THE ASSOCIATION BETWEEN BODY MASS INDEX (BMI), BODY FAT PERCENTAGE AND

CIRCADIAN RHYTHM DISTURBANCES AMONG UNDERGRADUATE STUDENTS

INUNIVERSITI SAINS MALAYSIA, KUBANG KERIAN

By

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Declaration

I hereby declare that this dissertation is the result of my own investigations, except where otherwise stated and duly acknowledged. I also declare that it has not been previously or concurrently submitted as a whole for any other degrees at Universiti Sains Malaysia or other institutions. I grant Universiti Sains Malaysia the right to use the dissertation for teaching, research and promotional purposes.

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1/7/2025

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PERKAITAN ANTARA INDEKS JISIM TUBUH IJT), PERATUSAN LEMAK BADAN DAN GANGGUAN RITMA SIRKADIAN DALAM KALANGAN PELAJAR IJAZAH SARJANA MUDA DI UNIVERSITI SAINS MALAYSIA, KUBANG KERIAN

Abstrak

Kajian ini bertujuan untuk mengkaji perkaitan antara Indeks Jisim Tubuh (IJT), peratusan lemak badan dan gangguan ritma sirkadian dalam kalangan pelajar ijazah sarjana muda di Universiti Sains Malaysia, Kubang Kerian. Kajian ini merupakan kajian keratan rentas yang dijalankan dalam kalangan125 pelajar ijazah sarjana muda di Universiti Sains Malaysia, Kubang Kerian dengan menggunakan soal selidik dalam talian. Subjek dalam kajian ini dipilih menggunakan persampelan rawak mudah dan data dalam kajian ini telah dianalisis menggunakan perisian SPSS versi 29.0. Perkaitan antara IJT peratusan lemak badan dengan gangguan ritma sirkadian telah diuji menggunakan ujian Khi Kuasa Dua Pearson. Hasil kajian menunjukkan salah satu daripada enam tingkah laku chrononutrition iaitu *evening latency* mempunyai perkaitan yang signifikan secara statistik dengan IJT (p = 0.002). Manakala untuk peratusan lemak badan (%), tiada perkaitan yang secara signifikan dengan enam tingkah laku chrononutrition.Kesimpulannya, kajian ini mencadangkan bahawa usaha diperlukan untuk menggalakkan pengurusan ritma sirkadian yang lebih baik dalam kalangan pelajar untuk menyokong status IJT dan peratusan lemak badan yang sihat dan gangguan ritma sirkadian

ASSOCIATION BETWEEN BMI, BODY FAT PERCENTAGE AND CIRCADIAN RHYTHM DISTURBANCES AMONG UNDERGRADUATE STUDENTS IN USM

Abstract

Body mass index (BMI) and body fat percentage are important indicators of nutritional status. Despite their importance, many still experience issues related to BMI and body fat that may be associated with circadian rhythm disturbances, especially among university students. The objective of this research was to study the association between BMI, body fat percentage, and circadian rhythm disturbances among undergraduate students in Universiti Sains Malaysia (USM), Kubang Kerian. This study was a cross-sectional study conducted on a total of 125 undergraduate students in Universiti Sains Malaysia, Kubang Kerian by using a self-administered online questionnaire. The subjects in this study were chosen using a simple random sampling and the data analysis was analysed using the SPSS version 29.0 software. The association between BMI, body fat percentage, and circadian rhythm disturbances was tested using Pearson's Chi-Square test. Among the analyses, one of the six chrononutrition behaviours, evening latency, had a statistically significant association with BMI ($p = 0.002$). However, no significant association was found between body fat percentage and any of the six chrononutrition behaviours. In conclusion, this study suggests that efforts are required to promote better circadian rhythm management among university students to support healthy BMI and body fat percentage status.

CHAPTER 1: INTRODUCTION

1.1   BACKGROUND STUDY

In the human body, there is a human circadian system that has a period of 24 hours. Lifestyle and environmental factors of our modern societies like artificial lighting, jetlag, shift work and access to energy dense food for 24 hours can promote disruptions in the circadian system and adversely affect individual health. A lