study and "Prudent dietary pattern" which comprised high intake of fruits, fruit products, nuts, dairy and a low consumption of grains was found to be inversely associated with MetS risk among Korean women (151). In another study, unbalanced Korean diet characterized by high intake of carbohydrates and sodium was found to be associated with higher risk of developing MetS among Korean women (152). Yoo et al., reported the relationship of breakfast dietary patterns with MetS (153). They have shown that dairy cereal breakfast or high energy and high fibre breakfast was associated with a reduced risk of MetS (153). In KNHANES IV, consumption of instant noodle was found to be associated with increased risk of MetS (154). Among various dietary components, dairy intake has been reported to be inversely associated with the prevalence of MetS (155). Similar, findings have been reported about the relationship between the consumption of dairy products and MetS in a French Study over a 9-year follow-up (156). At least four studies have shown protective effect of cheese intake against the risk of MetS (157-160). Daily intake of dairy products has been found to be protective against the development of MetS, especially abdominal obesity among Korean adults (161). The possible mechanism could be that dairy proteins are precursors of angiotensin-I converting enzyme–inhibitory peptides which may lower blood pressure (162).

Ethnic minorities and immigrants from other countries exhibit variability in diet intake, and hence their preponderance to MetS and MetS components may be different due to genetic and environmental factors. A study on South Asians (Bangladeshi, Indian, Nepali, Pakistani, and Sri Lankan) living in the United States showed that the animal protein and the fried snacks, sweets, and high-fat dairy patterns were associated with increased risk for MetS components (especially hyperglycemia, low HDL-cholesterol and abdominal obesity). Inversely, fruits, vegetables, nuts and legumes intake patterns were linked with reduced risk of MetS among the South Asians (163). It is important to note that out of 892 subjects in the study, 84% were of Indian origin (163).

One of the few studies carried out on dietary patterns among Malaysians indicated that the main sources of energy among the Malays and the Aborigines were rice, sugar and cooking oil, while fish and eggs were the major sources of protein (164). Chee et al., reported that major sources of protein in the Malay diet were anchovies and fish, while in the Indian diet, protein was mainly provided by salted fish, anchovies, egg, fish and pulses. The main sources of energy in both these groups were rice, sugar and cooking oil, while consumption of poultry, meat and dairy products was low in these two ethnic communities (165).

As regards to association of dietary patterns with health-related factors among Malaysians, most studies have been carried out on the adolescents. There have been hardly any studies on the relationship of dietary patterns with the risk of MetS among the general population. Two recent study reports indicate the relationship of dietary patterns with cognitive ability among 12-13 years old adolescents (166), and a relationship of dietary pattern with health related factors among patients with coronary artery disease (167). Another report showed unfavourable association of sugar-sweetened beverage intake with increased waist circumferences, raised serum levels of triglycerides, fasting glucose and insulin and low HDL-cholesterol among Malaysian adolescents (57). Tan and colleagues while exploring the ethnic differences with fruit and vegetable intake,

showed that the Chinese relatively consume more fruits, compared to the Indians and the Malays (112). Apart from these studies, there are very few available reports on the association of dietary patterns with the risk of MetS among the Malaysian population.

In general, a diet low in saturated fats, trans fats, simple sugars and high in fruits and green leafy vegetables, legumes, fibre, lean protein and whole grains have been shown to reduce the risk of MetS (145, 168, 169). Therefore, modification in diet and dietary habits is an important change that can reduce the risk of MetS.

2.4.2.5.2 Nutrient intake and MetS

Since MetS is a cluster of chronic metabolic disease conditions, the role of nutrients influencing these conditions cannot be ignored. Studies suggest a variety of nutrients and diet factors may contribute to or limit the progression of MetS and its associated factors (170-172).

Diets with high protein have been proposed to prevent MetS (173). Studies indicate that diet high in plant protein are associated with lower blood pressure and serum cholesterol (174). Furthermore, studies have also demonstrated that diets comprising high protein and low carbohydrate contents result in reducing fat mass, serum triglycerides and blood pressure, and increase HDL-cholesterol (175-178).

Literature has shown that high cholesterol levels are associated with high fat diets, however, there is a dearth of information linking low fat diets to preventing cardiovascular mortality (179, 180). Growing evidence suggests that fat type modification, instead of fat reduction in diets might be more effective in preventing cardiometabolic sequelae (181-183).

Fats are formed by fatty acids that may be saturated fatty acids (SFA), polyunsaturated fatty acids (PUFA), monounsaturated fatty acids (MUFA) and trans fatty acids (TFA) (181). MUFA and PUFA, in general, have been demonstrated to have cardioprotective properties such as lowering of blood pressure, reduction in total cholesterol levels, and reducing coronary artery disease risk (184, 185).

Omega-6-PUFA and omega-3 PUFA are two groups for long chains PUFA, both have been found to reduce coronary artery disease risk (181). Studies indicate that omega-3-PUFA lower triglycerides, blood pressure, inflammation, and improve myocardial and vascular functions (186, 187). However, long chain PUFAs may also lead to oxidation of LDL-cholesterol, platelet aggregation and interfere with essential fatty acids role in phospholipids of cell membrane (186).

Epidemiological studies have shown that omega-6 / omega-3 ratio is a sensitive biomarker for cardiometabolic disease risk (186). This ratio has been found to be 15/1 to 16.7/1 in Western diets; and is considered as high and associated with pathogenesis of cardiometabolic diseases (188-190). In this regard, a lower omega-6 / omega-3 ratio is suggested for prevention of metabolic disease conditions (190).

Industrial hydrogenation of vegetable or fish oils, commercial cooking and frying are sources of TFA (191, 192). Studies have shown a clear association of TFA with cardiovascular diseases, including increasing serum cholesterol, LDL-cholesterol and inflammation, and reduction of HDL-cholesterol (191, 193-195). Elimination of TFA from the diet may also reduce the risk of metabolic diseases and its sequelae (195, 196).

Carbohydrates play an important role in the human diet as they contribute to generation of energy for daily activities. High carbohydrates intake is associated with high blood pressure and MetS

(197, 198). Low carbohydrate foods have been shown to be effective in resolving MetS, as it is associated with lower triglyceride levels and higher HDL-cholesterol concentrations (199, 200).

Fibre helps in the regulation of body weight, improves glucose metabolism, regulates blood pressure and reduces chronic inflammation (201-203). Furthermore, its high consumption also lowers total cholesterol and LDL-cholesterol and raises HDL-cholesterol (202-204). Collectively, increasing the intake of fibre would protect against MetS.

According to literature, micronutrients such as sodium, potassium, calcium and iron have been shown to influence cardiometabolic health. Sodium modulates renal tubular Na^+-K^+ ATPase activity. Inhibition of this activity increases intracellular Na^+ and Ca^{2+} in vascular smooth muscles, leading to an increase in blood pressure (205, 206). Moderate reduction of salt intake reduces blood pressure and decreases mortality from coronary artery disease and stroke (207, 208). Potassium intake has been demonstrated to reduce systolic and diastolic blood pressure, along with a reduction in incidence of stroke, myocardial infarction and coronary artery disease (209-211). Because of the direct relationship of sodium with blood pressure, it is suggested that the consumption of diets low in sodium and high in potassium to prevent the risk of cardiometabolic complications (209).

Calcium may also influence development of MetS and its subsequent sequelae. Increasing calcium has been shown to lower serum cholesterol by decreasing fatty acid absorption (212). However, literature also suggests that high calcium levels might also result in vascular calcification which may increase risk of myocardial infarction (212-214). Furthermore, calcium has been shown to have cardioprotective effects like lowering of blood pressure and platelet aggregation (212). Hence, where moderate calcium intake may slow down progression of MetS and/or its components, an excessive intake might lead to cardiovascular risks (212-214).

Iron is another important micronutrient that affects metabolic disease risk. Studies have also shown that MetS affects iron homeostasis. Increasing iron stores would increase lipid peroxidation and production of free radicals, which may in turn increase the risk of cardiovascular complications (215, 216). In contrast, iron deficiency is also found to be associated with heart failure; hence iron deficiency or iron overload might be associated with an increased risk of metabolic complications (215-218).

Vitamin A (retinol) and Vitamin C (ascorbic acid) are antioxidant vitamins which are commonly found in fruits and vegetables (219). These vitamins may improve endothelial function by reducing the concentration of reactive oxygen species (ROS) in the vessel walls and prevent oxidation of LDL-cholesterol (220, 221).

The intake of Niacin, a water-soluble B vitamin, present abundantly in fruits and vegetables, nuts and whole grains, has demonstrated to have cardioprotective effects. Studies have shown that niacin raises HDL-cholesterol by 16% to 25%, warranting its use as a medication with statins in dyslipidemic patients (222-224).

According to the Malaysian Adult Nutrition Survey (MANS) 2003, among macronutrients, the mean intakes of proteins, fats, and carbohydrates were 59 g/day, 50 g/day and 232 g/day, respectively. The lowest intake of the three was among the Indians (48 g/day for proteins, 44 g/day for fats, 212 g/day for carbohydrates), while the highest intakes were among the Malays for carbohydrates, and among the Chinese for proteins and fats (225). These intakes appeared to have decreased when reassessed by MANS in 2014; median intakes for proteins, fats and carbohydrates were 57 g/day, 46 g/day and 195 g/day, respectively, with the highest intakes were found among the Chinese for all 3 macronutrients (226). Despite the decrease in macronutrient

(and energy) intake, the prevalence of obesity rose from 12.2% in 2003 to 18.5% in 2014 (227). Furthermore, according to a systematic review across 20 studies, Malaysian adults tend to meet or exceed the Malaysian Recommended Intake (RNI) guidelines for proteins and fats; nevertheless, adherence to energy and carbohydrates intakes among Malaysian adults to RNI guidelines remains unclear, perhaps due to methodological limitations in diet assessments, limited information in the food composition database, and respondents' tendency to under-report intakes (227).

Fibre intake has been recommended to be 20-30 g/day (228). According to a local study, where 39 food items from MANS 2003 with fibre content were extracted to determine the mean intake among Malaysians, it was found to be 19.2 g/day (229). It can be speculated that over time, fibre intakes might have improved across the population of Malaysia. However, the high prevalence values of obesity, high blood pressure and low HDL-cholesterol, according to the nationwide survey hint that fibre intake might be less than its recommended value. For micronutrient intakes, results of the MANS 2014 had shown reduced median intakes for calcium, iron, vitamin C and retinol, compared to the RNI guidelines 2017, with the Chinese having the maximum intakes compared to the Malays and the Indians (226, 228). Furthermore, the median intake of sodium was higher compared to the RNI guidelines (1935 mg/day, while the recommended intake is 1500 mg/day) (226, 228). The Chinese have been reported to have the highest intake of sodium of 2251 mg/day, followed by the Indians (1870 mg/day), and lowest among the Malays (1839 mg/day) (226). Paradoxically, the nationwide survey, though indicating an overall high prevalence of high blood pressure (52.3%), showed that the prevalence of high blood pressure was maximum among the Malays (52.2%), followed by the Chinese (48.4%) and the Indians (47.0%). While the methodological limitations of studies cannot be ruled out, inherent variabilities across different races of Malaysia may also have some effect in moderating the MetS spectrum across the Malaysian population.

2.4.2.6 Other risk factors for MetS

As MetS encompasses other cardiometabolic diseases as well, individuals suffering from these diseases usually have a poorer quality of life compared to those without MetS. Several investigations have shown that the quality of life is impaired with hypertension, obesity and insulin resistance; and all of these are components of MetS (230-240). However, studies have also indicated that people suffering from MetS have the worst quality of life compared to those not having this syndrome (241-243).

Studies have been carried out to investigate the relationship of socioeconomic status (SES) and risk of MetS. However, the results have been variable. In a study carried out in West Bengal, India, higher socio-economic status was found to be linked with higher prevalence of MetS (244). Similar results have been obtained in a Sri Lankan study in which higher socio-economic status in terms of education and income has been found to be associated with higher risk of MetS among Sri Lankan adults (245). On the other hand, Zhan et al., have shown that lower socio-economic status is associated with higher risk of MetS in Chinese women in the general population, but not among Chinese men (246). It would be important to explore the kind of relationship that exists between the socio-economic status of the communities in Johor and MetS and its components.

Several studies carried out on South Asian populations have shown that family history of a component of MetS is significantly associated with the risk of developing MetS (247-250). Surveys from several countries have revealed that adults living in urban areas have higher risk of developing MetS. In a study from Sri Lanka, the prevalence of MetS was 34.8% in urban adults compared to 28.3% in rural adults (251), while in India, prevalence in urban adults was nearly three times higher compared to rural adults (252). This indicates that perhaps urbanization, leads

to an altered lifestyle and diet leading to increased risk of developing MetS. Even in Malaysia, the prevalence of MetS was higher among urban dwellers (21, 29).

Loh et al., have recently reported the association of sugar-sweetened beverages intake with metabolic risks among adolescents (57). Chun et al., have shown that high levels of consumption of sugar-sweetened carbonated beverages are associated with calcification of coronary artery (a complication of MetS) in asymptomatic men and women (253).

Studies have also identified additional lifestyle risk factors for MetS, such as short sleep duration, increased frequency of dinning out, areca nut (betel nut) chewing, house-hold income, having more than one child, frequent tea consumption, and chronic stress (129, 254-259). Being modifiable, these risk factors may provide an opportunity to control incidence of MetS in any population.

2.5 Final thoughts

The narrative above shows evidence from literature that a variety of potential risk factors may affect the development and progression of MetS in many populations. Inherent to the syndrome, a great deal of variability exists with respect to its definition and studied populations. Malaysia is a unique country in Asia with respect to its ethnic diversity, culture, standard of living, lifestyle choices, diet intake, etc.; these non-modifiable and modifiable risk factors may be attributed to the MetS epidemic in the country and have not been fully studied, especially for elements related to nutrition. Hence, research on these elements can provide a wealth of information for Government stakeholders to formulate policies and develop strategies, tailored to each Malaysian ethnicity, to contain this syndrome and prevent the progression of its complications.

Chapter 3: Methodology

3.1 Study design

The research followed a non-randomized cross-sectional design, employing a non-probability sampling strategy for selecting participants for the study. Participants were invited to the study research camps in various locations in Johor, where after registration, signing of informed consent forms and screening to determine eligibility, blood samples and data were collected.

3.2 Study location

The data and blood samples were collected from adult Malaysians residing in the Johor Bahru and Kulai districts, Johor, Malaysia. According to the Department of Statistics, Malaysia, the overall population of Malaysia was estimated to be 31.6 million in 2016 (260). In the state of Johor, the total population in 2016 was reported as 3.65 million, of which 1.97 million (54%) were Malays, 1.08 million (30%) were Chinese and 0.23 million (6%) were Indians, while the remaining proportion consisted of people of other ethnicities and non-Malaysian citizens (260).

Research camps were structured in Kulai and Felda Taib Andak of the Kulai district and Johor Bahru, Ulu Tiram and Kota Masai of the Johor Bahru district, with the assistance from stakeholders and community elders. The selection of these study locations was partly based on the available percentages of MetS across each major ethnicity of Malaysia, reported in the nationwide survey 2008, to have enough subjects to represent each ethnicity in Johor so that data could be available for in-depth analysis for the stated objectives. Consented participants were invited to visit these camps for a physical examination and collection of blood samples upon observing a 10 to12-hour fast. Upon sample collection, the subjects were asked about their lifestyle and dietary habits.

3.3 Ethics

Ethical approval was sought from the Monash University Human Research Ethics Committee (MUHREC), which was granted on March 15, 2016 (Project # CF15/56-2016000022).

With the approval in hand, relevant authorities were approached to assist in setting up research camps starting from Kulai (May 2016), Felda Taib Andak (August 2016), Johor Bahru (December 2016), Ulu Tiram (February 2017) and Kota Masai (July 2017).

3.4 Screening and recruitment of study participants

3.4.1 Eligibility criteria

The inclusion criteria for the study were that the subjects should be of age 18 years or above, of either sex, and had been residing in Johor for at least one year. The subjects were requested to observe a 10 to12-hour fast before arriving at the medical camp to donate blood samples for accurate assessment of fasting serum levels of glucose, triglycerides and HDL (high density lipoprotein)-cholesterol. Exclusion criteria included pregnancy or having any illness which could preclude participation in the study such as cancer, liver disease, etc. Participants not observing fast were excluded from the data analysis.

3.4.2 Advertisement methods

With the assistance from community elders and stakeholders, advertisements in the form of banners, flyers and word of mouth, informed the locals of the medical camps for physical examination and donation of fasting blood samples and other information relevant to the study.

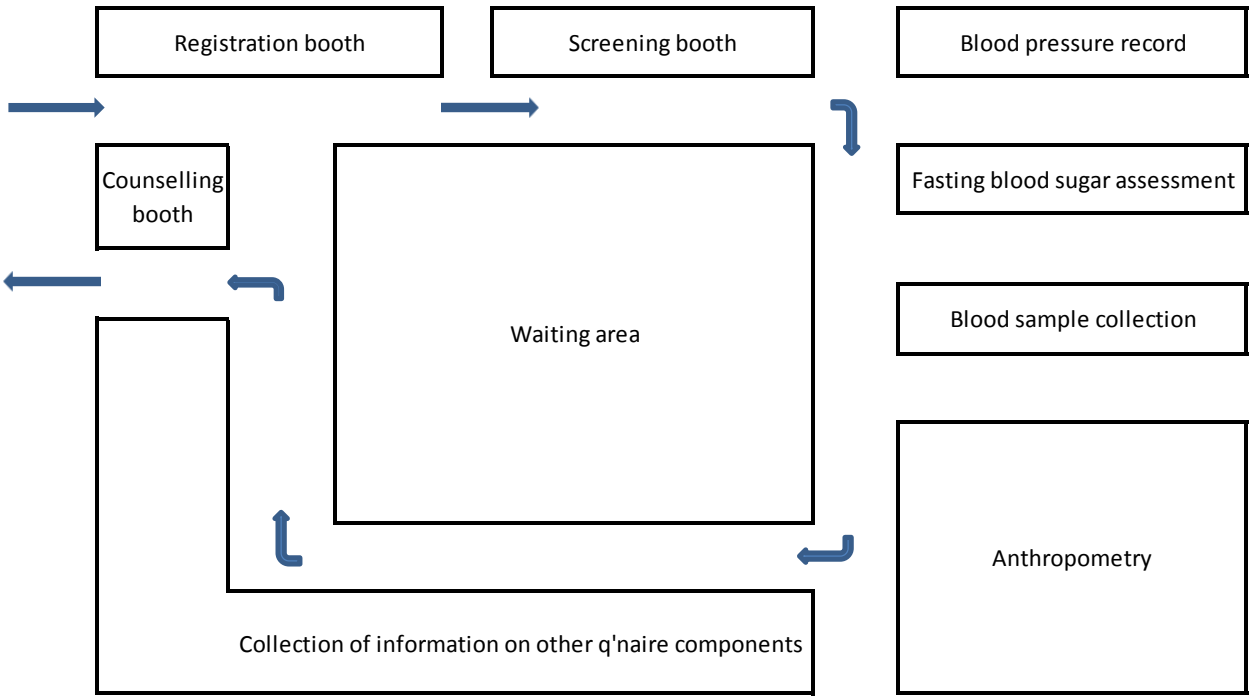
3.4.3 Community medical camps

Field research camps were set up in central locations, which were easily accessible to the target community. The people were then invited to visit these camps to provide research data and blood samples. Assistance was sought from community elders for making the locals aware of research camps and to convey the requests for their participation.

3.5 Data collection process

As mentioned earlier, the field research/medical camps were set up in central locations and the local community was invited to visit these camps for participation in this study. Figure 2 shows the general scheme of such a medical camp. The camp had a number of booths/stations where blood samples/data were collected from those visiting these camps.

Figure 2: General scheme of a medical research camp



The point of entry for each invitee led to a registration booth where the subject was informed about the research and a request was generated for his/her participation. Upon consent, the invitee was registered, allotted an identification number, and signature of consent. The participant was then directed to stations for recording of his/her blood pressure and fasting blood sample. Each participant provided a 10-ml blood sample for analysis of biomarkers (fasting serum glucose, fasting serum triglycerides and fasting serum HDL [high density lipoprotein]-cholesterol) for assessment of presence/ absence of MetS. After this, the participants was directed to a station for recording of his/her anthropometric measurements (height, weight, and body mass index).

Questions pertaining to socio-demographics, lifestyle habits and nutrition intake were asked and recorded. If a subject wanted to have a better understanding of the question, this was explained. Once all components of the questionnaire were completed, the participants were directed to the counselling booth for consultation with the available doctor. At this booth, the questionnaire forms were collected by the research staff and the participants were thanked for their participation. The participants were paid in kind for their contribution into the study.

A designated waiting area was available for the participants in case any booth was occupied by a previous subject.

3.6 Study instruments

3.6.1 Questionnaire

The 2016-17 questionnaire contained sections detailing risk factors and behaviours to be ascertained from the attending study participants. The questionnaire was designed in English and translated in the Bahasa Malaysia language. A copy of the questionnaire is attached in the appendix. The questionnaire contained the following sections:

i. *Personal details*
ii. *Selection criteria*
iii. *Anthropometry*
iv. *Socio-demographic information*
v. *Lifestyle habits*
vi. *Semi-food frequency questionnaire*

3.6.2 Anthropometry measures

Body height was measured using Seca stadiometers (Seca, USA), while the weight was measured using the InBody 120 body fat analyser (Biospace, Korea). Measures were taken to ensure that the subjects wore light clothing and no shoes. The measurement was recorded to the nearest 0.1 cm and 0.1 kg, respectively.

Waist circumference was measured using a measuring tape. The measurements were taken at the mid-point, between the lower rib margin (12^{th} rib) and the iliac crest. Caution was maintained during measurements that the subject was standing straight with feet together and arms relaxed on either side. It was also ensured that the tape was held in a horizontal position, wrapped around the waist, loose enough for the assessor to insert his/her finger between the tape and the subject's body. The subject was instructed to breathe normally during the assessment, with the measurement recorded at the end of a normal exhalation and rounded to the nearest 0.1 cm.

3.6.3 Blood pressure assessment

Blood pressure was recorded using the Omron digital sphygmomanometers HEM 7121 (Omron Healthcare, Japan). The subject was provided a 4-5-minute rest, in a seated position, with the arm supported at heart level. At least two readings were taken from each subject, recording the concurrent or highest measurement obtained from the two readings. A third reading was taken in

case, the difference between the two readings for systolic blood pressure was more than 10 mmHg, and for diastolic blood pressure more than 5 mmHg, upon which the preceding value was recorded. This ensured that the blood pressure was being assessed in a relaxed setting.

3.6.4 Blood sample analysis

Fasting blood samples were collected from study participants for determining the levels of fasting serum glucose (in mmol/L), fasting serum triglycerides (in mmol/L) and fasting serum HDL-cholesterol (in mmol/L). Standard guidelines for phlebotomy were followed throughout the venipuncture procedure (261).

Collected samples were transported in cold chain to the laboratory where these were centrifuged, and the sera separated and placed in identity marked cryotubes or Eppendorf tubes. These were then placed in a -60 degree Celsius freezer till laboratory analysis.

The blood analysis for determination of serum levels of fasting glucose (mmol/L), triglycerides (mmol/L) and HDL-cholesterol (mmol/L) was carried out using clinical chemistry analyser (Cobas C III). Its reagents were purchased from Randox Laboratories, United Kingdom. The summary of the analysis protocol is provided below:

The analyser has a carousel where reagents (for glucose, triglycerides and HDL-cholesterol) are placed. Reaction cuvettes are placed on its rim. On the side of the analyser is a tray where microcuvettes are placed for the probe to collect and deliver the contents of microcuvette to the reaction cuvettes for analysis.

As the analyser runs, the probe first cleans its tip, and proceeds to deliver reagents to the reaction cuvettes in the carousel. After that, the probe collects solution from the microcuvette on the tray and delivers it to the reaction cuvette. The process continues till all samples have been analysed.

Before running the analyser, microcuvettes are labelled and about 200-µl of serum is pipetted in each of these microcuvettes. These are placed in the tray bearing specific labels to ensure that the results are for the intended participant. When the analysis is complete, results are then recorded in the questionnaire forms.

3.6.5 Lifestyle habits

These habits included questions on physical activity, smoking status, alcohol consumption, quick finishing of their meals, frequency of late dining, frequency of skipping breakfast and frequency of dining out.

The participants' physical activity status was inquired using the International Physical Activity Questionnaire (IPAQ) (262). The questionnaire contained seven questions; the first two pertaining to the time spent on vigorous activities performed, the next two for moderate activities, the next two for mild activities and the last question on the time spent while sitting. Responses were converted to Metabolic Equivalent Task minutes per week (MET-min/week) according to the IPAQ scoring protocol. The protocol also provides details for data processing, cleaning and truncation. Total minutes over last seven days spent on vigorous, moderate, and mild activities were multiplied by 8.0, 4.0, and 3.3, respectively, to create MET scores for each activity level. MET scores across the three sub-components were then summed to indicate the overall physical activity score. These overall scores were then categorized into high (total activity of at least 3000 MET-min/week), moderate (total activity of at least 600 MET-min/week) and low (total activity < 600 MET-min/week).

For the quick finishing of meals, the question was asked on the subject's perception on finishing their meals either fast (less than 10-15 minutes) or not fast (41, 125, 263). The other three

questions were based on the participants' frequency per week; three times or less were considered favourable (41). "Late dining" was defined as a meal eaten within two hours before bed-time. "Dining out" was defined as a meal consumed by the participant that is not prepared at his/her home (264-266).

3.6.7 Nutritional assessment

The semi-food frequency questionnaire was helpful in collecting details on the food intake practices over the last one year from all the research participants. The questionnaire was derived from the Malaysian Adult Nutrition Survey (MANS) 2014, from which 78 commonly consumed food items were extracted for this research (267). As the questionnaire had been used to study nutrition among Malaysians of various ethnic backgrounds, the questionnaire was appropriate for its use among the Johor population. The participant was asked about the frequency of intake (in days, weeks or months) of each meal consumed, followed by the portion size of the consumed food. The information was then converted into amounts (in grams) consumed in a day, which were then entered in a computer program (DietPlus version 3) to derive intakes of the following nutrients:

- Carbohydrates (g),
- Proteins (g),
- Fats (g),
- Fibre (mg),
- Iron (mg),
- Sodium (mg),
- Potassium (mg),
- Retinol (µg),

- Niacin (mg),
- Vitamin C (mg),
- Cholesterol (mg),
- Omega-6-polyunsaturated fatty acids (g),
- Omega-3-polyunsaturated fatty acids (g),
- Trans fatty acids (g)

The DietPlus software provided details for portion sizes that were employed for calculating the nutrient intakes (268). The medium portion size was incorporated for certain items where portion sizes could not be reported.

To identify outliers, the Goldberg formula (ratio of energy intake to the basal metabolic rate) was employed (269). Mathematically,

Energy intake (EI): Basal Metabolic Rate (BMR)

To calculate basal metabolic rates (BMR), specific for Malaysian adults, we used equations described by Ismail et al., (270). These were as follows:

For males: BMR (MJ/day) = 0.047 [weight (kg)] – 0.035 [age (years)] + 3.083

For females: BMR (MJ/day) = 0.054 [weight (kg)] – 0.027 [age (years)] + 1.985

Subjects having EI: BMR values less than 1.2 were considered under-reporters and were removed from the analyses. Furthermore, standardized values on subjects with the ratio of energy intake to basal metabolic rate beyond 3 SD (standard deviations) were also identified as outliers and removed from analyses. Additionally, standardized energy intakes beyond 3 SD (standard deviations) were also treated as outliers and hence, removed.

Information on serving intakes of various food items as consumed by the target population was helpful in converting these into relevant food groups for analysis. These groups were as follows:

- Cereals and cereal products
- Vegetables
- Fruits
- Meat, poultry and eggs
- Fish
- Legumes
- Milk and milk products
- Fats, oils and sugars

These groups were then analysed for studying their association with MetS and its components, overall and across the three ethnicities.

For evaluating dietary patterns, the frequency estimate per day of each food item was used. These estimates were then subjected to factor analysis. Diet patterns identified were then analysed for their relationship with MetS and its components, overall and across the three ethnicities.

3.6.8 Assessment of Metabolic syndrome (MetS)

The Harmonized criteria was used to assess metabolic syndrome among the participants. Table 1 shows the definitions for assessing MetS based on NCEP-ATP III, IDF and Harmonized criteria.

3.7 Sample size estimate & statistical analysis

The sample size estimate was calculated using figures of various components of MetS reported in the 2008 nationwide survey (29). According to the calculation, increased blood pressure yielded the maximum sample size estimate of 386 at 5% level of significance and a precision of 0.05.

Data entry was performed using EpiData version 3.1. During the process of data entry, 5% of the forms were re-checked for accounting any errors during entry of data. All data were analysed using Statistical Package for Social Sciences (SPSS) version 23 (IBM SPSS Statistics for Windows, Version 23.0. Armonk, NY: IBM Corp.). For nutrient analyses, the data were entered in DietPlus Version 3 (268). Information on nutrient intakes obtained from DietPlus was then exported to SPSS for further analyses.

Descriptive statistics were calculated for each entered variable. Continuous variables were expressed as a means with standard deviation (SD) or medians with interquartile ranges (IQR). Frequencies and percentages were obtained for categorical variables. Chi square tests for Independence were used to determine the association between categorical variables, while Independent Sample's t-test was employed to study mean differences among continuous variables across presence of MetS and its components. Non-parametric alternatives were employed for non-normal data, ascertained by Shapiro-Wilk's test for normality. Logistic regression analyses were used to determine the associations of lifestyle and nutritional factors with MetS. We employed the enter method to perform the regression analyses. $P < 0.25$ was the criterion for eligibility of the characteristic to be part of the multivariable analysis. Binary logistic regression was employed as the outcome (MetS) was binary, calculating odds ratios with 95% confidence intervals, while adjusting for confounding factors. Effect modification (interaction) was

studied using logistic regression, including both main and interactive effects. If model found to be unstable, effect modification was studied using stratification.

Factor analysis was employed to identify diet patterns among the participants using principal component analysis. The varimax rotation method was adopted for generating the distinctive matrix that was easy to interpret. Eigenvalues > 1 and the point of inflexion on the SCREE plot was used to determine the number of diet patterns to analyze. Kaiser-Meyer-Olkin (KMO) and the Bartlett's Test of Sphericity were used to determine adequacy of samples and relationship across variables, respectively. Factor loading values greater than 0.3 were considered for determining the food items in each diet pattern. Using SPSS AMOS (Analysis of Moment Structures) version 23 (Arbuckle JL. AMOS (Version 23.0) for Windows. Chicago: IBM SPSS), confirmatory factor analysis was performed for better visualization and interpretability of the diet patterns across the target population.

Diet pattern scores, which were then divided into quartiles, were generated; increasing intake of diet pattern represented the higher quartile. Taking the lowest quartile as reference, odds ratios (with 95% confidence intervals) were calculated using logistic regression analysis to study the association of each diet pattern with MetS and its components, while adjusting for confounding factors.

$P < 0.05$ were considered significant.

Chapter 4.1: Results

As mentioned in the previous chapters, the population of Johor is known for its diversity and consists of three major ethnicities - Malay, Chinese and Indian. Each ethnic group has its own peculiar/ special life style and dietary habits which can influence the risk of MetS. The nationwide survey-2008 which also included the Johor population has provided us the information about the prevalence of MetS in this country for all these three major ethnicities. However, the information specific to the population of Johor was missing. Therefore, we embarked on this study to find out the prevalence of MetS among the Johor population, and to investigate the influence of lifestyle and nutritional factors on the risk of MetS.

The specific objectives of this study that have been dealt with in this section are:

1. to find out the prevalence of MetS among the population of Johor comprising of three major ethnicities using Harmonized, NCEP ATP III and IDF criteria.
2. to investigate the association of lifestyle factors with MetS among the Johor population
3. to determine whether there is an association of nutritional factors with the risk of MetS in this population.

For these objectives, data from a total of 481 subjects were analysed. The results below elucidate the prevalence of MetS and the influence of certain lifestyle and nutritional factors on MetS among Malaysian adults in Johor.

4.1.1 Prevalence of MetS

Table 2 provides the summary of the distribution of study subjects by socio-demographic factors, MetS and MetS components. Regarding the socio-demographic characteristics, there were more

females compared to males (64.9% vs. 35.1%). The percentages of Malays, Chinese and Indians were 30.6%, 47.4% and 22.0%, respectively. The prevalence of MetS according to the Harmonized criteria was 32.2% which is higher than the prevalence values obtained using IDF (31.2%) and NCEP ATP III (22.7%) criteria. Prevalence of abdominal obesity (62.0%) and high blood pressure (56.8%) were the highest in this cohort compared to other metabolic abnormalities – low HDL-cholesterol, hypertriglyceridemia and fasting hyperglycemia.

Table 2: Distribution of study respondents by sociodemographic characteristics, MetS and components of MetS

Characteristic		n (%)
Gender	**Male**	169 (35.1)
	Female	312 (64.9)
Age (years)	**< 40**	112 (23.3)
	40-49	129 (26.8)
	50-59	117 (24.3)
	≥ 60	123 (25.6)
Ethnicity	**Malay**	147 (30.6)
	Chinese	228 (47.4)
	Indian	106 (22.0)
Marital status	**Single**	63 (13.1)
	Married/living with partner	378 (78.6)
	Separated/divorced	40 (8.3)
Education	**Primary or lower**	95 (19.8)
	Secondary	291 (60.5)
	Tertiary	95 (19.8)
Employment status	**Employed**	206 (42.8)
	Unemployed	275 (57.2)
Abdominal Obesity		298 (62.0)
High Blood Pressure		273 (56.8)
Low HDL-Cholesterol		142 (29.5)
High Triglycerides		119 (24.7)
High Blood Glucose		90 (18.7)
MetS (NCEP ATP III)		109 (22.7)
MetS (IDF)		150 (31.2)
MetS (Harmonized)		155 (32.2)

Table 3 shows the comparison of unadjusted prevalence values (with 95% CI) for MetS (based on Harmonized criteria), hypertension and diabetes mellitus among Malaysian adults in Johor, by gender, age and ethnicity. The prevalence of MetS was found to be 32.2% in the study subjects; highest among the Indians (51.9%) and lowest among the Chinese (20.2%). Hypertension was more prevalent among males compared to females (44.4% vs. 34.9%), while diabetes mellitus was also more commonly found in males (8.7%) compared to females (7.1%), and its percentage was highest among the Malays (12.9%) compared to the Indians (8.5%) and the Chinese (3.5%).

Table 3: Unadjusted prevalence (in %) (with 95% CI) for MetS (based on the Harmonized criteria), hypertension (BP ≥ 140/90 mmHg) and diabetes mellitus (FBG ≥ 7.0 mmol/L) among Malaysian adults: overall, by gender, age and ethnicity

			MetS	Hypertension	Diabetes Mellitus
		n	Harmonized (2009)	BP ≥ 140/90 mmHg	FBG ≥ 7.0 mmol/L
Overall		**481**	32.2 (28.0, 36.4)	38.3 (34.0, 42.6)	7.5 (5.1, 9.8)
Gender	**Male**	**169**	33.7 (26.6, 40.8)	44.4 (36.9, 51.9)	8.3 (4.1, 12.5)
	Female	**312**	31.4 (26.2, 36.6)	34.9 (29.6, 40.2)	7.1 (4.2, 10.0)
Age (years)	**< 40**	**112**	19.6 (12.2, 27.0)	22.3 (14.6, 30.0)	0.9 (-0.8, 2.6)
	40-49	**129**	37.2 (28.8, 45.5)	38.8 (30.4, 47.2)	7.8 (3.2, 12.4)
	50-59	**117**	30.8 (22.4, 39.2)	39.3 (30.5, 48.2)	8.5 (3.4, 13.6)
	≥ 60	**123**	39.8 (31.1, 48.4)	51.2 (42.4, 60.0)	12.2 (6.4, 18.0)
Ethnicity	**Malay**	**147**	36.7 (28.9, 44.4)	40.8 (32.8, 48.7)	12.9 (7.5, 18.3)
	Chinese	**228**	20.2 (15.0, 25.4)	36.0 (29.8, 42.2)	3.5 (1.1, 5.9)
	Indian	**106**	51.9 (42.4, 61.4)	39.6 (30.3, 48.9)	8.5 (3.2, 13.8)

Table 4 compares the socio-demographic characteristics among study subjects with and without MetS in Johor. Significant differences were observed with age, marital status, education and ethnicity. Table 5 shows the adjusted analysis of socio-demographic characteristics obtained via logistic regression, while reporting adjusted odds ratios (AOR) with 95% confidence interval (CI) for study subjects. The analysis reveals that the odds of MetS increase with increasing age and decrease with higher education. Moreover, the odds of MetS among the Chinese was found to be protective, while, among the Indians, the odds of MetS increased by nearly two folds (AOR = 1.942 [95% CI = 1.133-3.330]).

Table 4: Comparison of sociodemographic characteristics among study respondents with and without MetS (n=481)

			Total (n=481)	No MetS (n=326)	MetS (n=155)	P-value*
Gender	**Male**	**n (%)**	169	112 (66.3)	57 (33.7)	0.604
	Female	**n (%)**	312	214 (68.6)	98 (31.4)	
Age (years)	**< 40**	**n (%)**	112	90 (80.4)	22 (19.6)	0.005
	40-49	**n (%)**	129	81 (62.8)	48 (37.2)	
	50-59	**n (%)**	117	81 (69.2)	36 (30.8)	
	≥ 60	**n (%)**	123	74 (60.2)	49 (39.8)	
Ethnicity	**Malay**	**n (%)**	147	93 (63.3)	54 (36.7)	< 0.001
	Chinese	**n (%)**	228	182 (79.8)	46 (20.2)	
	Indian	**n (%)**	106	51 (48.1)	55 (51.9)	
Marital status	**Single**	**n (%)**	63	50 (79.4)	13 (20.6)	0.002
	Married/living with partner	**n (%)**	378	255 (67.5)	123 (32.5)	
	Separated/divorced	**n (%)**	40	21 (52.5)	19 (47.5)	
Education	**Primary or lower**	**n (%)**	95	48 (50.5)	47 (49.5)	< 0.001
	Secondary	**n (%)**	291	199 (68.4)	92 (31.6)	
	Tertiary	**n (%)**	95	79 (83.2)	16 (16.8)	
Employment status	**Employed**	**n (%)**	206	145 (70.4)	61 (29.6)	0.289
	Unemployed	**n (%)**	275	181 (65.8)	94 (34.2)	

*P-value ascertained by chi square test

Table 5: Association of sociodemographic characteristics with MetS (defined by Harmonized criteria) among Malaysian Adults in Johor (n=481)

Characteristic		Crude Odds ratio (COR)*	95% CI		Adjusted Odds ratio (AOR)*	95% CI	
			Lower	Upper		Lower	Upper
Gender	**Male**	1.00			1.00		
	Female	0.90	0.60	1.34	0.85	0.52	1.40
Age (years)	**< 40**	1.00			1.00		
	40-49	2.42	1.35	4.36	2.35	1.22	4.50
	50-59	1.82	0.99	3.34	2.65	1.28	5.46
	≥ 60	2.71	1.50	4.88	3.88	1.79	8.38
Ethnicity	**Malay**	1.00			1.00		
	Chinese	0.44	0.27	0.69	0.35	0.20	0.62
	Indian	1.86	1.12	3.09	1.94	1.13	3.33
Marital status	**Single**	1.00			1.00		
	Married/living with partner	1.86	0.97	3.54	0.75	0.36	1.56
	Separated/divorced	3.48	1.46	8.31	0.73	0.25	2.11
Education	**Primary or lower**	1.00			1.00		
	Secondary	0.47	0.29	0.76	0.60	0.35	1.02
	Tertiary	0.21	0.11	0.40	0.40	0.18	0.87
Employment status	**Employed**	1.00			1.00		
	Unemployed	1.23	0.84	1.82	0.93	0.57	1.53

*Analysed by logistic regression

4.1.2 Effect of lifestyle characteristics with MetS

The effect of lifestyle habits which could be associated with MetS were analysed for the subjects in the Johor cohort. The main habits considered were physical activity, smoking status and alcohol consumption and four more diet related lifestyle habits namely, frequency of dining out of home, late dining, skipping breakfast, and quick finishing of meals.

Comparison of lifestyle habits among subjects with and without MetS was carried out in Johor. Only physical activity was found to be significantly associated with MetS ($p = 0.045$) (Supplementary Table 1). Table 6 shows the logistic regression models for studying the association of each lifestyle factor with MetS in the study subjects. Results indicate that overall in this population, frequent dining out of home more than three times per week is associated with two times odds of having MetS (AOR = 2.043 [95% CI = 1.207-3.459]), when adjusted for age, ethnicity, marital status and education. Across ethnicities, higher odds for MetS were observed with quick finishing of meals among the Malays (AOR = 2.114 [95% CI = 1.010-4.422]), low physical activity among the Chinese (AOR = 4.765 [95% CI = 1.488-15.257]) and frequent dining out more than three times per week among the Indians (AOR = 4.379 [95% CI = 1.030-18.612]) (Table 7).

Table 6: Association of lifestyle characteristics associated with MetS (defined according to Harmonized criteria) from Johor (n=481)

	Characteristic		OR	95% CI		P-value
				Lower	Upper	
Model 1	**Physical activity**	**High**	1.00			
		Moderate	1.04	0.60	1.80	0.89
		Low	1.67	0.98	2.86	0.06
Model 2	**Physical activity**	**High**	1.00			
		Moderate	1.12	0.62	2.02	0.70
		Low	1.72	0.97	3.06	0.07
Model 1	**Smoking status**	**Never smoked**	1.00			
		Past/Current smoker	0.77	0.43	1.39	0.39
Model 2	**Smoking status**	**Never smoked**	1.00			
		Past/Current smoker	0.70	0.37	1.33	0.27
Model 1	**Alcohol consumption**	**Never consumed/past consumer**	1.00			
		Current consumer	1.39	0.72	2.68	0.33
Model 2	**Alcohol consumption**	**Never consumed/past consumer**	1.00			
		Current consumer	1.98	0.93	4.24	0.08
Model 1	**Frequent dining out**	**≤ 3 times/week**	1.00			
		> 3 times/week	0.81	0.54	1.24	0.33
Model 2	**Frequent dining out**	**≤ 3 times/week**	1.00			
		> 3 times/week	2.04	1.21	3.46	0.01
Model 1	**Late dining**	**≤ 3 times/week**	1.00			
		> 3 times/week	1.20	0.66	2.18	0.55
Model 2	**Late dining**	**≤ 3 times/week**	1.00			
		> 3 times/week	1.16	0.61	2.23	0.65
Model 1	**Skipping breakfast**	**≤ 3 times/week**	1.00			
		> 3 times/week	0.92	0.58	1.43	0.70
Model 2	**Skipping breakfast**	**≤ 3 times/week**	1.00			
		> 3 times/week	0.86	0.52	1.41	0.55
Model 1	**Finishing meals**	**Not fast**	1.00			
		Fast	1.35	0.92	1.98	0.13
Model 2	**Finishing meals**	**Not fast**	1.00			
		Fast	1.12	0.73	1.72	0.61

Model 1: Unadjusted
Model 2: Adjusted for age, ethnicity, marital status and education

Table 7: Association of lifestyle characteristics associated with MetS (defined according to Harmonized criteria) across ethnicities from Johor

	Characteristic		Malay (n=147)				Chinese (n=228)				Indian (n=106)			
			OR	95% CI		P-value	OR	95% CI		P-value	OR	95% CI		P-value
				Lower	Upper			Lower	Upper			Lower	Upper	
Model 1	**Physical activity**	**High**	1.00				1.00				1.00			
		Moderate	0.73	0.28	1.89	0.51	2.35	0.75	7.35	0.14	0.91	0.31	2.64	0.86
		Low	1.13	0.46	2.78	0.79	4.07	1.31	12.64	0.02	1.03	0.37	2.90	0.95
Model 2	**Physical activity**	**High**	1.00				1.00				1.00			
		Moderate	0.66	0.24	1.84	0.43	2.30	0.72	7.34	0.16	0.96	0.28	3.26	0.94
		Low	0.89	0.33	2.36	0.81	4.77	1.49	15.26	0.01	0.95	0.29	3.10	0.93
Model 1	**Smoking status**	**Never smoked**	1.00				1.00				1.00			
		Past/Current smoker	0.43	0.15	1.22	0.11	0.57	0.16	1.99	0.37	1.23	0.42	3.59	0.71
Model 2	**Smoking status**	**Never smoked**	1.00				1.00				1.00			
		Past/Current smoker	0.51	0.13	1.99	0.33	0.61	0.17	2.21	0.46	1.04	0.25	4.33	0.96
Model 1	**Alcohol consumption**	**Never consumed/past consumer**	1.00				1.00				1.00			
		Current consumer	-	-	-	-	0.99	0.38	2.58	0.98	9.78	1.19	80.24	0.03
Model 2	**Alcohol consumption**	**Never consumed/past consumer**	1.00				1.00				1.00			
		Current consumer	-	-	-	-	1.07	0.40	2.87	0.90	7.92	0.82	76.96	0.07
Model 1	**Frequent dining out**	**≤ 3 times/week**	1.00				1.00				1.00			
		> 3 times/week	1.58	0.54	4.64	0.40	1.02	0.54	1.95	0.95	2.15	0.79	5.85	0.14
Model 2	**Frequent dining out**	**≤ 3 times/week**	1.00				1.00				1.00			
		> 3 times/week	2.12	0.66	6.84	0.21	1.58	0.78	3.21	0.20	4.38	1.03	18.61	0.05
Model 1	**Late dining**	**≤ 3 times/week**	1.00				1.00				1.00			
		> 3 times/week	0.63	0.21	1.87	0.40	1.36	0.47	3.95	0.58	1.47	0.48	4.46	0.50
Model 2	**Late dining**	**≤ 3 times/week**	1.00				1.00				1.00			
		> 3 times/week	0.64	0.20	2.03	0.45	1.39	0.45	4.35	0.57	1.13	0.29	4.41	0.86
Model 1	**Skipping breakfast**	**≤ 3 times/week**	1.00				1.00				1.00			
		> 3 times/week	1.19	0.52	2.71	0.68	0.76	0.34	1.70	0.51	0.63	0.28	1.44	0.27
Model 2	**Skipping breakfast**	**≤ 3 times/week**	1.00				1.00				1.00			
		> 3 times/week	1.33	0.54	3.25	0.53	0.82	0.35	1.89	0.64	0.83	0.31	2.22	0.70
Model 1	**Finishing meals**	**Not fast**	1.00				1.00				1.00			
		Fast	1.81	0.92	3.56	0.09	1.05	0.55	2.00	0.89	0.57	0.24	1.35	0.20
Model 2	**Finishing meals**	**Not fast**	1.00				1.00				1.00			
		Fast	2.11	1.01	4.42	0.05	1.05	0.53	2.06	0.89	0.62	0.23	1.67	0.34

Model 1: Unadjusted
Model 2: Adjusted for gender, marital status, education and employment status (Malay); age and employment status (Chinese); gender and age (Indian)

4.1.3 Effect of nutrients with MetS

In the nationwide survey of 2008, limited information on nutrition was obtained from the subjects. However, in the light of rising prevalence of being overweight and obese across Malaysia, it was conceived that nutrition could play an important part in influencing the prevalence of MetS among Malaysians (271). In the current study, we collected information on the nutrient intake status using a validated semi-food frequency questionnaire.

Table 8 shows the median nutrient intakes per day of Malaysian population in this cohort. Among the 15 nutrients, the daily median intakes of proteins, fats, carbohydrates, sodium, omega-6-PUFA and trans fatty acids were highest among the Malays compared to the Indians and the Chinese, while the intakes of fibre, calcium, iron, potassium, retinol, niacin, cholesterol, vitamin C and omega-3-PUFA were highest among the Chinese compared to the other two ethnic groups. Conversely, the Indians had the lowest intakes of proteins, fibre, iron, potassium, retinol, niacin, vitamin C, cholesterol and omega-3-PUFA compared to the Malays and the Chinese. This indicates that nutrient intakes are quite different among the three ethnic communities in Johor. Therefore, the influence of these dietary items on MetS or its components would be expected to be quite variable.

Median (and interquartile range) nutrient intakes by subjects in this cohort with and without MetS has been shown in Supplementary Table 2. Median intakes for sodium, potassium, retinol and cholesterol were found to be significantly less among subjects with MetS ($p < 0.05$). However, median intake of trans fatty acids was found to be significantly higher among subjects with MetS ($p < 0.001$). Table 9 shows the regression analysis results for association of any nutrient intake with MetS. The analyses were adjusted for socio-demographic characteristics (model 2) and further adjusted for lifestyle characteristics that influence MetS. The results indicate a modest

reduction in carbohydrates intake among the MetS group of subjects (AOR = 0.997 [95% CI = 0.99-1.00], adjusted for socio-demographic and lifestyle characteristics. Where the association suggests that carbohydrate intake per day is associated with MetS, the (adjusted) OR reports as a 1 g change, which appears to be small but significant. Table 10 shows the same analyses across the three races. Among the Malays, increased intake of omega-3-PUFA was associated with more than 5.8 folds odds of MetS when the model was adjusted for sociodemographic and lifestyle factors (p = 0.011). Among the Chinese, fat intake increased the odds of MetS by 1.4% while adjusting the analyses with sociodemographic factors, and by 1.7% when analyses were further adjusted with lifestyle factors (p = 0.019). Among the Indians, retinol intake was found to be slightly protective against MetS when adjusted for gender, age and energy.

Table 8: Comparison of median nutrient intakes per day among Malaysians in 2016-17

	All (n=481)		Malay (n=147)		Chinese (n=228)		Indian (n=106)	
	Median	**IQR**	**Median**	**IQR**	**Median**	**IQR**	**Median**	**IQR**
Energy (kcal)	2358.32	1354.93	2881.94	1501.77	2157.60	1161.20	2349.80	1247.85
Protein (g)	76.98	43.77	83.87	47.55	74.17	46.44	66.55	35.38
Fats (g)	78.85	61.41	106.25	82.34	67.85	42.67	79.69	63.65
Carbohydrates (g)	302.90	189.32	357.25	208.36	282.64	179.45	295.68	178.11
Fibre (g)	21.09	18.05	19.33	19.59	22.81	17.81	18.70	13.60
Calcium (mg)	879.39	595.68	866.64	759.32	882.13	481.27	870.66	566.10
Iron (mg)	14.76	10.39	14.64	13.20	15.66	9.68	12.04	8.66
Sodium (mg)	2456.35	1533.10	2625.24	1825.50	2611.47	1562.60	2108.77	1138.69
Potassium (mg)	2432.10	1518.95	2295.70	1807.20	2566.55	1459.33	2244.20	1373.30
Retinol (µg)	1044.89	713.31	1016.06	769.58	1141.21	789.23	953.60	576.47
Niacin (mg)	20.93	17.35	19.19	13.20	23.82	20.14	18.32	14.68
Vitamin C (mg)	190.01	172.82	190.19	188.34	205.74	201.84	166.47	127.24
Cholesterol (mg)	217.09	184.54	216.08	179.50	244.22	182.72	140.85	152.41
Omega-6 PUFA (g)	9.62	7.68	13.04	10.15	8.83	5.77	9.47	6.64
Omega-3 PUFA (g)	0.66	0.52	0.61	0.49	0.72	0.55	0.56	0.56
Trans fatty acids (g)	0.09	0.17	0.18	0.18	0.04	0.07	0.15	0.20

Table 9: Association of nutrient intakes among Malaysians associated with MetS (defined according to Harmonized criteria) (n=481)

Nutrient		OR	95% CI		P-value
			Lower	Upper	
Protein (g)	**Model 1**	1.00	0.99	1.00	0.34
	Model 2	1.00	0.99	1.01	0.50
	Model 3	1.00	0.99	1.01	0.68
Fats (g)	**Model 1**	1.00	1.00	1.01	0.21
	Model 2	1.01	1.00	1.01	0.06
	Model 3	1.01	1.00	1.01	0.05
Carbohydrates (g)	**Model 1**	1.00	1.00	1.00	0.45
	Model 2	1.00	0.99	1.00	0.04
	Model 3	1.00	0.99	1.00	0.04
Fibre (g)	**Model 1**	1.00	0.99	1.01	0.47
	Model 2	1.00	0.99	1.01	0.67
	Model 3	1.00	0.98	1.01	0.55
Calcium (mg)	**Model 1**	1.00	1.00	1.00	0.10
	Model 2	1.00	1.00	1.00	0.12
	Model 3	1.00	1.00	1.00	0.09
Iron (mg)	**Model 1**	0.98	0.96	1.00	0.07
	Model 2	0.98	0.94	1.01	0.22
	Model 3	0.98	0.94	1.01	0.23
Sodium (mg)	**Model 1**	1.00	1.00	1.00	0.29
	Model 2	1.00	1.00	1.00	0.87
	Model 3	1.00	1.00	1.00	0.93
Potassium (mg)	**Model 1**	1.00	1.00	1.00	0.33
	Model 2	1.00	1.00	1.00	0.71
	Model 3	1.00	1.00	1.00	0.55
Retinol (µg)	**Model 1**	1.00	1.00	1.00	0.19
	Model 2	1.00	1.00	1.00	0.53
	Model 3	1.00	1.00	1.00	0.48
Niacin (mg)	**Model 1**	0.99	0.98	1.00	0.11
	Model 2	0.99	0.98	1.01	0.40
	Model 3	0.99	0.98	1.01	0.53
Vitamin C (mg)	**Model 1**	1.00	1.00	1.00	0.36
	Model 2	1.00	1.00	1.00	0.96
	Model 3	1.00	1.00	1.00	0.93
Cholesterol (mg)	**Model 1**	1.00	1.00	1.00	0.03
	Model 2	1.00	1.00	1.00	0.71
	Model 3	1.00	1.00	1.00	0.61
Omega-6 PUFA (g)	**Model 1**	1.01	0.98	1.03	0.70
	Model 2	1.04	0.99	1.09	0.12
	Model 3	1.04	0.99	1.09	0.11
Omega-3 PUFA (g)	**Model 1**	0.99	0.62	1.58	0.97
	Model 2	1.69	0.89	3.19	0.11
	Model 3	1.74	0.91	3.32	0.09
Trans fatty acids (g)	**Model 1**	1.85	0.84	4.07	0.13
	Model 2	1.83	0.79	4.26	0.16
	Model 3	1.90	0.80	4.49	0.15

Model 1: Unadjusted
Model 2: Adjusted for age, ethnicity, marital status, education and energy
Model 3: Adjusted for age, ethnicity, marital status, education, energy, quick finishing of meals and physical activity

Table 10: Association of nutrient intakes across ethnicities associated with MetS (defined according to Harmonized criteria)

		Malay (n=147)				Chinese (n=228)				Indian (n=106)			
			95% CI				95% CI				95% CI		
Nutrient		OR	Lower	Upper	P-value	OR	Lower	Upper	P-value	OR	Lower	Upper	P-value
Protein (g)	**Model 1**	1.00	0.99	1.01	0.91	1.00	0.99	1.01	0.31	1.00	0.99	1.01	0.90
	Model 2	1.01	0.99	1.02	0.27	1.01	0.99	1.02	0.61	0.99	0.97	1.02	0.52
	Model 3	1.01	0.99	1.02	0.38	1.00	0.99	1.02	0.65	0.99	0.97	1.02	0.58
Fats (g)	**Model 1**	1.00	1.00	1.01	0.61	1.00	0.99	1.01	0.87	1.00	0.99	1.01	0.71
	Model 2	1.00	0.99	1.01	0.58	1.01	1.00	1.03	0.05	1.00	0.99	1.02	0.90
	Model 3	1.00	0.99	1.01	0.58	1.02	1.00	1.03	0.02	1.00	0.99	1.02	0.70
Carbohydrates (g)	**Model 1**	1.00	1.00	1.00	0.33	1.00	1.00	1.00	0.07	1.00	1.00	1.00	0.67
	Model 2	1.00	0.99	1.00	0.34	0.99	0.99	1.00	0.04	1.00	0.99	1.01	0.82
	Model 3	1.00	0.99	1.00	0.37	0.99	0.99	1.00	0.02	1.00	0.99	1.01	0.92
Fibre (g)	**Model 1**	1.00	0.99	1.02	0.98	0.99	0.97	1.01	0.38	1.00	0.98	1.03	0.77
	Model 2	1.00	0.98	1.02	0.74	1.00	0.97	1.02	0.68	1.00	0.97	1.03	0.92
	Model 3	1.00	0.98	1.02	0.66	0.99	0.97	1.01	0.47	1.01	0.98	1.04	0.61
Calcium (mg)	**Model 1**	1.00	1.00	1.00	0.32	1.00	1.00	1.00	0.54	1.00	1.00	1.00	0.53
	Model 2	1.00	1.00	1.00	0.35	1.00	1.00	1.00	0.83	1.00	1.00	1.00	0.20
	Model 3	1.00	1.00	1.00	0.42	1.00	1.00	1.00	0.83	1.00	1.00	1.00	0.21
Iron (mg)	**Model 1**	0.99	0.96	1.03	0.74	0.97	0.93	1.01	0.14	1.01	0.95	1.07	0.79
	Model 2	1.00	0.95	1.05	1.00	0.97	0.91	1.03	0.31	0.98	0.89	1.09	0.73
	Model 3	1.01	0.95	1.06	0.85	0.97	0.91	1.03	0.36	0.99	0.89	1.10	0.79
Sodium (mg)	**Model 1**	1.00	1.00	1.00	0.26	1.00	1.00	1.00	0.17	1.00	1.00	1.00	0.94
	Model 2	1.00	1.00	1.00	0.13	1.00	1.00	1.00	0.46	1.00	1.00	1.00	0.29
	Model 3	1.00	1.00	1.00	0.14	1.00	1.00	1.00	0.55	1.00	1.00	1.00	0.35
Potassium (mg)	**Model 1**	1.00	1.00	1.00	0.80	1.00	1.00	1.00	0.39	1.00	1.00	1.00	0.91
	Model 2	1.00	1.00	1.00	0.78	1.00	1.00	1.00	0.73	1.00	1.00	1.00	0.46
	Model 3	1.00	1.00	1.00	0.85	1.00	1.00	1.00	0.58	1.00	1.00	1.00	0.78
Retinol (µg)	**Model 1**	1.00	1.00	1.00	0.53	1.00	1.00	1.00	0.66	1.00	1.00	1.00	0.13
	Model 2	1.00	1.00	1.00	0.61	1.00	1.00	1.00	0.82	1.00	1.00	1.00	0.03
	Model 3	1.00	1.00	1.00	0.64	1.00	1.00	1.00	0.89	1.00	1.00	1.00	0.07
Niacin (mg)	**Model 1**	1.00	0.97	1.02	0.72	1.00	0.98	1.02	0.65	1.00	0.97	1.04	0.83
	Model 2	1.00	0.97	1.04	0.84	1.00	0.97	1.02	0.73	1.00	0.95	1.05	0.97
	Model 3	1.01	0.98	1.04	0.55	1.00	0.97	1.03	0.88	1.00	0.95	1.06	0.95
Vitamin C (mg)	**Model 1**	1.00	1.00	1.00	0.18	1.00	1.00	1.00	0.50	1.00	1.00	1.00	0.26
	Model 2	1.00	1.00	1.00	0.16	1.00	1.00	1.00	0.53	1.00	0.99	1.00	0.12
	Model 3	1.00	1.00	1.00	0.14	1.00	1.00	1.00	0.52	1.00	0.99	1.00	0.19
Cholesterol (mg)	**Model 1**	1.00	1.00	1.00	0.37	1.00	1.00	1.00	0.67	1.00	1.00	1.00	0.55
	Model 2	1.00	1.00	1.00	0.41	1.00	1.00	1.00	0.38	1.00	0.99	1.00	0.25
	Model 3	1.00	1.00	1.00	0.36	1.00	1.00	1.00	0.18	1.00	0.99	1.00	0.22
Omega-6 PUFA (g)	**Model 1**	1.02	0.98	1.06	0.42	0.98	0.92	1.04	0.51	0.99	0.93	1.05	0.71
	Model 2	1.03	0.96	1.11	0.39	1.03	0.95	1.12	0.51	1.02	0.91	1.14	0.77
	Model 3	1.03	0.96	1.11	0.44	1.04	0.95	1.13	0.40	1.05	0.92	1.19	0.47
Omega-3 PUFA (g)	**Model 1**	2.47	1.07	5.72	0.03	0.61	0.26	1.46	0.27	1.03	0.43	2.46	0.96
	Model 2	6.05	1.59	23.10	0.01	1.05	0.35	3.13	0.93	0.99	0.29	3.40	0.98
	Model 3	5.88	1.50	23.01	0.01	1.40	0.44	4.43	0.57	1.26	0.33	4.78	0.74
Trans fatty acids (g)	**Model 1**	3.39	0.43	26.57	0.25	0.96	0.31	2.92	0.94	1.37	0.27	7.08	0.71
	Model 2	3.74	0.30	46.48	0.30	1.58	0.48	5.25	0.46	0.90	0.08	10.11	0.93
	Model 3	4.49	0.33	60.42	0.26	1.81	0.58	5.66	0.31	1.81	0.10	31.96	0.68

Model 1: Unadjusted
Model 2: Adjusted for gender, marital status, education, employment status and energy (Malay); age, employment status and energy (Chinese); gender, age and energy (Indian)
Model 3: Adjusted for Model 2 plus alcohol intake and quick finishing meals (Malay); Model 2 plus physical activity (Chinese); Model 2 plus alcohol intake, frequent dining out, and quick finishing meals (Indian)

4.1.4 Effect of diet patterns with MetS

To ascertain the effect of major diet patterns consumed by the adult Malaysians in Johor, we performed a principal component analysis on the food items consumed by study participants which yielded three major diet patterns. Table 11 and Figure 2 show the major diet patterns identified among Malaysian adults in Johor.

Pattern 1 was a vegetable-based diet, comprising of legumes, cruciferous vegetables, roots and fruit vegetables. Pattern 2 consisted of noodle soup, chocolates, soy milk and potatoes, and Pattern 3 comprised of chicken rice, fried noodles and nasi lemak, a traditional dish of Malaysia. The diet patterns were then categorized into quartiles (lowest quartile signifying lowest intake) which were then subjected to logistic regression analysis for exploring the association of intakes of these diet patterns with MetS.

Table 12 shows the regression analysis models for studying the association of the three identified diet patterns with MetS, among Malaysian adults in Johor. Results indicate no association of increased intake of any diet pattern with MetS. Tables 13-15 show the same results of the influence of diet patterns with MetS across the three major ethnicities in the Johor cohort.

Table 11: Factor loadings for 3 major diet patterns identified among Malaysian adults (n=481)

Food Items	Pattern 1	Pattern 2	Pattern 3	Pattern 4	Pattern 5	Pattern 6	Pattern 7	h^2*
Leguminous vegetables	**0.88**							0.80
Cruciferous vegetables	**0.83**							0.72
Roots	**0.75**							0.61
Fruit vegetables	**0.67**							0.54
Noodle soup		**0.82**						0.71
Chocolates		**0.76**						0.63
Soy milk		**0.73**						0.59
Potatoes		**0.69**						0.55
Chicken rice			**0.81**					0.67
Fried noodles			**0.77**					0.61
Nasi Lemak			**0.70**					0.53
Chapati				0.81				0.67
Idli / Putu Mayam				0.77				0.63
Thosai				0.69				0.54
Ice cream					0.76			0.75
Seafood					0.76			0.69
Local fruits					0.65			0.68
Imported fruits						0.71		0.61
Dried fruits						0.70		0.51
Yoghurt / Tairu						0.61		0.57
Nuts							0.85	0.52
Honey							0.77	0.41

*h^2 denotes communality
Factor loadings less than 0.3 have been omitted for simplicity;
Kaiser-Meyer-Olkin (KMO) Measure of Sampling Adequacy = 0.72; Bartlett's Test of Sphericity < 0.001;
Total variance accounted = 61.6%;
3 major diet patterns (Pattern 1, Pattern 2, Pattern 3) selected (based on inflexion point on scree plot) for further analysis

Figure 3: Structure of diet patterns identified among adults residing in Johor, Malaysia (n=481)

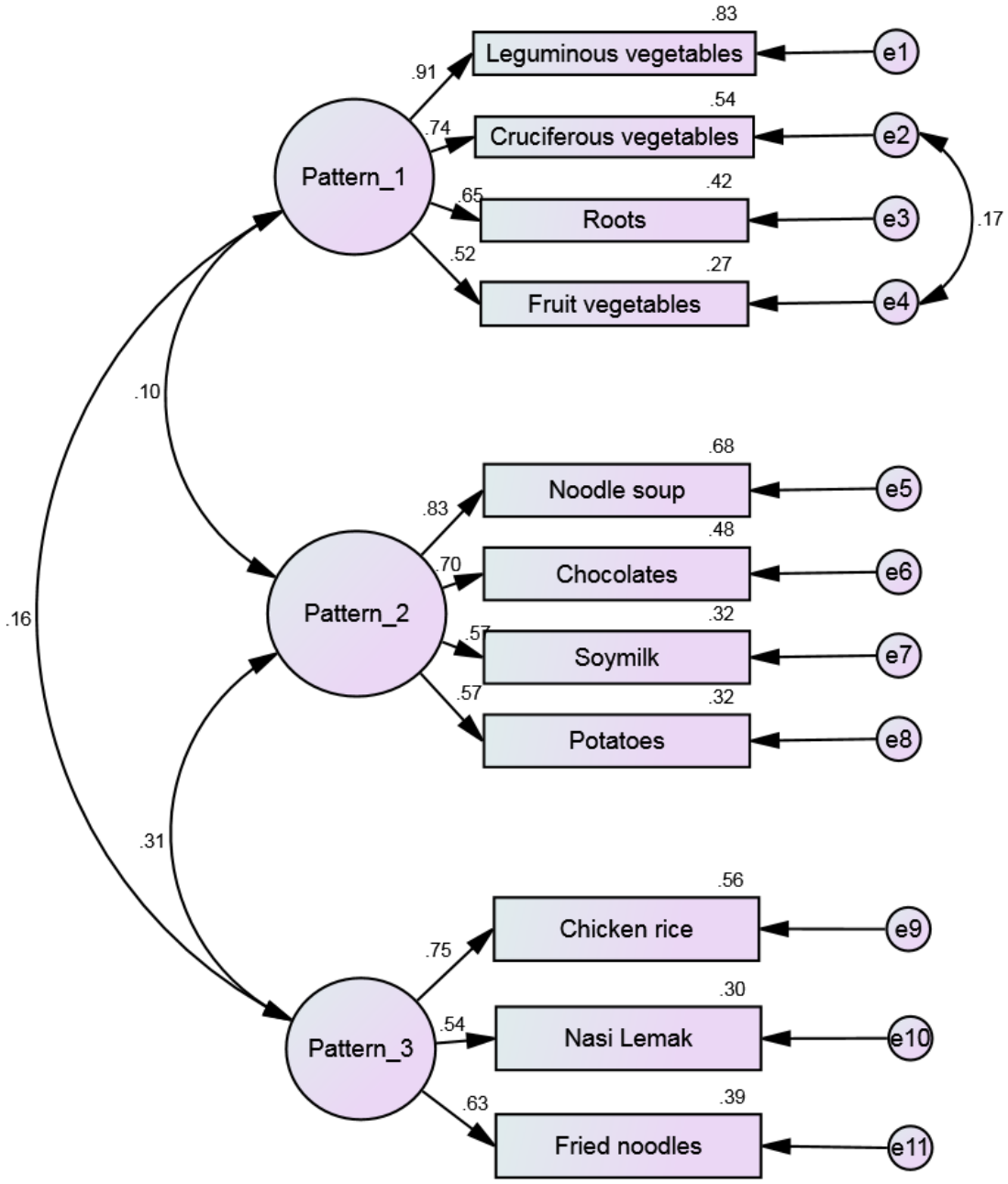


Table 12: Association for MetS across quartile (Q) categories of the identified diet patterns among Malaysians (n=481)

	Characteristic		OR	95% CI		P-value	P-value for trend
				Lower	Upper		
Model 1	**Pattern 1**	**Q1**	1.00				0.78
		Q2	1.05	0.61	1.80	0.86	
		Q3	0.87	0.50	1.50	0.61	
		Q4	1.15	0.67	1.96	0.62	
Model 2	**Pattern 1**	**Q1**	1.00				< 0.001
		Q2	1.14	0.63	2.06	0.66	
		Q3	0.71	0.38	1.33	0.29	
		Q4	1.04	0.55	1.96	0.91	
Model 3	**Pattern 1**	**Q1**	1.00				< 0.001
		Q2	1.24	0.68	2.27	0.48	
		Q3	0.75	0.40	1.40	0.37	
		Q4	1.01	0.53	1.91	0.99	
Model 1	**Pattern 2**	**Q1**	1.00				0.70
		Q2	0.92	0.54	1.56	0.75	
		Q3	0.74	0.43	1.27	0.27	
		Q4	0.81	0.47	1.38	0.44	
Model 2	**Pattern 2**	**Q1**	1.00				< 0.001
		Q2	1.07	0.60	1.92	0.83	
		Q3	0.85	0.47	1.56	0.60	
		Q4	0.83	0.44	1.58	0.57	
Model 3	**Pattern 2**	**Q1**	1.00				< 0.001
		Q2	1.05	0.59	1.89	0.87	
		Q3	0.87	0.48	1.59	0.65	
		Q4	0.81	0.42	1.55	0.52	
Model 1	**Pattern 3**	**Q1**	1.00				0.99
		Q2	0.86	0.95	0.55	1.64	
		Q3	0.79	0.93	0.54	1.61	
		Q4	0.79	0.93	0.53	1.61	
Model 2	**Pattern 3**	**Q1**	1.00				< 0.001
		Q2	1.14	0.63	2.09	0.66	
		Q3	1.18	0.63	2.19	0.60	
		Q4	1.14	0.59	2.22	0.70	
Model 3	**Pattern 3**	**Q1**	1.00				< 0.001
		Q2	1.13	0.62	2.06	0.70	
		Q3	1.13	0.61	2.12	0.69	
		Q4	1.06	0.54	2.08	0.86	

Model 1: Unadjusted
Model 2: Adjusted for age, ethnicity, marital status, education and energy
Model 3: Adjusted for age, ethnicity, marital status, education, energy, quick finishing of meals and physical activity

Table 13: Association for MetS across quartile (Q) categories of the identified diet patterns among Malays (n=147)

			Malay				
	Characteristic		OR	95% CI		P-value	P-value for trend
				Lower	Upper		
Model 1	**Pattern 1**	**Q1**	1.00				0.81
		Q2	1.40	0.60	3.31	0.44	
		Q3	0.87	0.32	2.38	0.78	
		Q4	1.01	0.40	2.55	0.98	
Model 2	**Pattern 1**	**Q1**	1.00				0.04
		Q2	1.84	0.72	4.71	0.21	
		Q3	1.05	0.36	3.12	0.93	
		Q4	0.83	0.28	2.46	0.74	
Model 3	**Pattern 1**	**Q1**	1.00				0.01
		Q2	2.12	0.80	5.62	0.13	
		Q3	0.96	0.30	3.03	0.94	
		Q4	0.80	0.26	2.45	0.70	
Model 1	**Pattern 2**	**Q1**	1.00				0.14
		Q2	1.82	0.76	4.40	0.18	
		Q3	0.59	0.24	1.50	0.27	
		Q4	0.86	0.31	2.41	0.78	
Model 2	**Pattern 2**	**Q1**	1.00				0.03
		Q2	1.64	0.63	4.27	0.31	
		Q3	0.62	0.22	1.75	0.37	
		Q4	0.82	0.24	2.81	0.75	
Model 3	**Pattern 2**	**Q1**	1.00				0.01
		Q2	1.54	0.58	4.05	0.39	
		Q3	0.61	0.21	1.78	0.36	
		Q4	0.84	0.24	2.99	0.79	
Model 1	**Pattern 3**	**Q1**	1.00				0.38
		Q2	1.13	0.35	3.67	0.84	
		Q3	0.95	0.31	2.96	0.93	
		Q4	0.54	0.17	1.70	0.29	
Model 2	**Pattern 3**	**Q1**	1.00				0.04
		Q2	1.52	0.42	5.53	0.53	
		Q3	1.25	0.36	4.40	0.73	
		Q4	0.63	0.16	2.45	0.51	
Model 3	**Pattern 3**	**Q1**	1.00				0.01
		Q2	1.21	0.32	4.57	0.78	
		Q3	1.01	0.28	3.69	0.99	
		Q4	0.49	0.12	2.00	0.32	

Model 1: Unadjusted
Model 2: Adjusted for gender, marital status, education, employment status and energy
Model 3: Adjusted for gender, marital status, education, employment status, energy, alcohol consumption and quick finishing of meals

Table 14: Association for MetS across quartile (Q) categories of the identified diet patterns among Chinese (n=228)

			Chinese				
	Characteristic		OR	95% CI		P-value	P-value for trend
				Lower	Upper		
Model 1	**Pattern 1**	**Q1**	1.00				0.19
		Q2	0.70	0.29	1.72	0.44	
		Q3	0.41	0.15	1.12	0.08	
		Q4	1.10	0.47	2.60	0.82	
Model 2	**Pattern 1**	**Q1**	1.00				0.02
		Q2	0.76	0.30	1.90	0.55	
		Q3	0.42	0.15	1.19	0.10	
		Q4	1.45	0.56	3.74	0.45	
Model 3	**Pattern 1**	**Q1**	1.00				0.00
		Q2	0.77	0.30	1.98	0.58	
		Q3	0.39	0.13	1.15	0.09	
		Q4	1.25	0.47	3.29	0.66	
Model 1	**Pattern 2**	**Q1**	1.00				0.32
		Q2	0.69	0.29	1.66	0.41	
		Q3	0.60	0.25	1.44	0.25	
		Q4	0.42	0.16	1.08	0.07	
Model 2	**Pattern 2**	**Q1**	1.00				0.08
		Q2	0.88	0.35	2.21	0.79	
		Q3	0.79	0.31	2.06	0.64	
		Q4	0.53	0.19	1.48	0.22	
Model 3	**Pattern 2**	**Q1**	1.00				0.01
		Q2	0.77	0.30	2.00	0.60	
		Q3	0.71	0.27	1.87	0.49	
		Q4	0.54	0.19	1.55	0.25	
Model 1	**Pattern 3**	**Q1**	1.00				0.72
		Q2	0.78	0.34	1.82	0.57	
		Q3	0.59	0.23	1.47	0.26	
		Q4	0.81	0.32	2.05	0.65	
Model 2	**Pattern 3**	**Q1**	1.00				0.10
		Q2	0.93	0.38	2.25	0.87	
		Q3	0.69	0.27	1.80	0.45	
		Q4	1.17	0.43	3.20	0.76	
Model 3	**Pattern 3**	**Q1**	1.00				0.01
		Q2	0.82	0.33	2.04	0.67	
		Q3	0.62	0.23	1.67	0.35	
		Q4	1.14	0.40	3.20	0.81	

Model 1: Unadjusted
Model 2: Adjusted for age, employment status and energy
Model 3: Adjusted for age, employment status, energy and physical activity

Table 15: Association for MetS across quartile (Q) categories of the identified diet patterns among Indians (n=106)

			Indian				
	Characteristic		OR	95% CI		P-value	P-value for trend
				Lower	Upper		
Model 1	**Pattern 1**	**Q1**	1.00				0.92
		Q2	1.00	0.23	4.28	1.00	
		Q3	0.98	0.25	3.79	0.98	
		Q4	0.75	0.19	2.89	0.67	
Model 2	**Pattern 1**	**Q1**	1.00				0.00
		Q2	1.59	0.27	9.27	0.61	
		Q3	1.29	0.25	6.60	0.76	
		Q4	0.94	0.16	5.45	0.94	
Model 3	**Pattern 1**	**Q1**	1.00				< 0.001
		Q2	1.16	0.18	7.37	0.88	
		Q3	1.21	0.23	6.22	0.82	
		Q4	1.09	0.19	6.36	0.92	
Model 1	**Pattern 2**	**Q1**	1.00				0.33
		Q2	0.47	0.14	1.59	0.22	
		Q3	1.24	0.36	4.35	0.73	
		Q4	0.99	0.32	3.05	0.98	
Model 2	**Pattern 2**	**Q1**	1.00				< 0.001
		Q2	0.64	0.16	2.63	0.54	
		Q3	1.21	0.28	5.24	0.80	
		Q4	0.89	0.22	3.67	0.87	
Model 3	**Pattern 2**	**Q1**	1.00				< 0.001
		Q2	0.84	0.18	3.81	0.82	
		Q3	1.69	0.36	7.95	0.51	
		Q4	0.82	0.17	3.87	0.80	
Model 1	**Pattern 3**	**Q1**	1.00				0.67
		Q2	0.98	0.36	2.72	0.97	
		Q3	1.51	0.50	4.58	0.47	
		Q4	1.70	0.59	4.90	0.33	
Model 2	**Pattern 3**	**Q1**	1.00				< 0.001
		Q2	0.96	0.29	3.23	0.95	
		Q3	2.72	0.65	11.33	0.17	
		Q4	1.89	0.47	7.65	0.37	
Model 3	**Pattern 3**	**Q1**	1.00				< 0.001
		Q2	0.90	0.26	3.17	0.87	
		Q3	3.78	0.81	17.62	0.09	
		Q4	1.75	0.41	7.42	0.45	

Model 1: Unadjusted
Model 2: Adjusted for gender, age and energy
Model 3: Adjusted for gender, age, energy, alcohol consumption, frequent dining out, and quick finishing of meals

4.1.5 Effect of food groups with MetS

One limitation of the diet patterns is that the focus is more on commonly consumed food items by the population. Malaysia being a country with diversity of cultures and races, the diet patterns may not fully represent the eating habits and food intakes by all ethnicities. In this regard, food items with their servings were cumulated to develop food categories/ groups, which were then analysed across the MetS spectrum.

Table 16 shows the median intake of food groups, in comparison with the recommended servings according to the Malaysian Food Pyramid. The intake of meat, poultry and eggs was found to be adequate by the participants of this cohort, in comparison to that provided range by the Malaysian Food Pyramid. Fats, oils and sugars are recommended to be taken in fewer quantities (< 1 serving per day), however, in the present cohort, the intake of this group was remarkably higher than the recommended intake. All other food groups/ categories were found to be eaten less among the study subjects.

A comparison of the median intake of food group categories among Malaysian subjects with and without MetS in this cohort shows no significant relationship of any food group with MetS (Supplementary Table 3). Table 17 shows the logistic regression models for the association of these food groups with MetS, revealing no significant association. While exploring the association across the three ethnicities, no association was found among the Malays and the Chinese, however, among the Indians, the intake of milk and milk products was inversely associated with MetS (AOR = 0.32 [95%CI = 0.14-0.69]), when adjusted for socio-demographic and lifestyle factors (Table 18). In other words, the intake of milk and milk products has been found to be protective against MetS among Malaysian Indians.

Table 16: Median (IQR) intakes across food groups among Malaysians

	Recommended serving/day*	Median (IQR) serving/day	Median (IQR) serving/day	Median (IQR) serving/day	Median (IQR) serving/day
		All (n=481)	Malay (n=147)	Chinese (n=228)	Indian (n=106)
Cereals and cereal products	4-8	3.37 (1.86)	3.56 (2.09)	3.11 (1.85)	3.66 (1.68)
Vegetables	3	2.57 (2.21)	2.45 (2.16)	2.52 (1.82)	2.86 (2.28)
Fruits	2	1.03 (1.57)	0.91 (1.47)	1.29 (1.45)	0.80 (0.95)
Poultry, meat, egg	0.5-2	1.15 (1.16)	1.00 (1.60)	1.34 (0.88)	0.57 (0.75)
Fish	1	0.60 (0.72)	1.00 (1.05)	0.57 (0.71)	0.57 (0.58)
Legumes	0.5-1	0.29 (0.36)	0.14 (0.26)	0.29 (0.36)	0.29 (0.43)
Milk and milk products	1-3	0.57 (1.06)	0.72 (1.12)	0.30 (0.97)	1.00 (1.10)
Fats, oils, sugars	Eat less (< 1)	2.00 (1.43)	2.00 (1.46)	1.16 (1.14)	2.14 (1.83)

*Based on the Malaysian Food Pyramid

Table 17: Association of food groups with MetS (defined according to Harmonized criteria) among Malaysians (n=481)

			95%CI		
		OR	Lower	Upper	P-value
Cereals and cereal products	**Model 1**	1.01	0.93	1.10	0.77
	Model 2	0.99	0.88	1.11	0.81
	Model 3	0.98	0.87	1.10	0.69
Vegetables	**Model 1**	1.02	0.93	1.12	0.65
	Model 2	1.01	0.91	1.12	0.93
	Model 3	1.00	0.90	1.11	0.98
Fruits	**Model 1**	0.89	0.76	1.05	0.17
	Model 2	0.89	0.74	1.06	0.20
	Model 3	0.88	0.73	1.06	0.19
Poultry, meat, egg	**Model 1**	0.84	0.69	1.04	0.11
	Model 2	1.20	0.93	1.53	0.16
	Model 3	1.17	0.91	1.50	0.24
Fish	**Model 1**	1.22	0.94	1.58	0.14
	Model 2	1.20	0.88	1.63	0.25
	Model 3	1.19	0.87	1.62	0.27
Legumes	**Model 1**	0.99	0.71	1.39	0.97
	Model 2	0.89	0.61	1.29	0.54
	Model 3	0.82	0.56	1.21	0.32
Milk and milk products	**Model 1**	0.98	0.80	1.20	0.82
	Model 2	0.80	0.62	1.03	0.08
	Model 3	0.77	0.60	1.00	0.05
Fats, oils, sugars	**Model 1**	1.04	0.90	1.19	0.61
	Model 2	0.97	0.82	1.15	0.73
	Model 3	0.98	0.82	1.16	0.78

Model 1: Unadjusted
Model 2: Adjusted for age, ethnicity, marital status, education and energy
Model 3: Adjusted for age, ethnicity, marital status, education, energy, quick finishing of meals and physical activity

Table 18: Association of food groups with MetS (defined according to Harmonized criteria) across ethnicities

		Malay (n=147)				Chinese (n=228)				Indian (n=106)			
			95%CI				95%CI				95%CI		
		OR	Lower	Upper	P-value	OR	Lower	Upper	P-value	OR	Lower	Upper	P-value
Cereals and cereal products	**Model 1**	0.96	0.84	1.08	0.47	0.95	0.79	1.14	0.60	1.23	0.93	1.61	0.14
	Model 2	0.97	0.82	1.14	0.69	0.98	0.76	1.25	0.84	1.13	0.74	1.72	0.56
	Model 3	0.98	0.83	1.15	0.79	0.97	0.76	1.24	0.82	1.12	0.69	1.82	0.66
Vegetables	**Model 1**	1.07	0.93	1.24	0.36	1.00	0.83	1.20	1.00	0.91	0.76	1.08	0.26
	Model 2	1.07	0.90	1.26	0.46	1.03	0.84	1.27	0.75	0.86	0.70	1.05	0.14
	Model 3	1.06	0.90	1.26	0.48	1.03	0.84	1.27	0.79	0.90	0.73	1.10	0.31
Fruits	**Model 1**	1.11	0.88	1.40	0.37	0.84	0.63	1.14	0.27	0.71	0.45	1.13	0.15
	Model 2	1.03	0.79	1.34	0.82	0.77	0.54	1.08	0.13	0.61	0.34	1.11	0.11
	Model 3	1.02	0.77	1.34	0.90	0.77	0.54	1.08	0.13	0.59	0.30	1.14	0.11
Poultry, meat, egg	**Model 1**	1.12	0.81	1.55	0.50	0.91	0.64	1.29	0.59	1.00	0.59	1.72	0.99
	Model 2	1.13	0.77	1.64	0.54	1.17	0.77	1.79	0.47	1.04	0.49	2.21	0.93
	Model 3	1.10	0.75	1.62	0.63	1.20	0.78	1.84	0.41	1.06	0.45	2.50	0.90
Fish	**Model 1**	1.42	0.97	2.07	0.07	1.02	0.59	1.78	0.94	0.75	0.35	1.63	0.47
	Model 2	1.49	0.99	2.25	0.06	1.21	0.65	2.25	0.55	0.57	0.21	1.51	0.26
	Model 3	1.48	0.98	2.25	0.07	1.15	0.60	2.22	0.67	0.51	0.18	1.43	0.20
Legumes	**Model 1**	0.94	0.55	1.60	0.82	0.91	0.43	1.93	0.80	0.79	0.45	1.38	0.41
	Model 2	0.81	0.44	1.51	0.51	1.21	0.55	2.68	0.64	0.68	0.37	1.27	0.22
	Model 3	0.80	0.42	1.51	0.48	0.94	0.40	2.21	0.89	0.81	0.43	1.55	0.53
Milk and milk products	**Model 1**	0.89	0.66	1.18	0.41	1.04	0.66	1.65	0.87	0.63	0.39	1.02	0.06
	Model 2	0.85	0.60	1.20	0.36	1.02	0.62	1.67	0.94	0.37	0.19	0.74	0.01
	Model 3	0.84	0.59	1.20	0.34	1.07	0.64	1.78	0.80	0.32	0.14	0.69	0.00
Fats, oils, sugars	**Model 1**	0.95	0.72	1.24	0.69	1.06	0.85	1.33	0.60	0.81	0.61	1.10	0.17
	Model 2	0.99	0.72	1.35	0.93	1.13	0.88	1.46	0.34	0.97	0.65	1.46	0.90
	Model 3	1.02	0.74	1.40	0.93	1.19	0.92	1.55	0.18	1.10	0.71	1.70	0.66

Model 1: Unadjusted
Model 2: Adjusted for gender, marital status, education, employment status and energy (Malay); age, employment status and energy (Chinese); gender, age and energy (Indian)
Model 3: Adjusted for Model 2 plus alcohol intake and quick finishing meals (Malay); Model 2 plus physical activity (Chinese); Model 2 plus alcohol intake, frequent dining out, and quick finishing meals (Indian)

4.1.6 Summary

Key findings of this study and their fit with the hypotheses have been given below:

1. Using the Harmonized criteria, the prevalence of MetS in Johor was found to be 32.2%. Keeping in view the prevalence of 42.5% in the nationwide survey-2008, we had expected it to be higher or close to this figure.

2. The prevalence values of MetS for the Indians and Chinese ethnic groups were 51.9% and 20.2%, respectively. These values, again, were not exactly according to our hypothesis, and we did not expect such a decline as in the prevalence of MetS among the Chinese in Johor compared to prevalence of MetS among this group in the nationwide survey.

3. Tertiary education of subjects among the Johor population was found to be protective against MetS. This was an unexpected finding because the general belief was that highly educated people (hence belonging to the better socio-economic class) had greater access to unhealthy and energy-rich food such as that available in restaurants and fast food cafes. However, higher education turned out to be a factor having a positive influence on health of people in Johor.

4. No association was found between the lack of physical activity and the risk of MetS in the Johor population as a whole. However, this association was observed only among the Chinese. This was an unexpected result because the lack of physical activity was expected to be a risk factor for MetS in all ethnic groups in Johor.

5. Frequent dining out was a risk factor for MetS in the overall Johor population, while quick finishing of meals among the Malays and frequent dining out among the Indians were

identified as new risk factors for this syndrome in this population. This was in line with our hypothesis.

6. The most striking observation was the variability of nutrient intakes among the three ethnic communities in Johor. Though we did not analyse the differences among them, it did provide very useful information about which nutrients were consumed more by an ethnic group and which nutrients were not preferentially taken by the other groups. Therefore, the expected overall influence of nutrient intakes on the risk of MetS appeared to have been neutralized perhaps due to this variability in nutrient intakes by the three ethnic groups. At the univariate level, a relationship was found between the median intakes of sodium, potassium, retinol, cholesterol and trans fatty acids. However, significant association was found only among the Malays between intake of omega-3-PUFA and MetS.

7. Three major dietary patterns were identified in the Johor cohort. However, no association was found between any diet pattern and the risk of MetS. The results were contrary to our expectations as a number of studies in the region had indicated association of dietary patterns with MetS. This could be, again, due to diversity in the dietary habits of the three ethnic communities in Johor that the identified diet patterns did not fully represent the eating habits and food intake of these communities.

8. The third important component of nutrition was the median intake of food groups by the population in Johor. A comparison of food group intake with the recommended servings according to the Malaysian Food Pyramid indicated that the intake of fats, oils and sugars was remarkably higher among the three ethnic groups. However, no association of any food group with the risk of MetS was observed, except among the Indians where intake of milk and milk products was found to be inversely associated with MetS.

In summing-up, except for the dietary habit of frequent dining out for more than three times per week, no other dietary factor was found to be associated with MetS in this Johor cohort. However, a number of dietary factors were associated with MetS among various ethnic groups. This also alluded to the fact that the Malaysian population is a diverse population comprising of three major ethnic communities with different lifestyles and eating habits, and some of these lifestyles and dietary factors are associated with MetS. Therefore, it was important to analyse the effect of these lifestyle and dietary factors on the five metabolic abnormalities (constituting the “cluster” of MetS) across the three major ethnic groups in Johor.

Chapter 4.2: Results

MetS is a cluster of at least 3 out of 5 metabolic abnormalities, namely abdominal obesity, high blood pressure, hypertriglyceridemia, low HDL-cholesterol and fasting hyperglycemia. It has been mentioned in the previous chapter that perhaps due to different dietary habits of the three major ethnic groups in Johor, we did not find a good number of associations of dietary factors with MetS in this population. However, the possibility that these dietary factors could be having a significant effect on one or more of these metabolic abnormalities cannot be discounted. Therefore, we ventured into investigating the effect of lifestyle and dietary factors on the risk of metabolic abnormalities in the Johor population.

The specific objectives addressed in this section are:

1. to determine the prevalence values of five metabolic abnormalities in the Johor population
2. to find out if there is any association of lifestyle factors such as physical activity, smoking and alcohol consumption with the risk of developing a particular metabolic abnormality in the Johor cohort
3. to ascertain any association of dietary habits and nutritional intakes with the risk of a metabolic abnormality in the study population.

With these objectives in mind, we analysed the data from this cohort comprising of 147 Malays, 228 Chinese and 106 Indians. The results given below indicate the prevalence of these metabolic conditions and the influence of life style and dietary factors on the risk of their development in the Johor population.

4.2.1 Prevalence of MetS components

Table 19 summarizes the unadjusted prevalence estimates (with 95% CI) of metabolic abnormalities in the Johor cohort based on Harmonized criteria in Malaysian adults by gender, age and ethnicity. Prevalence of abdominal obesity was higher among the females (65.7%) compared to the males (55.0%). In general, the prevalence of obesity increased with age and was highest among the Indians (82.1%) compared to the Malays (70.7%) and the Chinese (46.9%). High blood pressure, on the other hand, was most prevalent among the males compared to the females (63.9% vs. 52.9%), especially among aged subjects, and the Malays (61.9%) compared to the Indians (58.5%) and the Chinese (52.6%). The prevalence value of low HDL-cholesterol was highest among Indians (64.2%) and lowest among the Chinese (9.6%). Fasting hyperglycemia was found to be most prevalent among the males compared to the females (22.5% vs. 16.7%) and was more prominent among the Malays (27.2%) compared to the Indians and the Chinese.

Table 19: Unadjusted prevalence (in %) (with 95% CI) for MetS components based on the Harmonized criteria among Malaysian adults: overall, by gender, age and ethnicity

		n	Abdominal obesity	High BP	Low HDL-C	High TG	High FBG
Overall		**481**	62.0 (57.7, 66.3)	56.8 (52.3, 61.2)	29.5 (25.4, 33.6)	24.7 (20.8, 28.6)	18.7 (15.2, 22.2)
Gender	**Male**	**169**	55.0 (47.5, 62.5)	63.9 (56.6, 71.1)	21.3 (15.1, 27.5)	30.6 (23.6, 37.5)	22.5 (16.2, 28.8)
	Female	**312**	65.7 (60.3, 70.8)	52.9 (47.3, 58.4)	34.0 (28.9, 39.4)	21.5 (17.3, 26.4)	16.7 (12.9, 21.2)
Age (years)	**< 40**	**112**	51.8 (42.6, 60.8)	37.5 (29.1, 46.7)	46.4 (37.5, 55.6)	17.0 (11.1, 25.0)	6.2 (3.1, 12.3)
	40-49	**129**	65.1 (56.6, 72.8)	55.8 (47.2, 64.1)	34.9 (27.2, 43.4)	25.6 (18.8, 33.7)	18.6 (12.8, 26.2)
	50-59	**117**	62.4 (53.6, 71.2)	62.4 (53.6, 71.2)	16.2 (9.5, 22.9)	28.2 (20.0, 36.4)	18.8 (11.7, 25.9)
	≥ 60	**123**	67.5 (58.8, 75.1)	69.9 (61.3, 77.3)	21.1 (14.8, 29.2)	27.6 (20.5, 36.1)	30.1 (22.7, 38.7)
Ethnicity	**Malay**	**147**	70.7 (63.3, 78.1)	61.9 (54.0, 69.8)	35.4 (27.7, 43.1)	23.1 (16.3, 29.9)	27.2 (20.0, 34.4)
	Chinese	**228**	46.9 (40.6, 53.4)	52.6 (46.2, 59.0)	9.6 (6.5, 14.2)	24.1 (19.0, 30.1)	14.0 (10.1, 19.1)
	Indian	**106**	82.1 (73.7, 88.2)	58.5 (49.0, 67.4)	64.2 (54.7, 72.6)	28.3 (20.6, 37.5)	17.0 (11.0, 25.2)

4.2.2 Effect of lifestyle characteristics with MetS components

As mentioned in Chapter 4.1, some of the lifestyle and nutritional factors were associated with MetS in the Johor cohort. However, the relationship of these factors with the five major metabolic components of MetS needed to be investigated. The main habits considered were physical activity, smoking status, alcohol consumption, frequency of dining out, late dining, skipping breakfast, and quick finishing of meals.

4.2.2.1 Effect of lifestyle characteristics with MetS component – Abdominal obesity

A comparison of lifestyle characteristics among study subjects with/without abdominal obesity in Johor showed frequent dining out (more than three times per week) to be associated with abdominal obesity (Supplementary Table 4). Tables 20-21 show the logistic regression models for studying the association of lifestyle habits with abdominal obesity, overall and across the three ethnicities in this cohort. No significant association of lifestyle characteristics with abdominal obesity was found after adjusting for socio-demographic characteristics.

Table 20: Association of lifestyle characteristics associated with abdominal obesity from Johor (n=481)

	Characteristic		OR	95% CI		P-value
				Lower	Upper	
Model 1	**Physical activity**	**High**	1.00			
		Moderate	0.73	0.44	1.22	0.23
		Low	1.08	0.65	1.81	0.77
Model 2	**Physical activity**	**High**	1.00			
		Moderate	0.72	0.41	1.26	0.25
		Low	1.08	0.61	1.90	0.80
Model 1	**Smoking status**	**Never smoked**	1.00			
		Past/Current smoker	0.71	0.42	1.22	0.22
Model 2	**Smoking status**	**Never smoked**	1.00			
		Past/Current smoker	0.70	0.36	1.35	0.29
Model 1	**Alcohol consumption**	**Never consumed/past consumer**	1.00			
		Current consumer	1.20	0.61	2.36	0.59
Model 2	**Alcohol consumption**	**Never consumed/past consumer**	1.00			
		Current consumer	2.01	0.94	4.31	0.07
Model 1	**Frequent dining out**	**≤ 3 times/week**	1.00			
		> 3 times/week	0.54	0.37	0.80	0.00
Model 2	**Frequent dining out**	**≤ 3 times/week**	1.00			
		> 3 times/week	1.24	0.76	2.04	0.39
Model 1	**Late dining**	**≤ 3 times/week**	1.00			
		> 3 times/week	1.11	0.61	2.01	0.73
Model 2	**Late dining**	**≤ 3 times/week**	1.00			
		> 3 times/week	1.19	0.61	2.30	0.61
Model 1	**Skipping breakfast**	**≤ 3 times/week**	1.00			
		> 3 times/week	1.08	0.70	1.66	0.74
Model 2	**Skipping breakfast**	**≤ 3 times/week**	1.00			
		> 3 times/week	1.07	0.66	1.73	0.80
Model 1	**Finishing meals**	**Not fast**	1.00			
		Fast	1.19	0.82	1.72	0.36
Model 2	**Finishing meals**	**Not fast**	1.00			
		Fast	1.03	0.68	1.55	0.90

Model 1: Unadjusted
Model 2: Adjusted for gender, age, ethnicity, marital status, education, employment status

Table 21: Association of lifestyle characteristics associated with abdominal obesity across ethnicities from Johor

Characteristic			Malay (n=147)				Chinese (n=228)				Indian (n=106)			
			OR	95% CI		P-value	OR	95% CI		P-value	OR	95% CI		P-value
				Lower	Upper			Lower	Upper			Lower	Upper	
Model 1	**Physical activity**	**High**	1.00				1.00				1.00			
		Moderate	0.66	0.25	1.78	0.41	0.79	0.39	1.59	0.50	0.88	0.23	3.37	0.86
		Low	1.19	0.44	3.20	0.73	0.85	0.41	1.75	0.65	1.35	0.35	5.20	0.67
Model 2	**Physical activity**	**High**	1.00				1.00				1.00			
		Moderate	0.47	0.16	1.38	0.17	0.78	0.37	1.65	0.52	0.69	0.15	3.29	0.64
		Low	0.79	0.27	2.30	0.66	1.04	0.47	2.28	0.93	1.34	0.29	6.11	0.71
Model 1	**Smoking status**	**Never smoked**	1.00				1.00				1.00			
		Past/Current smoker	0.38	0.15	0.94	0.04	1.04	0.44	2.47	0.93	0.41	0.12	1.35	0.14
Model 2	**Smoking status**	**Never smoked**	1.00				1.00				1.00			
		Past/Current smoker	0.74	0.22	2.48	0.63	1.07	0.43	2.65	0.89	0.53	0.13	2.17	0.37
Model 1	**Alcohol consumption**	**Never consumed/past consumer**	1.00				1.00				1.00			
		Current consumer	-	-	-	-	1.34	0.62	2.90	0.45	-	-	-	-
Model 2	**Alcohol consumption**	**Never consumed/past consumer**	1.00				1.00				1.00			
		Current consumer	-	-	-	-	1.43	0.63	3.27	0.39	-	-	-	-
Model 1	**Frequent dining out**	**≤ 3 times/week**	1.00				1.00				1.00			
		> 3 times/week	0.81	0.26	2.52	0.71	0.91	0.54	1.53	0.72	0.63	0.20	2.01	0.44
Model 2	**Frequent dining out**	**≤ 3 times/week**	1.00				1.00				1.00			
		> 3 times/week	1.11	0.32	3.80	0.87	1.32	0.74	2.36	0.36	1.12	0.28	4.44	0.88
Model 1	**Late dining**	**≤ 3 times/week**	1.00				1.00				1.00			
		> 3 times/week	1.09	0.36	3.26	0.88	1.14	0.46	2.87	0.77	0.54	0.15	1.94	0.35
Model 2	**Late dining**	**≤ 3 times/week**	1.00				1.00				1.00			
		> 3 times/week	1.17	0.37	3.72	0.79	1.45	0.52	4.03	0.47	0.52	0.12	2.23	0.38
Model 1	**Skipping breakfast**	**≤ 3 times/week**	1.00				1.00				1.00			
		> 3 times/week	0.96	0.40	2.30	0.92	1.01	0.55	1.87	0.97	1.03	0.35	2.99	0.96
Model 2	**Skipping breakfast**	**≤ 3 times/week**	1.00				1.00				1.00			
		> 3 times/week	0.99	0.38	2.56	0.98	1.27	0.65	2.48	0.49	1.34	0.36	4.98	0.66
Model 1	**Finishing meals**	**Not fast**	1.00				1.00				1.00			
		Fast	0.99	0.48	2.01	0.97	1.22	0.72	2.05	0.46	0.26	0.06	1.21	0.09
Model 2	**Finishing meals**	**Not fast**	1.00				1.00				1.00			
		Fast	1.14	0.54	2.45	0.73	1.41	0.80	2.47	0.24	0.25	0.05	1.34	0.11

Model 1: Unadjusted
Model 2: Adjusted for gender, marital status, education and employment status (Malay); age, marital status and education (Chinese); age, education and employment status (Indian)

4.2.2.2 Effect of lifestyle characteristics with MetS component – High blood pressure

A comparison of lifestyle factors in subjects with and without high blood pressure in Johor showed that physical activity was significantly associated with high blood pressure (p = 0.031) (Supplementary Table 5). Tables 22-23 show the regression analyses for the association of lifestyle factors with high blood pressure; overall and across the three ethnicities for this cohort. The analysis of the data reveals that low level of physical activity was found to have higher odds of having high blood pressure among all the subjects (AOR = 1.822 [95%CI = 1.063 – 3.122]) after adjusting for socio-demographic characteristics (Table 22). Results pertaining to the three ethnicities showed that among the Chinese, low physical activity (AOR = 3.056 [95% CI = 1.321-7.069]) and past / current smoking status (AOR = 2.946 [95% CI = 1.015-8.556]) were positively associated with high blood pressure, when adjusted for gender, age, marital status and education (Table 23).

Table 22: Association of lifestyle characteristics associated with high blood pressure from Johor (n=481)

	Characteristic		OR	95% CI		P-value
				Lower	Upper	
Model 1	**Physical activity**	**High**	1.00			
		Moderate	0.90	0.55	1.47	0.67
		Low	1.53	0.93	2.52	0.10
Model 2	**Physical activity**	**High**	1.00			
		Moderate	1.01	0.59	1.71	0.98
		Low	1.82	1.06	3.12	0.03
Model 1	**Smoking status**	**Never smoked**	1.00			
		Past/Current smoker	1.34	0.77	2.32	0.30
Model 2	**Smoking status**	**Never smoked**	1.00			
		Past/Current smoker	1.03	0.54	1.97	0.94
Model 1	**Alcohol consumption**	**Never consumed/past consumer**	1.00			
		Current consumer	1.21	0.63	2.33	0.57
Model 2	**Alcohol consumption**	**Never consumed/past consumer**	1.00			
		Current consumer	1.27	0.63	2.58	0.50
Model 1	**Frequent dining out**	**≤ 3 times/week**	1.00			
		> 3 times/week	0.98	0.67	1.45	0.94
Model 2	**Frequent dining out**	**≤ 3 times/week**	1.00			
		> 3 times/week	1.53	0.95	2.47	0.08
Model 1	**Late dining**	**≤ 3 times/week**	1.00			
		> 3 times/week	1.08	0.61	1.93	0.79
Model 2	**Late dining**	**≤ 3 times/week**	1.00			
		> 3 times/week	1.09	0.58	2.03	0.80
Model 1	**Skipping breakfast**	**≤ 3 times/week**	1.00			
		> 3 times/week	0.90	0.59	1.36	0.61
Model 2	**Skipping breakfast**	**≤ 3 times/week**	1.00			
		> 3 times/week	0.96	0.61	1.51	0.86
Model 1	**Finishing meals**	**Not fast**	1.00			
		Fast	1.00	0.70	1.43	1.00
Model 2	**Finishing meals**	**Not fast**	1.00			
		Fast	0.99	0.67	1.48	0.97

Model 1: Unadjusted
Model 2: Adjusted for gender, age, ethnicity, marital status, education

Table 23: Association of lifestyle characteristics associated with high blood pressure across ethnicities from Johor

	Characteristic		Malay (n=147)				Chinese (n=228)				Indian (n=106)			
			OR	95% CI		P-value	OR	95% CI		P-value	OR	95% CI		P-value
				Lower	Upper			Lower	Upper			Lower	Upper	
Model 1	**Physical activity**	**High**	1.00				1.00				1.00			
		Moderate	0.77	0.30	1.95	0.58	0.86	0.43	1.73	0.67	1.39	0.48	4.09	0.55
		Low	1.22	0.49	3.03	0.67	1.88	0.89	3.93	0.10	1.34	0.48	3.77	0.58
Model 2	**Physical activity**	**High**	1.00				1.00				1.00			
		Moderate	0.88	0.33	2.36	0.80	1.07	0.49	2.32	0.87	1.46	0.43	4.98	0.54
		Low	1.35	0.51	3.57	0.55	3.06	1.32	7.07	0.01	1.22	0.38	3.91	0.74
Model 1	**Smoking status**	**Never smoked**	1.00				1.00				1.00			
		Past/Current smoker	0.77	0.31	1.89	0.56	2.81	1.06	7.40	0.04	0.90	0.31	2.63	0.84
Model 2	**Smoking status**	**Never smoked**	1.00				1.00				1.00			
		Past/Current smoker	0.74	0.28	1.93	0.53	2.95	1.02	8.56	0.05	0.67	0.15	2.93	0.59
Model 1	**Alcohol consumption**	**Never consumed/past consumer**	1.00				1.00				1.00			
		Current consumer	-	-	-	-	1.21	0.56	2.62	0.64	1.74	0.42	7.14	0.44
Model 2	**Alcohol consumption**	**Never consumed/past consumer**	1.00				1.00				1.00			
		Current consumer	-	-	-	-	1.24	0.54	2.83	0.61	0.97	0.19	4.96	0.97
Model 1	**Frequent dining out**	**≤ 3 times/week**	1.00				1.00				1.00			
		> 3 times/week	1.26	0.41	3.90	0.69	1.07	0.63	1.79	0.81	1.54	0.57	4.21	0.40
Model 2	**Frequent dining out**	**≤ 3 times/week**	1.00				1.00				1.00			
		> 3 times/week	1.52	0.46	5.00	0.49	1.56	0.86	2.85	0.15	2.72	0.71	10.44	0.15
Model 1	**Late dining**	**≤ 3 times/week**	1.00				1.00				1.00			
		> 3 times/week	0.57	0.21	1.54	0.27	1.75	0.67	4.57	0.25	1.08	0.35	3.28	0.90
Model 2	**Late dining**	**≤ 3 times/week**	1.00				1.00				1.00			
		> 3 times/week	0.72	0.25	2.06	0.53	1.57	0.53	4.60	0.41	0.93	0.25	3.51	0.92
Model 1	**Skipping breakfast**	**≤ 3 times/week**	1.00				1.00				1.00			
		> 3 times/week	1.57	0.66	3.72	0.31	0.75	0.41	1.39	0.36	0.72	0.31	1.63	0.43
Model 2	**Skipping breakfast**	**≤ 3 times/week**	1.00				1.00				1.00			
		> 3 times/week	1.60	0.64	3.99	0.32	0.72	0.37	1.42	0.35	0.82	0.31	2.19	0.69
Model 1	**Finishing meals**	**Not fast**	1.00				1.00				1.00			
		Fast	0.99	0.51	1.93	0.97	1.05	0.62	1.77	0.86	0.82	0.34	1.96	0.65
Model 2	**Finishing meals**	**Not fast**	1.00				1.00				1.00			
		Fast	1.02	0.50	2.06	0.96	1.04	0.59	1.83	0.90	0.91	0.34	2.47	0.86

Model 1: Unadjusted
Model 2: Adjusted for age, marital status and education (Malay); gender, age, marital status and education (Chinese); gender, age and marital status (Indian)

4.2.2.3 Effect of lifestyle characteristics with MetS component – Low HDL (high density lipoprotein) cholesterol

A comparison of lifestyle factors among subjects with and without low HDL-cholesterol in Johor showed that physical activity, skipping breakfast and quick finishing of meals were significantly associated with low HDL-cholesterol ($p < 0.05$) (Supplementary Table 6). Tables 24-25 show the regression analyses for studying the association of lifestyle factors with low HDL-cholesterol, overall and across the three ethnicities. Frequent dining out (AOR = 2.279 [95% CI = 1.171-4.436]) and skipping breakfast (AOR = 2.122 [95% CI = 1.246-3.614]) more than three times per week resulted in higher odds for low HDL-cholesterol, when adjusted for gender, age, ethnicity, education and employment status (Table 24). Across the major ethnicities, skipping breakfast was the only significant feature among the Chinese, where the odds of low HDL-cholesterol increased by 3.108 times ($p = 0.016$) for skipping breakfast more than three times per week after adjusting for gender and education (Table 25). Where in the overall model, there were minimal difference between crude and adjusted estimates, upon stratification, a drastic increase in OR by 3.11 times was observed for skipping breakfast (> 3 times per week) with low HDL-cholesterol, among the Chinese, adjusted for gender and education.

Table 24: Association of lifestyle characteristics associated with low HDL-C from Johor (n=481)

	Characteristic		OR	95% CI		P-value
				Lower	Upper	
Model 1	**Physical activity**	**High**	1.00			
		Moderate	1.11	0.62	1.97	0.73
		Low	1.96	1.12	3.42	0.02
Model 2	**Physical activity**	**High**	1.00			
		Moderate	1.19	0.60	2.36	0.62
		Low	1.88	0.97	3.62	0.06
Model 1	**Smoking status**	**Never smoked**	1.00			
		Past/Current smoker	0.66	0.35	1.25	0.20
Model 2	**Smoking status**	**Never smoked**	1.00			
		Past/Current smoker	0.64	0.28	1.46	0.29
Model 1	**Alcohol consumption**	**Never consumed/past consumer**	1.00			
		Current consumer	0.87	0.42	1.78	0.69
Model 2	**Alcohol consumption**	**Never consumed/past consumer**	1.00			
		Current consumer	1.66	0.66	4.16	0.28
Model 1	**Frequent dining out**	**≤ 3 times/week**	1.00			
		> 3 times/week	0.67	0.43	1.04	0.07
Model 2	**Frequent dining out**	**≤ 3 times/week**	1.00			
		> 3 times/week	2.28	1.17	4.44	0.02
Model 1	**Late dining**	**≤ 3 times/week**	1.00			
		> 3 times/week	0.94	0.50	1.76	0.84
Model 2	**Late dining**	**≤ 3 times/week**	1.00			
		> 3 times/week	0.68	0.32	1.43	0.31
Model 1	**Skipping breakfast**	**≤ 3 times/week**	1.00			
		> 3 times/week	2.10	1.36	3.25	0.00
Model 2	**Skipping breakfast**	**≤ 3 times/week**	1.00			
		> 3 times/week	2.12	1.25	3.61	0.01
Model 1	**Finishing meals**	**Not fast**	1.00			
		Fast	1.81	1.21	2.71	0.00
Model 2	**Finishing meals**	**Not fast**	1.00			
		Fast	1.31	0.81	2.11	0.27

Model 1: Unadjusted
Model 2: Adjusted for gender, age, ethnicity, education, employment status

Table 25: Association of lifestyle characteristics associated with low HDL-C across different ethnicities from Johor

	Characteristic		Malay (n=147)				Chinese (n=228)				Indian (n=106)			
			OR	95% CI		P-value	OR	95% CI		P-value	OR	95% CI		P-value
				Lower	Upper			Lower	Upper			Lower	Upper	
Model 1	**Physical activity**	**High**	1.00				1.00				1.00			
		Moderate	1.08	0.41	2.87	0.88	-	-	-	-	0.76	0.26	2.26	0.62
		Low	1.44	0.57	3.66	0.44	-	-	-	-	1.61	0.54	4.78	0.39
Model 2	**Physical activity**	**High**	1.00				1.00				1.00			
		Moderate	0.82	0.29	2.33	0.70	-	-	-	-	0.60	0.19	1.87	0.38
		Low	1.05	0.38	2.89	0.92	-	-	-	-	1.45	0.47	4.46	0.52
Model 1	**Smoking status**	**Never smoked**	1.00				1.00				1.00			
		Past/Current smoker	0.33	0.11	1.04	0.06	0.40	0.05	3.11	0.38	0.68	0.23	1.99	0.48
Model 2	**Smoking status**	**Never smoked**	1.00				1.00				1.00			
		Past/Current smoker	0.44	0.11	1.84	0.26	0.56	0.07	4.74	0.60	1.36	0.39	4.83	0.63
Model 1	**Alcohol consumption**	**Never consumed/past consumer**	1.00				1.00				1.00			
		Current consumer	-	-	-	-	1.05	0.29	3.78	0.94	1.34	0.33	5.51	0.69
Model 2	**Alcohol consumption**	**Never consumed/past consumer**	1.00				1.00				1.00			
		Current consumer	-	-	-	-	1.25	0.34	4.64	0.74	2.28	0.51	10.17	0.28
Model 1	**Frequent dining out**	**≤ 3 times/week**	1.00				1.00				1.00			
		> 3 times/week	2.29	0.78	6.71	0.13	1.72	0.69	4.27	0.25	1.51	0.53	4.29	0.44
Model 2	**Frequent dining out**	**≤ 3 times/week**	1.00				1.00				1.00			
		> 3 times/week	3.24	0.93	11.27	0.07	2.20	0.85	5.71	0.11	3.00	0.87	10.32	0.08
Model 1	**Late dining**	**≤ 3 times/week**	1.00				1.00				1.00			
		> 3 times/week	0.48	0.15	1.55	0.22	1.04	0.23	4.83	0.96	0.81	0.27	2.49	0.72
Model 2	**Late dining**	**≤ 3 times/week**	1.00				1.00				1.00			
		> 3 times/week	0.36	0.10	1.23	0.10	1.07	0.22	5.24	0.94	1.18	0.35	3.98	0.79
Model 1	**Skipping breakfast**	**≤ 3 times/week**	1.00				1.00				1.00			
		> 3 times/week	1.82	0.81	4.11	0.15	3.16	1.28	7.80	0.01	1.87	0.77	4.59	0.17
Model 2	**Skipping breakfast**	**≤ 3 times/week**	1.00				1.00				1.00			
		> 3 times/week	1.95	0.82	4.62	0.13	3.11	1.24	7.82	0.02	1.89	0.75	4.76	0.18
Model 1	**Finishing meals**	**Not fast**	1.00				1.00				1.00			
		Fast	1.60	0.81	3.17	0.17	1.15	0.48	2.76	0.76	1.13	0.47	2.74	0.78
Model 2	**Finishing meals**	**Not fast**	1.00				1.00				1.00			
		Fast	1.75	0.85	3.62	0.13	1.01	0.41	2.48	0.99	0.98	0.39	2.43	0.96

Model 1: Unadjusted
Model 2: Adjusted for gender and age (Malay); gender and education (Chinese); gender and marital status (Indian)

4.2.2.4 Effect of lifestyle characteristics with MetS component – High triglycerides (hypertriglyceridemia)

A comparison of lifestyle characteristics with and without hypertriglyceridemia was carried out, and the results showed no significant associations of lifestyle characteristics with hypertriglyceridemia (Supplementary Table 7). For investigating the association of the lifestyle factors with hypertriglyceridemia, logistic regression analysis was carried out for the whole population in this cohort and across the three ethnicities. No significant association was observed for lifestyle factors with high triglyceride levels in this population (Table 26). However, across the three ethnicities, low physical activity among the Chinese resulted in an increased odds ratio (AOR = 4.313 [95% CI = 1.484-12.529]) for hypertriglyceridemia, when adjusted for gender, age and employment status (Table 27). Moreover, among the Indians, significantly increased odds of hypertriglyceridemia with active alcohol consumption (AOR = 16.975 [95% CI = 1.885-152.88) was observed, after adjusting for gender, age, marital status and employment status (Table 27).

Table 26: Association of lifestyle characteristics associated with high triglycerides from Johor (n=481)

	Characteristic		OR	95% CI		P-value
				Lower	Upper	
Model 1	**Physical activity**	**High**	1.00			
		Moderate	1.18	0.65	2.14	0.58
		Low	1.41	0.79	2.53	0.25
Model 2	**Physical activity**	**High**	1.00			
		Moderate	1.37	0.74	2.54	0.31
		Low	1.59	0.87	2.91	0.13
Model 1	**Smoking status**	**Never smoked**	1.00			
		Past/Current smoker	1.07	0.58	1.97	0.84
Model 2	**Smoking status**	**Never smoked**	1.00			
		Past/Current smoker	0.74	0.37	1.46	0.38
Model 1	**Alcohol consumption**	**Never consumed/past consumer**	1.00			
		Current consumer	1.13	0.55	2.33	0.75
Model 2	**Alcohol consumption**	**Never consumed/past consumer**	1.00			
		Current consumer	1.06	0.50	2.23	0.89
Model 1	**Frequent dining out**	**≤ 3 times/week**	1.00			
		> 3 times/week	1.22	0.79	1.89	0.38
Model 2	**Frequent dining out**	**≤ 3 times/week**	1.00			
		> 3 times/week	1.21	0.75	1.94	0.43
Model 1	**Late dining**	**≤ 3 times/week**	1.00			
		> 3 times/week	1.36	0.73	2.55	0.33
Model 2	**Late dining**	**≤ 3 times/week**	1.00			
		> 3 times/week	1.32	0.69	2.55	0.41
Model 1	**Skipping breakfast**	**≤ 3 times/week**	1.00			
		> 3 times/week	0.68	0.41	1.14	0.15
Model 2	**Skipping breakfast**	**≤ 3 times/week**	1.00			
		> 3 times/week	0.69	0.41	1.18	0.17
Model 1	**Finishing meals**	**Not fast**	1.00			
		Fast	1.18	0.78	1.79	0.44
Model 2	**Finishing meals**	**Not fast**	1.00			
		Fast	1.15	0.75	1.77	0.52

Model 1: Unadjusted
Model 2: Adjusted for gender, age, education

Table 27: Association of lifestyle characteristics associated with high triglycerides across ethnicities from Johor

	Characteristic		Malay (n=147)				Chinese (n=228)				Indian (n=106)			
			OR	95% CI		P-value	OR	95% CI		P-value	OR	95% CI		P-value
				Lower	Upper			Lower	Upper			Lower	Upper	
Model 1	**Physical activity**	**High**	1.00				1.00				1.00			
		Moderate	1.41	0.48	4.19	0.53	2.60	0.92	7.30	0.07	0.30	0.09	0.99	0.05
		Low	1.03	0.35	3.02	0.95	3.57	1.26	10.13	0.02	0.57	0.20	1.64	0.30
Model 2	**Physical activity**	**High**	1.00				1.00				1.00			
		Moderate	1.38	0.44	4.39	0.58	2.80	0.98	8.02	0.06	0.24	0.06	1.03	0.05
		Low	0.64	0.19	2.08	0.45	4.31	1.48	12.53	0.01	0.33	0.09	1.29	0.11
Model 1	**Smoking status**	**Never smoked**	1.00				1.00				1.00			
		Past/Current smoker	0.91	0.31	2.67	0.86	0.44	0.13	1.55	0.20	3.09	1.04	9.21	0.04
Model 2	**Smoking status**	**Never smoked**	1.00				1.00				1.00			
		Past/Current smoker	1.56	0.46	5.28	0.47	0.34	0.09	1.24	0.10	6.23	0.80	48.29	0.08
Model 1	**Alcohol consumption**	**Never consumed/past consumer**	1.00				1.00				1.00			
		Current consumer	-	-	-	-	0.44	0.15	1.33	0.15	7.41	1.77	30.99	0.01
Model 2	**Alcohol consumption**	**Never consumed/past consumer**	1.00				1.00				1.00			
		Current consumer	-	-	-	-	0.42	0.14	1.27	0.12	16.98	1.89	152.88	0.01
Model 1	**Frequent dining out**	**≤ 3 times/week**	1.00				1.00				1.00			
		> 3 times/week	1.78	0.56	5.61	0.33	0.79	0.43	1.45	0.45	3.82	1.41	10.35	0.01
Model 2	**Frequent dining out**	**≤ 3 times/week**	1.00				1.00				1.00			
		> 3 times/week	3.03	0.82	11.22	0.10	0.97	0.50	1.89	0.93	3.85	0.69	21.31	0.12
Model 1	**Late dining**	**≤ 3 times/week**	1.00				1.00				1.00			
		> 3 times/week	0.38	0.08	1.74	0.21	1.39	0.51	3.81	0.52	3.58	1.17	11.01	0.03
Model 2	**Late dining**	**≤ 3 times/week**	1.00				1.00				1.00			
		> 3 times/week	0.51	0.11	2.45	0.40	1.30	0.46	3.70	0.62	2.37	0.49	11.47	0.28
Model 1	**Skipping breakfast**	**≤ 3 times/week**	1.00				1.00				1.00			
		> 3 times/week	0.61	0.21	1.73	0.35	0.67	0.31	1.45	0.31	0.70	0.27	1.79	0.46
Model 2	**Skipping breakfast**	**≤ 3 times/week**	1.00				1.00				1.00			
		> 3 times/week	0.74	0.24	2.25	0.59	0.73	0.33	1.58	0.42	1.32	0.39	4.49	0.66
Model 1	**Finishing meals**	**Not fast**	1.00				1.00				1.00			
		Fast	0.89	0.41	1.93	0.78	1.12	0.61	2.06	0.71	1.74	0.63	4.81	0.29
Model 2	**Finishing meals**	**Not fast**	1.00				1.00				1.00			
		Fast	1.02	0.43	2.37	0.97	1.15	0.62	2.13	0.67	2.18	0.63	7.54	0.22

Model 1: Unadjusted
Model 2: Adjusted for marital status, education and employment status (Malay); gender, age and employment status (Chinese); gender, age, marital status and employment status (Indian)

4.2.2.5 Effect of lifestyle characteristics with MetS component – High fasting blood glucose (FBG; fasting hyperglycemia)

Lifestyle characteristics in subjects with and without fasting hyperglycemia were compared and analysed in this cohort (Supplementary Table 8). Frequent dining out was found to be associated with high fasting blood glucose ($p = 0.003$). Tables 28-29 show the regression analyses for the association of lifestyle factors with fasting hyperglycemia, overall and across the three ethnicities. No significant association was identified overall, however, quick finishing of meals was found to increase the odds of fasting hyperglycemia by 2.494 times among the Malays ($p = 0.029$), after adjusting for age, marital status and education (Table 29). Among the Indians, past/active smoking status increased the odds of fasting hyperglycemia by 8.295 times ($p = 0.017$), and late dining more than three times per week increased the odds of fasting hyperglycemia by 5.361 folds ($p = 0.032$), after adjusting for gender, age and marital status (Table 29).

Table 28: Association of lifestyle characteristics associated with high fasting blood glucose from Johor (n=481)

	Characteristic		OR	95% CI		P-value
				Lower	Upper	
Model 1	**Physical activity**	**High**	1.00			
		Moderate	0.95	0.49	1.84	0.88
		Low	1.41	0.75	2.65	0.29
Model 2	**Physical activity**	**High**	1.00			
		Moderate	1.04	0.51	2.10	0.92
		Low	1.62	0.82	3.20	0.17
Model 1	**Smoking status**	**Never smoked**	1.00			
		Past/Current smoker	1.62	0.87	3.02	0.13
Model 2	**Smoking status**	**Never smoked**	1.00			
		Past/Current smoker	1.35	0.63	2.87	0.44
Model 1	**Alcohol consumption**	**Never consumed/past consumer**	1.00			
		Current consumer	1.25	0.57	2.71	0.58
Model 2	**Alcohol consumption**	**Never consumed/past consumer**	1.00			
		Current consumer	1.54	0.65	3.66	0.33
Model 1	**Frequent dining out**	**≤ 3 times/week**	1.00			
		> 3 times/week	0.43	0.25	0.76	0.00
Model 2	**Frequent dining out**	**≤ 3 times/week**	1.00			
		> 3 times/week	0.75	0.39	1.47	0.41
Model 1	**Late dining**	**≤ 3 times/week**	1.00			
		> 3 times/week	1.66	0.86	3.21	0.13
Model 2	**Late dining**	**≤ 3 times/week**	1.00			
		> 3 times/week	1.77	0.86	3.64	0.12
Model 1	**Skipping breakfast**	**≤ 3 times/week**	1.00			
		> 3 times/week	0.87	0.50	1.50	0.61
Model 2	**Skipping breakfast**	**≤ 3 times/week**	1.00			
		> 3 times/week	0.89	0.49	1.60	0.69
Model 1	**Finishing meals**	**Not fast**	1.00			
		Fast	1.38	0.87	2.20	0.17
Model 2	**Finishing meals**	**Not fast**	1.00			
		Fast	1.52	0.92	2.53	0.10

Model 1: Unadjusted
Model 2: Adjusted for gender, age, ethnicity, education, employment status

Table 29: Association of lifestyle characteristics associated with high fasting blood glucose across ethnicities from Johor

	Characteristic		Malay (n=147)				Chinese (n=228)				Indian (n=106)			
			OR	95% CI		P-value	OR	95% CI		P-value	OR	95% CI		P-value
				Lower	Upper			Lower	Upper			Lower	Upper	
Model 1	**Physical activity**	**High**	1.00				1.00				1.00			
		Moderate	0.67	0.24	1.84	0.44	1.03	0.37	2.89	0.95	6.86	0.83	56.71	0.07
		Low	0.90	0.35	2.32	0.83	1.13	0.39	3.25	0.82	3.03	0.33	27.84	0.33
Model 2	**Physical activity**	**High**	1.00				1.00				1.00			
		Moderate	0.71	0.23	2.15	0.54	0.98	0.33	2.88	0.97	3.63	0.36	36.67	0.28
		Low	0.80	0.28	2.30	0.68	1.33	0.44	4.05	0.61	8.35	0.92	76.00	0.06
Model 1	**Smoking status**	**Never smoked**	1.00				1.00				1.00			
		Past/Current smoker	1.21	0.46	3.19	0.71	0.91	0.25	3.26	0.89	3.90	1.20	12.70	0.02
Model 2	**Smoking status**	**Never smoked**	1.00				1.00				1.00			
		Past/Current smoker	1.45	0.50	4.27	0.50	0.74	0.19	2.92	0.66	8.30	1.45	47.37	0.02
Model 1	**Alcohol consumption**	**Never consumed/past consumer**	1.00				1.00				1.00			
		Current consumer	-	-	-	-	0.93	0.30	2.88	0.91	6.39	1.62	25.14	0.01
Model 2	**Alcohol consumption**	**Never consumed/past consumer**	1.00				1.00				1.00			
		Current consumer	-	-	-	-	0.99	0.30	3.26	0.98	5.17	0.99	27.06	0.05
Model 1	**Frequent dining out**	**≤ 3 times/week**	1.00				1.00				1.00			
		> 3 times/week	0.97	0.29	3.24	0.96	0.31	0.14	0.71	0.01	1.19	0.35	4.09	0.78
Model 2	**Frequent dining out**	**≤ 3 times/week**	1.00				1.00				1.00			
		> 3 times/week	1.33	0.37	4.81	0.67	0.44	0.18	1.06	0.07	1.26	0.21	7.66	0.80
Model 1	**Late dining**	**≤ 3 times/week**	1.00				1.00				1.00			
		> 3 times/week	1.03	0.34	3.11	0.95	1.09	0.30	3.95	0.90	4.39	1.32	14.55	0.02
Model 2	**Late dining**	**≤ 3 times/week**	1.00				1.00				1.00			
		> 3 times/week	1.40	0.42	4.69	0.59	0.84	0.21	3.31	0.80	5.36	1.15	24.97	0.03
Model 1	**Skipping breakfast**	**≤ 3 times/week**	1.00				1.00				1.00			
		> 3 times/week	0.61	0.23	1.63	0.32	1.92	0.86	4.30	0.11	0.37	0.10	1.37	0.14
Model 2	**Skipping breakfast**	**≤ 3 times/week**	1.00				1.00				1.00			
		> 3 times/week	0.58	0.20	1.64	0.30	2.43	1.02	5.78	0.05	0.44	0.11	1.85	0.26
Model 1	**Finishing meals**	**Not fast**	1.00				1.00				1.00			
		Fast	2.15	1.02	4.50	0.04	1.34	0.63	2.82	0.45	0.71	0.24	2.10	0.53
Model 2	**Finishing meals**	**Not fast**	1.00				1.00				1.00			
		Fast	2.49	1.10	5.65	0.03	1.38	0.63	3.05	0.42	0.83	0.25	2.74	0.75

Model 1: Unadjusted
Model 2: Adjusted for age, marital status and education (Malay); gender, age and employment status (Chinese); gender, age and marital status (Indian)

4.2.3 Effect of nutrients with MetS components

Results in the previous chapter have revealed that certain nutrients have an association with MetS in this population. Therefore, the effects of nutrients on metabolic components of this syndrome were investigated and the results have been presented in the following subsections.

4.2.3.1 Effect of nutrients with MetS component – Abdominal obesity

Median nutrient intake among Malaysian adults with and without abdominal obesity were compared (Supplementary Table 9). A significant decline in median intake of proteins, sodium, retinol and cholesterol, and a significant increase in median intake of trans fatty acids have been found among subjects with abdominal obesity. Table 30 shows the results of logistic regression analyses for the association of nutrient intakes with abdominal obesity on all subjects, which were found to be insignificant. Table 31 shows the regression analyses across the three ethnicities for the same objective. The results indicate that fibre intake was about 3% higher among the Malays with abdominal obesity (AOR = 1.03 [95% CI = 1.001-1.06]), adjusted for relevant socio-demographic and lifestyle factors. Moreover, among the same ethnic group, vitamin C intake was 0.3% higher in subjects with abdominal obesity. Additionally, intake of omega-3-PUFA was associated with 5.44 times odds of abdominal obesity among the Malays when adjusted for gender, marital status, education, employment status, energy and smoking ($p = 0.022$). No significant associations of nutrient intake with abdominal obesity were observed among the Chinese and the Indians after adjusting for socio-demographic and lifestyle characteristics (Table 31).

Table 30: Association of nutrient intakes among Malaysians associated with abdominal obesity (n=481)

Nutrient		OR	95%CI Lower	95%CI Upper	P-value
Protein (g)	**Model 1**	1.00	0.99	1.00	0.11
	Model 2	1.00	0.99	1.01	0.70
	Model 3	1.00	0.99	1.01	0.66
Fats (g)	**Model 1**	1.00	1.00	1.01	0.23
	Model 2	1.00	1.00	1.01	0.45
	Model 3	1.00	1.00	1.01	0.47
Carbohydrates (g)	**Model 1**	1.00	1.00	1.00	0.88
	Model 2	1.00	1.00	1.00	0.56
	Model 3	1.00	1.00	1.00	0.57
Fibre (g)	**Model 1**	1.00	0.99	1.01	0.79
	Model 2	1.00	0.99	1.01	0.80
	Model 3	1.00	0.99	1.01	0.93
Calcium (mg)	**Model 1**	1.00	1.00	1.00	0.47
	Model 2	1.00	1.00	1.00	0.66
	Model 3	1.00	1.00	1.00	0.69
Iron (mg)	**Model 1**	0.99	0.97	1.01	0.19
	Model 2	0.99	0.96	1.03	0.71
	Model 3	1.00	0.96	1.03	0.76
Sodium (mg)	**Model 1**	1.00	1.00	1.00	0.11
	Model 2	1.00	1.00	1.00	0.70
	Model 3	1.00	1.00	1.00	0.67
Potassium (mg)	**Model 1**	1.00	1.00	1.00	0.48
	Model 2	1.00	1.00	1.00	0.95
	Model 3	1.00	1.00	1.00	0.96
Retinol (µg)	**Model 1**	1.00	1.00	1.00	0.08
	Model 2	1.00	1.00	1.00	0.31
	Model 3	1.00	1.00	1.00	0.27
Niacin (mg)	**Model 1**	0.99	0.98	1.01	0.31
	Model 2	1.00	0.98	1.02	0.96
	Model 3	1.00	0.99	1.02	0.88
Vitamin C (mg)	**Model 1**	1.00	1.00	1.00	0.36
	Model 2	1.00	1.00	1.00	1.00
	Model 3	1.00	1.00	1.00	0.89
Cholesterol (mg)	**Model 1**	1.00	1.00	1.00	< 0.01
	Model 2	1.00	1.00	1.00	0.08
	Model 3	1.00	1.00	1.00	0.10
Omega-6 PUFA (g)	**Model 1**	1.00	0.98	1.03	0.78
	Model 2	1.01	0.97	1.06	0.58
	Model 3	1.01	0.97	1.06	0.65
Omega-3 PUFA (g)	**Model 1**	0.76	0.49	1.19	0.23
	Model 2	1.11	0.59	2.09	0.75
	Model 3	1.11	0.58	2.12	0.75
Trans fatty acids (g)	**Model 1**	1.37	0.60	3.11	0.46
	Model 2	0.98	0.37	2.58	0.96
	Model 3	0.96	0.35	2.59	0.93

Model 1: Unadjusted
Model 2: Adjusted for gender, age, ethnicity, marital status, education, employment status and energy
Model 3: Adjusted for gender, age, ethnicity, marital status, education, employment status, energy, physical activity, smoking status and frequent dining out

Table 31: Association of nutrient intakes across ethnicities associated with abdominal obesity

		Malay (n=147)				Chinese (n=228)				Indian (n=106)			
			95% CI				95% CI				95% CI		
Nutrient		OR	Lower	Upper	P-value	OR	Lower	Upper	P-value	OR	Lower	Upper	P-value
Protein (g)	**Model 1**	1.00	0.99	1.01	0.63	1.00	0.99	1.00	0.34	0.98	0.97	1.00	0.02
	Model 2	1.01	0.99	1.02	0.44	1.00	0.98	1.01	0.57	0.99	0.96	1.02	0.37
	Model 3	1.01	0.99	1.02	0.43	-	-	-	-	0.99	0.96	1.02	0.39
Fats (g)	**Model 1**	1.00	1.00	1.01	0.20	1.00	0.99	1.01	0.84	0.99	0.98	1.00	0.04
	Model 2	1.01	0.99	1.02	0.38	1.00	0.99	1.01	0.85	1.00	0.98	1.02	0.93
	Model 3	1.01	0.99	1.02	0.36	-	-	-	-	1.00	0.99	1.02	0.79
Carbohydrates (g)	**Model 1**	1.00	1.00	1.00	0.73	1.00	1.00	1.00	0.93	1.00	0.99	1.00	0.08
	Model 2	1.00	0.99	1.00	0.27	1.00	1.00	1.01	0.97	1.00	0.99	1.01	0.69
	Model 3	1.00	0.99	1.00	0.26	-	-	-	-	1.00	0.99	1.01	0.99
Fibre (g)	**Model 1**	1.03	1.00	1.05	0.04	0.99	0.98	1.00	0.15	0.99	0.97	1.02	0.67
	Model 2	1.03	1.00	1.07	0.04	0.99	0.97	1.00	0.10	1.00	0.97	1.04	0.96
	Model 3	1.03	1.00	1.07	0.04	-	-	-	-	1.01	0.97	1.05	0.71
Calcium (mg)	**Model 1**	1.00	1.00	1.00	0.78	1.00	1.00	1.00	0.43	1.00	1.00	1.00	0.04
	Model 2	1.00	1.00	1.00	0.74	1.00	1.00	1.00	0.55	1.00	1.00	1.00	0.29
	Model 3	1.00	1.00	1.00	0.73	-	-	-	-	1.00	1.00	1.00	0.18
Iron (mg)	**Model 1**	1.00	0.97	1.04	0.86	1.00	0.97	1.03	0.91	0.94	0.88	1.01	0.10
	Model 2	1.00	0.95	1.05	0.97	0.99	0.95	1.04	0.77	0.99	0.88	1.13	0.92
	Model 3	1.00	0.95	1.05	0.97	-	-	-	-	0.97	0.84	1.12	0.70
Sodium (mg)	**Model 1**	1.00	1.00	1.00	0.21	1.00	1.00	1.00	0.24	1.00	1.00	1.00	0.02
	Model 2	1.00	1.00	1.00	0.17	1.00	1.00	1.00	0.28	1.00	1.00	1.00	0.12
	Model 3	1.00	1.00	1.00	0.17	-	-	-	-	1.00	1.00	1.00	0.06
Potassium (mg)	**Model 1**	1.00	1.00	1.00	0.09	1.00	1.00	1.00	0.34	1.00	1.00	1.00	0.25
	Model 2	1.00	1.00	1.00	0.04	1.00	1.00	1.00	0.24	1.00	1.00	1.00	0.63
	Model 3	1.00	1.00	1.00	0.04	-	-	-	-	1.00	1.00	1.00	0.70
Retinol (µg)	**Model 1**	1.00	1.00	1.00	0.41	1.00	1.00	1.00	0.24	1.00	1.00	1.00	0.08
	Model 2	1.00	1.00	1.00	0.42	1.00	1.00	1.00	0.14	1.00	1.00	1.00	0.21
	Model 3	1.00	1.00	1.00	0.43	-	-	-	-	1.00	1.00	1.00	0.32
Niacin (mg)	**Model 1**	0.99	0.97	1.01	0.38	1.01	1.00	1.03	0.16	0.97	0.92	1.01	0.14
	Model 2	0.99	0.96	1.02	0.38	1.01	0.99	1.03	0.44	0.99	0.93	1.06	0.79
	Model 3	0.99	0.96	1.02	0.39	-	-	-	-	0.97	0.90	1.05	0.48
Vitamin C (mg)	**Model 1**	1.00	1.00	1.01	0.07	1.00	1.00	1.00	0.25	1.00	1.00	1.00	0.57
	Model 2	1.00	1.00	1.01	0.05	1.00	1.00	1.00	0.10	1.00	0.99	1.01	0.85
	Model 3	1.00	1.00	1.01	0.05	-	-	-	-	1.00	0.99	1.01	0.96
Cholesterol (mg)	**Model 1**	1.00	1.00	1.00	0.78	1.00	1.00	1.00	0.06	1.00	0.99	1.00	0.01
	Model 2	1.00	1.00	1.00	0.80	1.00	1.00	1.00	0.23	1.00	0.99	1.00	0.27
	Model 3	1.00	1.00	1.00	0.82	-	-	-	-	1.00	0.99	1.00	0.69
Omega-6 PUFA (g)	**Model 1**	1.05	1.00	1.11	0.07	0.98	0.93	1.02	0.29	0.92	0.85	0.99	0.03
	Model 2	1.07	0.98	1.17	0.12	0.96	0.89	1.04	0.32	0.98	0.87	1.11	0.79
	Model 3	1.07	0.98	1.17	0.11	-	-	-	-	1.00	0.87	1.16	0.96
Omega-3 PUFA (g)	**Model 1**	2.98	1.08	8.28	0.04	0.68	0.35	1.32	0.25	0.37	0.13	1.05	0.06
	Model 2	5.42	1.26	23.29	0.02	0.77	0.31	1.89	0.57	0.42	0.10	1.81	0.25
	Model 3	5.44	1.27	23.28	0.02	-	-	-	-	0.47	0.08	2.73	0.40
Trans fatty acids (g)	**Model 1**	12.33	0.83	182.33	0.07	0.53	0.14	2.09	0.37	0.43	0.07	2.46	0.34
	Model 2	11.70	0.46	298.71	0.14	0.62	0.11	3.48	0.58	2.62	0.14	48.32	0.52
	Model 3	11.52	0.45	296.62	0.14	-	-	-	-	1.21	0.02	61.72	0.92

Model 1: Unadjusted
Model 2: Adjusted for gender, marital status, education, employment status and energy (Malay); age, marital status, education and energy (Chinese); age, education, employment status and energy (Indian)
Model 3: Adjusted for Model 2 and smoking (Malay); Model 2 only (Chinese); Model 2 plus smoking status, alcohol intake, quick finishing meals (Indian)

4.2.3.2 Effect of nutrients with MetS component – High blood pressure

A comparison of the median nutrient intakes among Malaysian adults with and without high blood pressure indicates that differences in intakes exist between subjects with and without high blood pressure; however these differences were not statistically significant (Supplementary Table 10). Tables 32-33 show the logistic regression models for exploring the association of nutrients with high blood pressure, overall and across the three ethnicities. The results indicate no significant association among the Malays and the Chinese. However, among the Indians, a modest protection against high blood pressure has been found with intake of retinol (AOR = 0.99 [95% CI = 0.99-1.00]) and vitamin C (AOR = 0.99 [95% CI = 0.99-0.99]) when adjusted for gender, age, marital status and energy (Table 33)

Table 32: Association of nutrient intakes among Malaysians associated with high blood pressure (n=481)

Nutrient		OR	95%CI Lower	95%CI Upper	P-value
Protein (g)	**Model 1**	1.00	0.99	1.00	0.75
	Model 2	1.00	0.99	1.01	0.94
	Model 3	1.00	0.99	1.01	0.71
Fats (g)	**Model 1**	1.00	1.00	1.00	0.97
	Model 2	1.00	1.00	1.01	0.84
	Model 3	1.00	1.00	1.01	0.72
Carbohydrates (g)	**Model 1**	1.00	1.00	1.00	0.62
	Model 2	1.00	1.00	1.00	0.89
	Model 3	1.00	1.00	1.00	0.82
Fibre (g)	**Model 1**	1.00	0.99	1.01	0.73
	Model 2	1.00	0.99	1.01	0.62
	Model 3	1.00	0.98	1.01	0.43
Calcium (mg)	**Model 1**	1.00	1.00	1.00	0.64
	Model 2	1.00	1.00	1.00	0.37
	Model 3	1.00	1.00	1.00	0.31
Iron (mg)	**Model 1**	1.00	0.98	1.02	0.87
	Model 2	0.99	0.96	1.02	0.60
	Model 3	0.99	0.96	1.03	0.63
Sodium (mg)	**Model 1**	1.00	1.00	1.00	0.92
	Model 2	1.00	1.00	1.00	0.99
	Model 3	1.00	1.00	1.00	0.97
Potassium (mg)	**Model 1**	1.00	1.00	1.00	0.72
	Model 2	1.00	1.00	1.00	0.64
	Model 3	1.00	1.00	1.00	0.43
Retinol (µg)	**Model 1**	1.00	1.00	1.00	0.19
	Model 2	1.00	1.00	1.00	0.11
	Model 3	1.00	1.00	1.00	0.09
Niacin (mg)	**Model 1**	1.01	0.99	1.02	0.30
	Model 2	1.01	0.99	1.02	0.48
	Model 3	1.01	0.99	1.02	0.33
Vitamin C (mg)	**Model 1**	1.00	1.00	1.00	0.37
	Model 2	1.00	1.00	1.00	0.34
	Model 3	1.00	1.00	1.00	0.29
Cholesterol (mg)	**Model 1**	1.00	1.00	1.00	0.69
	Model 2	1.00	1.00	1.00	0.91
	Model 3	1.00	1.00	1.00	0.90
Omega-6 PUFA (g)	**Model 1**	1.00	0.97	1.03	0.97
	Model 2	1.01	0.96	1.05	0.77
	Model 3	1.01	0.97	1.06	0.66
Omega-3 PUFA (g)	**Model 1**	0.84	0.54	1.30	0.43
	Model 2	0.93	0.51	1.69	0.81
	Model 3	0.99	0.54	1.81	0.97
Trans fatty acids (g)	**Model 1**	1.18	0.57	2.45	0.66
	Model 2	1.15	0.52	2.56	0.73
	Model 3	1.24	0.55	2.78	0.61

Model 1: Unadjusted
Model 2: Adjusted for gender, age, ethnicity, marital status, education and energy
Model 3: Adjusted for gender, age, ethnicity, marital status, education, energy and physical activity

Table 33: Association of nutrient intakes across ethnicities associated with high blood pressure

		Malay (n=147)				Chinese (n=228)				Indian (n=106)			
			95% CI				95% CI				95% CI		
Nutrient		OR	Lower	Upper	P-value	OR	Lower	Upper	P-value	OR	Lower	Upper	P-value
Protein (g)	**Model 1**	1.00	0.99	1.01	0.63	1.00	0.99	1.01	0.61	1.00	0.99	1.02	0.54
	Model 2	1.00	0.98	1.01	0.80	1.01	0.99	1.02	0.50	1.00	0.97	1.02	0.68
	Model 3	-	-	-	-	1.00	0.99	1.02	0.67	-	-	-	-
Fats (g)	**Model 1**	1.00	0.99	1.00	0.54	1.00	0.99	1.01	0.56	1.00	0.99	1.01	0.70
	Model 2	1.00	0.99	1.01	0.87	1.00	0.99	1.01	0.91	1.00	0.99	1.02	0.61
	Model 3	-	-	-	-	1.00	0.99	1.02	0.54	-	-	-	-
Carbohydrates (g)	**Model 1**	1.00	1.00	1.00	0.76	1.00	1.00	1.00	0.95	1.00	1.00	1.00	0.43
	Model 2	1.00	1.00	1.01	0.80	1.00	0.99	1.00	0.77	1.00	0.99	1.01	0.74
	Model 3	-	-	-	-	1.00	0.99	1.00	0.49	-	-	-	-
Fibre (g)	**Model 1**	1.00	0.98	1.01	0.58	1.00	0.99	1.01	1.00	1.00	0.98	1.02	0.95
	Model 2	0.99	0.98	1.01	0.47	1.01	0.99	1.02	0.46	0.99	0.96	1.02	0.41
	Model 3	-	-	-	-	1.00	0.98	1.02	0.78	-	-	-	-
Calcium (mg)	**Model 1**	1.00	1.00	1.00	0.76	1.00	1.00	1.00	0.97	1.00	1.00	1.00	0.61
	Model 2	1.00	1.00	1.00	0.64	1.00	1.00	1.00	0.68	1.00	1.00	1.00	0.09
	Model 3	-	-	-	-	1.00	1.00	1.00	0.72	-	-	-	-
Iron (mg)	**Model 1**	1.00	0.96	1.03	0.76	1.00	0.97	1.02	0.73	1.03	0.97	1.09	0.34
	Model 2	0.99	0.94	1.04	0.71	1.00	0.95	1.05	1.00	1.00	0.89	1.11	0.94
	Model 3	-	-	-	-	1.00	0.95	1.05	0.92	-	-	-	-
Sodium (mg)	**Model 1**	1.00	1.00	1.00	0.82	1.00	1.00	1.00	0.51	1.00	1.00	1.00	0.43
	Model 2	1.00	1.00	1.00	0.81	1.00	1.00	1.00	0.95	1.00	1.00	1.00	0.90
	Model 3	-	-	-	-	1.00	1.00	1.00	1.00	-	-	-	-
Potassium (mg)	**Model 1**	1.00	1.00	1.00	0.69	1.00	1.00	1.00	0.98	1.00	1.00	1.00	0.95
	Model 2	1.00	1.00	1.00	0.55	1.00	1.00	1.00	0.42	1.00	1.00	1.00	0.26
	Model 3	-	-	-	-	1.00	1.00	1.00	0.63	-	-	-	-
Retinol (µg)	**Model 1**	1.00	1.00	1.00	0.61	1.00	1.00	1.00	0.56	1.00	1.00	1.00	0.19
	Model 2	1.00	1.00	1.00	0.37	1.00	1.00	1.00	0.90	1.00	1.00	1.00	0.03
	Model 3	-	-	-	-	1.00	1.00	1.00	1.00	-	-	-	-
Niacin (mg)	**Model 1**	1.00	0.98	1.03	0.82	1.01	0.99	1.03	0.25	1.02	0.98	1.06	0.31
	Model 2	1.00	0.97	1.03	0.92	1.01	0.99	1.03	0.36	1.01	0.96	1.07	0.64
	Model 3	-	-	-	-	1.01	0.99	1.04	0.26	-	-	-	-
Vitamin C (mg)	**Model 1**	1.00	1.00	1.00	0.99	1.00	1.00	1.00	0.70	1.00	0.99	1.00	0.12
	Model 2	1.00	1.00	1.00	0.98	1.00	1.00	1.00	0.92	1.00	0.99	1.00	0.03
	Model 3	-	-	-	-	1.00	1.00	1.00	0.92	-	-	-	-
Cholesterol (mg)	**Model 1**	1.00	1.00	1.00	0.45	1.00	1.00	1.00	0.86	1.00	1.00	1.00	0.42
	Model 2	1.00	1.00	1.00	0.51	1.00	1.00	1.00	0.58	1.00	1.00	1.01	0.49
	Model 3	-	-	-	-	1.00	1.00	1.00	0.34	-	-	-	-
Omega-6 PUFA (g)	**Model 1**	0.98	0.94	1.02	0.37	1.00	0.95	1.04	0.83	1.02	0.96	1.09	0.51
	Model 2	0.98	0.91	1.05	0.53	1.02	0.95	1.10	0.52	1.09	0.95	1.25	0.23
	Model 3	-	-	-	-	1.04	0.96	1.11	0.37	-	-	-	-
Omega-3 PUFA (g)	**Model 1**	1.03	0.45	2.34	0.95	0.69	0.35	1.33	0.26	1.10	0.45	2.69	0.83
	Model 2	1.19	0.37	3.78	0.77	0.84	0.34	2.11	0.71	0.97	0.28	3.34	0.96
	Model 3	-	-	-	-	1.12	0.43	2.94	0.82	-	-	-	-
Trans fatty acids (g)	**Model 1**	0.81	0.11	6.20	0.84	0.89	0.38	2.12	0.80	2.22	0.34	14.64	0.41
	Model 2	1.01	0.09	11.46	1.00	1.16	0.46	2.97	0.75	1.05	0.05	21.61	0.97
	Model 3	-	-	-	-	1.44	0.56	3.69	0.45	-	-	-	-

Model 1: Unadjusted
Model 2: Adjusted for age, marital status, education, employment status and energy (Malay); gender, age, marital status, education and energy (Chinese); gender, age, marital status and energy (Indian)
Model 3: Adjusted for Model 2 only (Malay); Model 2 plus physical activity, smoking and late dining of meals (Chinese); Model 2 only (Indian)

4.2.3.3 Effect of nutrients with MetS component – Low HDL (high density lipoprotein)-cholesterol

A comparison of median nutrient intake in subjects with normal and low HDL–cholesterol levels revealed significant differences with intake of retinol, vitamin C, cholesterol, and trans fatty acids ($p < 0.05$) (Supplementary Table 11). Lower intake of retinol, vitamin C and cholesterol, and higher intake of trans fatty acids have been observed among subjects with low HDL-cholesterol ($p < 0.05$). Table 34 shows the logistic regression results overall, suggesting the intake of cholesterol to be slightly protective against low HDL-cholesterol (AOR = 0.99 [95% CI = 0.99-1.00]), when adjusted for socio-demographic and lifestyle factors. Similar results regarding intake of cholesterol were also observed among the Malays (AOR = 0.99 [95% CI = 0.99-0.99]), when adjusted for socio-demographic and lifestyle characteristics (Table 35). Among the Chinese, protein intake was found to slightly increase the odds of low HDL-cholesterol (AOR = 1.03 [95% CI = 1.00-1.05]), when adjusted for socio-demographic and lifestyle factors (Table 35). No association of nutrient intake with low HDL-cholesterol was observed among the Indians (Table 35).

Table 34: Association of nutrient intakes among Malaysians associated with low HDL-Cholesterol (n=481)

Nutrient		Crude OR	95%CI		P-value
			Lower	Upper	
Protein (g)	**Model 1**	1.00	0.99	1.00	0.35
	Model 2	1.00	0.99	1.01	0.90
	Model 3	1.00	0.99	1.01	0.59
Fats (g)	**Model 1**	1.00	1.00	1.01	0.07
	Model 2	1.00	0.99	1.00	0.31
	Model 3	1.00	0.99	1.00	0.33
Carbohydrates (g)	**Model 1**	1.00	1.00	1.00	0.09
	Model 2	1.00	1.00	1.01	0.24
	Model 3	1.00	1.00	1.01	0.22
Fibre (g)	**Model 1**	1.00	0.99	1.01	0.86
	Model 2	1.00	0.99	1.02	0.69
	Model 3	1.00	0.99	1.02	0.84
Calcium (mg)	**Model 1**	1.00	1.00	1.00	0.40
	Model 2	1.00	1.00	1.00	0.98
	Model 3	1.00	1.00	1.00	0.89
Iron (mg)	**Model 1**	0.98	0.96	1.01	0.17
	Model 2	1.01	0.97	1.05	0.74
	Model 3	1.00	0.96	1.04	0.99
Sodium (mg)	**Model 1**	1.00	1.00	1.00	0.14
	Model 2	1.00	1.00	1.00	0.68
	Model 3	1.00	1.00	1.00	0.97
Potassium (mg)	**Model 1**	1.00	1.00	1.00	0.71
	Model 2	1.00	1.00	1.00	0.35
	Model 3	1.00	1.00	1.00	0.46
Retinol (µg)	**Model 1**	1.00	1.00	1.00	0.11
	Model 2	1.00	1.00	1.00	0.92
	Model 3	1.00	1.00	1.00	0.94
Niacin (mg)	**Model 1**	0.98	0.97	1.00	0.03
	Model 2	1.00	0.98	1.02	0.86
	Model 3	1.00	0.98	1.02	0.81
Vitamin C (mg)	**Model 1**	1.00	1.00	1.00	0.13
	Model 2	1.00	1.00	1.00	0.77
	Model 3	1.00	1.00	1.00	0.77
Cholesterol (mg)	**Model 1**	1.00	1.00	1.00	< 0.001
	Model 2	1.00	1.00	1.00	0.04
	Model 3	1.00	1.00	1.00	0.02
Omega-6 PUFA (g)	**Model 1**	1.01	0.98	1.04	0.59
	Model 2	0.97	0.92	1.02	0.27
	Model 3	0.97	0.92	1.02	0.26
Omega-3 PUFA (g)	**Model 1**	0.76	0.46	1.23	0.26
	Model 2	0.83	0.41	1.69	0.61
	Model 3	0.81	0.39	1.68	0.58
Trans fatty acids (g)	**Model 1**	1.93	0.87	4.27	0.11
	Model 2	0.88	0.29	2.72	0.83
	Model 3	0.95	0.30	2.99	0.92

Model 1: Unadjusted
Model 2: Adjusted for gender, age, ethnicity, education, Employment status and energy
Model 3: Adjusted for gender, age, ethnicity, education, Employment status, energy, physical activity, frequent dining out, skipping breakfast and quick finishing meals

Table 35: Association of nutrient intakes across ethnicities associated with low HDL-Cholesterol

		Malay (n=147)				Chinese (n=228)				Indian (n=106)			
			95% CI				95% CI				95% CI		
Nutrient		OR	Lower	Upper	P-value	OR	Lower	Upper	P-value	OR	Lower	Upper	P-value
Protein (g)	**Model 1**	0.99	0.99	1.00	0.24	1.00	0.99	1.01	0.99	1.01	1.00	1.03	0.09
	Model 2	0.99	0.97	1.00	0.09	1.02	1.00	1.05	0.06	1.01	0.98	1.03	0.55
	Model 3	0.99	0.97	1.01	0.21	1.03	1.00	1.05	0.05	1.01	0.98	1.04	0.48
Fats (g)	**Model 1**	1.00	0.99	1.01	0.95	1.00	0.99	1.01	0.79	1.00	0.99	1.01	0.58
	Model 2	1.00	0.99	1.01	0.65	1.01	0.99	1.03	0.26	0.99	0.98	1.00	0.11
	Model 3	1.00	0.99	1.01	0.45	1.01	0.99	1.03	0.29	0.99	0.97	1.00	0.09
Carbohydrates (g)	**Model 1**	1.00	1.00	1.00	0.65	1.00	0.99	1.00	0.12	1.00	1.00	1.01	0.03
	Model 2	1.00	1.00	1.01	0.34	0.99	0.99	1.00	0.09	1.01	1.00	1.01	0.08
	Model 3	1.00	1.00	1.01	0.26	0.99	0.98	1.00	0.11	1.01	1.00	1.01	0.07
Fibre (g)	**Model 1**	1.00	0.99	1.02	0.76	0.99	0.96	1.02	0.45	1.02	0.99	1.05	0.18
	Model 2	1.00	0.99	1.02	0.72	1.00	0.96	1.03	0.73	1.01	0.98	1.04	0.69
	Model 3	1.01	0.99	1.03	0.49	1.00	0.97	1.03	0.88	1.01	0.98	1.04	0.68
Calcium (mg)	**Model 1**	1.00	1.00	1.00	0.39	1.00	1.00	1.00	0.78	1.00	1.00	1.00	0.29
	Model 2	1.00	1.00	1.00	0.57	1.00	1.00	1.00	0.77	1.00	1.00	1.00	0.70
	Model 3	1.00	1.00	1.00	0.95	1.00	1.00	1.00	0.53	1.00	1.00	1.00	0.83
Iron (mg)	**Model 1**	1.00	0.96	1.03	0.89	0.97	0.92	1.03	0.28	1.07	1.00	1.14	0.06
	Model 2	1.00	0.95	1.06	0.89	0.98	0.90	1.07	0.65	1.05	0.94	1.16	0.40
	Model 3	1.01	0.96	1.07	0.68	1.00	0.92	1.09	0.99	1.05	0.94	1.16	0.40
Sodium (mg)	**Model 1**	1.00	1.00	1.00	0.97	1.00	1.00	1.00	0.93	1.00	1.00	1.00	0.37
	Model 2	1.00	1.00	1.00	0.69	1.00	1.00	1.00	0.50	1.00	1.00	1.00	0.83
	Model 3	1.00	1.00	1.00	0.72	1.00	1.00	1.00	0.30	1.00	1.00	1.00	0.81
Potassium (mg)	**Model 1**	1.00	1.00	1.00	0.96	1.00	1.00	1.00	0.71	1.00	1.00	1.00	0.09
	Model 2	1.00	1.00	1.00	0.67	1.00	1.00	1.00	0.82	1.00	1.00	1.00	0.49
	Model 3	1.00	1.00	1.00	0.43	1.00	1.00	1.00	0.70	1.00	1.00	1.00	0.44
Retinol (µg)	**Model 1**	1.00	1.00	1.00	0.62	1.00	1.00	1.00	0.76	1.00	1.00	1.00	0.59
	Model 2	1.00	1.00	1.00	0.33	1.00	1.00	1.00	0.95	1.00	1.00	1.00	0.07
	Model 3	1.00	1.00	1.00	0.36	1.00	1.00	1.00	0.64	1.00	1.00	1.00	0.09
Niacin (mg)	**Model 1**	1.00	0.97	1.02	0.91	0.98	0.95	1.01	0.22	1.03	0.99	1.08	0.14
	Model 2	1.01	0.98	1.04	0.55	0.98	0.94	1.02	0.35	1.01	0.96	1.06	0.73
	Model 3	1.01	0.98	1.05	0.48	0.99	0.95	1.03	0.68	1.01	0.96	1.06	0.71
Vitamin C (mg)	**Model 1**	1.00	1.00	1.00	0.45	1.00	1.00	1.00	0.88	1.00	1.00	1.00	0.54
	Model 2	1.00	1.00	1.00	0.34	1.00	1.00	1.00	0.86	1.00	0.99	1.00	0.12
	Model 3	1.00	1.00	1.00	0.38	1.00	1.00	1.00	0.73	1.00	0.99	1.00	0.17
Cholesterol (mg)	**Model 1**	1.00	1.00	1.00	0.02	1.00	1.00	1.00	0.62	1.00	1.00	1.00	0.54
	Model 2	1.00	0.99	1.00	0.01	1.00	1.00	1.00	0.81	1.00	1.00	1.00	0.88
	Model 3	1.00	0.99	1.00	0.04	1.00	1.00	1.00	0.99	1.00	1.00	1.00	0.94
Omega-6 PUFA (g)	**Model 1**	1.00	0.95	1.04	0.84	0.97	0.89	1.06	0.50	1.04	0.96	1.12	0.33
	Model 2	0.97	0.91	1.05	0.46	1.02	0.91	1.14	0.78	0.95	0.85	1.07	0.38
	Model 3	0.96	0.89	1.03	0.28	1.01	0.89	1.14	0.87	0.95	0.84	1.06	0.35
Omega-3 PUFA (g)	**Model 1**	0.89	0.39	2.07	0.79	0.99	0.33	3.03	0.99	1.13	0.45	2.83	0.80
	Model 2	0.69	0.21	2.29	0.55	2.19	0.50	9.66	0.30	0.52	0.15	1.78	0.30
	Model 3	0.60	0.17	2.15	0.43	3.38	0.66	17.29	0.14	0.51	0.15	1.80	0.30
Trans fatty acids (g)	**Model 1**	2.06	0.27	15.93	0.49	0.35	0.00	32.41	0.65	0.81	0.16	4.16	0.80
	Model 2	2.74	0.22	33.90	0.43	0.63	0.01	45.56	0.83	0.37	0.05	2.96	0.35
	Model 3	2.34	0.15	36.16	0.54	1.06	0.08	13.59	0.97	0.42	0.05	3.57	0.43

Model 1: Unadjusted
Model 2: Adjusted for gender, age and energy (Malay); gender, education and energy (Chinese); gender, marital status and energy (Indian)
Model 3: Adjusted for Model 2 plus alcohol intake, frequent dining out, late dining, skipping breakfast and quick finishing meals (Malay); Model 2 plus physical activity, frequent dining out and skipping breakfast (Chinese); Model 2 plus skipping breakfast (Indian)

4.2.3.4 Effect of nutrients with MetS component – High triglycerides (hypertriglyceridemia)

A comparison of median nutrient intakes among subjects with normal and high triglycerides levels showed no significant differences between the two groups (Supplementary Table 12). Table 36 explores the association of nutrients with hypertriglyceridemia via logistic regression models. The results indicate no significant association. A very modest association of potassium with high triglycerides has been found among the Malays ($p = 0.029$) (Table 37). Among the Chinese, intake of proteins is positively associated with hypertriglyceridemia after adjusting for sociodemographic and lifestyle factors (Table 37). No association of any nutrient's intake with hypertriglyceridemia was found among the Indians (Table 37).

Table 36: Association of nutrient intakes among Malaysians associated with hypertriglyceridemia (n=481)

			95%CI		
		OR	Lower	Upper	P-value
Protein (g)	**Model 1**	1.00	0.99	1.00	0.72
	Model 2	1.00	0.99	1.01	0.90
	Model 3	1.00	0.99	1.01	0.86
Fats (g)	**Model 1**	1.00	1.00	1.00	0.91
	Model 2	1.00	1.00	1.01	0.33
	Model 3	1.00	1.00	1.01	0.34
Carbohydrates (g)	**Model 1**	1.00	1.00	1.00	0.43
	Model 2	1.00	1.00	1.00	0.28
	Model 3	1.00	1.00	1.00	0.27
Fibre (g)	**Model 1**	1.00	0.99	1.01	0.48
	Model 2	1.00	0.99	1.01	0.63
	Model 3	1.00	0.98	1.01	0.62
Calcium (mg)	**Model 1**	1.00	1.00	1.00	0.20
	Model 2	1.00	1.00	1.00	0.14
	Model 3	1.00	1.00	1.00	0.17
Iron (mg)	**Model 1**	1.00	0.98	1.02	0.99
	Model 2	1.01	0.98	1.04	0.60
	Model 3	1.01	0.98	1.04	0.56
Sodium (mg)	**Model 1**	1.00	1.00	1.00	0.43
	Model 2	1.00	1.00	1.00	0.48
	Model 3	1.00	1.00	1.00	0.54
Potassium (mg)	**Model 1**	1.00	1.00	1.00	0.23
	Model 2	1.00	1.00	1.00	0.23
	Model 3	1.00	1.00	1.00	0.24
Retinol (µg)	**Model 1**	1.00	1.00	1.00	0.17
	Model 2	1.00	1.00	1.00	0.16
	Model 3	1.00	1.00	1.00	0.17
Niacin (mg)	**Model 1**	1.01	0.99	1.02	0.43
	Model 2	1.01	0.99	1.03	0.30
	Model 3	1.01	0.99	1.03	0.27
Vitamin C (mg)	**Model 1**	1.00	1.00	1.00	0.27
	Model 2	1.00	1.00	1.00	0.30
	Model 3	1.00	1.00	1.00	0.32
Cholesterol (mg)	**Model 1**	1.00	1.00	1.00	0.99
	Model 2	1.00	1.00	1.00	0.87
	Model 3	1.00	1.00	1.00	0.81
Omega-6 PUFA (g)	**Model 1**	1.00	0.97	1.03	0.97
	Model 2	1.02	0.97	1.07	0.40
	Model 3	1.02	0.97	1.07	0.42
Omega-3 PUFA (g)	**Model 1**	1.03	0.62	1.71	0.90
	Model 2	1.21	0.65	2.26	0.55
	Model 3	1.22	0.65	2.27	0.54
Trans fatty acids (g)	**Model 1**	1.37	0.67	2.83	0.39
	Model 2	1.67	0.75	3.70	0.21
	Model 3	1.61	0.72	3.58	0.24

Model 1: Unadjusted
Model 2: Adjusted for gender, age, education and energy
Model 3: Adjusted for gender, age, education, energy and skipping breakfast

Table 37: Association of nutrient intakes across ethnicities associated with hypertriglyceridemia

		Malay (n=147)				Chinese (n=228)				Indian (n=106)			
			95% CI				95% CI				95% CI		
Nutrient		OR	Lower	Upper	P-value	OR	Lower	Upper	P-value	OR	Lower	Upper	P-value
Protein (g)	**Model 1**	0.99	0.98	1.00	0.10	1.00	0.99	1.01	0.80	1.01	1.00	1.02	0.16
	Model 2	0.98	0.96	1.01	0.13	1.02	1.00	1.03	0.05	1.00	0.97	1.03	1.00
	Model 3	0.98	0.96	1.01	0.16	1.02	1.00	1.04	0.03	1.01	0.97	1.05	0.56
Fats (g)	**Model 1**	1.00	0.99	1.01	0.78	1.00	0.99	1.01	0.51	1.00	1.00	1.01	0.50
	Model 2	1.00	0.99	1.02	0.44	1.00	0.99	1.01	0.80	1.00	0.99	1.02	0.97
	Model 3	1.00	0.99	1.02	0.52	1.00	0.99	1.01	0.93	1.01	0.98	1.03	0.63
Carbohydrates (g)	**Model 1**	1.00	1.00	1.00	0.24	1.00	1.00	1.00	0.55	1.00	1.00	1.00	0.47
	Model 2	1.00	0.99	1.00	0.62	1.00	0.99	1.00	0.71	1.00	0.99	1.01	0.96
	Model 3	1.00	0.99	1.00	0.69	1.00	0.99	1.00	0.50	1.00	0.99	1.01	0.57
Fibre (g)	**Model 1**	0.99	0.97	1.01	0.21	1.00	0.99	1.02	0.90	1.00	0.98	1.03	0.91
	Model 2	0.98	0.96	1.01	0.20	1.01	0.99	1.03	0.45	1.00	0.96	1.03	0.84
	Model 3	0.98	0.96	1.01	0.23	1.01	0.99	1.02	0.59	1.02	0.98	1.06	0.38
Calcium (mg)	**Model 1**	1.00	1.00	1.00	0.04	1.00	1.00	1.00	0.82	1.00	1.00	1.00	0.69
	Model 2	1.00	1.00	1.00	0.05	1.00	1.00	1.00	0.92	1.00	1.00	1.00	0.51
	Model 3	1.00	1.00	1.00	0.06	1.00	1.00	1.00	0.85	1.00	1.00	1.00	0.97
Iron (mg)	**Model 1**	0.98	0.94	1.02	0.30	1.01	0.98	1.05	0.50	1.03	0.97	1.09	0.38
	Model 2	0.99	0.92	1.05	0.70	1.05	0.99	1.10	0.09	1.00	0.88	1.13	0.95
	Model 3	0.99	0.93	1.06	0.75	1.05	1.00	1.11	0.07	0.99	0.84	1.17	0.93
Sodium (mg)	**Model 1**	1.00	1.00	1.00	0.30	1.00	1.00	1.00	0.98	1.00	1.00	1.00	0.79
	Model 2	1.00	1.00	1.00	0.50	1.00	1.00	1.00	0.58	1.00	1.00	1.00	0.13
	Model 3	1.00	1.00	1.00	0.51	1.00	1.00	1.00	0.38	1.00	1.00	1.00	0.12
Potassium (mg)	**Model 1**	1.00	1.00	1.00	0.04	1.00	1.00	1.00	0.96	1.00	1.00	1.00	0.77
	Model 2	1.00	1.00	1.00	0.03	1.00	1.00	1.00	0.56	1.00	1.00	1.00	0.61
	Model 3	1.00	1.00	1.00	0.03	1.00	1.00	1.00	0.58	1.00	1.00	1.00	0.57
Retinol (µg)	**Model 1**	1.00	1.00	1.00	0.22	1.00	1.00	1.00	0.73	1.00	1.00	1.00	0.54
	Model 2	1.00	1.00	1.00	0.28	1.00	1.00	1.00	0.93	1.00	1.00	1.00	0.10
	Model 3	1.00	1.00	1.00	0.25	1.00	1.00	1.00	0.93	1.00	1.00	1.00	0.26
Niacin (mg)	**Model 1**	0.99	0.97	1.02	0.70	1.01	0.99	1.03	0.26	1.01	0.97	1.05	0.54
	Model 2	1.01	0.97	1.05	0.53	1.02	0.99	1.04	0.17	1.02	0.95	1.09	0.68
	Model 3	1.01	0.97	1.05	0.55	1.02	1.00	1.04	0.09	1.05	0.95	1.16	0.36
Vitamin C (mg)	**Model 1**	1.00	1.00	1.00	0.27	1.00	1.00	1.00	0.84	1.00	1.00	1.00	0.64
	Model 2	1.00	1.00	1.00	0.41	1.00	1.00	1.00	0.98	1.00	0.99	1.00	0.38
	Model 3	1.00	1.00	1.00	0.39	1.00	1.00	1.00	0.97	1.00	0.99	1.00	0.33
Cholesterol (mg)	**Model 1**	1.00	1.00	1.00	0.18	1.00	1.00	1.00	0.70	1.00	1.00	1.01	0.07
	Model 2	1.00	0.99	1.00	0.14	1.00	1.00	1.00	0.19	1.00	1.00	1.01	0.74
	Model 3	1.00	0.99	1.00	0.16	1.00	1.00	1.00	0.08	1.00	1.00	1.01	0.37
Omega-6 PUFA (g)	**Model 1**	1.01	0.96	1.06	0.68	0.98	0.92	1.03	0.41	1.03	0.96	1.10	0.48
	Model 2	1.03	0.95	1.12	0.44	0.98	0.90	1.07	0.66	1.02	0.90	1.16	0.79
	Model 3	1.03	0.95	1.12	0.49	0.99	0.91	1.08	0.86	1.07	0.91	1.26	0.39
Omega-3 PUFA (g)	**Model 1**	1.17	0.46	2.97	0.74	0.80	0.36	1.75	0.57	1.40	0.55	3.58	0.49
	Model 2	1.42	0.34	5.95	0.63	1.03	0.38	2.79	0.96	0.77	0.20	3.01	0.70
	Model 3	1.32	0.31	5.61	0.71	1.43	0.49	4.22	0.52	0.69	0.13	3.71	0.67
Trans fatty acids (g)	**Model 1**	2.41	0.26	22.37	0.44	1.13	0.45	2.83	0.80	1.91	0.36	10.02	0.45
	Model 2	4.31	0.24	78.88	0.32	1.40	0.52	3.78	0.51	0.78	0.05	12.19	0.86
	Model 3	4.04	0.21	76.69	0.35	1.47	0.54	3.99	0.45	5.77	0.09	373.16	0.41

Model 1: Unadjusted
Model 2: Adjusted for marital status, education, employment and energy (Malay); gender, age, employment and energy (Chinese); gender, age, marital status, employment and energy (Indian)
Model 3: Adjusted for Model 2 plus late dining (Malay); Model 2 plus physical activity and alcohol intake (Chinese); Model 2 plus physical activity, smoking, alcohol intake, frequent dining out and late dining (Indian)

4.2.3.5 Effect of nutrients with MetS component – High fasting blood glucose (hyperglycemia)

A comparison of median nutrient intake among subjects with normal and high fasting blood glucose levels showed reduced intake of carbohydrates and calcium and increased intake of trans fatty acids among fasting hyperglycemic subjects (Supplementary Table 13). Table 38 shows logistic regression models exploring the association of nutrient intakes with fasting hyperglycemia among Malaysian adults in Johor. The analysis reveals that hyperglycemic subjects consume more fats and less carbohydrates. Higher intakes are also observed for omega-6-PUFA and omega-3-PUFA by hyperglycemic subjects. Higher intake of omega-3-PUFA was associated with more than 3-fold odds of fasting hyperglycemia (AOR = 3.57 [95% CI = 1.65-7.73]), when adjusted for socio-demographic and lifestyle characteristics. Similarly, intake of trans fatty acids was also associated with more than 3-fold odds of fasting hyperglycemia (AOR = 3.25 [95% CI = 1.33-7.99]). Table 39 shows the logistic regression analysis among the Malays, revealing higher median intakes of protein, omega-6-PUFA and omega-3-PUFA. In fact, intake of omega-3-PUFA by the Malays increased the odds of fasting hyperglycemia by more than 17-fold after adjusting for age, marital status, education, energy and quick finishing of meals (p = 0.001). No association of nutrient intake and fasting hyperglycemia was found among the Chinese after adjusting for sociodemographic and lifestyle factors (Table 39). However, among the hyperglycemic Indians, intakes of fats were higher (AOR = 1.04 [95% CI = 1.00-1.08]), while intakes of carbohydrates were lower (AOR = 0.98 [95% CI = 0.96-0.99]) when adjusted for the socio-demographic and lifestyle factors (Table 39). Moreover, intakes of omega-6-PUFA were also found to be higher among the Indians with high fasting blood glucose (AOR = 1.41 [95%CI = 1.04-1.89]). The analysis further reveals that the intake of trans fatty acids were a lot higher among the Indian subjects with fasting hyperglycemia (p = 0.049), when adjusted for the socio-demographic and lifestyle factors.

Table 38: Association of nutrient intakes among Malaysians associated with hyperglycemia (n=481)

			95%CI		
		OR	Lower	Upper	P-value
Protein (g)	**Model 1**	1.00	0.99	1.01	0.99
	Model 2	1.01	1.00	1.02	0.11
	Model 3	1.01	1.00	1.02	0.17
Fats (g)	**Model 1**	1.00	1.00	1.01	0.19
	Model 2	1.01	1.00	1.02	0.00
	Model 3	1.01	1.00	1.02	0.00
Carbohydrates (g)	**Model 1**	1.00	1.00	1.00	0.07
	Model 2	0.99	0.99	1.00	0.00
	Model 3	0.99	0.99	1.00	0.00
Fibre (g)	**Model 1**	1.00	0.99	1.01	0.84
	Model 2	1.00	0.99	1.02	0.85
	Model 3	1.00	0.99	1.02	0.77
Calcium (mg)	**Model 1**	1.00	1.00	1.00	0.25
	Model 2	1.00	1.00	1.00	0.24
	Model 3	1.00	1.00	1.00	0.23
Iron (mg)	**Model 1**	0.98	0.96	1.01	0.23
	Model 2	0.98	0.94	1.02	0.30
	Model 3	0.98	0.94	1.02	0.37
Sodium (mg)	**Model 1**	1.00	1.00	1.00	0.59
	Model 2	1.00	1.00	1.00	0.40
	Model 3	1.00	1.00	1.00	0.37
Potassium (mg)	**Model 1**	1.00	1.00	1.00	0.91
	Model 2	1.00	1.00	1.00	0.73
	Model 3	1.00	1.00	1.00	0.68
Retinol (µg)	**Model 1**	1.00	1.00	1.00	0.87
	Model 2	1.00	1.00	1.00	1.00
	Model 3	1.00	1.00	1.00	0.95
Niacin (mg)	**Model 1**	0.99	0.98	1.01	0.41
	Model 2	0.99	0.97	1.01	0.44
	Model 3	0.99	0.97	1.02	0.58
Vitamin C (mg)	**Model 1**	1.00	1.00	1.00	0.49
	Model 2	1.00	1.00	1.00	0.53
	Model 3	1.00	1.00	1.00	0.42
Cholesterol (mg)	**Model 1**	1.00	1.00	1.00	0.99
	Model 2	1.00	1.00	1.00	0.26
	Model 3	1.00	1.00	1.00	0.43
Omega-6 PUFA (g)	**Model 1**	1.02	0.99	1.05	0.22
	Model 2	1.09	1.03	1.15	0.00
	Model 3	1.10	1.04	1.16	0.00
Omega-3 PUFA (g)	**Model 1**	1.42	0.83	2.44	0.20
	Model 2	3.38	1.59	7.18	0.00
	Model 3	3.57	1.65	7.73	0.00
Trans fatty acids (g)	**Model 1**	2.08	0.94	4.62	0.07
	Model 2	3.11	1.28	7.56	0.01
	Model 3	3.25	1.33	7.99	0.01

Model 1: Unadjusted
Model 2: Adjusted for gender, age, ethnicity, education, Employment status and energy
Model 3: Adjusted for gender, age, ethnicity, education, Employment status, energy, smoking status, frequent dining out, late dining and quick finishing meals

Table 39: Association of nutrient intakes across ethnicities associated with hyperglycemia

		Malay (n=147)				Chinese (n=228)				Indian (n=106)			
			95% CI				95% CI				95% CI		
Nutrient		OR	Lower	Upper	P-value	OR	Lower	Upper	P-value	OR	Lower	Upper	P-value
Protein (g)	**Model 1**	1.01	1.00	1.02	0.19	0.99	0.97	1.00	0.03	1.00	0.99	1.02	0.82
	Model 2	1.03	1.01	1.05	0.01	1.00	0.98	1.02	0.93	0.99	0.96	1.02	0.57
	Model 3	1.03	1.01	1.05	0.01	1.00	0.98	1.03	0.91	0.99	0.96	1.03	0.67
Fats (g)	**Model 1**	1.00	1.00	1.01	0.66	1.00	0.99	1.01	0.38	1.00	1.00	1.01	0.34
	Model 2	1.01	0.99	1.02	0.39	1.01	1.00	1.03	0.18	1.02	1.00	1.04	0.11
	Model 3	1.01	0.99	1.02	0.35	1.01	0.99	1.03	0.19	1.04	1.00	1.08	0.04
Carbohydrates (g)	**Model 1**	1.00	1.00	1.00	0.19	1.00	0.99	1.00	0.01	1.00	1.00	1.00	0.64
	Model 2	1.00	0.99	1.00	0.06	1.00	0.99	1.00	0.19	0.99	0.98	1.00	0.09
	Model 3	1.00	0.99	1.00	0.06	1.00	0.99	1.00	0.18	0.98	0.96	1.00	0.01
Fibre (g)	**Model 1**	1.01	0.99	1.02	0.38	0.98	0.96	1.01	0.20	1.00	0.97	1.03	0.84
	Model 2	1.01	0.99	1.03	0.64	1.00	0.97	1.03	0.90	0.99	0.95	1.03	0.56
	Model 3	1.00	0.98	1.03	0.67	1.00	0.97	1.04	0.86	0.99	0.95	1.04	0.77
Calcium (mg)	**Model 1**	1.00	1.00	1.00	0.44	1.00	1.00	1.00	0.36	1.00	1.00	1.00	0.87
	Model 2	1.00	1.00	1.00	0.14	1.00	1.00	1.00	0.58	1.00	1.00	1.00	0.52
	Model 3	1.00	1.00	1.00	0.16	1.00	1.00	1.00	0.84	1.00	1.00	1.00	0.73
Iron (mg)	**Model 1**	1.00	0.96	1.04	0.88	0.95	0.91	1.01	0.08	0.99	0.92	1.07	0.84
	Model 2	0.99	0.93	1.05	0.72	0.98	0.91	1.06	0.64	0.92	0.81	1.05	0.23
	Model 3	1.00	0.94	1.06	0.86	0.99	0.91	1.07	0.71	0.92	0.79	1.08	0.29
Sodium (mg)	**Model 1**	1.00	1.00	1.00	0.36	1.00	1.00	1.00	0.70	1.00	1.00	1.00	0.76
	Model 2	1.00	1.00	1.00	0.47	1.00	1.00	1.00	0.29	1.00	1.00	1.00	0.26
	Model 3	1.00	1.00	1.00	0.60	1.00	1.00	1.00	0.44	1.00	1.00	1.00	0.83
Potassium (mg)	**Model 1**	1.00	1.00	1.00	0.26	1.00	1.00	1.00	0.27	1.00	1.00	1.00	0.70
	Model 2	1.00	1.00	1.00	0.37	1.00	1.00	1.00	0.55	1.00	1.00	1.00	0.33
	Model 3	1.00	1.00	1.00	0.41	1.00	1.00	1.00	0.73	1.00	1.00	1.00	0.55
Retinol (µg)	**Model 1**	1.00	1.00	1.00	0.68	1.00	1.00	1.00	0.61	1.00	1.00	1.00	0.30
	Model 2	1.00	1.00	1.00	0.71	1.00	1.00	1.00	0.21	1.00	1.00	1.00	0.11
	Model 3	1.00	1.00	1.00	0.56	1.00	1.00	1.00	0.57	1.00	1.00	1.00	0.16
Niacin (mg)	**Model 1**	1.00	0.98	1.03	0.88	0.99	0.97	1.02	0.54	0.99	0.94	1.04	0.66
	Model 2	1.00	0.97	1.04	0.86	1.00	0.97	1.03	0.99	0.96	0.89	1.04	0.30
	Model 3	1.01	0.97	1.05	0.62	1.01	0.98	1.04	0.66	0.96	0.88	1.05	0.39
Vitamin C (mg)	**Model 1**	1.00	1.00	1.00	0.39	1.00	1.00	1.00	0.55	1.00	0.99	1.00	0.39
	Model 2	1.00	1.00	1.00	0.71	1.00	1.00	1.00	0.19	1.00	0.99	1.00	0.24
	Model 3	1.00	1.00	1.00	0.75	1.00	1.00	1.00	0.49	0.99	0.99	1.00	0.20
Cholesterol (mg)	**Model 1**	1.00	1.00	1.00	0.40	1.00	1.00	1.00	0.23	1.00	1.00	1.00	0.64
	Model 2	1.00	1.00	1.00	0.35	1.00	1.00	1.00	0.88	1.00	1.00	1.01	0.83
	Model 3	1.00	1.00	1.00	0.37	1.00	1.00	1.00	1.00	1.00	0.99	1.01	0.80
Omega-6 PUFA (g)	**Model 1**	1.03	0.98	1.07	0.29	0.95	0.88	1.03	0.24	1.03	0.95	1.11	0.48
	Model 2	1.08	1.00	1.17	0.06	1.05	0.94	1.17	0.36	1.11	0.96	1.28	0.17
	Model 3	1.08	1.00	1.17	0.05	1.08	0.96	1.22	0.18	1.41	1.04	1.90	0.03
Omega-3 PUFA (g)	**Model 1**	3.54	1.45	8.66	0.01	0.70	0.26	1.89	0.48	1.19	0.39	3.68	0.76
	Model 2	16.57	3.15	87.05	0.00	2.16	0.59	7.95	0.25	1.13	0.22	5.79	0.88
	Model 3	17.22	3.15	94.21	0.00	1.70	0.42	6.93	0.46	2.39	0.25	23.22	0.45
Trans fatty acids (g)	**Model 1**	3.04	0.36	25.81	0.31	1.07	0.34	3.36	0.91	9.07	1.11	74.14	0.04
	Model 2	3.24	0.21	49.29	0.40	2.06	0.62	6.89	0.24	28.17	0.53	1498.83	0.10
	Model 3	3.75	0.24	57.60	0.34	2.34	0.67	8.22	0.18	2237.09	1.03	4851889.00	0.05

Model 1: Unadjusted
Model 2: Adjusted for age, marital status, education and energy (Malay); gender, age, employment status and energy (Chinese); gender, age, marital status and energy (Indian)
Model 3: Adjusted for Model 2 plus quick finishing of meals (Malay); Model 2 plus smoking status, frequent dining out and skipping breakfast (Chinese); Model 2 plus physical activity, smoking status, alcohol consumption, late dining and skipping breakfast (Indian)

4.2.4 Effect of diet patterns with MetS components

As mentioned in chapter 4.1 that the three major diet patterns were identified in this Johor cohort. However, no association of any diet pattern with MetS was found. In order to study the relationship of these diet patterns with individual components of metabolic syndrome, regression analysis models were carried out on the data.

4.2.4.1 Effect of diet patterns with MetS component – Abdominal obesity

Table 40 shows the regression analysis models for studying the association of the three identified diet patterns with abdominal obesity. Results indicate that higher intakes (Q2 and Q3) of diet pattern 2 (noodle soup, chocolates, soy milk and potatoes) were associated with abdominal obesity when adjusted for gender, age, ethnicity, marital status, education, employment status and energy ($p < 0.05$). This effect disappears when the model is further adjusted with lifestyle factors. Table 41 shows the adjusted models among the Malays indicating that modest consumption (Q2) of diet pattern 1 consisting of legumes, cruciferous vegetables, roots and fruit vegetables is associated with abdominal obesity among this ethnic group when adjusted for gender, marital status, education, employment status and energy ($p = 0.039$). The association remains even when the model is further adjusted for smoking status. On the other hand, no significant association of any diet pattern with abdominal obesity is seen among the Chinese (Table 42). However, among the Indians, increased intake of diet pattern 3 (chicken rice, fried noodles, nasi lemak) has been found to be associated with more than 15 times odds of abdominal obesity (AOR = 15.19 [95%CI = 1.38-167.48]) after adjusting for sociodemographic and lifestyle factors (Table 43).

Table 40: Association for abdominal obesity across quartile (Q) categories of the identified diet patterns among Malaysians (n=481)

	Characteristic		OR	95% CI		P-value	P-value for trend
				Lower	Upper		
Model 1	**Pattern 1**	**Q1**	1.00				0.36
		Q2	1.34	0.80	2.25	0.27	
		Q3	1.50	0.89	2.52	0.13	
		Q4	1.24	0.74	2.07	0.42	
Model 2	**Pattern 1**	**Q1**	1.00				< 0.01
		Q2	1.57	0.89	2.78	0.12	
		Q3	1.59	0.88	2.88	0.13	
		Q4	1.24	0.67	2.28	0.50	
Model 3	**Pattern 1**	**Q1**	1.00				< 0.01
		Q2	1.57	0.88	2.81	0.13	
		Q3	1.52	0.83	2.78	0.17	
		Q4	1.16	0.62	2.15	0.65	
Model 1	**Pattern 2**	**Q1**	1.00				0.43
		Q2	1.49	0.88	2.51	0.14	
		Q3	1.37	0.82	2.29	0.24	
		Q4	1.13	0.68	1.89	0.64	
Model 2	**Pattern 2**	**Q1**	1.00				< 0.01
		Q2	1.82	1.01	3.28	0.05	
		Q3	1.92	1.06	3.47	0.03	
		Q4	1.23	0.66	2.29	0.51	
Model 3	**Pattern 2**	**Q1**	1.00				< 0.01
		Q2	1.67	0.92	3.02	0.09	
		Q3	1.76	0.96	3.21	0.07	
		Q4	1.07	0.56	2.02	0.85	
Model 1	**Pattern 3**	**Q1**	1.00				0.88
		Q2	0.88	0.52	1.48	0.63	
		Q3	1.06	0.62	1.79	0.84	
		Q4	1.05	0.62	1.79	0.85	
Model 2	**Pattern 3**	**Q1**	1.00				< 0.01
		Q2	0.98	0.55	1.76	0.95	
		Q3	1.18	0.64	2.15	0.60	
		Q4	1.17	0.61	2.22	0.64	
Model 3	**Pattern 3**	**Q1**	1.00				< 0.01
		Q2	0.99	0.55	1.79	0.97	
		Q3	1.22	0.67	2.25	0.52	
		Q4	1.18	0.61	2.26	0.62	

Model 1: Unadjusted
Model 2: Adjusted for gender, age, ethnicity, marital status, education, employment status and energy
Model 3: Adjusted for gender, age, ethnicity, marital status, education, employment status, energy, physical activity, smoking status and frequent dining out

Table 41: Association for abdominal obesity across quartile (Q) categories of the identified diet patterns among Malays (n=147)

			Malay				
	Characteristic		OR	95% CI		P-value	P-value for trend
				Lower	Upper		
Model 1	**Pattern 1**	**Q1**	1.00				0.25
		Q2	2.31	0.89	6.00	0.09	
		Q3	1.64	0.58	4.59	0.35	
		Q4	2.18	0.80	5.96	0.13	
Model 2	**Pattern 1**	**Q1**	1.00				0.03
		Q2	3.04	1.06	8.73	0.04	
		Q3	2.04	0.67	6.19	0.21	
		Q4	1.91	0.62	5.89	0.26	
Model 3	**Pattern 1**	**Q1**	1.00				0.04
		Q2	3.04	1.06	8.72	0.04	
		Q3	2.04	0.67	6.17	0.21	
		Q4	1.90	0.62	5.88	0.26	
Model 1	**Pattern 2**	**Q1**	1.00				0.12
		Q2	2.53	0.92	6.94	0.07	
		Q3	2.45	0.93	6.45	0.07	
		Q4	1.06	0.39	2.89	0.92	
Model 2	**Pattern 2**	**Q1**	1.00				0.02
		Q2	2.03	0.69	5.96	0.20	
		Q3	2.71	0.92	8.02	0.07	
		Q4	0.83	0.25	2.81	0.77	
Model 3	**Pattern 2**	**Q1**	1.00				0.03
		Q2	2.03	0.69	5.96	0.20	
		Q3	2.70	0.91	8.04	0.07	
		Q4	0.83	0.24	2.81	0.76	
Model 1	**Pattern 3**	**Q1**	1.00				0.88
		Q2	1.16	0.32	4.21	0.82	
		Q3	1.15	0.33	3.94	0.83	
		Q4	0.83	0.25	2.75	0.77	
Model 2	**Pattern 3**	**Q1**	1.00				0.10
		Q2	1.38	0.34	5.64	0.65	
		Q3	1.37	0.35	5.37	0.66	
		Q4	0.95	0.23	3.83	0.94	
Model 3	**Pattern 3**	**Q1**	1.00				0.14
		Q2	1.36	0.33	5.64	0.67	
		Q3	1.34	0.34	5.38	0.68	
		Q4	0.94	0.23	3.82	0.93	

Model 1: Unadjusted
Model 2: Adjusted for gender, marital status, education, employment status and energy
Model 3: Adjusted for gender, marital status, education, employment status, energy and smoking

Table 42: Association for abdominal obesity across quartile (Q) categories of the identified diet patterns among Chinese (n=228)

	Chinese						
	Characteristic		OR	95% CI		P-value	P-value for trend
				Lower	Upper		
Model 1	**Pattern 1**	**Q1**	1.00				0.17
		Q2	1.00	0.48	2.08	0.99	
		Q3	1.07	0.52	2.23	0.85	
		Q4	0.85	0.40	1.81	0.68	
Model 2	**Pattern 1**	**Q1**	1.00				0.02
		Q2	1.14	0.51	2.51	0.76	
		Q3	1.11	0.50	2.47	0.79	
		Q4	0.90	0.39	2.10	0.81	
Model 3	**Pattern 1**	**Q1**	1.00				-
		Q2	-	-	-	-	
		Q3	-	-	-	-	
		Q4	-	-	-	-	
Model 1	**Pattern 2**	**Q1**	1.00				0.88
		Q2	1.21	0.57	2.55	0.62	
		Q3	0.99	0.47	2.07	0.97	
		Q4	1.25	0.59	2.63	0.56	
Model 2	**Pattern 2**	**Q1**	1.00				0.01
		Q2	1.64	0.73	3.71	0.23	
		Q3	1.50	0.66	3.43	0.33	
		Q4	1.65	0.71	3.86	0.25	
Model 3	**Pattern 2**	**Q1**	1.00				-
		Q2	-	-	-	-	
		Q3	-	-	-	-	
		Q4	-	-	-	-	
Model 1	**Pattern 3**	**Q1**	1.00				0.57
		Q2	0.67	0.33	1.35	0.26	
		Q3	0.90	0.44	1.85	0.77	
		Q4	1.10	0.51	2.37	0.82	
Model 2	**Pattern 3**	**Q1**	1.00				0.01
		Q2	0.84	0.39	1.80	0.66	
		Q3	1.06	0.48	2.32	0.89	
		Q4	1.39	0.58	3.30	0.46	
Model 3	**Pattern 3**	**Q1**	1.00				-
		Q2	-	-	-	-	
		Q3	-	-	-	-	
		Q4	-	-	-	-	

Model 1: Unadjusted
Model 2: Adjusted for age, marital status, education and energy

Table 43: Association for abdominal obesity across quartile (Q) categories of the identified diet patterns among Indians (n=106)

			Indian				
	Characteristic		OR	95% CI		P-value	P-value for trend
				Lower	Upper		
Model 1	**Pattern 1**	**Q1**	1.00				0.46
		Q2	1.00	0.15	6.53	1.00	
		Q3	1.83	0.29	11.67	0.52	
		Q4	0.67	0.12	3.68	0.64	
Model 2	**Pattern 1**	**Q1**	1.00				0.03
		Q2	4.65	0.47	45.64	0.19	
		Q3	5.08	0.56	46.41	0.15	
		Q4	2.99	0.33	27.45	0.33	
Model 3	**Pattern 1**	**Q1**	1.00				0.00
		Q2	4.56	0.40	51.63	0.22	
		Q3	7.58	0.64	90.44	0.11	
		Q4	3.64	0.36	37.27	0.28	
Model 1	**Pattern 2**	**Q1**	1.00				0.33
		Q2	1.15	0.23	5.88	0.87	
		Q3	2.10	0.31	14.15	0.45	
		Q4	0.56	0.13	2.35	0.43	
Model 2	**Pattern 2**	**Q1**	1.00				0.02
		Q2	3.04	0.46	20.09	0.25	
		Q3	3.25	0.40	26.32	0.27	
		Q4	1.17	0.21	6.51	0.86	
Model 3	**Pattern 2**	**Q1**	1.00				< 0.01
		Q2	6.55	0.73	58.47	0.09	
		Q3	15.14	0.88	259.50	0.06	
		Q4	1.04	0.17	6.53	0.97	
Model 1	**Pattern 3**	**Q1**	1.00				0.79
		Q2	1.39	0.35	5.51	0.64	
		Q3	1.39	0.31	6.27	0.67	
		Q4	0.73	0.20	2.62	0.63	
Model 2	**Pattern 3**	**Q1**	1.00				0.02
		Q2	2.71	0.52	14.07	0.24	
		Q3	5.25	0.75	36.68	0.09	
		Q4	2.51	0.41	15.25	0.32	
Model 3	**Pattern 3**	**Q1**	1.00				< 0.01
		Q2	3.23	0.50	20.97	0.22	
		Q3	15.19	1.38	167.49	0.03	
		Q4	3.84	0.54	27.60	0.18	

Model 1: Unadjusted
Model 2: Adjusted for age, education, employment status and energy
Model 3: Adjusted for age, education, employment status, energy, smoking status, alcohol consumption, quick finishing of meals

4.2.4.2 Effect of diet patterns with MetS component – High blood pressure

Table 44 shows the regression analysis models for investigating any association of the three identified diet patterns with high blood pressure. No significant association was found on the increasing intake of the three diet patterns with high blood pressure. Tables 45-47 show the regression models across the three Malaysian races, yielding no significant influence of diet patterns on high blood pressure.

Table 44: Association for high blood pressure across quartile (Q) categories of the identified diet patterns among Malaysians (n=481)

	Characteristic		OR	95% CI		P-value	P-value for trend
				Lower	Upper		
Model 1	**Pattern 1**	**Q1**	1.00				0.62
		Q2	1.12	0.67	1.88	0.66	
		Q3	0.83	0.50	1.38	0.48	
		Q4	0.85	0.51	1.41	0.53	
Model 2	**Pattern 1**	**Q1**	1.00				< 0.01
		Q2	1.32	0.75	2.32	0.33	
		Q3	0.86	0.49	1.51	0.60	
		Q4	0.90	0.50	1.64	0.73	
Model 3	**Pattern 1**	**Q1**	1.00				< 0.01
		Q2	1.41	0.80	2.50	0.23	
		Q3	0.86	0.49	1.52	0.61	
		Q4	0.83	0.45	1.52	0.55	
Model 1	**Pattern 2**	**Q1**	1.00				0.69
		Q2	1.04	0.62	1.74	0.88	
		Q3	0.79	0.48	1.31	0.37	
		Q4	1.02	0.61	1.70	0.94	
Model 2	**Pattern 2**	**Q1**	1.00				< 0.01
		Q2	1.41	0.80	2.48	0.24	
		Q3	1.05	0.60	1.84	0.87	
		Q4	1.34	0.74	2.44	0.34	
Model 3	**Pattern 2**	**Q1**	1.00				< 0.01
		Q2	1.44	0.81	2.55	0.21	
		Q3	1.06	0.60	1.86	0.84	
		Q4	1.36	0.74	2.49	0.33	
Model 1	**Pattern 3**	**Q1**	1.00				0.85
		Q2	1.10	0.66	1.84	0.72	
		Q3	0.88	0.53	1.48	0.63	
		Q4	1.03	0.61	1.74	0.91	
Model 2	**Pattern 3**	**Q1**	1.00				< 0.01
		Q2	1.54	0.88	2.70	0.13	
		Q3	1.09	0.61	1.93	0.77	
		Q4	1.28	0.69	2.37	0.44	
Model 3	**Pattern 3**	**Q1**	1.00				< 0.01
		Q2	1.50	0.85	2.65	0.16	
		Q3	1.08	0.60	1.92	0.80	
		Q4	1.21	0.65	2.26	0.55	

Model 1: Unadjusted
Model 2: Adjusted for gender, age, ethnicity, marital status, education and energy
Model 3: Adjusted for gender, age, ethnicity, marital status, education, energy and physical activity

Table 45: Association for high blood pressure across quartile (Q) categories of the identified diet patterns among Malays (n=147)

			Malay				
	Characteristic		OR	95% CI		P-value	P-value for trend
				Lower	Upper		
Model 1	**Pattern 1**	**Q1**	1.00				0.44
		Q2	2.00	0.81	4.95	0.13	
		Q3	1.11	0.42	2.92	0.83	
		Q4	1.03	0.42	2.51	0.95	
Model 2	**Pattern 1**	**Q1**	1.00				0.15
		Q2	2.40	0.91	6.31	0.08	
		Q3	1.40	0.50	3.90	0.52	
		Q4	1.08	0.39	2.98	0.88	
Model 3	**Pattern 1**	**Q1**	1.00				-
		Q2	-	-	-	-	
		Q3	-	-	-	-	
		Q4	-	-	-	-	
Model 1	**Pattern 2**	**Q1**	1.00				0.21
		Q2	1.51	0.60	3.75	0.38	
		Q3	0.73	0.31	1.70	0.46	
		Q4	2.07	0.70	6.13	0.19	
Model 2	**Pattern 2**	**Q1**	1.00				0.13
		Q2	1.84	0.68	5.03	0.23	
		Q3	0.94	0.37	2.39	0.90	
		Q4	2.55	0.76	8.59	0.13	
Model 3	**Pattern 2**	**Q1**	1.00				-
		Q2	-	-	-	-	
		Q3	-	-	-	-	
		Q4	-	-	-	-	
Model 1	**Pattern 3**	**Q1**	1.00				0.40
		Q2	2.47	0.73	8.36	0.15	
		Q3	1.22	0.40	3.73	0.73	
		Q4	1.38	0.46	4.16	0.57	
Model 2	**Pattern 3**	**Q1**	1.00				0.11
		Q2	4.06	1.03	16.12	0.05	
		Q3	1.97	0.55	7.03	0.30	
		Q4	2.83	0.74	10.83	0.13	
Model 3	**Pattern 3**	**Q1**	1.00				-
		Q2	-	-	-	-	
		Q3	-	-	-	-	
		Q4	-	-	-	-	

Model 1: Unadjusted
Model 2: Adjusted for age, marital status, education, employment status and energy

Table 46: Association for high blood pressure across quartile (Q) categories of the identified diet patterns among Chinese (n=228)

	Chinese						
	Characteristic		OR	95% CI		P-value	P-value for trend
				Lower	Upper		
Model 1	**Pattern 1**	**Q1**	1.00				0.78
		Q2	0.87	0.42	1.80	0.70	
		Q3	0.71	0.34	1.47	0.35	
		Q4	0.94	0.45	2.00	0.88	
Model 2	**Pattern 1**	**Q1**	1.00				0.00
		Q2	0.86	0.38	1.92	0.71	
		Q3	0.56	0.25	1.25	0.16	
		Q4	1.04	0.46	2.34	0.92	
Model 3	**Pattern 1**	**Q1**	1.00				< 0.001
		Q2	0.90	0.39	2.10	0.81	
		Q3	0.55	0.23	1.27	0.16	
		Q4	0.97	0.42	2.26	0.95	
Model 1	**Pattern 2**	**Q1**	1.00				0.46
		Q2	1.18	0.56	2.51	0.66	
		Q3	0.68	0.32	1.42	0.30	
		Q4	0.80	0.38	1.68	0.56	
Model 2	**Pattern 2**	**Q1**	1.00				0.00
		Q2	1.70	0.74	3.94	0.22	
		Q3	0.91	0.40	2.04	0.81	
		Q4	1.02	0.46	2.31	0.95	
Model 3	**Pattern 2**	**Q1**	1.00				< 0.001
		Q2	1.73	0.69	4.30	0.24	
		Q3	0.96	0.41	2.25	0.92	
		Q4	1.24	0.52	2.99	0.63	
Model 1	**Pattern 3**	**Q1**	1.00				0.91
		Q2	0.85	0.42	1.70	0.64	
		Q3	0.80	0.39	1.65	0.54	
		Q4	0.77	0.36	1.68	0.51	
Model 2	**Pattern 3**	**Q1**	1.00				0.00
		Q2	1.30	0.60	2.83	0.51	
		Q3	1.09	0.49	2.42	0.83	
		Q4	1.08	0.46	2.52	0.86	
Model 3	**Pattern 3**	**Q1**	1.00				< 0.001
		Q2	1.33	0.59	3.01	0.49	
		Q3	1.09	0.47	2.51	0.84	
		Q4	1.07	0.44	2.60	0.89	

Model 1: Unadjusted
Model 2: Adjusted for gender, age, marital status, education and energy
Model 3: Adjusted for gender, age, marital status, education, energy, physical activity, smoking status and late dining of meals

Table 47: Association for high blood pressure across quartile (Q) categories of the identified diet patterns among Indians (n=106)

			Indian				
	Characteristic		OR	95% CI		P-value	P-value for trend
				Lower	Upper		
Model 1	**Pattern 1**	**Q1**	1.00				0.52
		Q2	0.66	0.13	3.21	0.60	
		Q3	0.55	0.13	2.42	0.43	
		Q4	0.38	0.09	1.65	0.19	
Model 2	**Pattern 1**	**Q1**	1.00				<0.01
		Q2	0.60	0.09	4.08	0.60	
		Q3	0.48	0.08	2.84	0.42	
		Q4	0.19	0.03	1.33	0.09	
Model 3	**Pattern 1**	**Q1**	1.00				-
		Q2	-	-	-	-	
		Q3	-	-	-	-	
		Q4	-	-	-	-	
Model 1	**Pattern 2**	**Q1**	1.00				0.32
		Q2	0.51	0.15	1.71	0.28	
		Q3	1.46	0.40	5.33	0.57	
		Q4	0.98	0.31	3.08	0.97	
Model 2	**Pattern 2**	**Q1**	1.00				< 0.01
		Q2	0.80	0.18	3.52	0.77	
		Q3	1.78	0.38	8.32	0.47	
		Q4	0.93	0.22	4.01	0.92	
Model 3	**Pattern 2**	**Q1**	1.00				-
		Q2	-	-	-	-	
		Q3	-	-	-	-	
		Q4	-	-	-	-	
Model 1	**Pattern 3**	**Q1**	1.00				0.88
		Q2	0.91	0.33	2.55	0.86	
		Q3	0.75	0.25	2.28	0.62	
		Q4	1.22	0.41	3.58	0.72	
Model 2	**Pattern 3**	**Q1**	1.00				< 0.01
		Q2	0.89	0.26	3.02	0.85	
		Q3	0.90	0.23	3.48	0.88	
		Q4	0.94	0.23	3.80	0.93	
Model 3	**Pattern 3**	**Q1**	1.00				-
		Q2	-	-	-	-	
		Q3	-	-	-	-	
		Q4	-	-	-	-	

Model 1: Unadjusted
Model 2: Adjusted for gender, age, marital status and energy

4.2.4.3 Effect of diet patterns with MetS component – Low HDL-cholesterol

Table 48 shows the regression analysis models for studying the association of the three identified diet patterns with low HDL-cholesterol. Results indicate that moderately high (Q3) intake of diet pattern 1 (legumes, cruciferous vegetables, roots and fruit vegetables) is associated with more than two-fold increased odds of having low HDL-cholesterol (AOR = 2.44 [95%CI = 1.17-5.09]), after adjusting for socio-demographic and lifestyle characteristics. The effect disappears at highest (Q4) intake of this diet pattern. Tables 49-51 show the regression models across the three Malaysian races regarding influence of diet patterns with low HDL-cholesterol. No association was found among the Malays and the Chinese (Tables 49-50). However, among the Indian subjects an association was observed between higher intakes of pattern 1 (legumes, cruciferous vegetables, roots and fruit vegetables) and pattern 2 (noodle soup, chocolates, soy milk and potatoes) and low HDL-cholesterol while adjusting for socio-demographic and lifestyle characteristics. The highest consumption (Q4) of diet pattern 2 was associated with more than four times odds of having low HDL-cholesterol among the Indians (Table 51).

Table 48: Association for low HDL-cholesterol across quartile (Q) categories of the identified diet patterns among Malaysians (n=481)

	Characteristic		OR	95% CI		P-value	P-value for trend
				Lower	Upper		
Model 1	**Pattern 1**	**Q1**	1.00				0.03
		Q2	1.65	0.91	3.01	0.10	
		Q3	2.17	1.21	3.89	0.01	
		Q4	2.20	1.23	3.94	0.01	
Model 2	**Pattern 1**	**Q1**	1.00				< 0.01
		Q2	1.63	0.82	3.26	0.17	
		Q3	2.03	1.00	4.14	0.05	
		Q4	1.77	0.85	3.68	0.13	
Model 3	**Pattern 1**	**Q1**	1.00				< 0.01
		Q2	2.00	0.98	4.11	0.06	
		Q3	2.44	1.17	5.09	0.02	
		Q4	1.93	0.91	4.09	0.09	
Model 1	**Pattern 2**	**Q1**	1.00				0.33
		Q2	1.21	0.69	2.13	0.51	
		Q3	1.09	0.62	1.93	0.77	
		Q4	1.62	0.93	2.82	0.09	
Model 2	**Pattern 2**	**Q1**	1.00				< 0.01
		Q2	0.98	0.50	1.94	0.95	
		Q3	0.99	0.50	1.96	0.98	
		Q4	1.54	0.74	3.18	0.25	
Model 3	**Pattern 2**	**Q1**	1.00				< 0.01
		Q2	1.00	0.50	2.00	1.00	
		Q3	0.94	0.47	1.88	0.86	
		Q4	1.23	0.57	2.64	0.59	
Model 1	**Pattern 3**	**Q1**	1.00				0.34
		Q2	1.45	0.81	2.59	0.21	
		Q3	1.35	0.75	2.43	0.31	
		Q4	1.70	0.95	3.03	0.07	
Model 2	**Pattern 3**	**Q1**	1.00				< 0.01
		Q2	1.65	0.81	3.36	0.17	
		Q3	1.60	0.76	3.38	0.22	
		Q4	1.84	0.84	4.03	0.13	
Model 3	**Pattern 3**	**Q1**	1.00				< 0.01
		Q2	1.59	0.77	3.29	0.21	
		Q3	1.59	0.75	3.38	0.23	
		Q4	1.63	0.72	3.67	0.24	

Model 1: Unadjusted
Model 2: Adjusted for gender, age, ethnicity, education, employment status and energy
Model 3: Adjusted for gender, age, ethnicity, education, employment status, energy, physical activity, frequent dining out, skipping breakfast and quick finishing meals

Table 49: Association for low HDL-cholesterol across quartile (Q) categories of the identified diet patterns among Malays (n=147)

			Malay				
	Characteristic		OR	95% CI		P-value	P-value for trend
				Lower	Upper		
Model 1	**Pattern 1**	**Q1**	1.00				0.31
		Q2	2.18	0.89	5.31	0.09	
		Q3	1.91	0.70	5.21	0.21	
		Q4	1.81	0.70	4.64	0.22	
Model 2	**Pattern 1**	**Q1**	1.00				0.02
		Q2	2.42	0.93	6.33	0.07	
		Q3	1.99	0.67	5.86	0.21	
		Q4	1.70	0.58	4.96	0.33	
Model 3	**Pattern 1**	**Q1**	1.00				< 0.01
		Q2	2.44	0.87	6.80	0.09	
		Q3	1.71	0.53	5.54	0.37	
		Q4	1.79	0.59	5.49	0.31	
Model 1	**Pattern 2**	**Q1**	1.00				0.78
		Q2	1.18	0.47	2.98	0.72	
		Q3	1.42	0.58	3.44	0.44	
		Q4	1.62	0.59	4.46	0.35	
Model 2	**Pattern 2**	**Q1**	1.00				0.04
		Q2	0.94	0.34	2.61	0.91	
		Q3	1.18	0.45	3.15	0.74	
		Q4	1.69	0.51	5.62	0.40	
Model 3	**Pattern 2**	**Q1**	1.00				< 0.01
		Q2	0.78	0.26	2.33	0.66	
		Q3	1.12	0.40	3.18	0.83	
		Q4	1.32	0.35	4.89	0.68	
Model 1	**Pattern 3**	**Q1**	1.00				0.43
		Q2	2.89	0.69	12.02	0.15	
		Q3	3.73	0.94	14.82	0.06	
		Q4	2.13	0.54	8.48	0.28	
Model 2	**Pattern 3**	**Q1**	1.00				0.01
		Q2	2.77	0.62	12.36	0.18	
		Q3	4.02	0.94	17.29	0.06	
		Q4	1.74	0.38	7.94	0.48	
Model 3	**Pattern 3**	**Q1**	1.00				< 0.01
		Q2	2.51	0.52	12.12	0.25	
		Q3	4.13	0.90	19.06	0.07	
		Q4	1.65	0.34	8.06	0.54	

Model 1: Unadjusted
Model 2: Adjusted for gender, age and energy
Model 3: Adjusted for gender, age, energy, alcohol consumption, frequent dining out, late dining, skipping breakfast and quick finishing meals

Table 50: Association for low HDL-cholesterol across quartile (Q) categories of the identified diet patterns among Chinese (n=228)

			Chinese				
	Characteristic		OR	95% CI		P-value	P-value for trend
				Lower	Upper		
Model 1	**Pattern 1**	**Q1**	1.00				0.50
		Q2	0.52	0.14	1.88	0.32	
		Q3	0.52	0.14	1.88	0.32	
		Q4	1.09	0.35	3.34	0.88	
Model 2	**Pattern 1**	**Q1**	1.00				0.29
		Q2	0.52	0.14	1.93	0.33	
		Q3	0.60	0.16	2.26	0.45	
		Q4	1.35	0.40	4.58	0.63	
Model 3	**Pattern 1**	**Q1**	1.00				0.01
		Q2	0.64	0.16	2.53	0.53	
		Q3	0.60	0.15	2.43	0.47	
		Q4	1.35	0.36	5.01	0.66	
Model 1	**Pattern 2**	**Q1**	1.00				0.54
		Q2	0.55	0.17	1.81	0.33	
		Q3	0.53	0.16	1.74	0.30	
		Q4	0.43	0.12	1.51	0.19	
Model 2	**Pattern 2**	**Q1**	1.00				0.43
		Q2	0.63	0.18	2.17	0.46	
		Q3	0.59	0.17	2.06	0.41	
		Q4	0.52	0.13	2.07	0.35	
Model 3	**Pattern 2**	**Q1**	1.00				0.01
		Q2	0.66	0.17	2.51	0.54	
		Q3	0.55	0.14	2.12	0.38	
		Q4	0.50	0.11	2.23	0.37	
Model 1	**Pattern 3**	**Q1**	1.00				0.73
		Q2	1.60	0.49	5.19	0.43	
		Q3	0.86	0.22	3.38	0.83	
		Q4	1.46	0.40	5.39	0.57	
Model 2	**Pattern 3**	**Q1**	1.00				0.34
		Q2	1.73	0.51	5.85	0.38	
		Q3	1.05	0.25	4.41	0.94	
		Q4	2.41	0.58	10.07	0.23	
Model 3	**Pattern 3**	**Q1**	1.00				0.01
		Q2	1.31	0.35	4.86	0.69	
		Q3	0.85	0.19	3.85	0.84	
		Q4	2.15	0.44	10.41	0.34	

Model 1: Unadjusted
Model 2: Adjusted for gender, education and energy
Model 3: Adjusted for gender, education, energy, physical activity, frequent dining out and skipping breakfast

Table 51: Association for low HDL-cholesterol across quartile (Q) categories of the identified diet patterns among Indians (n=106)

			Indian				
	Characteristic		OR	95% CI		P-value	P-value for trend
				Lower	Upper		
Model 1	**Pattern 1**	**Q1**	1.00				0.04
		Q2	4.67	0.96	22.79	0.06	
		Q3	8.30	1.81	38.11	0.01	
		Q4	4.72	1.06	20.96	0.04	
Model 2	**Pattern 1**	**Q1**	1.00				0.03
		Q2	2.52	0.44	14.64	0.30	
		Q3	5.36	1.01	28.54	0.05	
		Q4	2.28	0.40	13.10	0.36	
Model 3	**Pattern 1**	**Q1**	1.00				0.01
		Q2	4.12	0.64	26.68	0.14	
		Q3	9.30	1.53	56.40	0.02	
		Q4	3.61	0.56	23.07	0.18	
Model 1	**Pattern 2**	**Q1**	1.00				0.11
		Q2	2.50	0.73	8.52	0.14	
		Q3	1.63	0.47	5.63	0.44	
		Q4	4.03	1.22	13.28	0.02	
Model 2	**Pattern 2**	**Q1**	1.00				0.04
		Q2	2.41	0.62	9.39	0.20	
		Q3	1.81	0.45	7.24	0.40	
		Q4	4.52	1.09	18.79	0.04	
Model 3	**Pattern 2**	**Q1**	1.00				0.02
		Q2	2.67	0.66	10.82	0.17	
		Q3	1.81	0.44	7.44	0.41	
		Q4	4.68	1.09	20.04	0.04	
Model 1	**Pattern 3**	**Q1**	1.00				0.23
		Q2	1.40	0.49	3.97	0.53	
		Q3	1.04	0.34	3.15	0.95	
		Q4	3.11	0.93	10.36	0.07	
Model 2	**Pattern 3**	**Q1**	1.00				< 0.01
		Q2	1.35	0.42	4.37	0.61	
		Q3	0.85	0.24	3.05	0.81	
		Q4	3.83	0.91	16.01	0.07	
Model 3	**Pattern 3**	**Q1**	1.00				< 0.01
		Q2	1.41	0.43	4.61	0.57	
		Q3	0.81	0.22	2.98	0.76	
		Q4	3.40	0.79	14.61	0.10	

Model 1: Unadjusted
Model 2: Adjusted for gender, marital status and energy
Model 3: Adjusted for gender, marital status, energy and skipping breakfast

4.2.4.4 Effect of diet patterns with MetS component – High triglycerides (hypertriglyceridemia)

Table 52 shows the regression analysis models for finding out any association of the three identified diet patterns with hypertriglyceridemia. No association of any diet pattern was observed with high triglyceride levels in this cohort. Tables 53-55 show the regression models across the three ethnicities, revealing that the Malay subjects with hypertriglyceridemia were consuming less amounts of pattern 3 (chicken rice, fried noodles and nasi lemak), when adjusted for socio-demographic and lifestyle factors (Table 53). In other words, the highest consumption (Q4) of this diet pattern 3 was protective against hypertriglyceridemia among the Malays (AOR = 0.199 [95%CI = 0.037-0.841]). No association of any diet pattern with hypertriglyceridemia was found among the Chinese and the Indians (Table 54-55).

Table 52: Association for high triglycerides across quartile (Q) categories of the identified diet patterns among Malaysians (n=481)

	Characteristic		OR	95% CI		P-value	P-value for trend
				Lower	Upper		
Model 1	**Pattern 1**	**Q1**	1.00				0.17
		Q2	0.73	0.40	1.32	0.29	
		Q3	0.67	0.37	1.22	0.19	
		Q4	1.20	0.69	2.10	0.52	
Model 2	**Pattern 1**	**Q1**	1.00				< 0.01
		Q2	0.77	0.42	1.43	0.41	
		Q3	0.63	0.34	1.17	0.15	
		Q4	1.39	0.76	2.54	0.29	
Model 3	**Pattern 1**	**Q1**	1.00				< 0.01
		Q2	0.77	0.42	1.42	0.41	
		Q3	0.66	0.36	1.22	0.19	
		Q4	1.40	0.76	2.56	0.28	
Model 1	**Pattern 2**	**Q1**	1.00				0.99
		Q2	0.94	0.52	1.68	0.82	
		Q3	0.96	0.54	1.71	0.88	
		Q4	0.93	0.52	1.66	0.79	
Model 2	**Pattern 2**	**Q1**	1.00				< 0.01
		Q2	1.12	0.61	2.06	0.71	
		Q3	1.06	0.57	1.94	0.86	
		Q4	1.05	0.55	1.98	0.89	
Model 3	**Pattern 2**	**Q1**	1.00				< 0.01
		Q2	1.08	0.59	1.98	0.80	
		Q3	1.09	0.60	2.00	0.78	
		Q4	1.09	0.58	2.06	0.79	
Model 1	**Pattern 3**	**Q1**	1.00				0.43
		Q2	1.40	0.78	2.50	0.26	
		Q3	0.88	0.47	1.62	0.68	
		Q4	1.04	0.57	1.91	0.90	
Model 2	**Pattern 3**	**Q1**	1.00				< 0.01
		Q2	1.51	0.82	2.76	0.19	
		Q3	1.00	0.52	1.91	0.99	
		Q4	1.11	0.56	2.19	0.77	
Model 3	**Pattern 3**	**Q1**	1.00				< 0.001
		Q2	1.55	0.85	2.83	0.15	
		Q3	0.97	0.51	1.85	0.93	
		Q4	1.08	0.55	2.14	0.82	

Model 1: Unadjusted
Model 2: Adjusted for gender, age, education and energy
Model 3: Adjusted for gender, age, education, energy and skipping breakfast

Table 53: Association for high triglycerides across quartile (Q) categories of the identified diet patterns among Malays (n=147)

			Malay				
	Characteristic		OR	95% CI		P-value	P-value for trend
				Lower	Upper		
Model 1	**Pattern 1**	**Q1**	1.00				0.47
		Q2	1.06	0.41	2.73	0.91	
		Q3	0.39	0.10	1.51	0.17	
		Q4	0.83	0.30	2.36	0.73	
Model 2	**Pattern 1**	**Q1**	1.00				< 0.01
		Q2	1.37	0.48	3.92	0.56	
		Q3	0.51	0.12	2.10	0.35	
		Q4	0.80	0.23	2.83	0.73	
Model 3	**Pattern 1**	**Q1**	1.00				< 0.01
		Q2	1.28	0.44	3.70	0.65	
		Q3	0.48	0.12	2.01	0.32	
		Q4	0.81	0.23	2.87	0.75	
Model 1	**Pattern 2**	**Q1**	1.00				0.17
		Q2	1.41	0.54	3.71	0.48	
		Q3	0.93	0.34	2.49	0.88	
		Q4	0.28	0.06	1.37	0.12	
Model 2	**Pattern 2**	**Q1**	1.00				< 0.01
		Q2	1.47	0.50	4.32	0.49	
		Q3	1.28	0.41	4.02	0.68	
		Q4	0.15	0.02	1.49	0.11	
Model 3	**Pattern 2**	**Q1**	1.00				< 0.01
		Q2	1.45	0.49	4.29	0.50	
		Q3	1.25	0.39	3.96	0.71	
		Q4	0.15	0.02	1.43	0.10	
Model 1	**Pattern 3**	**Q1**	1.00				0.06
		Q2	0.51	0.15	1.76	0.29	
		Q3	0.52	0.16	1.67	0.27	
		Q4	0.19	0.05	0.69	0.01	
Model 2	**Pattern 3**	**Q1**	1.00				< 0.01
		Q2	0.60	0.16	2.27	0.45	
		Q3	0.53	0.15	1.96	0.34	
		Q4	0.17	0.04	0.79	0.02	
Model 3	**Pattern 3**	**Q1**	1.00				< 0.01
		Q2	0.63	0.17	2.41	0.50	
		Q3	0.56	0.15	2.07	0.39	
		Q4	0.18	0.04	0.84	0.03	

Model 1: Unadjusted
Model 2: Adjusted for marital status, education, employment status and energy
Model 3: Adjusted for marital status, education, employment status, energy and late dining

Table 54: Association for high triglycerides across quartile (Q) categories of the identified diet patterns among Chinese (n=228)

			Chinese				
	Characteristic		OR	95% CI		P-value	P-value for trend
				Lower	Upper		
Model 1	**Pattern 1**	**Q1**	1.00				0.01
		Q2	0.40	0.16	1.03	0.06	
		Q3	0.52	0.21	1.28	0.16	
		Q4	1.68	0.76	3.74	0.20	
Model 2	**Pattern 1**	**Q1**	1.00				0.01
		Q2	0.45	0.17	1.17	0.10	
		Q3	0.60	0.23	1.52	0.28	
		Q4	2.38	0.96	5.87	0.06	
Model 3	**Pattern 1**	**Q1**	1.00				< 0.01
		Q2	0.44	0.17	1.19	0.11	
		Q3	0.60	0.22	1.59	0.30	
		Q4	2.30	0.90	5.87	0.08	
Model 1	**Pattern 2**	**Q1**	1.00				0.96
		Q2	1.13	0.48	2.66	0.79	
		Q3	0.89	0.37	2.14	0.80	
		Q4	1.00	0.42	2.39	0.99	
Model 2	**Pattern 2**	**Q1**	1.00				0.56
		Q2	1.48	0.60	3.63	0.39	
		Q3	1.23	0.48	3.11	0.67	
		Q4	1.35	0.53	3.49	0.53	
Model 3	**Pattern 2**	**Q1**	1.00				0.07
		Q2	1.41	0.55	3.58	0.47	
		Q3	1.13	0.44	2.93	0.80	
		Q4	1.59	0.59	4.25	0.36	
Model 1	**Pattern 3**	**Q1**	1.00				0.08
		Q2	1.68	0.75	3.76	0.21	
		Q3	0.62	0.23	1.62	0.32	
		Q4	1.76	0.73	4.25	0.21	
Model 2	**Pattern 3**	**Q1**	1.00				0.09
		Q2	2.23	0.95	5.22	0.07	
		Q3	0.77	0.29	2.08	0.61	
		Q4	2.24	0.86	5.79	0.10	
Model 3	**Pattern 3**	**Q1**	1.00				0.01
		Q2	2.03	0.85	4.87	0.11	
		Q3	0.71	0.25	1.97	0.51	
		Q4	2.21	0.82	5.95	0.12	

Model 1: Unadjusted
Model 2: Adjusted for gender, age, employment status and energy
Model 3: Adjusted for gender, age, employment status, energy, physical activity and alcohol consumption

Table 55: Association for high triglycerides across quartile (Q) categories of the identified diet patterns among Indians (n=106)

			Indians				
	Characteristic		OR	95% CI		P-value	P-value for trend
				Lower	Upper		
Model 1	**Pattern 1**	**Q1**	1.00				0.95
		Q2	1.24	0.25	6.17	0.79	
		Q3	1.13	0.25	5.07	0.88	
		Q4	0.89	0.19	4.09	0.88	
Model 2	**Pattern 1**	**Q1**	1.00				< 0.01
		Q2	1.10	0.12	10.43	0.94	
		Q3	1.15	0.15	8.78	0.89	
		Q4	0.95	0.11	8.32	0.96	
Model 3	**Pattern 1**	**Q1**	1.00				< 0.01
		Q2	0.41	0.02	8.23	0.56	
		Q3	1.54	0.08	31.68	0.78	
		Q4	1.37	0.05	35.80	0.85	
Model 1	**Pattern 2**	**Q1**	1.00				0.11
		Q2	0.25	0.05	1.18	0.08	
		Q3	1.07	0.29	3.92	0.92	
		Q4	1.04	0.32	3.41	0.95	
Model 2	**Pattern 2**	**Q1**	1.00				< 0.01
		Q2	0.14	0.02	1.03	0.05	
		Q3	0.52	0.09	2.88	0.46	
		Q4	0.44	0.08	2.35	0.34	
Model 3	**Pattern 2**	**Q1**	1.00				< 0.01
		Q2	0.21	0.02	1.96	0.17	
		Q3	0.52	0.07	3.91	0.52	
		Q4	0.30	0.04	2.38	0.25	
Model 1	**Pattern 3**	**Q1**	1.00				0.48
		Q2	2.05	0.62	6.75	0.24	
		Q3	1.73	0.47	6.35	0.41	
		Q4	2.44	0.73	8.14	0.15	
Model 2	**Pattern 3**	**Q1**	1.00				< 0.01
		Q2	2.12	0.44	10.25	0.35	
		Q3	2.08	0.35	12.50	0.43	
		Q4	1.94	0.34	11.10	0.46	
Model 3	**Pattern 3**	**Q1**	1.00				< 0.01
		Q2	1.51	0.24	9.52	0.66	
		Q3	2.39	0.27	21.19	0.43	
		Q4	2.12	0.28	15.96	0.47	

Model 1: Unadjusted
Model 2: Adjusted for gender, age, marital status, employment status and energy
Model 3: Adjusted for gender, age, marital status, employment status, energy physical activity, smoking status, alcohol consumption, frequent dining out and late dining

4.2.4.5 Effect of diet patterns with MetS component – High fasting blood glucose (fasting hyperglycemia)

Table 56 shows the regression analysis models exploring the association of the three identified diet patterns with fasting hyperglycemia. Analysis indicates no significant association of fasting hyperglycemia with increasing intake of any diet pattern by all the subjects in this cohort. Tables 57-59 show the regression models across the three Malaysian races to find out any association of diet patterns with fasting high blood glucose. No association was found among the Malays and the Chinese (Tables 57-58).However, hyperglycemic Indians were found to be consuming small amounts of diet pattern 1 (legumes, cruciferous vegetables, roots and fruit vegetables) and diet pattern 2 (noodle soup, chocolates, soy milk and potatoes), after adjusting for socio-demographic and lifestyle factors (Table 59).

Table 56: Association for high fasting blood glucose across quartile (Q) categories of the identified diet patterns among Malaysians (n=481)

	Characteristic		OR	95% CI		P-value	P-value for trend
				Lower	Upper		
Model 1	**Pattern 1**	**Q1**	1.00				0.10
		Q2	0.60	0.32	1.13	0.11	
		Q3	0.45	0.23	0.87	0.02	
		Q4	0.70	0.38	1.28	0.25	
Model 2	**Pattern 1**	**Q1**	1.00				< 0.01
		Q2	0.79	0.40	1.57	0.50	
		Q3	0.55	0.26	1.14	0.11	
		Q4	0.97	0.47	2.00	0.93	
Model 3	**Pattern 1**	**Q1**	1.00				< 0.01
		Q2	0.82	0.41	1.63	0.57	
		Q3	0.58	0.28	1.21	0.15	
		Q4	0.95	0.46	1.99	0.90	
Model 1	**Pattern 2**	**Q1**	1.00				0.10
		Q2	0.56	0.30	1.05	0.07	
		Q3	0.49	0.26	0.93	0.03	
		Q4	0.56	0.30	1.04	0.07	
Model 2	**Pattern 2**	**Q1**	1.00				< 0.01
		Q2	0.72	0.37	1.42	0.34	
		Q3	0.64	0.32	1.28	0.21	
		Q4	0.78	0.37	1.65	0.52	
Model 3	**Pattern 2**	**Q1**	1.00				< 0.01
		Q2	0.74	0.37	1.47	0.38	
		Q3	0.67	0.33	1.36	0.27	
		Q4	0.86	0.40	1.85	0.70	
Model 1	**Pattern 3**	**Q1**	1.00				0.57
		Q2	0.85	0.44	1.65	0.63	
		Q3	1.26	0.67	2.38	0.47	
		Q4	0.86	0.44	1.68	0.66	
Model 2	**Pattern 3**	**Q1**	1.00				< 0.01
		Q2	1.13	0.55	2.35	0.74	
		Q3	1.60	0.77	3.30	0.21	
		Q4	1.01	0.45	2.26	0.99	
Model 3	**Pattern 3**	**Q1**	1.00				< 0.01
		Q2	1.06	0.51	2.22	0.87	
		Q3	1.54	0.74	3.22	0.25	
		Q4	0.93	0.41	2.11	0.86	

Model 1: Unadjusted
Model 2: Adjusted for gender, age, ethnicity, education, Employment status and energy
Model 3: Adjusted for gender, age, ethnicity, education, Employment status, energy, smoking status, frequent dining out, late dining and quick finishing meals

Table 57: Association for high fasting blood glucose across quartile (Q) categories of the identified diet patterns among Malays (n=147)

			Malay				
	Characteristic		OR	95% CI		P-value	P-value for trend
				Lower	Upper		
Model 1	**Pattern 1**	**Q1**	1.00				0.73
		Q2	0.66	0.25	1.74	0.40	
		Q3	0.75	0.25	2.23	0.60	
		Q4	1.13	0.44	2.93	0.80	
Model 2	**Pattern 1**	**Q1**	1.00				0.03
		Q2	0.79	0.28	2.24	0.65	
		Q3	0.75	0.23	2.48	0.64	
		Q4	0.96	0.30	3.11	0.95	
Model 3	**Pattern 1**	**Q1**	1.00				0.01
		Q2	0.94	0.32	2.76	0.91	
		Q3	0.81	0.24	2.77	0.74	
		Q4	0.97	0.29	3.24	0.96	
Model 1	**Pattern 2**	**Q1**	1.00				0.60
		Q2	1.30	0.51	3.32	0.58	
		Q3	0.65	0.24	1.74	0.39	
		Q4	0.83	0.27	2.54	0.75	
Model 2	**Pattern 2**	**Q1**	1.00				0.03
		Q2	1.16	0.41	3.29	0.78	
		Q3	0.72	0.24	2.18	0.56	
		Q4	0.64	0.16	2.52	0.52	
Model 3	**Pattern 2**	**Q1**	1.00				0.01
		Q2	1.14	0.40	3.28	0.81	
		Q3	0.83	0.27	2.57	0.74	
		Q4	0.68	0.17	2.78	0.59	
Model 1	**Pattern 3**	**Q1**	1.00				0.35
		Q2	1.35	0.35	5.18	0.66	
		Q3	1.79	0.50	6.42	0.37	
		Q4	0.79	0.21	2.96	0.73	
Model 2	**Pattern 3**	**Q1**	1.00				0.01
		Q2	1.83	0.42	7.90	0.42	
		Q3	2.67	0.64	11.23	0.18	
		Q4	1.04	0.22	5.03	0.96	
Model 3	**Pattern 3**	**Q1**	1.00				< 0.01
		Q2	1.49	0.33	6.67	0.61	
		Q3	2.09	0.48	9.15	0.33	
		Q4	0.75	0.15	3.85	0.73	

Model 1: Unadjusted
Model 2: Adjusted for age, marital status, education and energy
Model 3: Adjusted for age, marital status, education, energy and quick finishing of meals

Table 58: Association for high fasting blood glucose across quartile (Q) categories of the identified diet patterns among Chinese (n=228)

			Chinese				
	Characteristic		OR	95% CI		P-value	P-value for trend
				Lower	Upper		
Model 1	**Pattern 1**	**Q1**	1.00				0.17
		Q2	0.68	0.26	1.75	0.42	
		Q3	0.43	0.15	1.22	0.11	
		Q4	0.39	0.13	1.20	0.10	
Model 2	**Pattern 1**	**Q1**	1.00				< 0.01
		Q2	0.84	0.30	2.36	0.74	
		Q3	0.54	0.17	1.71	0.29	
		Q4	0.68	0.19	2.39	0.55	
Model 3	**Pattern 1**	**Q1**	1.00				< 0.01
		Q2	0.79	0.27	2.31	0.67	
		Q3	0.35	0.10	1.22	0.10	
		Q4	0.57	0.16	2.08	0.39	
Model 1	**Pattern 2**	**Q1**	1.00				0.21
		Q2	0.49	0.18	1.36	0.17	
		Q3	0.32	0.11	0.99	0.05	
		Q4	0.56	0.21	1.50	0.25	
Model 2	**Pattern 2**	**Q1**	1.00				< 0.01
		Q2	0.91	0.30	2.72	0.86	
		Q3	0.59	0.18	1.95	0.38	
		Q4	1.29	0.41	4.01	0.66	
Model 3	**Pattern 2**	**Q1**	1.00				< 0.01
		Q2	0.69	0.22	2.17	0.53	
		Q3	0.53	0.15	1.87	0.32	
		Q4	1.03	0.32	3.32	0.96	
Model 1	**Pattern 3**	**Q1**	1.00				0.32
		Q2	0.53	0.20	1.38	0.19	
		Q3	0.53	0.19	1.43	0.21	
		Q4	0.38	0.11	1.25	0.11	
Model 2	**Pattern 3**	**Q1**	1.00				< 0.01
		Q2	0.71	0.25	2.02	0.53	
		Q3	0.81	0.27	2.41	0.71	
		Q4	0.64	0.17	2.35	0.50	
Model 3	**Pattern 3**	**Q1**	1.00				< 0.01
		Q2	0.56	0.18	1.72	0.31	
		Q3	0.90	0.29	2.79	0.85	
		Q4	0.60	0.15	2.33	0.46	

Model 1: Unadjusted
Model 2: Adjusted for gender, age, employment status and energy
Model 3: Adjusted for gender, age, employment status, energy, smoking status, frequent dining out and skipping breakfast

Table 59: Association for high fasting blood glucose across quartile (Q) categories of the identified diet patterns among Indians (n=106)

			Indian				
	Characteristic		OR	95% CI		P-value	P-value for trend
				Lower	Upper		
Model 1	**Pattern 1**	**Q1**	1.00				0.44
		Q2	0.42	0.07	2.55	0.35	
		Q3	0.32	0.06	1.74	0.19	
		Q4	0.76	0.16	3.56	0.73	
Model 2	**Pattern 1**	**Q1**	1.00				0.01
		Q2	0.52	0.06	4.22	0.54	
		Q3	0.30	0.04	2.18	0.23	
		Q4	0.89	0.12	6.59	0.91	
Model 3	**Pattern 1**	**Q1**	1.00				< 0.01
		Q2	0.02	0.00	0.85	0.04	
		Q3	0.06	0.00	1.78	0.10	
		Q4	0.13	0.01	3.41	0.22	
Model 1	**Pattern 2**	**Q1**	1.00				0.05
		Q2	0.08	0.01	0.71	0.02	
		Q3	0.56	0.14	2.24	0.41	
		Q4	0.38	0.10	1.39	0.14	
Model 2	**Pattern 2**	**Q1**	1.00				< 0.01
		Q2	0.07	0.01	0.78	0.03	
		Q3	0.34	0.07	1.76	0.20	
		Q4	0.17	0.03	1.02	0.05	
Model 3	**Pattern 2**	**Q1**	1.00				< 0.01
		Q2	0.07	0.00	1.12	0.06	
		Q3	0.32	0.04	2.57	0.28	
		Q4	0.15	0.02	1.27	0.08	
Model 1	**Pattern 3**	**Q1**	1.00				0.42
		Q2	0.84	0.17	4.12	0.83	
		Q3	2.19	0.51	9.34	0.29	
		Q4	2.21	0.55	8.90	0.26	
Model 2	**Pattern 3**	**Q1**	1.00				0.01
		Q2	0.85	0.15	4.90	0.86	
		Q3	3.64	0.62	21.36	0.15	
		Q4	2.33	0.41	13.21	0.34	
Model 3	**Pattern 3**	**Q1**	1.00				< 0.01
		Q2	0.35	0.02	7.45	0.50	
		Q3	9.70	0.73	127.98	0.08	
		Q4	9.15	0.74	113.09	0.09	

Model 1: Unadjusted
Model 2: Adjusted for gender, age, marital status and energy
Model 3: Adjusted for gender, age, marital status, energy, physical activity, smoking status, alcohol consumption, late dining and skipping breakfast

4.2.5 Effect of food groups with MetS components

In the previous chapter (Chapter 4.1), it has been shown that the median intake of food groups by the three major ethnic groups are different (Table 9). However, no association of any food group was found with MetS except among the Indians. In this group, intake of milk and milk products was found to be inversely associated with MetS (AOR = 0.32 [95%CI = 0.14-0.69]), when adjusted for socio-demographic and lifestyle factors. This, however, points to the notion that food groups might be influencing the individual components of MetS. Therefore, we analysed the data to study the association of the intake of various food groups with the risk of having a metabolic abnormality in this population.

4.2.5.1 Effect of food groups with MetS component – Abdominal obesity

A comparison of median intake of food groups by study subjects with and without abdominal obesity showed that significant differences were observed with poultry, meat and egg group items, which were consumed less by subjects with abdominal obesity ($p < 0.001$) (Supplementary Table 14). However, fats, oils and sugars group items were consumed more by obese subjects ($p = 0.04$), suggesting an important role of these food items in causing obesity among Malaysian adults

Table 60 shows the regression analysis models to study the association of food groups with abdominal obesity in all the subjects in this cohort. No association has been observed between the intake of food groups and abdominal obesity when adjusted for demographic and lifestyle factors. Same results were obtained across the three races as well (Table 61).

Table 60: Association of food groups with abdominal obesity among Malaysians (n=481)

			95%CI		
		OR	Lower	Upper	P-value
Cereals and cereal products	**Model 1**	0.99	0.91	1.08	0.86
	Model 2	0.94	0.84	1.05	0.24
	Model 3	0.93	0.83	1.04	0.22
Vegetables	**Model 1**	1.05	0.96	1.15	0.32
	Model 2	1.04	0.93	1.16	0.51
	Model 3	1.03	0.92	1.15	0.62
Fruits	**Model 1**	0.97	0.84	1.12	0.71
	Model 2	1.00	0.84	1.18	0.95
	Model 3	0.98	0.83	1.16	0.81
Poultry, meat, egg	**Model 1**	0.73	0.60	0.89	< 0.01
	Model 2	0.96	0.76	1.22	0.73
	Model 3	0.96	0.75	1.22	0.73
Fish	**Model 1**	0.93	0.72	1.20	0.57
	Model 2	0.77	0.56	1.04	0.09
	Model 3	0.77	0.56	1.05	0.10
Legumes	**Model 1**	1.14	0.82	1.58	0.45
	Model 2	1.04	0.70	1.56	0.84
	Model 3	0.99	0.66	1.50	0.97
Milk and milk products	**Model 1**	1.12	0.91	1.37	0.28
	Model 2	0.91	0.72	1.15	0.43
	Model 3	0.89	0.70	1.14	0.37
Fats, oils, sugars	**Model 1**	1.09	0.95	1.26	0.22
	Model 2	1.02	0.87	1.20	0.81
	Model 3	1.03	0.87	1.21	0.73

Model 1: Unadjusted
Model 2: Adjusted for gender, age, ethnicity, marital status, education, Employment status and energy
Model 3: Adjusted for gender, age, ethnicity, marital status, education, Employment status, energy, physical activity, smoking status and frequent dining out

Table 61: Association of food groups with abdominal obesity across ethnicities

		Malay (n=147)				Chinese (n=228)				Indian (n=106)			
			95%CI				95%CI				95%CI		
		OR	Lower	Upper	P-value	OR	Lower	Upper	P-value	OR	Lower	Upper	P-value
Cereals and cereal products	**Model 1**	0.93	0.82	1.05	0.24	0.99	0.86	1.13	0.87	1.02	0.75	1.38	0.92
	Model 2	0.86	0.73	1.02	0.08	0.95	0.79	1.15	0.61	1.44	0.92	2.25	0.11
	Model 3	0.86	0.73	1.01	0.07	-	-	-	-	1.65	0.87	3.16	0.13
Vegetables	**Model 1**	1.20	0.99	1.44	0.06	0.96	0.83	1.11	0.58	0.93	0.76	1.14	0.51
	Model 2	1.23	0.99	1.54	0.06	0.96	0.81	1.14	0.63	0.90	0.69	1.17	0.45
	Model 3	1.23	0.99	1.54	0.06	-	-	-	-	0.90	0.66	1.22	0.49
Fruits	**Model 1**	1.13	0.86	1.49	0.37	1.02	0.84	1.25	0.84	0.81	0.48	1.37	0.44
	Model 2	1.07	0.78	1.47	0.68	0.95	0.75	1.20	0.66	1.03	0.55	1.92	0.92
	Model 3	1.07	0.78	1.47	0.68	-	-	-	-	0.88	0.42	1.83	0.73
Poultry, meat, egg	**Model 1**	1.11	0.78	1.60	0.56	0.77	0.58	1.03	0.08	0.57	0.31	1.05	0.07
	Model 2	1.04	0.69	1.56	0.85	0.93	0.66	1.31	0.67	1.05	0.45	2.44	0.91
	Model 3	1.05	0.70	1.58	0.82	-	-	-	-	1.25	0.47	3.31	0.65
Fish	**Model 1**	0.90	0.61	1.33	0.60	0.70	0.43	1.14	0.15	0.74	0.29	1.90	0.54
	Model 2	0.84	0.55	1.28	0.43	0.68	0.39	1.17	0.16	1.19	0.39	3.65	0.76
	Model 3	0.84	0.55	1.28	0.43	-	-	-	-	1.36	0.31	5.96	0.68
Legumes	**Model 1**	2.35	0.99	5.55	0.05	0.65	0.35	1.22	0.18	0.72	0.38	1.34	0.30
	Model 2	2.59	0.96	6.99	0.06	0.73	0.36	1.47	0.38	0.60	0.26	1.35	0.22
	Model 3	2.58	0.95	6.98	0.06	-	-	-	-	0.77	0.31	1.93	0.57
Milk and milk products	**Model 1**	0.90	0.68	1.19	0.48	1.44	0.98	2.12	0.06	0.50	0.28	0.87	0.02
	Model 2	0.85	0.62	1.17	0.32	1.43	0.93	2.20	0.10	0.47	0.22	1.02	0.06
	Model 3	0.85	0.61	1.17	0.31	-	-	-	-	0.45	0.18	1.15	0.10
Fats, oils, sugars	**Model 1**	1.09	0.81	1.47	0.56	1.05	0.86	1.26	0.65	0.75	0.53	1.07	0.11
	Model 2	1.12	0.81	1.56	0.49	1.08	0.88	1.34	0.45	0.97	0.63	1.51	0.91
	Model 3	1.13	0.81	1.57	0.49	-	-	-	-	1.07	0.65	1.77	0.79

Model 1: Unadjusted
Model 2: Adjusted for gender, marital status, education, employment status and energy (Malay); age, marital status, education and energy (Chinese); age, education, employment status and energy (Indian)
Model 3: Adjusted for Model 2 and smoking (Malay); Model 2 only (Chinese); Model 2 plus smoking status, alcohol intake, quick finishing meals (Indian)

4.2.5.2 Effect of food groups with MetS component – High blood pressure

A comparison of the median intakes of food groups by the study participants with and without high blood pressure indicates no significant differences between the two groups (Supplementary Table 15). Logistic regression models to study the association of food groups with high blood pressure yielded no significant association in this cohort (Table 62). Similar results were also obtained for the Malays and the Chinese in this cohort (Table 63). However, consumption of certain food items such as vegetables (AOR = 0.79 [95%CI = 0.63-0.98]), fruits (AOR = 0.53 [95%CI = 0.28-0.99]), and milk and milk products (AOR = 0.35 [95%CI = 0.18-0.71]) were inversely associated with high blood pressure among the Indians, when adjusted for gender, age, marital status and energy (Table 63).

Table 62: Association of food groups with high blood pressure among Malaysians (n=481)

			95%CI		
		OR	Lower	Upper	P-value
Cereals and cereal products	**Model 1**	1.03	0.95	1.12	0.46
	Model 2	1.02	0.91	1.13	0.79
	Model 3	1.01	0.91	1.13	0.85
Vegetables	**Model 1**	0.94	0.87	1.03	0.19
	Model 2	0.94	0.85	1.04	0.23
	Model 3	0.93	0.84	1.03	0.17
Fruits	**Model 1**	0.95	0.83	1.10	0.50
	Model 2	0.88	0.74	1.04	0.14
	Model 3	0.88	0.74	1.04	0.13
Poultry, meat, egg	**Model 1**	0.97	0.81	1.17	0.75
	Model 2	1.13	0.90	1.42	0.31
	Model 3	1.11	0.88	1.40	0.36
Fish	**Model 1**	1.12	0.86	1.45	0.39
	Model 2	1.10	0.82	1.49	0.53
	Model 3	1.10	0.81	1.49	0.54
Legumes	**Model 1**	0.85	0.62	1.16	0.31
	Model 2	0.82	0.57	1.17	0.27
	Model 3	0.74	0.51	1.06	0.10
Milk and milk products	**Model 1**	1.12	0.92	1.36	0.27
	Model 2	1.06	0.84	1.34	0.61
	Model 3	1.07	0.84	1.35	0.60
Fats, oils, sugars	**Model 1**	1.07	0.93	1.23	0.33
	Model 2	1.09	0.93	1.27	0.28
	Model 3	1.11	0.95	1.30	0.19

Model 1: Unadjusted
Model 2: Adjusted for gender, age, ethnicity, marital status, education and energy
Model 3: Adjusted for gender, age, ethnicity, marital status, education, energy and physical activity

Table 63: Association of food groups with high blood pressure across ethnicities

		Malay (n=147)				Chinese (n=228)				Indian (n=106)			
			95%CI				95%CI				95%CI		
		OR	Lower	Upper	P-value	OR	Lower	Upper	P-value	OR	Lower	Upper	P-value
Cereals and cereal products	**Model 1**	1.06	0.94	1.21	0.36	0.94	0.82	1.08	0.35	1.17	0.89	1.53	0.26
	Model 2	1.13	0.96	1.33	0.13	0.85	0.70	1.04	0.11	0.93	0.60	1.44	0.73
	Model 3	-	-	-	-	0.85	0.69	1.04	0.11	-	-	-	-
Vegetables	**Model 1**	0.99	0.86	1.15	0.89	0.95	0.82	1.10	0.49	0.86	0.72	1.03	0.10
	Model 2	1.01	0.85	1.19	0.93	0.99	0.83	1.17	0.87	0.79	0.63	0.98	0.03
	Model 3	-	-	-	-	0.98	0.82	1.17	0.79	-	-	-	-
Fruits	**Model 1**	1.03	0.81	1.30	0.81	0.97	0.80	1.19	0.80	0.71	0.45	1.12	0.14
	Model 2	0.98	0.75	1.29	0.90	0.97	0.76	1.23	0.78	0.53	0.29	1.00	0.05
	Model 3	-	-	-	-	0.98	0.77	1.25	0.89	-	-	-	-
Poultry, meat, egg	**Model 1**	1.06	0.76	1.48	0.72	0.89	0.68	1.16	0.39	1.41	0.78	2.53	0.25
	Model 2	1.12	0.77	1.62	0.57	1.03	0.73	1.44	0.87	1.81	0.82	4.00	0.14
	Model 3	-	-	-	-	1.08	0.76	1.52	0.68	-	-	-	-
Fish	**Model 1**	1.31	0.87	1.96	0.20	0.73	0.46	1.17	0.19	1.38	0.62	3.09	0.43
	Model 2	1.37	0.89	2.11	0.15	0.77	0.45	1.31	0.33	1.31	0.52	3.30	0.57
	Model 3	-	-	-	-	0.81	0.47	1.40	0.44	-	-	-	-
Legumes	**Model 1**	0.86	0.52	1.43	0.56	0.84	0.47	1.51	0.56	0.79	0.45	1.37	0.40
	Model 2	0.81	0.44	1.49	0.49	1.11	0.56	2.16	0.77	0.59	0.31	1.13	0.11
	Model 3	-	-	-	-	0.85	0.41	1.76	0.66	-	-	-	-
Milk and milk products	**Model 1**	1.23	0.91	1.66	0.19	1.11	0.76	1.62	0.59	0.75	0.47	1.18	0.21
	Model 2	1.28	0.91	1.79	0.16	1.19	0.78	1.83	0.42	0.35	0.18	0.71	0.00
	Model 3	-	-	-	-	1.25	0.80	1.94	0.33	-	-	-	-
Fats, oils, sugars	**Model 1**	1.03	0.78	1.34	0.85	1.10	0.91	1.34	0.34	0.98	0.73	1.31	0.88
	Model 2	1.08	0.80	1.47	0.61	1.13	0.91	1.40	0.27	1.18	0.80	1.73	0.40
	Model 3	-	-	-	-	1.21	0.97	1.51	0.10	-	-	-	-

Model 1: Unadjusted
Model 2: Adjusted for age, marital status, education, employment status and energy (Malay); gender, age, marital status, education and energy (Chinese); gender, age, marital status and energy (Indian)
Model 3: Adjusted for Model 2 only (Malay); Model 2 plus physical activity, smoking and late dining of meals (Chinese); Model 2 only (Indian)

4.2.5.3 Effect of food groups with MetS component – Low HDL-cholesterol

The median intakes of food groups by the study subjects with normal and low HDL-cholesterol were compared (Supplementary Table 16) The median intake of cereal and cereal products was significantly higher among subjects with low HDL-cholesterol (3.56 vs. 3.28; $p = 0.030$). The intake of fats, oils and sugars was also higher among subjects with low HDL-cholesterol (2.00 vs. 1.51; $p < 0.01$). Compared to the subjects with normal HDL-cholesterol, poultry, meat and eggs were consumed less (0.86 vs. 1.28; $p < 0.001$, while intake of legumes was more (0.29 vs. 0.14; $p = 0.02$) by subjects with low HDL-cholesterol. Table 64 shows the regression models to explore the association of food groups with low HDL-cholesterol. No significant association was observed overall in this cohort, and also among the Malays and the Chinese (Tables 64-65). However, higher intake of cereals and cereal products was found to be associated with low HDL-cholesterol among the Indians (AOR = 1.62 [95%CI = 1.00-2.62]), when adjusted for gender, marital status, energy and skipping breakfast (Table 65).

Table 64: Association of food groups with low HDL-cholesterol among Malaysians (n=481)

			95%CI		
		OR	Lower	Upper	P-value
Cereals and cereal products	**Model 1**	1.08	0.99	1.18	0.07
	Model 2	1.08	0.96	1.22	0.18
	Model 3	1.07	0.95	1.21	0.26
Vegetables	**Model 1**	1.08	0.98	1.18	0.10
	Model 2	1.03	0.93	1.15	0.58
	Model 3	1.04	0.93	1.15	0.53
Fruits	**Model 1**	0.89	0.75	1.05	0.17
	Model 2	1.01	0.83	1.22	0.94
	Model 3	1.03	0.85	1.24	0.79
Poultry, meat, egg	**Model 1**	0.75	0.60	0.94	0.01
	Model 2	1.04	0.79	1.35	0.80
	Model 3	0.96	0.73	1.27	0.78
Fish	**Model 1**	1.24	0.95	1.62	0.11
	Model 2	1.19	0.87	1.64	0.28
	Model 3	1.24	0.89	1.73	0.21
Legumes	**Model 1**	1.34	0.97	1.84	0.08
	Model 2	1.07	0.73	1.58	0.72
	Model 3	1.04	0.70	1.55	0.84
Milk and milk products	**Model 1**	1.15	0.95	1.41	0.16
	Model 2	0.93	0.72	1.20	0.58
	Model 3	0.88	0.67	1.16	0.37
Fats, oils, sugars	**Model 1**	1.19	1.03	1.38	0.02
	Model 2	1.03	0.85	1.25	0.75
	Model 3	1.07	0.88	1.30	0.49

Model 1: Unadjusted
Model 2: Adjusted for gender, age, ethnicity, education, Employment status and energy
Model 3: Adjusted for gender, age, ethnicity, education, energy, physical activity, frequent dining out, skipping breakfast and quick finishing meals

Table 65: Association of food groups with low HDL-cholesterol across ethnicities

		Malay (n=147)				Chinese (n=228)				Indian (n=106)			
			95%CI				95%CI				95%CI		
		OR	Lower	Upper	P-value	OR	Lower	Upper	P-value	OR	Lower	Upper	P-value
Cereals and cereal products	**Model 1**	1.05	0.93	1.18	0.41	0.88	0.66	1.18	0.39	1.45	1.02	2.05	0.04
	Model 2	1.06	0.91	1.22	0.47	0.89	0.63	1.26	0.50	1.64	1.03	2.61	0.04
	Model 3	1.11	0.93	1.32	0.24	0.92	0.64	1.32	0.65	1.62	1.00	2.62	0.05
Vegetables	**Model 1**	1.07	0.93	1.24	0.35	1.07	0.86	1.34	0.53	0.99	0.83	1.17	0.86
	Model 2	1.07	0.91	1.27	0.41	1.12	0.88	1.41	0.36	0.90	0.74	1.09	0.29
	Model 3	1.11	0.92	1.33	0.27	1.09	0.85	1.40	0.49	0.91	0.75	1.11	0.35
Fruits	**Model 1**	1.08	0.86	1.37	0.50	0.89	0.60	1.32	0.56	0.90	0.57	1.40	0.63
	Model 2	1.13	0.86	1.48	0.37	0.89	0.58	1.35	0.58	0.72	0.43	1.19	0.20
	Model 3	1.15	0.86	1.53	0.36	0.93	0.63	1.38	0.72	0.75	0.44	1.25	0.27
Poultry, meat, egg	**Model 1**	0.92	0.66	1.29	0.62	1.26	0.84	1.88	0.26	1.26	0.70	2.28	0.45
	Model 2	0.88	0.60	1.29	0.52	1.68	1.03	2.76	0.04	1.19	0.59	2.42	0.63
	Model 3	0.91	0.60	1.36	0.64	1.42	0.83	2.43	0.21	1.17	0.56	2.43	0.68
Fish	**Model 1**	1.21	0.83	1.75	0.33	1.03	0.49	2.18	0.93	1.58	0.67	3.72	0.30
	Model 2	1.21	0.81	1.80	0.35	1.16	0.51	2.62	0.72	1.27	0.49	3.31	0.62
	Model 3	1.28	0.83	1.98	0.27	1.26	0.53	3.01	0.60	1.27	0.48	3.39	0.63
Legumes	**Model 1**	0.93	0.54	1.59	0.79	1.09	0.42	2.82	0.86	1.39	0.73	2.66	0.32
	Model 2	0.88	0.46	1.67	0.69	1.32	0.50	3.52	0.58	1.17	0.60	2.26	0.65
	Model 3	1.01	0.51	1.99	0.99	1.14	0.41	3.15	0.80	1.22	0.62	2.41	0.56
Milk and milk products	**Model 1**	0.86	0.64	1.16	0.32	1.14	0.63	2.09	0.66	1.02	0.64	1.64	0.92
	Model 2	0.85	0.61	1.18	0.32	1.33	0.70	2.51	0.38	0.74	0.42	1.33	0.32
	Model 3	0.86	0.61	1.21	0.38	1.34	0.64	2.82	0.44	0.75	0.41	1.36	0.34
Fats, oils, sugars	**Model 1**	0.85	0.64	1.13	0.27	0.96	0.68	1.34	0.80	1.62	1.12	2.33	0.01
	Model 2	0.85	0.61	1.18	0.34	0.98	0.67	1.43	0.91	1.41	0.92	2.15	0.12
	Model 3	0.87	0.61	1.24	0.44	1.04	0.69	1.56	0.85	1.42	0.92	2.20	0.11

Model 1: Unadjusted
Model 2: Adjusted for gender, age and energy (Malay); gender, education and energy (Chinese); gender, marital status and energy (Indian)
Model 3: Adjusted for Model 2 plus alcohol intake, frequent dining out, late dining, skipping breakfast and quick finishing meals (Malay); Model 2 plus physical activity, frequent dining out and skipping breakfast (Chinese); Model 2 plus skipping breakfast (Indian)

4.2.5.4 Effect of food groups with MetS component – High triglycerides (hypertriglyceridemia)

A comparison of the median intakes of food groups in subjects with and without high triglycerides showed no significant differences in the intakes of various food groups by the subjects in this cohort (Supplementary Table 17). Analysis of the data to explore the association of food groups with high triglyceride levels revealed no significant association (Table 66). However, among the three ethnic groups, the intake of milk and milk products was negatively associated with hypertriglyceridemia among the Malays (AOR = 0.54 [95% CI = 0.30-0.96]), when adjusted for marital status, education, employment status, energy and late dining (Table 67). In other words, the Malays with hypertriglyceridemia were consuming lesser amounts of milk and milk products. Nevertheless, among the Chinese, significant association was found between the intakes of vegetables and fish and hypertriglyceridemia (AOR = 1.26 [95%CI = 1.05-1.53]); (AOR = 1.95 [95%CI = 1.10-3.51], respectively, while adjusting for gender, age, employment status and energy (Table 67). No significant association between intake of food groups and hypertriglyceridemia was found among the Indians (Table 67).

Table 66: Association of food groups with hypertriglyceridemia among Malaysians (n=481)

			95%CI		
		OR	Lower	Upper	P-value
Cereals and cereal products	**Model 1**	1.01	0.92	1.11	0.78
	Model 2	1.04	0.93	1.17	0.50
	Model 3	1.04	0.93	1.17	0.51
Vegetables	**Model 1**	1.02	0.92	1.13	0.69
	Model 2	1.05	0.94	1.17	0.38
	Model 3	1.05	0.94	1.16	0.42
Fruits	**Model 1**	1.00	0.85	1.17	0.96
	Model 2	1.01	0.85	1.21	0.89
	Model 3	1.01	0.84	1.21	0.94
Poultry, meat, egg	**Model 1**	1.10	0.90	1.36	0.35
	Model 2	1.21	0.96	1.53	0.11
	Model 3	1.22	0.97	1.55	0.09
Fish	**Model 1**	1.21	0.91	1.59	0.18
	Model 2	1.31	0.97	1.76	0.08
	Model 3	1.28	0.95	1.73	0.11
Legumes	**Model 1**	0.93	0.64	1.35	0.69
	Model 2	0.98	0.66	1.45	0.93
	Model 3	0.97	0.65	1.44	0.88
Milk and milk products	**Model 1**	0.86	0.68	1.09	0.21
	Model 2	0.86	0.67	1.12	0.27
	Model 3	0.87	0.67	1.12	0.27
Fats, oils, sugars	**Model 1**	0.92	0.78	1.08	0.33
	Model 2	0.93	0.78	1.11	0.42
	Model 3	0.93	0.78	1.11	0.40

Model 1: Unadjusted
Model 2: Adjusted for gender, age, education and energy
Model 3: Adjusted for gender, age, education, energy and skipping breakfast

Table 67: Association of food groups with hypertriglyceridemia across ethnicities

		Malay (n=147)				Chinese (n=228)				Indian (n=106)			
			95%CI				95%CI				95%CI		
		OR	Lower	Upper	P-value	OR	Lower	Upper	P-value	OR	Lower	Upper	P-value
Cereals and cereal products	**Model 1**	0.85	0.70	1.03	0.09	1.08	0.94	1.26	0.28	1.35	1.01	1.79	0.04
	Model 2	0.78	0.59	1.04	0.09	1.16	0.96	1.41	0.12	1.31	0.83	2.09	0.25
	Model 3	0.78	0.59	1.04	0.10	1.14	0.94	1.38	0.17	1.24	0.68	2.25	0.48
Vegetables	**Model 1**	0.99	0.84	1.18	0.92	1.13	0.97	1.33	0.13	0.90	0.73	1.11	0.32
	Model 2	0.99	0.81	1.21	0.93	1.26	1.05	1.53	0.02	0.88	0.67	1.14	0.32
	Model 3	0.99	0.81	1.22	0.95	1.27	1.05	1.54	0.02	0.97	0.70	1.34	0.85
Fruits	**Model 1**	1.08	0.84	1.39	0.55	0.99	0.78	1.25	0.93	0.82	0.49	1.39	0.46
	Model 2	1.00	0.75	1.35	0.98	0.98	0.74	1.28	0.86	0.71	0.35	1.46	0.36
	Model 3	1.01	0.75	1.35	0.96	0.97	0.74	1.28	0.85	0.58	0.21	1.58	0.29
Poultry, meat, egg	**Model 1**	1.13	0.78	1.62	0.52	1.05	0.77	1.43	0.78	1.62	0.92	2.87	0.10
	Model 2	1.09	0.70	1.70	0.71	1.25	0.85	1.84	0.25	1.23	0.49	3.08	0.66
	Model 3	1.11	0.70	1.75	0.66	1.27	0.86	1.87	0.24	1.64	0.48	5.60	0.43
Fish	**Model 1**	1.08	0.71	1.63	0.74	1.53	0.94	2.51	0.09	1.44	0.64	3.26	0.38
	Model 2	1.15	0.73	1.82	0.55	1.97	1.10	3.51	0.02	1.10	0.38	3.12	0.87
	Model 3	1.14	0.72	1.82	0.58	1.80	0.99	3.26	0.05	0.99	0.28	3.49	0.99
Legumes	**Model 1**	0.84	0.44	1.62	0.60	1.38	0.73	2.61	0.32	0.63	0.29	1.35	0.23
	Model 2	0.74	0.34	1.62	0.45	1.86	0.92	3.76	0.09	0.53	0.20	1.40	0.20
	Model 3	0.77	0.35	1.68	0.50	1.51	0.72	3.16	0.27	0.74	0.26	2.07	0.56
Milk and milk products	**Model 1**	0.74	0.50	1.11	0.15	0.89	0.57	1.40	0.61	0.99	0.60	1.63	0.97
	Model 2	0.53	0.29	0.95	0.03	0.91	0.56	1.47	0.69	0.77	0.36	1.62	0.49
	Model 3	0.54	0.30	0.96	0.04	0.88	0.53	1.46	0.62	0.81	0.31	2.10	0.66
Fats, oils, sugars	**Model 1**	0.95	0.69	1.30	0.73	0.98	0.78	1.22	0.83	0.75	0.52	1.07	0.11
	Model 2	0.99	0.69	1.43	0.97	1.00	0.78	1.27	0.98	0.74	0.42	1.31	0.31
	Model 3	1.00	0.69	1.44	0.99	1.02	0.80	1.31	0.86	0.62	0.30	1.25	0.18

Model 1: Unadjusted
Model 2: Adjusted for marital status, education, employment and energy (Malay); gender, age, employment and energy (Chinese); gender, age, marital status, employment and energy (Indian)
Model 3: Adjusted for Model 2 plus late dining (Malay); Model 2 plus physical activity and alcohol intake (Chinese); Model 2 plus physical activity, smoking, alcohol intake, frequent dining out and late dining (Indian)

4.2.5.5 Effect of food groups with MetS component – High fasting blood glucose (Fasting hyperglycemia)

The median intakes of food groups by Malaysian adults with and without fasting hyperglycemia were compared. The results show that the median intake of legumes is lower among hyperglycemics compared to subjects with normal fasting blood glucose (0.14 vs. 0.29; p = 0.03) (Supplementary Table 18). Table 68 shows the regression models for the association of food groups with high fasting blood glucose levels among the Malaysian adults in Johor. No significant association was found. However, among the Malays in this cohort, significantly higher intake of vegetables was observed among those who had high fasting blood glucose levels (AOR = 1.23 [95% CI = 1.01-1.50]), when adjusted for age, marital status, education, energy and quick finishing of meals (Table 69). However, no association of food groups with fasting hyperglycemia was observed among the Chinese and the Indians in this cohort (Table 69).

Table 68: Association of food groups with hyperglycemia among Malaysians (n=481)

			95%CI		
		OR	Lower	Upper	P-value
Cereals and cereal products	**Model 1**	0.97	0.87	1.08	0.60
	Model 2	0.96	0.83	1.11	0.54
	Model 3	0.95	0.82	1.10	0.46
Vegetables	**Model 1**	1.05	0.95	1.17	0.35
	Model 2	1.10	0.97	1.24	0.13
	Model 3	1.11	0.98	1.25	0.12
Fruits	**Model 1**	0.98	0.81	1.17	0.79
	Model 2	0.92	0.75	1.14	0.46
	Model 3	0.94	0.76	1.15	0.53
Poultry, meat, egg	**Model 1**	0.96	0.75	1.22	0.73
	Model 2	1.20	0.90	1.61	0.22
	Model 3	1.17	0.87	1.58	0.29
Fish	**Model 1**	1.18	0.88	1.60	0.27
	Model 2	1.03	0.73	1.46	0.86
	Model 3	1.03	0.73	1.46	0.86
Legumes	**Model 1**	0.91	0.60	1.39	0.67
	Model 2	0.99	0.63	1.54	0.96
	Model 3	0.97	0.62	1.53	0.89
Milk and milk products	**Model 1**	1.11	0.88	1.40	0.37
	Model 2	1.04	0.80	1.37	0.75
	Model 3	1.05	0.79	1.38	0.76
Fats, oils, sugars	**Model 1**	0.97	0.82	1.16	0.75
	Model 2	0.97	0.79	1.19	0.76
	Model 3	0.96	0.78	1.19	0.73

Model 1: Unadjusted
Model 2: Adjusted for gender, age, ethnicity, education, Employment status and energy
Model 3: Adjusted for gender, age, ethnicity, education, Employment status, energy, smoking status, frequent dining out, late dining and quick finishing meals

Table 69: Association of food groups with hyperglycemia across ethnicities

		Malay (n=147)				Chinese (n=228)				Indian (n=106)			
			95%CI				95%CI				95%CI		
		OR	Lower	Upper	P-value	OR	Lower	Upper	P-value	OR	Lower	Upper	P-value
Cereals and cereal products	**Model 1**	0.94	0.82	1.09	0.42	0.85	0.66	1.10	0.22	1.13	0.87	1.48	0.35
	Model 2	0.92	0.75	1.12	0.40	0.97	0.72	1.31	0.84	0.89	0.58	1.37	0.59
	Model 3	0.92	0.76	1.12	0.41	0.98	0.73	1.33	0.90	0.83	0.47	1.48	0.54
Vegetables	**Model 1**	1.18	1.02	1.38	0.03	0.94	0.75	1.18	0.61	0.92	0.71	1.18	0.50
	Model 2	1.22	1.01	1.48	0.04	1.13	0.85	1.50	0.42	0.89	0.66	1.20	0.44
	Model 3	1.23	1.01	1.50	0.04	1.06	0.78	1.45	0.70	0.87	0.62	1.22	0.42
Fruits	**Model 1**	1.10	0.86	1.40	0.45	0.83	0.58	1.18	0.31	0.93	0.51	1.70	0.81
	Model 2	0.94	0.70	1.24	0.65	0.79	0.53	1.18	0.24	0.88	0.42	1.86	0.74
	Model 3	0.94	0.70	1.26	0.69	0.74	0.49	1.11	0.14	0.63	0.23	1.73	0.37
Poultry, meat, egg	**Model 1**	1.17	0.83	1.65	0.37	0.74	0.47	1.17	0.20	1.08	0.54	2.16	0.83
	Model 2	1.26	0.82	1.93	0.29	0.89	0.51	1.53	0.66	1.07	0.37	3.12	0.91
	Model 3	1.24	0.81	1.92	0.33	0.83	0.47	1.47	0.52	1.66	0.40	6.85	0.49
Fish	**Model 1**	1.26	0.85	1.86	0.24	0.54	0.23	1.27	0.16	0.84	0.29	2.42	0.74
	Model 2	1.20	0.78	1.84	0.42	0.76	0.30	1.91	0.56	0.60	0.14	2.55	0.49
	Model 3	1.18	0.76	1.82	0.47	0.77	0.30	1.96	0.58	0.54	0.09	3.11	0.49
Legumes	**Model 1**	1.20	0.70	2.05	0.51	0.32	0.08	1.26	0.10	0.86	0.39	1.91	0.71
	Model 2	1.08	0.56	2.06	0.82	0.55	0.13	2.36	0.42	0.82	0.34	1.95	0.65
	Model 3	1.08	0.56	2.09	0.83	0.61	0.14	2.68	0.51	0.60	0.20	1.77	0.35
Milk and milk products	**Model 1**	1.05	0.79	1.40	0.73	0.84	0.47	1.50	0.55	1.21	0.68	2.14	0.52
	Model 2	0.97	0.66	1.42	0.88	0.98	0.52	1.85	0.95	1.17	0.58	2.39	0.66
	Model 3	0.96	0.65	1.42	0.84	0.93	0.48	1.80	0.83	1.64	0.64	4.22	0.30
Fats, oils, sugars	**Model 1**	1.06	0.79	1.41	0.71	1.00	0.77	1.32	0.98	0.64	0.40	1.03	0.07
	Model 2	1.06	0.76	1.47	0.74	1.13	0.83	1.55	0.44	0.52	0.25	1.07	0.07
	Model 3	1.07	0.77	1.50	0.68	1.13	0.81	1.59	0.47	0.61	0.26	1.44	0.25

Model 1: Unadjusted
Model 2: Adjusted for age, marital status, education and energy (Malay); gender, age, employment status and energy (Chinese); gender, age, marital status and energy (Indian)
Model 3: Adjusted for Model 2 plus quick finishing of meals (Malay); Model 2 plus smoking status, frequent dining out and skipping breakfast (Chinese); Model 2 plus physical activity, smoking status, alcohol consumption, late dining and skipping breakfast (Indian)

4.2.6 Summary

The major findings of the investigation reported in this section and whether or not these were according to our hypotheses have been listed below:

1. Prevalence of abdominal obesity was highest among females compared to males (65.7% vs. 55%), and with highest percentage among the Indians (82.1%), followed by the Malays (70.7%) and the Chinese (46.9%). These values were according to our hypothesis and were in line with the percentages reported in the nationwide survey-2008. However, very high prevalence of abdominal obesity among the Indians in Johor was an unexpected finding because the nationwide survey-2008 had no value of abdominal obesity of this magnitude.

2. High blood pressure and fasting hyperglycemia were most common among males, and the Malays seemed to be most affected.

3. Low HDL-cholesterol was in highest proportion among the Indians (64.2%) and in lowest proportion among the Chinese (9.6%). Keeping in view the percentages reported in the nationwide suvey-2008 for these two ethnic communities, it was an unexpected result and a significant decline in its prevalence among the Chinese could be due to their changed lifestyle and dietary habits in this region.

4. Regarding lifestyle factors, no association of any factor with abdominal obesity was observed in this population, however lower level of physical activity was found to be associated with high blood pressure, especially among the Chinese. This was contrary to our hypothesis as the general belief was that physical activity would be related to abdominal obesity.

5. Frequent dining out and skipping breakfast were found to be associated with low HDL-cholesterol. Considering these to be new risk factors for metabolic abnormalities, it was an expected result and very much in line with our hypothesis.

6. Hypertriglyceridemia was related to low level of physical activity among the Chinese, and with alcohol consumption among the Indians. These were expected findings as both of these life style factors have been known to be associated with MetS or its components.

7. Fasting hyperglycemia was found to be associated with quick finishing of meals among the Malays and with smoking and late dining among the Indians. These results were in accordance with our hypothesis, however, the associations were observed in the two ethnic communities and not in the overall population in this cohort.

8. Regarding intakes of nutrients, maximum effect was observed on fasting hyperglycemia by intakes of omega-3. PUFA (especially among the Malays) and trans fatty acids (especially among the Indians). This was an unexpected finding because the relationship of intakes of omega-3-PUFA and trans fatty acids with fasting hyperglycemia has been muddled with conflicting reports (272-274). About the three diet patterns identified in this population, the results have been variable. Increased intake of diet pattern 3 (chicken rice, fried noodles and nasi lemak) was associated with increased risk of abdominal obesity among the Indians but was protective among the Malays against hypertriglyceridemia. The observation of increased obesity with such a diet pattern among the Indians was understandable, but was difficult to explain for being protective among the Malays. The highest consumption of diet pattern 2 (noodle soup, chocolates, soy milk, potatoes) was increasing the risk of low HDL-cholesterol among the Indians and this was an interesting finding requiring a possible explanation.

Regarding the effect of food groups' intakes on the risk of metabolic abnormalities, consumption of vegetables, fruits, milk and milk products was found to be protective against high blood pressure among the Indians. However, higher intakes of cereals and cereal products by this ethnic group were found to be increasing the odds of low HDL-cholesterol. An unexpected observation was that the Chinese who consumed high amounts of vegetables and fish were found to be at risk of developing hypertriglyceridemia. Similarly, increased intake of vegetables was associated with fasting hyperglycemia among the Malays. While the results pertaining to the protective effects of vegetables, fruits, milk and milk products were in accordance with our hypothesis, the relationship

of increased intake of vegetables with hypertriglyceridemia among the Chinese and with hyperglycemia among the Malays is difficult to explain unless the high consumption was of starchy vegetables.

Chapter 5: Discussion

The study aimed to explore the prevalence of MetS and its components in Malaysian adults in Johor, and to evaluate the influence of lifestyle and nutritional factors on the risk this syndrome and its metabolic abnormalities. To the best of knowledge of the investigators of the current study, no research investigation in Malaysia has previously evaluated the influence of lifestyle and nutritional factors on the risk of MetS in Johor.

5.1 Prevalence of MetS and its components

This research endeavour showed the overall prevalence values in Johor, Malaysia in 2016-17 to be 32.2%, 31.2% and 22.7%, based on the Harmonized, IDF and NCEP-ATP III definitions, respectively. These estimates appear to be lower than the prevalence estimates reported in the nationwide survey 2008 using these three criteria – 42.5% (Harmonized), 37.1% (IDF), 34.3% (NCEP ATP III), and by other investigators in Malaysia (21, 29). For example, Ramli et al., reported the prevalence of MetS in Malaysian adults to be 37.4% and 26.5% using the IDF and NCEP-ATP III definitions, respectively (21). Had they used the Harmonized definition, which is known to capture more subjects with MetS, the percentage of MetS would have been even close to the value reported in the nationwide survey. In line with the findings of Rampal et al., that the Malaysian Chinese have the lowest and the Indians have the highest prevalence of this syndrome in Malaysia, a similar pattern has been observed in Johor population, where the prevalence values for Indians and Chinese were found to be 51.9% and 20.2%, respectively (47). These results are also corroborated by the findings of Tan et al., who have reported the Indians to be having the highest prevalence of MetS and the Chinese having the lowest (112). It is noteworthy that the prevalence of MetS (51.9%) found among the Indians in the current study is very similar to the one reported for this group by Mohamud et al., in the nationwide survey 2008, however, despite the limitation of the current study being a non-randomized cross-sectional study, the crude prevalence estimate of MetS among the Chinese (20.2%) in Johor appears to be significantly less than the value (42.1%) reported in the nationwide survey (29). Similarly, the prevalence of MetS among the Malays (36.7%) observed in the current study is also remarkably less than the value of 43.9% reported in the nationwide survey 2008 for this

ethnic group (29). Based on the fact that the nationwide survey did include a reasonable proportion of Johor population (more than 18%), it can be suggested that the prevalence values of MetS among the Malays and the Chinese in Johor appear to have decreased over a period of 9 years. However, confirmation of this deduction would require a separate analysis of the data obtained in Johor in 2008 for the nationwide survey.

MetS is a cluster of metabolic abnormalities; at least three, irrespective of the applied definition. The most prevalent combinations of these metabolic diseases in a community may offer a reason for the variation in the MetS prevalence in the current study in 2016-17. According to the nationwide survey, the three most prevalent metabolic abnormalities defining MetS were abdominal obesity (57.4%), high blood pressure (52.3%) and low HDL-cholesterol (42.7%) (29). In the current study, a similar pattern was observed in Johor, and the three most common metabolic abnormalities were abdominal obesity (62.0%), high blood pressure (56.8%) and low HDL-cholesterol (29.5%). However, among the Chinese, the most prevalent combination was abdominal obesity, high blood pressure and hypertriglyceridemia. The above mentioned information indicates that abdominal obesity and high blood pressure are the most prevalent metabolic risk factors in the Johor population, similar to the Malaysian adults in the country, however, the crude prevalence value of low HDL-cholesterol in Johor is quite low compared to the value reported in the nationwide survey (29.2% vs. 42.7%) (29).This is suggestive that the overall decrease in prevalence of MetS observed in the Johor population compared to the nationwide survey 2008 (32.2% vs. 42.5%) is most likely due to a decline in the percentage of low HDL-cholesterol. This crude comparison is, again, based on the information that approximately 18% - 19% of the population reported in the nationwide survey belonged to the Johor population.

Gender-wise, this pattern of three clustered metabolic risk factors is consistently present among the males and females in the nationwide survey and in the current study in Johor. The prevalence of MetS in the current study is higher in the males compared to the females (33.7% vs. 31.4%. This is different from the pattern reported in the nationwide survey 2008, where the females had higher prevalence of MetS compared to the males (43.7% vs. 40.2%) (29). However, a couple of other

studies carried out in Malaysia have shown that prevalence of MetS is not significantly different between males and females (21, 49). The nationwide survey indicated that hypertriglyceridemia was the third most common metabolic abnormality among the males, while low HDL-cholesterol was the third most common metabolic risk factor among the females (29). The same pattern is observed in the present study, however percentages of hypertriglyceridemia and low HDL-cholesterol among the males in Johor are considerably lower compared to values reported in the nationwide survey 2008 (30.6% vs. 43.4% for hypertriglyceridemia and 21.3% vs. 32.6% for low HDL-cholesterol) (29). This is suggestive that perhaps, changed nutrition and lifestyle habits have brought a change in the percentages of these metabolic abnormalities among the males and females in Johor, which might have affected the overall prevalence of MetS in this population.

Ethnicity-wise, a maximum decline was observed in low HDL-cholesterol levels among the Chinese cohort of the current study in Johor compared to the levels reported in the nationwide survey 2008 for this ethnic group in Malaysia (9.2% vs. 46.4%). Similarly, the percentage of hypertriglyceridemia among the Chinese in Johor is now at 24.1% compared to its prevalence of 47.4% in the nationwide survey 2008 (29). Conversely, the Indians in the current study have the highest prevalence of abdominal obesity (82.1%) compared to the Malays (70.7%) and the Chinese (46.9%). Comparing these values with those reported in the nationwide survey 2008 for these three ethnicities (Indians: 68.8%, Malays: 60.6% and Chinese: 49.5%), it becomes apparent that the Indians and the Malays in Johor are relatively more obese compared to their populations in other states of Malaysia. These observations are in line with some other studies in the country. For example, Mohamud et al., have reported a similar pattern of obesity among adults in five different regions in Peninsular and East Malaysia (271). This change in abdominal obesity points towards the influence of various factors such as changing lifestyle and nutritional habits in the Johor population which might have resulted in the increased abdominal obesity in this region.

In the nationwide survey, the overall prevalence of high blood pressure was 52.3%, and it was most prevalent among the Malays (52.2%), followed by the Chinese (48.4%) and then the Indians (47.0%) (29). Comparing these reported values with the estimates from the current study, an overall rise in

the prevalence of high blood pressure to 56.8% has been observed, with the highest among the Malays (61.9%) followed by the Indians (58.5%). The prevalence among the Chinese appears to be similar to the one reported in the nationwide survey (29). This changed prevalence of hypertension among adults in Johor, especially among the Malays and the Indians could be due to factors influencing this metabolic abnormality (vide infra).

The nationwide survey 2008, which included the Johor population as well (vide supra), reported a prevalence of high fasting blood glucose to be 36.7%; the highest among the Indians (45.2%), followed by the Malays (43.8%) and the Chinese (27.2%) (29). In the current study, a remarkable decline has been observed in the overall prevalence estimate for high fasting blood glucose, which has now been found to be 18.7%, and still higher among the Malays (27.2%), followed by the Indians (17.0%) and then the Chinese (14%). This significant decline in fasting hyperglycemia in Johor population since 2008 could be the consequence of lifestyle and nutritional changes over this period of nine years.

In light of the above mentioned evidence, it is conceivable that the population of Johor has certain characteristics which might have caused variation in the prevalence of MetS and its metabolic components, compared to other populations in other states of Malaysia. Overall, an improvement is apparent in certain metabolic disease conditions over a period of nine years, especially in hypertriglyceridemia, low HDL-cholesterol, and high fasting blood glucose leading to a lower prevalence of MetS in Johor. Keeping this in view, it was important to explore the influence of certain modifiable risk factors which might have been responsible for such a remarkable decrease in the prevalence estimates of MetS in this population compared to other populations in Malaysia (vide infra).

5.2 Sociodemographic characteristics and risk of MetS

Socio-demographic characteristics were assessed for the Johor cohort of this study, with emphasis on gender, age, ethnicity, marital status, education and employment status. Adjusted results indicate

that the odds of MetS increase with the increase in age. This relationship is also reported in other studies (21, 29, 47). As age increases, there is prolonged exposure to a variety of environmental insults and injuries that cause chronic inflammation. Furthermore, increasing age also increases exposure to unhealthy lifestyles such as physical inactivity, tobacco use, excessive alcohol consumption and poor nutrition. These factors further up-regulate the inflammatory processes and aggravate the metabolic disorders (275). In the present study, higher education offered protection against MetS, and this finding was consistent with the reports from other studies (21, 276-278). Higher education may lead to better awareness of the syndrome and its risk factors, and this would be helpful in taking timely measures to counteract the effects of MetS and its components. These measures include, better healthcare access, knowledge ~~on~~ about various treatment options and better management approaches (279, 280). Studies also show that higher education of individuals has been found to be protective against diabetes and hypertension, which are prominent risk components of MetS (281, 282). Conversely, in a recent study, Ching et al., have reported that there were no statistically significant differences in education levels of Malaysian vegetarians with and without MetS (51). However, this was a unique group among Malaysians with a specific dietary habit and the results pertaining to this population could be expected to be different from the general population in Malaysia. Ethnicity appears to have a profound influence on vulnerability to MetS. The Chinese ethnic community in Johor was found to be less vulnerable to developing MetS and the Indians had 1.94 times more odds of having MetS, compared to the Malays. This is consistent with the reports from other researchers from Malaysia that the Chinese have lower odds, while the Indians have higher odds of developing MetS (21, 47). This ethnicity based variation in susceptibility to developing MetS could be due to the peculiar lifestyle and nutritional habits of various ethnic groups in the Malaysian population.

5.3 Effect of lifestyle – Physical activity

Regarding physical activity, results of the current study show that physical activity is not associated with MetS in Johor population. However, among the Chinese, low physical activity increased the adjusted odds of MetS by 4.76 folds, high blood pressure by 3.06 times and hypertriglyceridemia by

4.31-fold. Despite the fact that no association of physical activity with MetS has been observed among the Malays and the Indians, its inverse relationship with metabolic complications among the Chinese ethnic group points towards the important role it can play in arresting the progression of MetS among Malaysians. This is supported by several other studies which have shown a direct relationship of sedentary lifestyle with the risk of metabolic diseases (30-34, 283). Bankoski et al have shown that greater time spent in sedentary behaviours increases the risk of having MetS, while breaks in sedentary time throughout the day are protective against MetS (109). Chu and Moy have shown that longer sitting time and insufficient physical activity have resulted in an almost four-fold increase in MetS risk among the Malays (53, 54). Moreover, the risk of MetS in moderate and high physical activity modes gets reduced by 50% compared to a physically inactive state (54). This shows that modification of lifestyle habits can bring about reduction in MetS and/or its associated components in Malaysia, and interventions promoting healthy lifestyle habits may bring about the desired outcome.

5.4 Effect of lifestyle – Smoking status

Results in this study indicate that smoking does not appear to be associated with MetS in the Johor population, though an inverse association of smoking with obesity has been shown in other studies (284-286). In the present study, the proportion of past / current smokers is quite small (12.9%). This perhaps could be one of the reasons that no association between smoking and MetS has been observed in the Johor population. However, influence of smoking on metabolic abnormalities has been observed among the various ethnic groups in this study. For example, among the Chinese, the adjusted odds of high blood pressure increased 2.94 times among past/ current smokers. The direct relationship between smoking and high blood pressure is well established as reported by Leone and other investigators (287-290). Regarding the effect of smoking on fasting hyperglycemia, our results indicate that among the Indians, past/ current smokers had 8.3 times higher odds of having hyperglycemia (adjusted for gender, age and marital status). This is corroborated by the findings of Pan et al., who have reported a direct relationship between smoking and incidence of type 2 diabetes

mellitus (123). Smoking cessation has been shown to increase body mass index (BMI) which may contribute to the increased obesity rates overtime (286, 290).

5.5 Effect of lifestyle – Alcohol consumption

As mentioned before, according to literature, high alcohol consumption has unfavourable effects on the MetS spectrum. Results of the current study indicate that the effects of alcohol consumption on MetS and its components among the subjects in this cohort have been insignificant. This is perhaps due to increasing awareness over time about the undesirable effects of alcohol in this community and/ or indulgence in moderate consumption of alcohol. Alcohol consumption was found to be associated with hypertriglyceridemia only among the Indians, increasing the adjusted odds to 16.98. This observation points towards the need to create more awareness among the Indians in Johor about the ill-health effects of alcohol in order to contain the MetS among the Indians.

5.5 Effect of lifestyle – Dietary habits

Dietary habits of the study subjects were evaluated, and an association of dietary habits with the risk of MetS and some of its components has been observed. For example, frequent dining out more than three times per week increased the adjusted odds of MetS by 2.04 times, and of low HDL-cholesterol by 2.28 times among Malaysian adults in Johor. Food prepared outside home in fast food and casual dining restaurants is generally higher in energy and is considered to be less healthy compared to food prepared at home (291). Results of this study show that frequent dining out is a relatively newish risk factor for MetS and its components. This finding is supported by other studies carried out in the region (129, 130). For example, Oh et al., in the Korean National Health and Nutrition Examination Survey have reported dinning out to be a risk factor for MetS among the Koreans (129).

Ethnic variations with respect to dietary habits have also been observed in the present study. For instance, among the Malays, quick finishing of meals increased the adjusted odds of MetS by 2.11 times, and of fasting hyperglycemia by 2.49 times. Rapid ingestion of food, in general, results in

excessive food consumption before one develops the feeling of fullness. This may lead to an increase in abdominal obesity and insulin resistance, both components of MetS as reported by Yamaji et al., (292).

Another important dietary habit from the present study, which appears to have an influence on the spread of MetS and its components is breakfast skipping. Results obtained show that skipping breakfast more than three times per week increases the adjusted odds of low HDL-cholesterol among Malaysian adults in Johor by 2.12 times, and specifically among the Chinese, where the adjusted odds of low HDL-cholesterol increases to 3.11. The underlying mechanism of the effect of skipping breakfast on MetS and its components is still unclear. However, studies show that the breakfast skippers tend to dine out more frequently, consume energy-dense foods and have a tendency to overeat at odd times of the day (293, 294).

Among the Indians, frequent dining out more than three times per week increases the adjusted odds of MetS by 4.38 times. Another prominent habit among Indians is late dining, and in the present study, late dining for more than three times per week increased the adjusted odds of fasting hyperglycemia by 5.36 folds. The plausible explanation could be that late dining follows a long period of inactivity that disrupts the routine meal eating habits. As a result, there would be a tendency to skip breakfasts and dine out more frequently, which in the current study has also been shown to increase the odds of MetS.

5.5 Effect of nutrition – Nutrient intakes

Nutrient intakes per day were assessed for all the subjects in this cohort. The data indicate that the intake of nutrients has been variable across the three major ethnicities of the country. According to the guidelines, total energy (in kcal/day) intake should not exceed 2240 kcal/day for males and 1900 kcal/day for females, however, in the current study comprising of approximately 65% females, the overall median intake was found to be 2358 kcal/day, which is much higher than that recommended in the Malaysian dietary guidelines (228). Across the three major ethnicities, the median energy

intake among the Chinese in Johor was found to be the lowest (2157 kcal/day), and a few years ago, it was reported to be the highest among the Chinese by the Malaysian Adults Nutrition Survey (MANS) in 2014, where the median intake was reported to be 1564 kcal/day (226). This shows that energy intake among Malaysians in Johor has risen considerably over time.

The recommended intake for proteins is 53 g/day and 62 g/day in females and males, respectively (228). The median intake of proteins has been found to be 76.98 g/day in the present study, with the minimum intake among the Indians at 66.6 g/day. According to MANS 2014, the overall median intake of proteins was 57 g/day; and even the Indians then had the minimum intake of proteins (52.48 g/day) (226). This shows an overall increase in intake of proteins in the Malaysian population in Johor.

Regarding fats, the median intake reported in MANS 2014 was 46 g/day; the highest among the Chinese (53.31 g/day) and lowest among the Malays (45.33 g/day) (226). In the present study, the median intake of fats overall was found to be 78.85 g/day; the highest among the Malays (106.25 g/day) and lowest among the Chinese (67.84 g/day). It has been recommended that the intake of fats should not exceed 75 g/day for males and 63 g/day for females. However, the current overall intake of fats in the Johor population appears to be very high; and only the Chinese who are known to consume less amount of fats in their daily diet appear to be meeting the expected recommended intake (228). A number of studies have shown that dietary fats rich in saturated and trans fatty acids have harmful effects on human health (193, 295). In the Johor cohort, the Chinese consuming lesser amount of fats compared to other ethnic groups have the lowest prevalence of MetS (20.2%), while the Malays consuming the highest amount of dietary fats and the Indians consuming high amounts of fats and oils, especially the trans fatty acids still have very high prevalence values of MetS (36.7% and 51.9%, respectively), and of abdominal obesity (70.7% and 82.1%, respectively) in the Johor population. This indicates that a modification in fat intake by these two ethnic groups could have beneficial effects on their health.

The recommended intake of fibre among Malaysians is between 20-30 g/day (228). The MANS 2003 reported the intake of fibre to be less; 19.2 g/day (229). The current study reports the median intake of fibre to be 21.1 g/day, hence meeting the expected recommendation for fibre intake among Malaysians. Across ethnicities, it has been noticed that the Chinese have the highest intake of fibre (22.81 g/day) compared to the Malays and Indians; both races having their median intakes less than the recommended intake (Malays: 19.33 g/day, Indians: 18.7 g/day). Since the variation in the median fibre intake among the three ethnic groups was small, this might be the reason that no association of fibre intake with MetS has been found in this Johor cohort.

In the current research, variable intakes of micronutrients across the three ethnicities have been observed. For example, median intake of sodium was 2456.35 g/day; much higher than the recommended intake of 1500 g/day (228). Higher intake of sodium has been documented in the MANS 2003 (2575 g/day) and MANS 2014 (1935 g/day) (225, 226). This may partly explain the persistent high prevalence of hypertension among Malaysians. As regards to the three major ethnic groups in Johor, the Malays and the Chinese have the highest intakes of sodium compared to the Indians. Moreover, comparatively higher intakes of potassium among the Chinese compared to the Malays and the Indians have been observed. Literature suggests that high potassium and low sodium intake offers protection against high blood pressure (220). In the current study, the prevalence of high blood pressure is higher among the Malays (61.9%), followed by the Indians (58.5%) and then among the Chinese (52.6%). Among other micronutrients, higher median intakes have been observed for niacin, retinol and vitamin C, all of which have their own respective roles in protecting against MetS and its components (296).

The current investigation also reveals that among the Malays, there is higher intake of omega-6-PUFA, followed by the Indians and then the Chinese. However, median intakes for omega-3-PUFA are higher among the Chinese, followed by the Malays and then the Indians. Simopoulos has reported that when omega-6 to omega-3 ratio, exceeds 15, then cardiometabolic sequelae starts to ensue (190). The ratio of omega-6 PUFA to omega-3 PUFA in the overall study the population of Johor was found to be 20. Among the Malays this was 21, and among the Indians and the Chinese

the ratios were 17 and 12, respectively. This may partly explain why the Malays in Johor have the highest prevalence of hypertension compared to the Indians and the Chinese. Lower ratios have been known to offer protection against cardio-metabolic complications, and this may also partly explain their protective role against MetS and its components among the Chinese in Johor (190). As regards to the effects of intake of omega-3-PUFA on MetS and its components, a direct relationship between higher intake of omega-3-PUFA and MetS, abdominal obesity and fasting hyperglycemia has been observed among the Malays. This observation is corroborated by the results of Chen et al., who have reported an increase in fasting blood glucose among Asians following supplementation in diabetic patients (273). The kind of relationship observed in the current study is only possible if the levels of omega-3-PUFA were relatively low among the Malays and a diet rich in omega-3-PUFA taken over several months would then lead to an increase in adipose tissue mass and plasma glucose. Sener et al., have shown a similar response in omega-3-depleted rats (297). However, in the absence of information about the levels of omega-3-PUFA among the Malays in Johor, this can only be considered a possible explanation. Moreover, Poudyal et al., have reported that none of the nutritionally important omega-3-PUFA improves insulin sensitivity in humans, thus fasting hyperglycemia can be expected in the subjects with increased intake of this fatty acid (298). Furthermore, Nieman et al., have shown that increased uptakes of omega-3-PUFA, especially alpha-linolenic acid have no beneficial effect on visceral adiposity (299). However, animal studies have shown that increasing intakes can increase adiposity (297, 298).

Median intake of trans fatty acids is also found to be the lowest among Chinese (0.04 g/day) in the current study. Trans fatty acids in the diet increase the risk of metabolic diseases and complications. Higher intakes of these fatty acids have been found among the Malays and Indians. This indicates that increased uptake of trans fatty acids among these two ethnic groups in Johor has a role in making them more prone to developing MetS or metabolic complications. This is evident from the results of the current study, and increased intake of trans fatty acids among the Malaysian adults in Johor increased the adjusted odds of fasting hyperglycemia by 3.2 folds. This feature was more prominent among the Indians, where the increased intake by this ethnic group increased the odds of fasting hyperglycemia by several folds. Although Aronis et al., have shown that increased intake

of trans fatty acids has no significant effect on plasma glucose concentration, yet Mazidi et al., recently have demonstrated an association between plasma levels of trans fatty acids and waist circumference, fat mass, fasting blood glucose, triglycerides, HOMA-IR (Homeostatic Model Assessment of Insulin Resistance) and LDL-cholesterol (272, 274).

This is further supported by trials which have shown that the intake of diets high in trans fatty acids, especially among those who are overweight and diabetics, has adverse effects on insulin sensitivity and increases blood glucose levels (300, 301). Despite reports that contents of trans fatty acid are low (< 1 g /100 g lipid) in majority of the food items in Malaysia, there is still a cause of concern as presence of any amount of trans fatty acids in the diet is harmful to human health and contributes to the metabolic disease spectrum and its sequelae (302). It is desirable to have zero content of trans fatty acids in most food items available in the country in order to contain the spread of MetS and its associated complications among the Malaysian population.

5.6 Effect of nutrition – Diet patterns

Several studies carried out in the region have shown the association of dietary patterns with MetS (151, 154). However, the three dietary patterns identified on the basis of commonly consumed food items in the Johor population were found to have no association with MetS.

Nevertheless, increased intake of pattern 2 (noodle soup, chocolates, soy milk and potatoes) increased the adjusted odds of abdominal obesity by nearly two times. A majority of the items in this pattern are rich in carbohydrates, hence it is conceivable that the increasing intakes of these items will promote abdominal obesity. Furthermore, when the model is further adjusted for lifestyle factors (physical activity, smoking and frequent dining out), this effect disappears. Across ethnicities, a modest increase in intakes of pattern 1 (legumes, cruciferous vegetables, roots and fruit vegetables) increased the odds of abdominal obesity among the Malays, but further increase had no influence on obesity. Among the Indians, higher intake of pattern 3 (chicken rice, fried noodles and nasi lemak) increases the odds of abdominal obesity by 15.2 times. These items are rich in carbohydrates and

fats, and hence, are likely to increase obesity which is evident from its high prevalence among the Indians in Johor.

Some paradoxical results were also obtained pertaining to association of diet pattern 1 (legumes, cruciferous vegetables, roots and fruit vegetables) with low HDL-cholesterol. Increasing the intake of food from this diet pattern increased the adjusted odds of low HDL-cholesterol by 2.44 times among Malaysian adults in Johor. However, this association was more prominent among the Indians where the adjusted odds of low HDL-cholesterol increased up to 9.3. These findings can be partly explained by the fact that these vegetable-based items are generally “cooked” in oils and fats in the Indian culinary, which may destroy the beneficial effects of legumes, vegetables and fruits. Moreover, the consumption of fats and oils might be contributing to this type of dyslipidemia.

Regarding hypertriglyceridemia, we found no effect of diet patterns except for pattern 3 (chicken rice, fried noodles and nasi lemak) which, if taken in increased amounts, was found to be protective against hypertriglyceridemia among the Malays. Partly, this finding can be explained on the premise that the Malays use considerable amounts of omega-3-PUFA. Higher intakes of omega-3-PUFA, especially eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA), modulate triacylglycerols levels, and studies have shown that they improve lipid profile by lowering triacylglycerols and increasing HDL-cholesterol (298, 303). Nevertheless, the effect of this diet pattern to improve HDL-cholesterol among the Malays has not been observed in the present study. Lack of association of the three major diet patterns with MetS in the population in Johor points towards the fact that the Malaysian population is quite diverse in terms of having three major ethnic groups which might have different preferences for dietary food items.

5.7 Effect of nutrition – Food groups

As mentioned above, diet patterns comprising of commonly consumed food items in Johor may not fully represent the foods consumed across the different ethnicities of the country. In this regard, it

becomes imperative to study the cumulated effects of food categories on MetS and metabolic abnormalities across the three major ethnicities of Malaysia in Johor

Comparing the median serving intakes of different ethnicities with the recommended intakes, it was noticed that cereals and cereal products, vegetables, fruits, fish, legumes and milk and milk products were consumed by the study population in amounts less than the recommended values. Variability however exists in their intakes among the three major races. For instance, the Chinese consume more fruits compared to the Malays and Indians. In fact, the lowest consumption of fruits was among the Indians. Since increased fruit consumption is known to be associated with decreased risk of MetS, this might explain why the Malaysian Chinese who consume more fruits compared to other ethnic groups have been found to have the lowest prevalence of MetS in most studies (296, 304). The Malays consume more fish; their median serving meets the expected recommendation, and this has not been observed among the other two races. Perhaps this could be one of the reasons that their intake of omega-3 PUFA is comparatively higher than the Chinese and the Indians. The Chinese consume more poultry, meat and eggs deriving their energy mostly from proteins. Dimarco et al., in a relatively recent study have shown that daily consumption of eggs increases the levels of HDL-cholesterol (305). This may partly explain why the Chinese in Johor have the lowest prevalence of low HDL-cholesterol (9.6%) compared to other two ethnic groups. Fats, oils and sugars are consumed in higher amounts by the Indians than the recommended amounts and much more than the Malays and the Chinese. This could be one of the reasons why Indians in Johor still have the highest prevalence of MetS and abdominal obesity compared to the Malays and the Chinese.

While studying the association of various food groups with MetS in the Johor population, it is noticeable that the intake of milk and milk products was much lower among the Indians compared to the Malays and the Chinese. Studies have shown that the daily intakes of dairy products are protective against MetS, therefore, it can be deduced that, reduced intakes may increase the risk of MetS, as is seen among the Indians who still have the highest prevalence of MetS in the Johor population (161, 162). Reduced intake of dairy products among Indians is also associated with high blood pressure. The biochemical basis of this effect can be explained by the evidence that dairy

products contain proteins that are precursors of angiotensin-1 converting enzyme, which helps in lowering blood pressure (162). Another factor contributing to increased prevalence of hypertension among the Indians is the reduced intakes of vegetables and fruits and higher intakes of cereal products. There is evidence in literature that cereal products, especially highly processed cereals have a high glycemic index and are adversely associated with MetS and its components (141). Additionally, studies have shown that HDL-cholesterol levels increase with minimally processed cereals than highly processed ones (306). In Malaysia, rice is the staple food; approximately 90% of Malaysians consume cooked rice, which is highly processed and has a high glycemic index (226). Therefore, the Indians consuming high amounts of processed rice could be at a greater risk of developing low HDL-cholesterol. This could be one of the reasons that this metabolic abnormality has the highest prevalence (64.2%) among this ethnic group in Johor.

5.8 Strengths and Limitations

Certain limitations warrant consideration. First and foremost, the present research study was cross-sectional in nature, assessing the exposures and outcomes at the same point in time. In this regard, the findings cannot indicate causality. Second, the selection of study locations harbouring subjects was non-random and partly based on the available information about percentage of MetS across each Malaysian ethnicity in Johor through the nationwide survey 2008, so that sufficient number of subjects in each ethnic group could be recruited for better analysis and interpretation (29). Therefore, a selection bias cannot be completely discounted. Furthermore, stratifying subjects based on their ethnicity mght have lowered the study power for interpretation of associations of various lifestyle and nutrition factors with MetS and its components. However, with a reasonable sample size within each ethnic group and employed standardization techniques, measurement errors were reduced and provided an opportunity to have an in-depth analysis of lifestyle and nutritional factors influencing MetS and its components across the three major races of this state in the country. In this regard, we believe the research to be adequate, and its findings quite comparable to those reported by other investigators using a non-randomized design.

For the present study, the validated questionnaire was modified to collect information of the participants' socio-demographics, lifestyle and nutritional behaviours based on the available body of knowledge across time; hence the modification might have added some variability when comparative differences were being assessed with the results from the nationwide survey 2008. Secondly, the lifestyle and nutritional information collected were based on recall, hence misreporting of information cannot be ruled out, and this might have further added to variability in results. Furthermore, the adopted validated questionnaire from MANS 2014 to collect nutritional information from the study participants employed the serving size as laid down by MANS. However, the definition of serving sizes comprehended by the participants might have been different, especially among various ethnic groups of the study population. Moreover, different races have different methods of preparing food, which may also add to further variability in the servings of food items by the study population that the questionnaire might have overlooked. Despite these sources of potential variability, the results do provide evidence towards the association of certain lifestyle and nutritional behaviours that affect the disease spectrum of MetS in Johor. The variable effects are attributed to the cultural diversities across the different ethnicities of Malaysia. The findings of this study are quite comparable to similar studies exploring association of various risk factors influencing metabolic diseases within Malaysia and abroad. The results pertaining to variable effects of dietary factors on metabolic abnormalities constituting MetS lend support a popular notion that MetS is not a disease but a syndrome arising from clustering of these metabolic disease conditions. Therefore, the control of this syndrome in a population would require interventions towards prevention of these metabolic abnormalities.

Chapter 6: Conclusion, recommendations and way forward

In the light of the aforementioned evidence, we have observed a relatively decreased prevalence estimate of MetS (using Harmonized definition) in Johor Malaysia; from 41.4% in the nationwide survey-2008 (which included a reasonable proportion of Johor population) to 32.2% in the current study. Keeping in view the results of the nationwide survey-2008, the prevalence values of MetS among the three major ethnicities in Johor appear to have increased among the Indians (from 42.6% to 51.9%), and decreased among the Malays (from 42% to 36.7%) and the Chinese (from 33.9% to 20.2%).This apparent decline among the Malays and the Chinese is attributed to a decreased prevalence of high fasting blood glucose, low HDL-cholesterol and hypertriglyceridemia. Age and ethnicity are important non-modifiable factors influencing the prevalence of MetS in Johor, Malaysia. The Chinese population was, and still is, found to be protected against MetS, while the Indians have an increased risk of developing MetS. Higher education of Malaysian adults appears to protect against developing MetS, probably because of better awareness of the modifiable risk factors and the measures to be taken to mitigate their ill-effects.

Healthy lifestyle habits such as physical activity, smoking cessation, moderate consumption of alcohol and healthy eating habits have been found to be major means to prevent / control MetS (41). Low level of physical activity has been found to influence MetS and its components (high blood pressure and hypertriglyceridemia) among our study population, especially among the Chinese where it has been found to increase the odds of MetS and hypertriglyceridemia by more than four-fold. This shows that the Chinese, though show reduction in the risk of developing MetS, can benefit more by engaging in moderate to high level of physical activity. Smoking has been an established risk factor for MetS and some of its components. In the current study, the Chinese involved in smoking had nearly three times odds of having high blood pressure compared to non-smokers. Similarly, Indian smokers had more than eight-fold odds of having fasting hyperglycemia compared to non-smokers. A national level campaign against smoking can mitigate the risk of MetS, but also prevent a number of other diseases afflicting the Malaysian population.

The consumption of alcohol has a relationship with MetS and metabolic abnormalities. We did not find an association of alcohol consumption with MetS among Malaysian adults in Johor. Nevertheless, the Indians in Johor who were consumers of alcohol had nearly 17 times more odds of having hypertriglyceridemia (a component of MetS) compared to non-consumers.

Diet habits reflecting lifestyle choices were also found to influence the MetS in our study population. These included, frequent dining out, skipping breakfast, late dining and quick finishing of meals. For example, frequent dining out for more than three times per week increased the risk of MetS among Malaysian adults in Johor by two folds, and among the Indians the odds were more than four folds. Skipping breakfast more than three times in a week reduced HDL-cholesterol among the Chinese. Among the Malays, quick finishing of meals increased the risk for MetS and hyperglycemia. Late dining out more than three times in a week was found to increase the odds of fasting hyperglycemia among the Indians by more than five folds. In view of these lines of evidence, it is apparent that the Indians in Johor are more prone to developing MetS and/or metabolic abnormalities, and hence, are at a greater risk of suffering from associated complications. Ethnicity-specific educational programs, tailored towards adopting healthier dietary behaviours and lifestyle choices might be of help in reducing the prevalence of MetS and metabolic abnormalities across the three major races of Malaysia.

Nutrition-wise, if we look at the micronutrient intake by the Johor population, the Malays and the Chinese have the highest intake of sodium, however the Chinese also have the highest intake of potassium which is known to be protective against the development of high blood pressure. This might explain the reason for the highest observed prevalence of high blood pressure in Johor is among the Malays (61.9%), followed by the Indians (58.5%) and then the Chinese (52.6%). Among the other micronutrients, highest intakes of retinol, niacin and vitamin C by the Chinese in Johor, all known for their protective roles against MetS and its components, explain why this could be one of reasons for remarkably low prevalence of MetS in this ethnic group compared to the Malays and the Indians. Moreover, the highest ratio of intakes of omega-6-PUFA to omega-3-PUFA, has been observed more among the Malays (the ratio is 21), while the lowest (which is 12) has been found

among the Chinese. Since there is a direct relationship between the high ratio of omega-6-PUFA to omega-3-PUFA and hypertension in a population, this explains why the Malays in Johor have the highest prevalence of high blood pressure compared to the Chinese (61.9% vs. 52.6%). High intakes of omega-3-PUFA, especially by the Malays, were found to be increasing the odds of fasting hyperglycemia. This observation is corroborated by the findings of Chen et al, who have reported an increase in fasting blood glucose among Asians following supplementation in diabetic patients (273).

Compared to the intakes of micronutrients, the intake of food groups (in terms of servings per day of various food items) also appeared to have a direct influence on the risk of developing MetS or metabolic abnormalities in the three ethnic groups in Johor population. For instance, the intake of milk and milk products among the Indians was found to be protective against MetS and high blood pressure. Similarly, consumption of vegetables and fruits was also protective against hypertension in this ethnic group because fruits and vegetables contain appreciable quantities of potassium and antioxidants. However, high consumption of fats, oils and sugars and low consumption of poultry, meat and eggs had a direct relationship with abdominal obesity among Malaysian adults in Johor. Furthermore, the Indians consume more cereals and cereal products and fats, oils and sugars, and less fruits and poultry, meat and eggs, compared to the Malays and the Chinese, and this pattern of nutritional intakes increases the risk of MetS and its components. This could be one of the reasons for the prevalence of MetS remaining high among the Indians in Johor since the nationwide survey 2008. On the other hand, the Chinese have the highest intake of fruits, poultry, meat and eggs and lowest intake of cereals and cereal products, fats, oils and sugars, and this might explains why the Chinese in Johor have such a significant decline in prevalence of MetS and some of its components such as low HDL-cholesterol, fasting hyperglycemia and hypertriglyceridemia in the 2016-17 survey of the current study compared to the nationwide survey-2008. The Malays in this study group were found to take very small amounts of legumes and very high amounts of fats, oils and sugars. This, perhaps, could be a reason that in spite of high consumption of animal proteins (fish, meat, poultry, eggs), the Malays, compared to the two other ethnic groups, still have the highest prevalence values for high blood pressure and fasting hyperglycemia. The prevalence of MetS in this ethnic group is still quite high (36.7%) compared to the Chinese (20.2%) in Johor.

Similar results were also obtained when the diet patterns were studied. For example, among the Indians in Johor, increased consumption of a diet pattern comprising of chicken rice, fried noodles and nasi lemak was associated with 15 times higher odds of having abdominal obesity. Similarly, a very high intake of a diet pattern comprising of noodle soup, chocolates, soy milk and potatoes increased the odds of low HDL-cholesterol by more than four, while a low consumption of diet pattern consisting of legumes, cruciferous vegetables, roots and fruit vegetables was also associated with increased odds for fasting hyperglycemia. Nonetheless, the diet intakes and variety across ethnicities is remarkably different and detailed studies on diet patterns in individual races might further elaborate the patterns consumed by each race, and how the prevalence of metabolic diseases is influenced by the consumption of food items in a diet pattern.

Our data clearly show that dietary factors do have a significant role on the risk of MetS among the three ethnic communities in Johor. The Indians and the Malays still appear to be at a greater risk of developing metabolic disease compared to the Chinese; therefore more efforts in terms of intervention would be needed on these two communities in Johor. Nonetheless, further studies are warranted on the role of dietary habits of these three major ethnicities in Malaysia, especially at the national level to contain the risk of MetS. The current study also highlights the role of trans fatty acids in increasing the risk of MetS and its components. For example, a 3.2-fold increase in fasting hyperglycemia among Malaysians in Johor due to increased intake of trans fatty acids has been observed, especially among the Indians where the odds increase many folds. Though, the prevalence of fasting hyperglycemia has reduced over time, the risk for cardiometabolic disorders is still high in Malaysia, and high consumption of trans fatty acids would still increase the risk for these conditions, including MetS. This is further supported by a recent report by Mazidi et al who have shown an association between plasma levels of trans fatty acids and waist circumference, fat mass, fasting serum glucose, HbA1C, triglycerides, HOMA-IR (Homeostatic Model Assessment of Insulin Resistance), LDL-cholesterol and total cholesterol (274). Food items such as margarine, *vanaspati*, ghee, frying fats, vegetable shortenings are consumed by Malaysians; these are obtained through industrial hydrogenation and contain significant amounts of trans fatty acids (193). The Food and

Agriculture Organization (FAO) of the United Nations and World Health Organization have recommended a reduction in the contents of trans fatty acids in human dietary fats to less than 4% (307). Denmark made a very serious effort in reducing trans fatty acid consumption from 6 g to 1g per day over a period of 20 years, resulting in a 50% drop in cardiovascular mortality (308). Similar measures, if taken by the Government of Malaysia, would certainly help in further mitigating the risks of MetS and its associated conditions.

Public health measures are imperative to further contain the prevalence of MetS and its associated complications. Though the overall prevalence of abdominal obesity has declined in Johor compared to its reported prevalence in the nationwide survey-2008, it is still high in Malaysia. Despite improved socio-economic conditions, continued urbanization and adoption of less healthy lifestyle and diet habits, obesity may still be a highly relevant public health challenge. As obesity is regarded one of the major sources of metabolic abnormalities, stringent measures and further research is needed for a better understanding of its association with lifestyle and nutrition among Malaysians to contain the risk of MetS.

A recent publication has indicated a significantly reduced prevalence of MetS among Malaysian vegetarians compared to the Malaysian general population (24.2% vs. 42.5%) (51). It was noteworthy that this prevalence was lower than the prevalence values among Korean postmenopausal vegetarians (33.9%) and US vegetarians (25.2%) (309, 310). This is suggestive that a diet rich in fruits and vegetables and dairy products is likely to have a major impact in reducing MetS in Malaysian population. Although Japan and North America have already developed dietary guidelines for vegetarians, no dietary guidelines for Malaysian vegetarians have been developed so far. It is imperative that dietary guidelines should not only be developed for vegetarians, but for the whole Malaysian population recommending those food items which have the potential to decrease the risk of MetS in the country (311, 312). It is intriguing that the prevalence of MetS is higher even among the Malaysian Indian vegetarians (34.1%) (51).

This shows that this ethnic group being exclusively vegetarian has a greater risk of developing MetS compared to other races in Malaysia. Indians in Johor appear to be consuming high amounts of oils and fats including trans fatty acids which increase the odds of high fasting serum glucose and this could be contributing to the risk of MetS and its complications in this community.

The differences among the ethnicities, in regard to MetS risk, also need to be further explored. Diversity in the cultures, lifestyle and eating habits might reveal more information as to how the risks could be better addressed among the different races in the country. Diets high in oil and fats, especially trans fatty acids still pose a great threat for cardio-metabolic abnormalities. There is a need to learn from the policy adopted in Denmark to control the cardiovascular disease among the Danish population. This can be achieved if stringent policies are put in place in reducing the amount of trans fatty acids in diets / foods available in Malaysia. With this, one can hope for another remarkable reduction in MetS and associated metabolic conditions. A concerted effort on the part of the health professionals is needed to develop guidelines for healthy diets and a healthy lifestyle for the Malaysian population in general and the population in Johor in particular.

Though the prevalence of MetS and some of its metabolic abnormalities appeared to have improved in Johor population since the nationwide survey 2008, the cumulative undesirable effects of lifestyle and nutritional risk factors still pose a threat to this population. Since the overall effect is of varying magnitude in the three different ethnic communities, ethnic-specific measures would be needed to further reduce the prevalence of this syndrome among Malaysian population in Johor. Increasing the awareness among the masses through electronic and print media about the beneficial effects of healthy diet and lifestyle is likely to be a very powerful approach to combat the menace of this syndrome in this country.

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Appendix 1 (Supplementary results)

Table 1: Comparison of lifestyle characteristics among study respondents with and without MetS in 2016-17 (n=481)

		Total (n=481)	No MetS (n=326)	MetS (n=155)	P-value*
		n (%)	n (%)	n (%)	
Physical activity	**High**	95 (19.8)	69 (21.2)	26 (16.8)	0.05
	Moderate	192 (39.9)	138 (42.3)	54 (34.8)	
	Low	194 (40.3)	119 (36.5)	75 (48.4)	
Smoking status	**Never smoked**	419 (87.1)	281 (86.2)	138 (89.0)	0.39
	Past/Current smoker	62 (12.9)	45 (13.8)	17 (11.0)	
Alcohol consumption	**Never consumed/past consumer**	440 (91.5)	301 (92.3)	139 (89.7)	0.33
	Current consumer	41 (8.5)	25 (7.7)	16 (10.3)	
Frequent dining out	**≤ 3 times/week**	327 (68.0)	217 (66.6)	110 (71.0)	0.33
	> 3 times/week	154 (32.0)	109 (33.4)	45 (29.0)	
Late dining	**≤ 3 times/week**	428 (89.0)	292 (89.6)	136 (87.7)	0.55
	> 3 times/week	53 (11.0)	34 (10.4)	19 (12.3)	
Skipping breakfast	**≤ 3 times/week**	364 (75.7)	245 (75.2)	119 (76.8)	0.70
	> 3 times/week	117 (24.3)	81 (24.8)	36 (23.2)	
Finishing meals	**Not fast**	229 (47.6)	163 (50.0)	66 (42.6)	0.13
	Fast	252 (52.4)	163 (50.0)	89 (57.4)	

*P-value ascertained by chi square test

Table 2: Comparison of median nutrient intakes among Malaysians with and without MetS (defined according to Harmonized criteria) in 2016-17 (n=481)

	All (n=481)		No MetS (n=326)		MetS (n=155)		
	Median	**IQR**	**Median**	**IQR**	**Median**	**IQR**	**P-value***
Energy (kcal)	2358.32	1354.93	2366.82	1303.57	2351.36	1381.96	0.88
Protein (g)	76.98	43.77	79.26	44.67	73.37	42.28	0.10
Fats (g)	78.85	61.41	77.81	56.92	79.02	67.57	0.42
Carbohydrates (g)	302.90	189.32	304.17	193.48	298.69	183.68	0.43
Fibre (g)	21.09	18.05	21.92	18.48	19.27	16.57	0.16
Calcium (mg)	879.39	595.68	891.50	599.38	810.58	577.49	0.07
Iron (mg)	14.76	10.39	15.21	10.91	13.29	10.57	0.05
Sodium (mg)	2456.35	1533.10	2544.85	1588.88	2325.33	1412.75	0.03
Potassium (mg)	2432.10	1518.95	2550.50	1547.28	2221.80	1459.90	0.03
Retinol (μg)	1044.89	713.31	1130.10	758.01	973.85	673.02	0.02
Niacin (mg)	20.93	17.35	21.55	17.80	19.19	14.86	0.08
Vitamin C (mg)	190.01	172.82	196.02	183.88	183.23	148.66	0.14
Cholesterol (mg)	217.09	184.54	223.80	177.51	185.87	186.78	0.01
Omega-6 PUFA (g)	9.62	7.68	9.67	7.45	9.54	8.26	0.93
Omega-3 PUFA (g)	0.66	0.52	0.69	0.47	0.62	0.57	0.69
Trans fatty acids (g)	0.09	0.17	0.07	0.15	0.12	0.20	< 0.01

*P-value ascertained by Mann-Whitney U test

Table 3: Comparison of the median (IQR) intakes of food groups with and without MetS (defined according to Harmonized criteria) among Malaysians in 2016-17 (n=481)

	Total (n=481)		No MetS (n=326)		MetS (n=155)		
	Median	**IQR**	**Median**	**IQR**	**Median**	**IQR**	**P-value***
Cereals and cereal products	3.37	1.86	3.34	1.85	3.44	1.95	0.78
Vegetables	2.57	2.21	2.55	1.99	2.58	2.28	0.56
Fruits	1.03	1.57	1.14	1.55	0.93	1.20	0.08
Poultry, meat, egg	1.15	1.16	1.17	1.16	0.91	1.28	0.05
Fish	0.60	0.72	0.60	0.68	0.71	0.72	0.15
Legumes	0.29	0.36	0.29	0.36	0.29	0.40	0.74
Milk and milk products	0.57	1.06	0.52	1.07	0.62	0.89	0.87
Fats, oils, sugars	2.00	1.43	1.71	1.44	2.00	1.43	0.20

*P-value ascertained by Mann-Whitney U test

Table 4: Comparison of lifestyle characteristics among study respondents with abdominal obesity in 2016-17 (n=481)

		Total (n=481)	Non-obese (n=183)	Obese (n=298)	P-value*
		n (%)	n (%)	n (%)	
Physical activity	**High**	95 (19.8)	34 (18.6)	61 (20.5)	0.16
	Moderate	192 (39.9)	83 (45.4)	109 (36.6)	
	Low	194 (40.3)	66 (36.1)	128 (43.0)	
Smoking status	**Never smoked**	419 (87.1)	155 (84.7)	264 (88.6)	0.22
	Past/Current smoker	62 (12.9)	28 (15.3)	34 (11.4)	
Alcohol consumption	**Never consumed/past consumer**	440 (91.5)	169 (92.3)	271 (90.9)	0.59
	Current consumer	41 (8.5)	14 (7.7)	27 (9.1)	
Frequent dining out	**≤ 3 times/week**	327 (68.0)	109 (59.6)	218 (73.2)	< 0.01
	> 3 times/week	154 (32.0)	74 (40.4)	80 (26.8)	
Late dining	**≤ 3 times/week**	428 (89.0)	164 (89.6)	264 (88.6)	0.73
	> 3 times/week	53 (11.0)	19 (10.4)	34 (11.4)	
Skipping breakfast	**≤ 3 times/week**	364 (75.7)	140 (76.5)	224 (75.2)	0.74
	> 3 times/week	117 (24.3)	43 (23.5)	74 (24.8)	
Finishing meals	**Not fast**	229 (47.6)	92 (50.3)	137 (46.0)	0.36
	Fast	252 (52.4)	91 (49.7)	161 (54.0)	

*P-value ascertained by chi square test

Table 5: Comparison of lifestyle characteristics among study respondents with and without high blood pressure (BP) in 2016-17 (n=481)

		Total (n=481)	Normal BP (n=208)	High BP (n=273)	P-value*
		n (%)	n (%)	n (%)	
Physical activity	**High**	95 (19.8)	70 (33.7)	124 (45.4)	0.03
	Moderate	192 (39.9)	94 (45.2)	98 (35.9)	
	Low	194 (40.3)	44 (21.2)	51 (18.7)	
Smoking status	**Never smoked**	419 (87.1)	185 (88.9)	234 (85.7)	0.30
	Past/Current smoker	62 (12.9)	23 (11.1)	39 (14.3)	
Alcohol consumption	**Never consumed/past consumer**	440 (91.5)	192 (92.3)	248 (90.8)	0.57
	Current consumer	41 (8.5)	16 (7.7)	25 (9.2)	
Frequent dining out	**≤ 3 times/week**	327 (68.0)	141 (67.8)	186 (68.1)	0.94
	> 3 times/week	154 (32.0)	67 (32.2)	87 (31.9)	
Late dining	**≤ 3 times/week**	428 (89.0)	186 (89.4)	242 (88.6)	0.79
	> 3 times/week	53 (11.0)	22 (10.6)	31 (11.4)	
Skipping breakfast	**≤ 3 times/week**	364 (75.7)	155 (74.5)	209 (76.6)	0.61
	> 3 times/week	117 (24.3)	53 (25.5)	64 (23.4)	
Finishing meals	**Not fast**	229 (47.6)	99 (47.6)	130 (47.6)	0.99
	Fast	252 (52.4)	109 (52.4)	143 (52.4)	

*P-value ascertained by chi square test

Table 6: Comparison of lifestyle characteristics among study respondents with and without low HDL-C in 2016-17 (n=481)

		Total (n=481)	Normal HDL-C (n=339)	Low HDL-C (n=142)	P-value*
		n (%)	n (%)	n (%)	
Physical activity	**High**	95 (19.8)	73 (21.5)	22 (15.5)	0.01
	Moderate	192 (39.9)	144 (42.5)	48 (33.8)	
	Low	194 (40.3)	122 (36.0)	72 (50.7)	
Smoking status	**Never smoked**	419 (87.1)	291 (85.8)	128 (90.1)	0.20
	Past/Current smoker	62 (12.9)	48 (14.2)	14 (9.9)	
Alcohol consumption	**Never consumed/past consumer**	440 (91.5)	309 (91.2)	131 (92.3)	0.69
	Current consumer	41 (8.5)	30 (8.8)	11 (7.7)	
Frequent dining out	**≤ 3 times/week**	327 (68.0)	222 (65.5)	105 (73.9)	0.07
	> 3 times/week	154 (32.0)	117 (34.5)	37 (26.1)	
Late dining	**≤ 3 times/week**	428 (89.0)	301 (88.8)	127 (89.4)	0.84
	> 3 times/week	53 (11.0)	38 (11.2)	15 (10.6)	
Skipping breakfast	**≤ 3 times/week**	364 (75.7)	271 (79.9)	93 (65.5)	< 0.01
	> 3 times/week	117 (24.3)	68 (20.1)	49 (34.5)	
Finishing meals	**Not fast**	229 (47.6)	176 (51.9)	53 (37.3)	< 0.01
	Fast	252 (52.4)	163 (48.1)	89 (62.7)	

*P-value ascertained by chi square test

Table 7: Comparison of lifestyle characteristics among study respondents with and without high triglycerides (TG) in 2016-17 (n=481)

		Total (n=481)	Normal TG (n=362)	High TG (n=119)	P-value*
		n (%)	n (%)	n (%)	
Physical activity	**High**	95 (19.8)	75 (39.0)	20 (16.8)	0.48
	Moderate	192 (39.9)	146 (40.3)	46 (38.7)	
	Low	194 (40.3)	141 (39.0)	53 (16.8)	
Smoking status	**Never smoked**	419 (87.1)	316 (87.3)	103 (86.6)	0.57
	Past/Current smoker	62 (12.9)	46 (12.7)	16 (13.4)	
Alcohol consumption	**Never consumed/past consumer**	440 (91.5)	332 (91.7)	108 (90.8)	0.75
	Current consumer	41 (8.5)	30 (8.3)	11 (9.2)	
Frequent dining out	**≤ 3 times/week**	327 (68.0)	250 (69.1)	77 (64.7)	0.38
	> 3 times/week	154 (32.0)	112 (30.9)	42 (35.3)	
Late dining	**≤ 3 times/week**	428 (89.0)	325 (89.8)	103 (86.6)	0.33
	> 3 times/week	53 (11.0)	37 (10.2)	16 (13.4)	
Skipping breakfast	**≤ 3 times/week**	364 (75.7)	268 (74.0)	96 (80.7)	0.14
	> 3 times/week	117 (24.3)	94 (26.0)	23 (19.3)	
Finishing meals	**Not fast**	229 (47.6)	176 (48.6)	53 (44.5)	0.44
	Fast	252 (52.4)	186 (51.4)	66 (55.5)	

*P-value ascertained by chi square test

Table 8: Comparison of lifestyle characteristics among study respondents with and without high fasting blood glucose in 2016-17 (n=481)

		Total (n=481)	Normal FBG (n=391)	High FBG (n=90)	P-value*
		n (%)	n (%)	n (%)	
Physical activity	**High**	95 (19.8)	79 (20.2)	16 (17.8)	0.28
	Moderate	192 (39.9)	161 (41.2)	31 (34.4)	
	Low	194 (40.3)	151 (38.6)	43 (47.8)	
Smoking status	**Never smoked**	419 (87.1)	345 (88.2)	74 (82.2)	0.13
	Past/Current smoker	62 (12.9)	46 (11.8)	16 (17.8)	
Alcohol consumption	**Never consumed/past consumer**	440 (91.5)	359 (91.8)	81 (90.0)	0.58
	Current consumer	41 (8.5)	32 (8.2)	9 (10.0)	
Frequent dining out	**≤ 3 times/week**	327 (68.0)	254 (65.0)	73 (81.1)	< 0.01
	> 3 times/week	154 (32.0)	137 (35.0)	17 (18.9)	
Late dining	**≤ 3 times/week**	428 (89.0)	352 (90.0)	76 (84.4)	0.13
	> 3 times/week	53 (11.0)	39 (10.0)	14 (15.6)	
Skipping breakfast	**≤ 3 times/week**	364 (75.7)	294 (75.2)	70 (77.8)	0.61
	> 3 times/week	117 (24.3)	97 (24.8)	20 (22.2)	
Finishing meals	**Not fast**	229 (47.6)	192 (49.1)	37 (41.1)	0.17
	Fast	252 (52.4)	199 (50.9)	53 (58.9)	

*P-value ascertained by chi square test

Table 9: Comparison of median nutrient intakes among Malaysians with and without abdominal obesity in 2016-17 (n=481)

	Total (n=481)		Non obese (n=183)		Obese (n=298)		
	Median	**IQR**	**Median**	**IQR**	**Median**	**IQR**	**P-value***
Energy (kcal)	2358.32	1354.93	2397.42	1266.70	2342.82	1379.02	0.97
Protein (g)	76.98	43.77	82.53	49.31	73.34	42.65	0.04
Fats (g)	78.85	61.41	79.27	56.18	77.81	64.31	0.61
Carbohydrates (g)	302.90	189.32	310.60	188.60	298.90	190.97	0.83
Fibre (g)	21.09	18.05	22.61	17.45	19.80	18.04	0.23
Calcium (mg)	879.39	595.68	890.85	565.33	859.13	623.56	0.42
Iron (mg)	14.76	10.39	16.74	10.29	13.91	10.47	0.05
Sodium (mg)	2456.35	1533.10	2720.83	1692.88	2353.10	1432.08	0.01
Potassium (mg)	2432.10	1518.95	2571.20	1540.60	2294.95	1431.53	0.11
Retinol (µg)	1044.89	713.31	1175.39	740.95	997.17	689.59	0.02
Niacin (mg)	20.93	17.35	21.99	17.65	19.83	15.47	0.17
Vitamin C (mg)	190.01	172.82	201.08	183.51	186.47	160.22	0.18
Cholesterol (mg)	217.09	184.54	226.68	184.99	199.97	185.60	< 0.01
Omega-6 PUFA (g)	9.62	7.68	9.69	7.53	9.56	7.75	0.78
Omega-3 PUFA (g)	0.66	0.52	0.71	0.54	0.62	0.50	0.11
Trans fatty acids (g)	0.09	0.17	0.06	0.14	0.10	0.18	< 0.01

*P-value ascertained by Mann-Whitney U test

Table 10: Comparison of median nutrient intakes among Malaysians with and without high blood pressure in 2016-17 (n=481)

	Total (n=481)		Normal BP (n=208)		High BP (n=273)		
	Median	**IQR**	**Median**	**IQR**	**Median**	**IQR**	**P-value***
Energy (kcal)	2358.32	1354.93	2385.41	1187.71	2348.23	1411.63	0.75
Protein (g)	76.98	43.77	79.10	43.83	75.43	44.47	0.49
Fats (g)	78.85	61.41	79.03	62.28	77.96	61.91	0.81
Carbohydrates (g)	302.90	189.32	303.00	172.00	301.83	199.14	0.70
Fibre (g)	21.09	18.05	21.76	18.61	20.41	16.43	0.67
Calcium (mg)	879.39	595.68	893.87	635.81	861.27	568.07	0.44
Iron (mg)	14.76	10.39	15.07	10.60	14.65	10.23	0.86
Sodium (mg)	2456.35	1533.10	2454.76	1521.30	2456.35	1545.03	0.75
Potassium (mg)	2432.10	1518.95	2538.85	1711.88	2326.80	1341.55	0.55
Retinol (µg)	1044.89	713.31	1097.48	851.87	1012.97	660.19	0.24
Niacin (mg)	20.93	17.35	20.71	15.64	20.93	17.70	0.71
Vitamin C (mg)	190.01	172.82	187.40	197.72	191.53	160.37	0.83
Cholesterol (mg)	217.09	184.54	220.69	179.52	215.05	187.16	0.46
Omega-6 PUFA (g)	9.62	7.68	9.71	7.48	9.54	7.88	0.84
Omega-3 PUFA (g)	0.66	0.52	0.73	0.52	0.61	0.51	0.20
Trans fatty acids (g)	0.09	0.17	0.08	0.16	0.10	0.17	0.15

*P-value ascertained by Mann-Whitney U test

Table 11: Comparison of median nutrient intakes among Malaysians with and without low HDL-Cholesterol in 2016-17 (n=481)

	Total (n=481)		Normal HDL-C (n=339)		Reduced HDL-C (n=142)		
	Median	**IQR**	**Median**	**IQR**	**Median**	**IQR**	**P-value***
Energy (kcal)	2358.32	1354.93	2335.74	1341.38	2574.72	1323.91	0.10
Protein (g)	76.98	43.77	76.85	44.63	77.02	42.85	0.56
Fats (g)	78.85	61.41	75.97	56.39	84.25	65.44	0.07
Carbohydrates (g)	302.90	189.32	295.51	188.61	317.46	199.53	0.09
Fibre (g)	21.09	18.05	21.65	18.02	19.58	17.73	0.64
Calcium (mg)	879.39	595.68	870.49	581.01	884.78	625.96	0.52
Iron (mg)	14.76	10.39	14.82	10.28	14.54	10.82	0.27
Sodium (mg)	2456.35	1533.10	2546.08	1568.02	2375.25	1422.91	0.08
Potassium (mg)	2432.10	1518.95	2479.50	1469.70	2321.90	1702.73	0.37
Retinol (µg)	1044.89	713.31	1084.64	741.97	959.07	721.23	0.02
Niacin (mg)	20.93	17.35	21.51	19.53	19.58	14.31	0.06
Vitamin C (mg)	190.01	172.82	197.38	183.76	178.28	152.04	0.04
Cholesterol (mg)	217.09	184.54	234.39	191.57	170.63	166.43	< 0.01
Omega-6 PUFA (g)	9.62	7.68	9.39	7.51	10.23	7.67	0.48
Omega-3 PUFA (g)	0.66	0.52	0.69	0.54	0.61	0.48	0.13
Trans fatty acids (g)	0.09	0.17	0.07	0.16	0.13	0.20	< 0.01

*P-value ascertained by Mann-Whitney U test

Table 12: Comparison of median nutrient intakes among Malaysians with and without hypertriglyceridemia in 2016-17 (n=481)

	Total (n=481)		Normal triglycerides (n=362)		High triglycerides (n=119)		
	Median	**IQR**	**Median**	**IQR**	**Median**	**IQR**	**P-value***
Energy (kcal)	2358.32	1354.93	2398.65	1365.26	2343.26	1354.84	0.53
Protein (g)	76.98	43.77	78.25	43.46	74.96	45.27	0.44
Fats (g)	78.85	61.41	78.55	61.70	78.85	53.69	0.94
Carbohydrates (g)	302.90	189.32	301.83	192.33	306.17	198.56	0.42
Fibre (g)	21.09	18.05	21.65	18.58	18.37	16.06	0.35
Calcium (mg)	879.39	595.68	885.82	601.28	844.32	559.85	0.25
Iron (mg)	14.76	10.39	15.06	10.63	14.51	9.37	0.71
Sodium (mg)	2456.35	1533.10	2462.26	1575.27	2397.50	1346.25	0.39
Potassium (mg)	2432.10	1518.95	2520.55	1547.53	2254.60	1451.90	0.15
Retinol (µg)	1044.89	713.31	1078.87	747.74	998.81	674.60	0.18
Niacin (mg)	20.93	17.35	20.74	16.18	21.31	19.39	0.52
Vitamin C (mg)	190.01	172.82	189.02	179.67	190.01	141.51	0.64
Cholesterol (mg)	217.09	184.54	221.09	182.95	200.95	211.28	0.72
Omega-6 PUFA (g)	9.62	7.68	9.59	7.66	9.88	7.94	0.90
Omega-3 PUFA (g)	0.66	0.52	0.66	0.48	0.63	0.59	0.99
Trans fatty acids (g)	0.09	0.17	0.09	0.16	0.09	0.19	0.60

*P-value ascertained by Mann-Whitney U test

Table 13: Comparison of median nutrient intakes among Malaysians with and without hyperglycemia in 2016-17 (n=481)

	Total (n=481)		Normal fasting blood glucose (n=391)		High fasting blood glucose (n=90)		
	Median	**IQR**	**Median**	**IQR**	**Median**	**IQR**	**P-value***
Energy (kcal)	2358.32	1354.93	2397.42	1286.94	2169.09	1496.80	0.35
Protein (g)	76.98	43.77	79.03	42.60	68.14	47.34	0.24
Fats (g)	78.85	61.41	78.85	58.28	78.58	71.67	0.74
Carbohydrates (g)	302.90	189.32	308.10	190.77	283.04	163.44	0.05
Fibre (g)	21.09	18.05	21.65	17.28	18.06	19.86	0.28
Calcium (mg)	879.39	595.68	893.42	561.94	772.70	689.71	0.03
Iron (mg)	14.76	10.39	15.16	10.43	12.85	11.05	0.08
Sodium (mg)	2456.35	1533.10	2510.49	1506.94	2270.82	1642.92	0.38
Potassium (mg)	2432.10	1518.95	2498.90	1433.20	2133.15	1788.18	0.19
Retinol (µg)	1044.89	713.31	1063.93	683.65	1005.09	974.98	0.46
Niacin (mg)	20.93	17.35	21.44	17.11	19.23	16.15	0.13
Vitamin C (mg)	190.01	172.82	191.53	172.80	183.70	219.93	0.75
Cholesterol (mg)	217.09	184.54	217.09	180.75	219.36	209.56	0.72
Omega-6 PUFA (g)	9.62	7.68	9.64	7.33	9.42	8.84	0.83
Omega-3 PUFA (g)	0.66	0.52	0.66	0.47	0.65	0.69	0.68
Trans fatty acids (g)	0.09	0.17	0.08	0.15	0.14	0.22	< 0.01

*P-value ascertained by Mann-Whitney U test

Table 14: Comparison of the median (IQR) intakes of food groups with and without abdominal obesity among Malaysians in 2016-17 (n=481)

	Total (n=481)		Non-obese (n=183)		Obese (n=298)		
	Median	**IQR**	**Median**	**IQR**	**Median**	**IQR**	**P-value***
Cereals and cereal products	3.37	1.86	3.21	1.95	3.46	1.80	0.41
Vegetables	2.57	2.21	2.47	2.15	2.57	2.27	0.41
Fruits	1.03	1.57	1.03	1.57	1.05	1.50	0.84
Poultry, meat, egg	1.15	1.16	1.29	1.23	1.01	1.14	< 0.01
Fish	0.60	0.72	0.71	0.75	0.60	0.64	0.88
Legumes	0.29	0.36	0.29	0.36	0.29	0.36	0.83
Milk and milk products	0.57	1.06	0.43	0.93	0.68	1.11	0.15
Fats, oils, sugars	2.00	1.43	1.29	1.42	2.00	1.51	0.04

*P-value ascertained by Mann-Whitney U test

Table 15: Comparison of the median (IQR) intakes of food groups with and without high blood pressure among Malaysians in 2016-17 (n=481)

	Total (n=481)		Normal BP (n=208)		High BP (n=273)		
	Median	IQR	Median	IQR	Median	IQR	P-value*
Cereals and cereal products	3.37	1.86	3.28	1.70	3.44	2.05	0.78
Vegetables	2.57	2.21	2.57	2.37	2.57	1.82	0.40
Fruits	1.03	1.57	1.01	1.54	1.06	1.57	0.69
Poultry, meat, egg	1.15	1.16	1.16	1.15	1.14	1.18	0.95
Fish	0.60	0.72	0.60	0.68	0.60	0.76	0.55
Legumes	0.29	0.36	0.29	0.29	0.14	0.40	0.08
Milk and milk products	0.57	1.06	0.50	1.01	0.70	1.07	0.49
Fats, oils, sugars	2.00	1.43	1.43	1.42	2.00	1.45	0.10

*P-value ascertained by Mann-Whitney U test

Table 16: Comparison of the median (IQR) intakes of food groups with and without low HDL-cholesterol among Malaysians in 2016-17 (n=481)

	Total (n=481)		Normal HDL-C (n=339)		Low HDL-C (n=142)		
	Median	IQR	Median	IQR	Median	IQR	P-value*
Cereals and cereal products	3.37	1.86	3.28	1.91	3.56	1.91	0.03
Vegetables	2.57	2.21	2.49	1.87	2.79	2.45	0.09
Fruits	1.03	1.57	1.17	1.57	0.87	1.06	0.06
Poultry, meat, egg	1.15	1.16	1.28	1.11	0.86	1.03	< 0.01
Fish	0.60	0.72	0.57	0.71	0.73	0.72	0.05
Legumes	0.29	0.36	0.14	0.36	0.29	0.33	0.02
Milk and milk products	0.57	1.06	0.43	1.00	0.80	1.03	0.11
Fats, oils, sugars	2.00	1.43	1.51	1.31	2.00	1.95	< 0.01

*P-value ascertained by Mann-Whitney U test

Table 17: Comparison of the median (IQR) intakes of food groups with and without hypertriglyceridemia among Malaysians in 2016-17 (n=481)

	Total (n=481)		Normal TG (n=362)		High TG (n=119)		
	Median	**IQR**	**Median**	**IQR**	**Median**	**IQR**	**P-value***
Cereals and cereal products	3.37	1.86	3.36	1.85	3.45	1.87	0.76
Vegetables	2.57	2.21	2.57	1.91	2.58	2.25	0.41
Fruits	1.03	1.57	1.07	1.57	1.00	1.24	0.88
Poultry, meat, egg	1.15	1.16	1.14	1.15	1.21	1.34	0.40
Fish	0.60	0.72	0.60	0.71	0.72	0.67	0.14
Legumes	0.29	0.36	0.29	0.36	0.29	0.33	0.71
Milk and milk products	0.57	1.06	0.58	1.09	0.57	0.86	0.47
Fats, oils, sugars	2.00	1.43	2.00	1.56	2.00	1.28	0.84

*Ascertained by Mann-Whitney U-test

Table 18: Comparison of the median (IQR) intakes of food groups with and without hyperglycemia among Malaysians in 2016-17 (n=481)

	Total (n=481)		Normal FBG (n=391)		High FBG (n=90)		
	Median	**IQR**	**Median**	**IQR**	**Median**	**IQR**	**P-value***
Cereals and cereal products	3.37	1.86	3.40	1.91	3.32	1.87	0.49
Vegetables	2.57	2.21	2.57	2.15	2.58	2.18	0.61
Fruits	1.03	1.57	1.07	1.55	0.91	1.34	0.19
Poultry, meat, egg	1.15	1.16	1.15	1.15	1.09	1.56	0.85
Fish	0.60	0.72	0.60	0.67	0.60	0.89	0.78
Legumes	0.29	0.36	0.29	0.33	0.14	0.26	0.03
Milk and milk products	0.57	1.06	0.57	1.07	0.57	1.04	0.85
Fats, oils, sugars	2.00	1.43	1.86	1.46	2.00	1.43	0.91

*Ascertained by Mann-Whitney U-test

Appendix 2 (Ethics approval)

MONASH University

Monash University Human Research Ethics Committee (MUHREC)
Research Office

Human Ethics Certificate of Approval

This is to certify that the project below was considered by the Monash University Human Research Ethics Committee. The Committee was satisfied that the proposal meets the requirements of the *National Statement on Ethical Conduct in Human Research* and has granted approval.

Project Number:	CF16/56 - 2016000022
Project Title:	Nutrition and lifestyle behaviours in cardiometabolic syndrome: development of a community-specific peer-support programme
Chief Investigator:	Ms Amutha Ramadas
Approved:	From: 15 March 2016 To: 15 March 2021

Terms of approval - Failure to comply with the terms below is in breach of your approval and the Australian Code for the Responsible Conduct of Research.

1. The Chief investigator is responsible for ensuring that permission letters are obtained, if relevant, before any data collection can occur at the specified organisation.
2. Approval is only valid whilst you hold a position at Monash University.
3. It is the responsibility of the Chief Investigator to ensure that all investigators are aware of the terms of approval and to ensure the project is conducted as approved by MUHREC.
4. You should notify MUHREC immediately of any serious or unexpected adverse effects on participants or unforeseen events affecting the ethical acceptability of the project.
5. The Explanatory Statement must be on Monash University letterhead and the Monash University complaints clause must include your project number.
6. **Amendments to the approved project (including changes in personnel):** Require the submission of a Request for Amendment form to MUHREC and must not begin without written approval from MUHREC. Substantial variations may require a new application.
7. **Future correspondence:** Please quote the project number and project title above in any further correspondence.
8. **Annual reports:** Continued approval of this project is dependent on the submission of an Annual Report. This is determined by the date of your letter of approval.
9. **Final report:** A Final Report should be provided at the conclusion of the project. MUHREC should be notified if the project is discontinued before the expected date of completion.
10. **Monitoring:** Projects may be subject to an audit or any other form of monitoring by MUHREC at any time.
11. **Retention and storage of data:** The Chief Investigator is responsible for the storage and retention of original data pertaining to a project for a minimum period of five years.

Professor Nip Thomson
Chair, MUHREC

cc: Assoc Prof Kia Fatt Quek, Prof Khalid Abdul Kadir, Dr Saleem Perwaiz Iqbal

Human Ethics Office
Monash University
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24 Sports Walk, Clayton Campus, Wellington Rd, Clayton VIC 3800, Australia
Telephone +61 3 9905 5490 Facsimile +61 3 9905 3831
Email muhrec@monash.edu http://intranet.monash.edu.au/researchadmin/human/index.php
ABN 12 377 614 012 CRICOS Provider #00008C

Appendix 3 (Questionnaire)

Tabiat Permakanan dan Gaya Hidup dalam
Sindrom Kardiometabolik:
Perangkaan Program Sokongan Kesihatan Komuniti

Nutrition and Lifestyle Behaviours in Cardiometabolic Syndrome: Development of a Community-Specific Peer-Support Programme

Fasa 1 (Kulai)

Phase 1 (Kulai)

Arahan *Instructions*
Semua bahagian soal selidik ini hendaklah dilengkapkan.
All parts of the questionnaire should be completed.

Sila tandakan (√) atau (X) jawapan anda, melainkan jika dinyatakan sebaliknya.
Please put a tick (√) or a cross (X) against your response, unless it is indicated otherwise.

Ruang yang disediakan untuk anda untuk menulis pandangan anda. Sekiranya anda memerlukan lebih banyak ruang untuk menulis, sila sertakan kertas tambahan.
Spaces are provided for you to write your views on the subject. Should you need more space to write, please feel free to attach additional sheets.

Sila berikan pendapat yang jujur dan butir-butir yang anda mampu. Hanya para penyelidik projek ini akan mempunyai akses kepada data anda.
Semua maklumat yang anda berikan di sini adalah sulit.
Please provide honest opinions and as much details as you can.
Only the Investigators of the project will have access to the data.
All information you provide here will remain confidential.

Terima kasih kerana bersetuju untuk mengambil bahagian dalam kajian ini.
Thank you for agreeing to take part in this study

CHECKLIST		
-	Consent form & Screening	
A	Personal info & sociodemography	
B	Dietary behaviour	
C	Physical activity (IPAQ)	
D	Lifestyle habits	
E	QOL	
F	Health screening	
G	Lab report	
H	Weight management strategies	
I	Food insecurity	
J	24-hour dietary recall	
K	FFQ	
L	Medical info	

BORANG KEIZINAN (FASA 1)

Tajuk Kajian: Tabiat Pemakanan dan Gaya Hidup dalam Sindrom Kardiometabolik: Perangkaan Program Sokongan Kesihatan Komuniti
Ketua Penyelidik: Dr Amutha Ramadas

Saya bersetuju untuk mengambil bahagian dalam kajian Monash University seperti di atas. Perihal dan butiran kajian telah diterangkan kepada saya. Saya telah membaca borang penjelasan kajian yang akan saya simpan sebagai rekod.

Saya juga bersetuju untuk:	Ya	Tidak
Membenarkan sampel darah diambil	☐	☐
Membenarkan tekanan darah, tinggi, berat, pinggang dan ukuran lemak dalam badan diambil	☐	☐
Ditemuramah untuk maklumat berkaitan butir-butir diri, pemakanan, gaya hidup dan kesihatan	☐	☐
Dihubungi semula untuk Fasa 2 dan 3	☐	☐
Dihubungi semula untuk kajian-kajian seterusnya	☐	☐

Saya akui bahawa penglibatan saya adalah secara sukarela, dan saya boleh memilih untuk tidak melibatkan diri ataupun boleh menarik diri dari sebarang tahap pengajian tanpa sebarang masalah.

Saya faham bahawa sebarang maklumat yang diperoleh daripada temuduga ini untuk laporan tidak mengandungi sebarang nama atau ciri-ciri peserta.

Saya faham maklumat yang saya berikan adalah peribadi dan tidak akan dibocorkan dalam laporan atau kepada pihak ketiga.

Laporan dan maklumat yang direkod dalam temuduga akan disimpan dengan selamat dan hanya akan diakses oleh pihak penyelidik kajian dan akan dimusnahkan selepas tamat kajian.

Tandatangan	
Nama Penuh	
MyKad	
Alamat	
No Telefon	
Tarikh	

CONSENT FORM (PHASE 1)

Project: Nutrition and Lifestyle Behaviours in Cardiometabolic Syndrome: Development of a Community-Specific Peer-Support Programme
Chief Investigator: Dr Amutha Ramadas

I agree to take part in the Monash University research project specified above. I have had the project explained to me, and I have read the Explanatory Statement, which I keep for my records.

I consent to the following:	Yes	No
Taking my blood sample	☐	☐
Taking my blood pressure, height, weight, waist and body fat measurements	☐	☐
Asking questions regarding my basic details, nutrition, lifestyle and quality of life	☐	☐
To be recontacted for Phase 2 and Phase 3	☐	☐
To be recontacted for future research	☐	☐

I understand that my participation is voluntary, that I can choose not to participate in part or all of the project, and that I can withdraw at any stage of the project without being penalised or disadvantaged in any way.

I understand that any data from the interview for use in reports will not, under any circumstances, contain names or identifying characteristics.

I understand that any information I provide is confidential, and that no information that could lead to the identification of any individual will be disclosed in any reports on the project, or to any other party.

I understand that reports based on the interview(s) will be kept in a secure storage and accessible only to the research team. I also understand that the collected data will be destroyed after the stipulated period.

Signature	
Full name	
MyKad	
Address	
Tel no.	
Date	

SCREENING QUESTIONNAIRE

Note: To be administered by the study researcher at Registration Counter
Tick (√) all characteristics that describe the individual

Inclusion criteria		
1	Age ≥ 18 years at the time of the study	☐
2	Malaysian citizen	☐

Exclusion criteria		
1	Pregnant women	☐
2	Psychiatric illness	☐
3	Subject with malignancy	☐
4	Drug/alcohol abuser	☐
5	End stage renal failure	☐
6	Chronic liver diseases including hepatoma	☐
7	Immuno-compromised subject such as HIV	☐
8	Cognitive impairment	☐
9	Speech difficulty	☐
10	Hearing difficulty	☐
11	Non-ambulatory	☐

A. MAKLUMAT SOSIO-DEMOGRAFI / *SOCIO-DEMOGRAPHIC INFORMATION*

1. Umur:
   Age: _____tahun / *years*

2. Jantina:
   Sex:
   ☐ (1) Lelaki / *Male*
   ☐ (2) Perempuan / *Female*

3. Status perkahwinan:
   Marital status:
   ☐ (1) Bujang / *Single*
   ☐ (2) Berkahwin / *Married*
   ☐ (3) Bersekedudukan / *Living with partner*
   ☐ (4) Janda/duda / *Widowed*
   ☐ (5) Bercerai / *Divorced*
   ☐ (6) Berpisah / *Separated*

4. Etnik:
   Ethnicity:
   ☐ (1) Melayu / *Malay*
   ☐ (2) Cina / *Chinese*
   ☐ (3) India / *India*
   ☐ (4) Lain-lain/ *Others*
   _____

5. Pendidikan:
   Education:
   ☐ (1) Rendah / *Primary*
   ☐ (2) Menengah rendah /*Lower secondary*
   ☐ (3) Menengah tinggi/ *Higher secondary*
   ☐ (4) Tertiari/tinggi/ *Tertiary*

6. Pekerjaan:
   Occupation:
   ☐ (1) Pelajar / *Student*
   ☐ (2) Bekerja / *Employed*
   ☐ (3) Tidak bekerja / *Unemployed*
   ☐ (4) Bersara / *Retired*

7. Pendapatan individu (RM):
   Personal income (RM):
   _____

8. Pendapatan isirumah (RM):
   Household income (RM):
   _____

9. Bilangan orang dalam isirumah:
   Number of people in the household:
   _____

10. Bilangan tahun bermastautin:
    Number of years of residence:
    _____tahun / *years*

B. TABIAT PEMAKANAN / *DIETARY BEHAVIOUR*

Adakah anda seorang vegetarian?
Are you a vegetarian?

☐ (1) Ya / *Yes*
Jenis / *Type:*
_____
☐ (2) Tidak / *No*

Berapa cepat anda habiskan makanan anda?
How fast do you finish your meals?

☐ (1) 40 minit atau lebih / *40 minutes or more*
☐ (2) 20-39 minit / *20-39 minutes*
☐ (3) kurang dari 20 minit / *less than 20 minutes*

Berapa kerap anda makan selepas 10 malam?
How frequent do you eat after 10pm?

☐ (1) Setiap hari / *Every day*
☐ (2) 3 – 6 kali seminggu / *3-6 times a week*
☐ (3) 1 – 3 kali seminggu / *1-3 times a week*
☐ (4) Kurang dari sekali seminggu / *Less than once a week*
☐ (5) Tidak pernah atau jarang / *Never or rare*

Berapa kerap anda mengelakkan makan sarapan?
How frequent do you skip your breakfast?

☐ (1) Setiap hari / *Every day*
☐ (2) 3 – 6 kali seminggu / *3-6 times a week*
☐ (3) 1 – 3 kali seminggu / *1-3 times a week*
☐ (4) Kurang dari sekali seminggu / *Less than once a week*
☐ (5) Tidak pernah atau jarang / *Never or rare*

Berapa kerap anda makan di luar?
How frequent do you dine out?

☐ (1) Setiap hari / *Every day*
☐ (2) 3 – 6 kali seminggu / *3-6 times a week*
☐ (3) 1 – 3 kali seminggu / *1-3 times a week*
☐ (4) Kurang dari sekali seminggu / *Less than once a week*
☐ (5) Tidak pernah atau jarang / *Never or rare*

Adakah anda aktif bersukan atau bergim?
Are you active in sports or gym?

☐ (1) Ya / *Yes*
☐ (2) Tidak / *No*

Adakah anda mengambil sebarang suplemen makanan?
Do you consume any nutritional supplement?

☐ (1) Ya
☐ (2) Tidak *(Skip to Section C / Sila ke Bhg. C)*

Adakah anda mendapat nasihat dari doktor / pakar pemakanan sebelum mengambil suplemen?
Did you seek advice from doctor or nutritionist before consuming supplements?

☐ (1) Ya / *Yes*
☐ (2) Tidak / *No*

Adakah anda lebih memilih atau mempercayai suplemen berbanding ubat-ubatan moden / diberikan oleh doktor?
Do you choose/trust supplements more than modern medicine / drugs given by doctor?

☐ (1) Ya / *Yes*
☐ (2) Tidak / *No*

Mengapakah anda mengambil supplemen pemakanan?
Why do you take supplements?

☐ (1) Merawat penyakit:*Treat disease:*
_____
☐ (2) Menambahbaik diet seharian
Improve my daily diet
☐ (3) Mengikut nasihat rakan / ahli keluarga
Friends' or family members' advice
☐ (4) Saranan doctor
Doctor's advice
☐ (5) Lain-lain / *others*: _____

C. AKTIVITI FIZIKAL / *PHYSICAL ACTIVITY*

Soalan-soalan berikut akan menyoal anda tentang jumlah masa yang anda gunakan untuk berada dalam keadaan aktif secara fizikal dalam tempoh 7 hari yang lepas ini.
The questions will ask you about the time you spent being physically active in the last 7 days.

Fikirkan tentang semua aktiviti fizikal berat yang anda telah lakukan dalam tempoh 7 hari yang lepas ini. Aktiviti fizikal berat adalah aktiviti yang menggunakan daya tenaga fizikal yang kuat dan membuat anda bernafas jauh lebih kuat daripada biasa. Fikirkan hanya tentang aktiviti-aktiviti fizikal yang anda telah lakukan selama sekurang-kurangnya 10 minit pada sesuatu masa.

Think about all the vigorous activities that you did in the last 7 days. Vigorous physical activities refer to activities that take hard physical effort and make you breathe much harder than normal. Think only about those physical activities that you did for at least 10 minutes at a time.

1.	Dalam tempoh 7 hari yang lepas ini, berapa harikah anda telah melakukan aktiviti fizikal berat, contohnya mengangkat barang berat, mencangkul, senaman aerobik atau berbasikal laju? *During the last 7 days, how many days did you do vigorous physical activities such as heavy lifting, digging, aerobics, or fast bicycling, or outdoor games (in days/week)?*	☐ _____hari/seminggu *days/week* ☐ (0) Tiada *(sila ke S3)* *None (skip to Q3)*	*METs Factor-8.0
2.	Berapakah masa yang anda biasa gunakan untuk melakukan aktiviti fizikal berat pada salah satu daripada hari berkenaan? *How much time did you spend doing vigorous physical activities on one of those days (in minutes/day)?*	☐ _____minit/sehari *minutes/day* ☐ (0) Tidak tahu / tidak pasti *Don't know / not sure*	

Think about all the moderate activities that you did in the last 7 days. Moderate activities refer to activities that take moderate physical effort and make you breathe somewhat harder than normal. Think only about those physical activities that you did for at least 10 minutes at a time.

Fikirkan tentang semua aktiviti fizikal sederhana yang anda telah lakukan dalam tempoh 7 hari yang lepas ini. Aktiviti fizikal sederhana adalah aktiviti yang menggunakan daya tenaga fizikal yang sederhana dan membuatkan anda bernafas agak lebih kuat daripada biasa. Fikirkan hanya tentang aktiviti-aktiviti fizikal yang anda telah lakukan selama sekurang-kurangnya 10 minit pada sesuatu masa.

3.	Dalam tempoh 7 hari yang lepas ini, berapa harikah anda telah melakukan aktiviti fizikal sederhana, contohnya mengangkat muatan ringan, mengelap lantai, berbasikal pada kelajuan biasa, atau bermain badminton beregu? Ini tidak termasuk berjalan kaki. *During the last 7 days, on how many days did you do moderate physical activities like carrying light loads, bicycling at a regular pace, or doubles tennis? (Do not include walking).*	☐ _____hari/seminggu *days/week* ☐ (0) Tiada *(sila ke S5)* *None (skip to Q5)*	*METs Factor-4.0
4.	Berapakah masa yang anda biasa gunakan untuk melakukan aktiviti fizikal sederhana pada salah satu daripada hari berkenaan? *How much time did you spend doing moderate physical activities on one of those days (in minutes/day)?*	☐ _____minit/sehari *minutes/day* ☐ (0) Tidak tahu / tidak pasti *Don't know / not sure*	

Think about the time you spent walking in the last 7 days. This includes at work and at home, walking to travel from place to place, and any other walking that you might do solely for recreation, sport, exercise, or leisure.

Fikirkan tentang masa yang anda telah gunakan untuk berjalan kaki dalam tempoh 7 hari yang lepas ini. Masa ini merangkumi berjalan kaki di tempat kerja dan di rumah, berjalan kaki dari satu tempat ke

tempat yang lain, dan berjalan kaki semata-mata untuk rekreasi, bersukan, bersenam atau pada masa lapang.

5.	Dalam tempoh 7 hari yang lepas ini, berapa harikah anda telah berjalan kaki selama sekurang-kurangnya 10 minit pada sesuatu masa? *During the last 7 days, on how many days did you walk for at least 10 minutes at a time?*	☐ _____hari/seminggu *days/week* ☐ (0) Tiada *(sila ke S7)* *None (skip to Q7)*	*METs Factor-3.3
6.	Berapakah masa yang anda biasa gunakan untuk berjalan kaki pada salah satu daripada hari berkenaan? *How much time did you usually spend walking on one of those days (in minutes/day)?*	☐ _____minit/sehari *minutes/day* ☐ (0) Tidak tahu / tidak pasti *Don't know / not sure*	

The last question is about the time you spent sitting on weekdays during the last 7 days. Include time spent at work, at home, while doing course work and during leisure time. This may include time spent sitting at a desk, visiting friends, reading, or sitting or lying down to watch television.

Soalan terakhir ini adalah berkaitan masa yang anda telah gunakan untuk duduk pada hari-hari bekerja dalam tempoh 7 hari yang lepas ini. Masukkan masa yang di habiskan duduk di tempat kerja, di rumah, sewaktu belajar dan di masa lapang. Masa ini juga merangkumi waktu yang di habiskan duduk di meja, menziarahi kawan-kawan, membaca, atau duduk atau baring sambil menonton televisyen.

7.	Dalam tempoh 7 hari yang lepas ini, berapakah masa yang anda telah gunakan untuk duduk pada sesuatu hari bekerja. *During the last 7 days, how much time did you spend sitting on a week day (in minutes/day)?*	☐ _____minit/sehari *minutes/day* ☐ (0) Tidak tahu / tidak pasti *Don't know / not sure*	
METs			

	Tahap aktiviti fizikal *Level of physical activity*	☐ aktif (≥3000) *active* ☐ sederhana (700-2900) *moderately active* ☐ tidak aktif (<600) *not active*

D. GAYA HIDUP / *LIFESTYLE HABITS*

Pernahkah anda merokok?
Do/did you smoke?

☐ (1) Tidak merokok / *non-smoker (Sila ke S4 / skip to Q4)*
☐ (2) Pernah merokok / *past-smoker*
☐ (3) Masih merokok / *current smoker*

Berapa lama anda telah merokok?
How long have you been smoking?

_____ tahun / *years*

Berapa batang rokok anda hisap sehari?
How many cigarettes do/did you smoke per day?

_____ batang / *sticks*

Pernahkah anda minum arak?
Do/did you drink alcohol?

☐ (1) Tidak minum / *non-drinker (sila ke S6 /skip to Q6)*
☐ (2) Pernah minum / *past-drinker*
☐ (3) Masih minum / *current drinker*

Berapa lama anda minum arak?
How long have you been consuming alcohol?

_____ tahun / *years*

Berapa lama anda tidur dalam sehari?
How many hours do you sleep in a day?

☐ (1) kurang dari 6 jam / *less than 6 hours*
☐ (2) 6-8 jam / *6-8 hours*
☐ (3) lebih dari 8 jam / *more than 8 hours*

E. KUALITI HIDUP / *QUALITY OF LIFE*

Soalan-soalan berikut bertanyakan pandangan anda tentang kualiti hidup, kesihatan atau aspek-aspek kehidupan yang lain. Pilih jawapan yang anda rasa paling bersesuaian. Sila ambil perhatian terhadap standad, harapan, keseronokan dan kebimbangan anda. Fikirkan tentang kehidupan anda dalam tempoh empat minggu lepas.

The following questions ask how you feel about your quality of life, health, or other areas of your life. I will read out each question to you, along with the response options. Please choose the answer that appears most appropriate. If you are unsure about which response to give to a question, the first response you think of is often the best one. Please keep in mind your standards, hopes, pleasures and concerns. We ask that you think about your life in the last four weeks.

	Sangat tidak baik *Very poor*	Tidak baik *Poor*	Sederhana *Neither poor nor good*	Baik *Good*	Sangat baik *Very good*
Bagaimanakah anda menilai kualiti kehidupan anda? *How would you rate your quality of life?*	1	2	3	4	5
	Sangat tidak berpuas hati *Very dissatisfied*	Tidak berpuas hati *Dissatisfied*	Sederhana *Neither satisfied nor dissatisfied*	Berpuas hati *Satisfied*	Sangat berpuas hati *Very satisfied*
Setakat manakah anda berpuas hati dengan kesihatan anda? *How satisfied are you with your health?*	1	2	3	4	5

Soalan-soalan berikutnya bertanyakan setakat mana anda telah mengalami sesuatu perkara dalam 4 minggu yang lepas.
The following questions ask about how much you have experienced certain things in the last four weeks.

	Tiada langsung	Sedikit sahaja	Sederhana	Sangat banyak	Teramat

	Not at all	*A little*	*A moderate amount*	*Very much*	*An extreme amount*
Setakat manakah anda berasa kesakitan (fizikal) menghalang anda dari melakukan apa yang anda perlu lakukan? *To what extent do you feel that physical pain prevents you from doing what you need to do?*	5	4	3	2	1
	Tiada langsung *Not at all*	Sedikit sahaja *A little*	Sederhana *A moderate amount*	Sangat banyak *Very much*	Teramat *An extreme amount*
Berapa banyakkah rawatan perubatan yang anda perlu untuk berfungsi dalam kehidupan harian anda? *How much do you need any medical treatment to function in your daily life?*	5	4	3	2	1
Berapa banyakkah anda menikmati keseronokan dalam hidup anda? *How much do you enjoy life?*	1	2	3	4	5
Setakat manakah anda rasa hidup anda bermakna? *To what extent do you feel your life to be meaningful?*	1	2	3	4	5
Berapa baikkah anda dapat memberi tumpuan? *How well are you able to concentrate?*	1	2	3	4	5
Berapa selamatkah anda rasa dalam kehidupan seharian anda? *How safe do you feel in your daily life?*	1	2	3	4	5
Berapa sihatkah persekitaran fizikal anda? *How healthy is your physical environment?*	1	2	3	4	5

Soalan-soalan berikut bertanyakan bagaimana sempurnanya anda mengalami atau berupaya melakukan sesuatu perkara dalam 4 minggu yang lepas.
The following questions ask about how completely you experience or were able to do certain things in the last four weeks.

	Tiada langsung *Not at all*	Sedikit sahaja *A little*	Sederhana *Moderately*	Kebanyakkannya *Mostly*	Sepenuhnya *Completely*
Adakah anda mempunyai cukup tenaga untuk kehidupan harian anda? *Do you have enough energy for everyday life?*	1	2	3	4	5
Adakah anda dapat menerima rupa dan betuk tubuh anda? *Are you able to accept your bodily appearance?*	1	2	3	4	5
Adakah anda mempunyai wang yang cukup untuk memenuhi keperluan anda? *Have you enough money to meet your needs?*	1	2	3	4	5
Setakat manakah kemudahan bagi anda untuk mendapatkan maklumat yang diperlukan dalam kehidupan harian? *How available to you is the information that you need in your day-to-day life?*	1	2	3	4	5
Setakat manakah anda mendapat peluang untuk aktiviti fizikal? *To what extent do you have the opportunity for leisure activities?*	1	2	3	4	5

Sebaik manakah keupayaan anda bergerak dari satu tempat ke satu tempat yang lain? *How well are you able to get around?*	1	2	3	4	5

	Sangat tidak berpuas hati *Very dissatisified*	Tidak berpuas hati *Dissatisfied*	Sederhana *Neither satisfied nor dissatisfied*	Berpuas hati *Satisfied*	Sangat berpuas hati *Very satisfied*
Adakah anda berpuas hati dengan tidur anda? *How satisfied are you with your sleep?*	1	2	3	4	5
Adakah anda berpuas hati dengan keupayaan anda melaksanakan aktiviti kehidupan harian anda? *How satisfied are you with your ability to perform your daily living activities?*	1	2	3	4	5
Adakah anda berpuas hati dengan keupayaan anda bekerja? *How satisfied are you with your capacity for work?*	1	2	3	4	5
Adakah anda berpuas hati dengan diri anda? *How satisfied are you with yourself?*	1	2	3	4	5
Adakah anda berpuas hati dengan perhubungan peribadi anda? *How satisfied are you with your personal relationships?*	1	2	3	4	5
Adakah anda berpuas hati dengan kehidupan seks anda? *How satisfied are you with your sex life?*	1	2	3	4	5
Adakah anda berpuas hati dengan sokongan yang anda dapati dari kawan-kawan anda? *How satisfied are you with the support you get from your friends?*	1	2	3	4	5
Adakah anda berpuas hati dengan keadaan tempat tinggal anda? *How satisfied are you with the conditions of your living place?*	1	2	3	4	5
Adakah anda berpuas hati dengan kemudahan mendapatkan perkhidmatan kesihatan? *How satisfied are you with your access to health services?*	1	2	3	4	5
Adakah anda berpuas hati dengan pengangkutan anda? *How satisfied are you with your transport?*	1	2	3	4	5

Soalan berikut merujuk kepada kekerapan anda merasa atau mengalami sesuatu emosi sepanjang 4 minggu yang lepas.
The following question refers to how often you have felt or experienced certain things in the last four weeks.

	Tidak pernah *Never*	Jarang-jarang *Seldom*	Kerap *Quite often*	Sangat kerap *Very often*	Sentiasa *Always*
Berapa kerapkah anda mempunyai perasaan-perasaan negative, seperti susah hati, kecewa, kegelisahan atau kemurungan?	5	4	3	2	1

How often do you have negative feelings such as blue mood, despair, anxiety, depression?					

F. SARINGAN KESIHATAN / *HEALTH SCREENING*

	Parameter Kesihatan / *Health parameter*	Bacaan / *Reading*
1.	Tekanan darah sistolik (mmHg) *Systolic blood pressure (mmHg)*	
2.	Tekanan darah diastolik (mmHg) *Diastolic blood pressure (mmHg)*	
3.	Tahap gula dalam darah (puasa) (mmol/L) *Fasting blood glucose (mmol/L)*	
4.	Tinggi (m) *Height (m)*	
5.	Berat (kg) *Weight (kg)*	
6.	BMI (kg/m^2) *BMI (kg/m^2)*	
7.	Ukurlilit pinggang (cm) *Waist circumference (cm)*	
8.	Peratusan lemak badan (%) *Body fat percentage (%)*	

G. LAPORAN MAKMAL PERUBATAN

Puasa (8-12 jam) / *Fasting (8-12 hours)*
- ☐ Ya / *Yes*
- ☐ Tidak / *No*

Tiub Sampel Darah / *Blood sample tube*
- ☐ Tiub Serum (Kuning) / *Serum tube (yellow)*
- ☐ Tiub EDTA (Ungu) / *EDTA tube (purple)*

1.	Tahap serum glukosa (berpuasa) (mmol/L) *Fasting serum glucose level (mmol/L)*	
2.	Index HbA1c (mmol/mol) *HbA1c index(mmol/mol)*	
3.	Peratusan HbA1c (%) *HbA1c percentage (%)*	
3.	Tahap serum trigliserida (mmol/L) *Serum triglyceride (mmol/L)*	
4.	Tahap serum kolesterol HDL (mmol/L) *Serum HDL cholesterol (mmol/L)*	

H. STRATEGI PENGURUSAN BERAT BADAN / *STRATEGIES FOR WEIGHT MANAGEMENT*

1. Pernahkah anda cuba mengurangkan berat badan?
   Have you ever tried to lose weight?
   ☐ Ya / *Yes*
   ☐ Tidak / *No*
2. Pernahkah anda berjaya kurangkan sebarang berat badan?
   Have you ever lost any weight intentionally?
   ☐ Ya / *Yes*
   ☐ Tidak / *No*
3. Jika ya, berapa kg berat anda telah kurangkan?
   If yes, how many kg have you lost?
   _____kg
4. Berapa lamakah anda telah cuba untuk kurangkan berat badan?
   How long have you been trying to lose weight?
   _____ minggu / bulan
   weeks / months

Dalam tempoh masa satu bulan yang lalu, berapa kerap anda menggunakan strategi berikut untuk mengawal berat badan?
Over the last 30 days, how often have you used the following strategies to manage your weight?

		Tidak Pernah Never or hardly ever (1)	Jarang *Some of the time* (2)	Kadangkala *About half of the time* (3)	Kerap *Much of the time* (4)	Selalu/ Hampir setiap masa *Always or almost always* (5)
SUBSKALA 1 – Jumlah Tenaga *SUBSCALE 1 : Energy intake*						
1.	Elak /mengurangkan pengambilan gula atau makanan ringan *Cut out/reduced sweets or junk food*					
2.	Elak / mengurangkan makan snek pada lewat malam *Cut out/reduced late night snacking*					
3.	Elak / mengurangkan snek di antara makan sarapan / tengah hari / malam *Cut out/reduced between meal snacks*					
4.	Mengurangkan pengambilan pencuci mulut *Decreased frequency or portion sizes of desserts*					
5.	Mengurangkan kalori dalam diet *Reduced my calorie intake*					
6.	Menyingkirkan makanan berkalori tinggi dari rumah/pejabat/bilik *Removed high calorie foods from my home, office or room*					

7.	Mengurangkan pengambilan makanan berlemak *Ate less fat*					
8.	Makan lebih banyak buah-buahan dan sayur-sayuran *Increased fruits and vegetables*					
SUBSKALA 2 – Penggunaan Tenaga *SUBSCALE 2: Energy expenditure*						
9.	Bersenam untuk tempoh masa 30 minit atau lebih Exercised for period of 30 minutes or more					
10.	Bersenam di gim atau menyertai apa-apa kelas senaman Exercised at a gym or participated in an exercise class					
11.	Mengubah gaya hidup supaya dapat membuat lebih banyak aktiviti fizikal *Altered my daily routine to get more lifestyle physical activity*					
		Tidak Pernah Never or hardly ever (1)	Jarang *Some of the time* (2)	Kadangkala *About half of the time* (3)	Kerap *Much of the time* (4)	Selalu/ Hampir setiap masa *Always or almost always* (5)
SUBSKALA 3 – Pemantuan *SUBSCALE 3: Self-monitoring*						
12.	Merekod berat badan saya *Recorded or graphed my weight*					
13.	Merekod aktiviti fizikal harian *Recorded or graphed my physical activity*					
14.	Merekod jenis and kuantiti makanan yang saya makan *Recorded or wrote down the type and quantity of food eaten*					
15.	Menimbang berat badan saya setiap hari atau dengan kerap *Weighed myself regularly or daily*					
SUBSKALA 4 – Kawalan *SUBSCALE 4: Self-regulation*						
16.	Saya akan meninggalkan baki makanan di pinggan saya jika dihidang dengan terlalu banyak makanan *If I was served too much, I left food on my plate*					
17.	Mengubah cara memasak *Changed food preparation techniques*					
18.	Mengurangkan kuantiti pengambilan makanan					

	Reduced portion sizes					
19.	Merancang jenis dan kuantiti makanan dan snek yang saya makan *Decided ahead of time what I would eat for meals and snacks*					
20.	Menyediakan snek sihat dan dalam kuantiti yang sesuai dengan diri saya *Kept healthy ready-to-eat or portion controlled snacks for myself*					

I. KEMANDIRIAN DIET / *FOOD INSECURITY*

Item		Tidak pernah *Never*	Kadang kala *Sometimes*	Selalu *Often*
1.	Saya bimbang sama ada makanan saya akan habis sebelum saya mendapatkan wang untuk membeli lagi *I worry whether my food will run out before I get money to buy more*			
2.	Makanan yang saya beli tidak cukup dan saya tidak mempunyai wang untuk membeli lagi *The food I bought just didn't last and I didn't have money to get more*			
3.	Saya kehabisan makanan yang diperlukan untuk memasak dan saya tidak mempunyai wang to membeli makanan lagi *I worry about where the next day's food is going to come from*			
4.	Saya bimbang bagaimana saya akan menyediakan makanan untuk esok hari *I can't afford to eat the way I should*			
5.	Saya tidak mempunyai wang untuk makan seperti yang sepatutnya *I can't afford to eat properly*			
6.	Saya tidak mampu untuk makan dengan betul *I am often hungry, but I don't eat because I can't afford enough food*			
7.	Saya selalu lapar, tetapi saya tidak makan kerana tidak mampu membeli makanan yang secukupnya *I eat less than I think I should because I don't have enough money for food*			
8.	Saya makan kurang daripada yang sepatutnya kerana tidak mempunyai wang yang cukup untuk makanan *I eat less than I think I should because I don't have enough money for food*			
9.	Saya tidak mampu memberikan makanan seimbang kepada anak-anak saya kerana saya tidak mampu *I can't afford to feed my child(ren) a balanced meal because I can't afford that*			
10.	Saya tidak mampu memberikan makanan kepada anak-anak saya seperti yang saya patut *I can't afford to feed my child(ren) the way I think I should*			
11.	Anak-anak saya tidak makan secukupnya kerana saya tidak mampu membeli makanan yang mencukupi *My child(ren) is/are not eating enough because I just can't afford enough food*			
12.	Saya tahu anak-anak saya kadang kala lapar tetapi saya tidak mampu membeli lebih banyak makanan *I know my child(ren) is/are hungry sometimes, but I just can't afford more food*			

J. REKOD DIET 24-JAM / *24-HOUR DIETARY RECALL*

Saiz Hidangan:
Sudu Teh =5 gm Sudu =15 gm Cawan = 120 gm
Mangkuk = 240 gm Gelas = 240 gm

Serving sizes:
Teaspoon =5 gm Table spoon =15 gm 1 soup cup = 120 gm
1 cup = 240 gm 1 glass = 240 gm

Hari 1 / *Day 1*: _____

SAJIAN *MEAL TIME*	MAKANAN *FOOD*	SAIZ HIDANGAN *SERVING SIZES*	BERAT *WEIGHT*
Sarapan *Breakfast*			
Minum Pagi *Mid-morning snacks*			
Makan Tengahari *Lunch*			
Minum Petang *Tea-time*			
Makan Malam *Dinner*			
Snek Malam *Supper*			

K. SOAL-SELIDIK KEKERAPAN MAKANAN / *SEMI-FOOD FREQUENCY QUESTIONNAIRE*

Berapa kerap anda makan makanan-makanan di bawah?

How often do you eat foods from each of the following categories?

1. BIJIRIN & PRODUK BERASASKAN BIJIRIN *CEREAL & CEREAL-BASED PRODUCTS*		Kali/hari *Times/day*	Kali/minggu *Times/week*	Kali/bulan *Times/month*	Tak Pernah *Never*	Saiz hidangan *Serving size*
1.1	Nasi Putih *White rice*					
1.2	Nasi Putih (Beras Rebus) *Parboiled rice*					
1.3	Nasi perang / multibijirin / merah / liar *Brown / multigrain / red / wild rice*					
1.4	Bubur Nasi *Rice porridge*					
1.5	Nasi goreng *Fried rice*					
1.6	Nasi Lemak *Nasi lemak*					
1.7	Nasi ayam /nasi minyak / nasi biryani *Chicken rice / oily rice / biryani rice*					
1.8	Bihun goreng *Fried meehoon*					
1.9	Bihun / Laksa sup *Meehoon / laksa soup*					
1.10	Thosai *Thosai*					
1.11	Idli / Putu mayam *Idli / putu mayam*					
1.12	Mee goreng *Fried noodles*					
1.13	Mee sup *Noodle soup*					
1.14	Pasta *Pasta*					
1.15	Spageti *Spaghetti*					
1.16	Capati *Capati*					
1.17	Roti canai *Roti canai*					
1.18	Mee segera *Instant noodles*					
1.19	Bijirin sarapan sedia makan (eg. cornflakes) *Ready-to-eat-cereals (eg. cornflakes)*					
1.20	Oat/ muesli *Oats/muesli*					
1.21	Kentang *Potaoes*					
1.22	Ubi keledek *Sweet potatoes*					
1.23	Keladi *Yam*					
	Bijirin lain: *Other cereals:*					
2. SAYUR-SAYURAN *VEGETABLES*		Kali/hari *Times/day*	Kali/minggu *Times/week*	Kali/bulan *Times/month*	Tak Pernah *Never*	Saiz hidangan *Serving size*

2.1	Sayuran hijau *Green leafy vegetables*					
2.2	Sayur buahan (eg. tomato, terung, labu) *Fruits vegetables (eg. tomato, eggplant, pumpkin)*					
2.3	Sayuran kobis (eg.kobis bunga, brokoli) *Cruciferous (cauliflower, broccoli)*					
2.4	Sayuran berkacang (eg. kacang panjang, kacang buncis) *Leguminous vegetables (long beans, French beans)*					
2.5	Akar/ubi (eg ubi bit, sengkuang, lobak merah) *Roots (beetroot, sengkuang, carrot)*					
2.6	Sayuran mentah (salad, ulam) *Uncooked vegetables (salad, ulam)*					
	Sayur-sayuran lain: *Other vegetables:*					
3. BUAH-BUAHAN *FRUITS*		Kali/hari *Times/day*	Kali/minggu *Times/week*	Kali/bulan *Times/month*	Tak Pernah *Never*	Saiz hidangan *Serving size*
3.1	Buah buahan tempatan (eg. betik, pisang, tembikai) *Local fruits (eg. papaya, banana, watermelon)*					
3.2	Buah-buahan import (eg. epal, oren, kiwi, strawberi) *Imported fruits (eg. apple, orange, kiwi, strawberry)*					
3.3	Buah buahan kering (eg. kismis, kurma, prun) *Dried fruits (eg. raisins, dates, prunes)*					
3.4	Buah dalam tin *Canned fruits in syrup*					
3.5	Jus Buah-buahan segar *Fresh fruit juices*					
	Buah- buahan lain: *Other fruits:*					
4. DAGING & PRODUK DAGING, KEKACANG & BIJIAN *FRUITS*		Kali/hari *Times/day*	Kali/minggu *Times/week*	Kali/bulan *Times/month*	Tak Pernah *Never*	Saiz hidangan *Serving size*
4.1	Daging merah (lembu, kambing, babi) *Red meat (beef, mutton, pork)*					
4.2	Daging putih (ayam, itik, arnab) *White meat (chicken, duck, rabbit)*					
4.3	Ikan *Fish*					
4.4	Makanan laut (udang, kerang) *Seafood (prawns, clams)*					
4.5	Ikan masin kering / makanan laut (termasuk ikan bilis) *Dried salted fish / seafood (including anchovies)*					
4.6	Telur (ayam, itik, puyuh) *Eggs (hen, duck, quill)*					
4.7	Sosej/nugets *Sausages / nuggets*					
4.8	Kepingan bakon / ham *Bacon / ham / slices*					

4.9	Susu segar *Fresh milk*					
4.10	Susu tepung /UHT penuh krim *Milk, full cream, powdered/UHT*					
4.11	Susu tepung /UHT skim *Milk, skim/low fat, powdered/UHT*					
4.12	Susu pekat manis *Condensed milk*					
4.13	Krim bukan susu *Non-dairy creamer*					
4.14	Keju *Cheese*					
4.15	Yogurt / tairu / mooru / dadih *Yogurt / tairu / mooru / dadih*					
4.16	Susu soya *Soy milk*					
4.17	Tofu / tofu Jepun / tempeh *Tofu / Japanese tofu / tempeh*					
4.18	Kacang (eg kacang tanah, almond, pistachio, badam) *Nuts (eg peanuts, almonds, pistachios, walnuts)*					
4.19	Bijian (kuaci) *Seeds (kuaci)*					
	Makanan berasaskan protein lain:					
5. LEMAK & MINYAK *FATS & OILS*		Kali/hari *Times/day*	Kali/minggu *Times/week*	Kali/bulan *Times/month*	Tak Pernah *Never*	Saiz hidangan *Serving size*
5.1	Minyak kelapa sawit *Palm oil*					
5.2	Minyak bunga matahari / zaitun *Sunflower / olive oil*					
5.3	Minyak campuran *Blended oil*					
5.4	Jenis lain minyak sayur-sayuran: *Other type of vegetable oil:* _____					
5.5	Minyak sapi *Ghee*					
5.6	Vanaspati *Vanaspati*					
5.7	Marjerin *Margerine*					
5.8	Lemak babi / haiwan *Lard / animal fat*					
	Lemak dan minyak yang lain: *Other type of fats & oils*					
6. MINUMAN *BEVERAGES & DRINKS*		Kali/hari *Times/day*	Kali/minggu *Times/week*	Kali/bulan *Times/month*	Tak Pernah *Never*	Saiz hidangan *Serving size*
6.1	Kopi *Coffee*					
6.2	Teh Tarik *Teh Tarik*					
6.3	Teh (eg. O, Cina, hijau) *Tea (eg. Black, Chinese, Green)*					
6.4	Minuman bertenaga (eg. Milo, Horlicks) *Malt drink (eg. Milo, Horlicks)*					

6.5	Minuman beralkohol – wain *Alcoholic drink – wine*					
6.6	Minuman beralkohol – bir *Alcoholic drink – beer*					
6.7	Minuman beralkohol – likur *Alcoholic drink - liquor*					
6.8	Kordial *Cordials*					
6.9	Minuman berkarbonat *Carbonated / soft drinks*					
	Minuman lain: *Other beverages / drinks:*					
7. LAIN-LAIN *MISCELLANEOUS*		Kali/hari *Times/day*	Kali/minggu *Times/week*	Kali/bulan *Times/month*	Tak Pernah *Never*	Saiz hidangan *Serving size*
7.1	Makanan segera *Fast foods*					
7.2	Coklat *Chocolates*					
7.3	Biskut *Cookies / biscuits*					
7.4	Kuih tempatan *Local kuih*					
7.5	Kek *Cake*					
7.6	Ais krim *Ice cream*					
7.7	Gula *Sugar*					
7.8	Madu *Honey*					
	Lain-lain: *Others:*					

8. SUPLEMEN
SUPPLEMENTS

Jenis Type	Kekerapan *Frequency*			
	Setiap hari *Every day*	>sekali / seminggu *> Once / week*	Sekali seminggu *Once a week*	1 – 3 kali / sebulan *1 – 3 times/month*
8.1 Multivitamin *Multivitamin*				
8.2 Vitamin B kompleks *B Complex*				
8.3 Vitamin C *Vitamin C*				
8.4 Kalsium *Calcium*				
8.5 Zat besi *Iron*				
8.6 Minyak ikan *Fish oil*				
8.7 Minyak evening primrose *Evening primrose oil*				
8.8 Herba Cina / ginseng *Chinese herbs/ginseng*				
8.9 Serbuk protein / whey *Protein powder / whey*				
Others:				

L. MAKLUMAT PERUBATAN / *MEDICAL INFO*

1. Adakah anda pernah mengalami masalah kesihatan yang berikut?
Presence of the following:

☐ *(1) Jaundice*
☐ *(2) Pallor*
☐ *(3) Clubbing*
☐ *(4) Koilonychias*
☐ *(5)Lymphadenopathy*
☐ *(6) Oedema*

2. Adakah anda mengambil sebarang ubat-ubatan sekarang?
Are you taking any medications for your disease?

☐ (1) Ya / *Yes*
☐ (2) Tidak */ No* *(sila ke S4 / skip to Q4)*

3.	Apakah ubat-ubatan yang anda ambil? *What are those medications?*	Kencing manis *Diabetes mellitus*	Darah tinggi *Hypertension*	Kolesterol tinggi *Hypercholesterolemia*	Lain-lain *Others*

4. Adakah mana-mana ahli keluarga anda (ibubapa, adik beradik, anak-anak) mempunyai sebarang sejarah penyakit?
Has/had any of your family members (parents, siblings, children) a history of any disease?

☐ (1) Ya / *Yes*
☐ (2) Tidak / *No*

5. Apakah penyakit-peyakit yang mereka ada/pernah ada?
Which of the listed diseases your family members has/had?

☐ (1) Kencing manis / *diabetes mellitus*
☐ (2) Darah tinggi / h*ypertension*
☐ (3) Kolesterol tinggi / *hypercholesterolemia*
☐ (4) Lain-lain / *others:*
_____

Perempuan sahaja / Female participants only

6.	Pernah ada kencing manis ketika mengandung? *Any history of diabetes reported during pregnancy?*	☐ (1) Ya / *Yes*	☐ (2) Tidak /*No*	☐ (3) Tidak berkaitan/*NA*
7.	Pernah ada darah tinggi ketika mengandung? *Any history of hypertension reported during pregnancy?*	☐ (1) Ya / *Yes*	☐ (2) Tidak /*No*	☐ (3) Tidak berkaitan/*NA*

PENYAKIT ARTERI KORONARI / *CORONARY ARTERY DISEASE*

8.	Pernahkah doktor memberitahu anda aliran darah ke jantung anda terhalang, juga dikenali sebagai penyakit arteri koronari? Halangan sedemikian boleh menyebabkan sakit dada yang juga dikenali sebagai angina. *Has a doctor ever told you that you have a blockage in the blood flow to your heart, also called CAD? Such blockage can lead to chest pain, also called angina?*	☐ (1) Ya / *Yes*	☐ (2) Tidak / *No*
9.	Pernahkah anda mendapat sakit atau tekanan dada dalam 6 bulan yang lepas? *In the past 6 months have you had chest pain or pressure?*	☐ (1) Ya / *Yes*	☐ (2) Tidak /*No*
10.	Adakah sakit atau tekanan tersebut disebabkan aktiviti fizikal atau stres? *Was the chest pain or pressure brought on by physical activity or stress?*	☐ (1) Ya / *Yes*	☐ (2) Tidak / *No*
11.	Adakah sakit atau tekanan dada tersebut pulih selepas berehat atau guna nitrogliserin? *Was the chest pain or pressure relieved by rest or nitroglycerine?*	☐ (1) Ya / *Yes*	☐ (2) Tidak / *No*
12.	Pernahkah doktor memberitahu anda telah diserang sakit jantung? *Has a doctor ever told you that you had a heart attack?*	☐ (1) Ya / *Yes*	☐ (2) Tidak / *No*

PENYAKIT CEREBROVASKULAR / *CEREBROVASCULAR DISEASE*

13. Pernahkah doktor memberitahu anda mendapat strok? *Have you ever been told by a doctor that you have had a stroke?* ☐ (1) Ya / *Yes* ☐ (2) Tidak / *No*

14. Pernahkah doktor memberitahu anda mendapat TIA? Ia just dipanggil "*Transient Ischemic Attack*" atau strok amaran. *Has a doctor ever told you that you have had a TIA? This is also called "Transient Ischemic Attack" or "warning stroke."* ☐ (1) Ya / *Yes* ☐ (2) Tidak / *No*

15. Pernahkah anda mendapat simptom-simptom seperti strok, contohnya rasa lemah sebelah badan anda, gagap, sebelah mulut kendur, meleleh air liur atau kesukaran melihat, tetapi kembali normal dalam masa sehari? *Have you ever developed sudden, stroke-like symptoms, for example, weakness on one side of your body, difficulty speaking, drooping of one side of your mouth, drooling, or trouble seeing, which completely returned to normal within a day?* ☐ (1) Ya / *Yes* ☐ (2) Tidak / *No*

PENYAKIT VASKULAR PERIFERAL / *PERIPHERAL VASCULAR DISEASE*

16. Pernahkah doktor memberitahu anda mempunyai saluran darah, arteri-arteri ke kaki tersumbat? Ia juga dipanggil penyakit vaskular periferal. *Has a doctor ever told you that you have blockages in the blood vessels, arteries to your legs, also called peripheral vascular disease?* ☐ (1) Ya / *Yes* ☐ (2) Tidak / *No*

17. Pernahkah anda mendapat kekejangan kaki atau kesakitan pada bahagian betis yang pulih selepas berehat dalam 6 bulan yang lepas? *During the past 6 months, have you had leg cramps or pain in your calf while walking, which was relieved by rest?* ☐ (1) Ya / *Yes* ☐ (2) Tidak / *No*

NEUROPATI / *NEUROPATHY*

18. Pernahkah anda rasa kehilangan sensasi atau rasa kebas di kaki dalam 6 bulan yang lepas? *During the past 6 months, have you had no feeling or numbness in your feet?* ☐ (1) Ya / *Yes* ☐ (2) Tidak / *No*

19. Berapa kerap anda mempunyai kehilangan kawalan membuang air besar atau cirit-birit semasa tidur dalam 4 minggu yang lepas? *During the past 4 weeks, how often have you had loss of bowel control or diarrhoea while sleeping?*
☐ (1) Tidak pernah / *Never*
☐ (2) 1 or 2 kali sebulan / *1-2 times a month*
☐ (3) Sekali seminggu / *once a week*
☐ (4) 2 or 3 kali seminggu / *2-3 times a week*
☐ (5) Selalu / *Always*

MASALAH BERKAITAN KAKI / *FOOT PROBLEMS*

20. Pernahkah anda mendapat ulser di jari kaki, kaki atau bahagian bawah kaki dalam 6 bulan lepas? *During the past 6 months, have you had ulcers on your toes, feet, or lower legs?* ☐ (1) Ya / *Yes* ☐ (2) Tidak / *No*

21. Pernahkah anda mendapat gangren pada jari-jari kaki? *Have you ever had gangrene on any of your toes?* ☐ (1) Ya / *Yes* ☐ (2) Tidak / *No*

22.	Pernahkah jari kaki atau kaki anda dipotong disebabkan kencing manis? *Have you ever had any part of your toes or feet amputated because of diabetes?*	☐ (1) Ya / *Yes*	☐ (2) Tidak / *No*

MASALAH BERKAITAN MATA / *EYE PROBLEMS*

23.	Adakah anda mempunyai katarak? *Do you now have cataracts?*	☐ (1) Ya / *Yes*	☐ (2) Tidak / *No*
24.	Pernahkah doktor memberitahu anda mempunyai penyakit mata kencing manis atau retinopati? *Has a doctor ever told you that you have retinopathy or diabetic eye disease?*	☐ (1) Ya / *Yes*	☐ (2) Tidak / *No*

Appendix 4 (Memoirs)







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Appendix 5 (Abstract presentation in ICNCD 2017)

ICNCD International Conference on Non Communicable Diseases 2017

[16]

NUTRITIONAL STATUS AND METABOLIC SYNDROME (MetS) AMONG ADULT MALAYSIAN INDIANS IN JOHOR

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ABSTRACT

Studies have shown relatively higher prevalence of metabolic syndrome (MetS) among Malaysian adults of Indian ethnicity, which predisposes them to the risk of developing cardiovascular disease and type 2 diabetes mellitus. Dietary intake has a central role in influencing the risk of MetS. This study aimed to investigate the association between nutritional status and MetS among Malaysian Indian adults. In a cross-sectional survey, 69 Malaysian Indian adults (27 males, 42 females; age range 19-76 years) residing in Kulai, Johor were recruited with written informed consent. The socio-demographic information, medical history and eating behaviour were determined using a structured questionnaire. A semi-food frequency questionnaire (77 food items) was used to assess the dietary intake. MetS status was determined using the Harmonized Criteria. Nutrient intake was analysed with DietPlus (Ver. 3). Statistical analysis was conducted with IBM® SPSS® Statistics 23.0. The prevalence of MetS amongst this cohort was 46%. Central obesity (79%) and low HDL-cholesterol (64%) were the most common metabolic abnormalities. Significant differences were observed with age (49.6 ± 2.2 vs. 40.5 ± 2.0; p=0.002), body mass index (BMI) (29.22 ± 0.8 vs. 24.65 ± 0.7; p=0.001) and retinol levels (915.5 ± 76.5 vs. 1243.8 ± 121.2; p=0.03) between those with MetS and without MetS. Logistic regression revealed that an increase in intake of sodium was associated with MetS; whereas increasing intake of fiber and retinol appeared to be protective against MetS in these subjects, adjusted for energy, age and BMI. Innovative health promotion strategies are warranted to improve the dietary habits of Malaysian Indians in Johor to prevent their vulnerability to MetS.

Keywords: Metabolic Syndrome, Nutrition, Nutrient Intake, Adult, Prevalence

Appendix 6 (Presentation in the 3-MT competition, School level)

Certificate of Award

2nd Prize Winner

Dr. Saleem Perwaiz Iqbal

2018 Three Minute Thesis 3MT™ Competition at School Level, organized by Jeffrey Cheah School of Medicine and Health Sciences, Monash University Malaysia on April 13.

Professor Mohamed Shajahan Bin Mohamed Yasin
Head, Jeffrey Cheah School of Medicine and Health Sciences
Monash University Malaysia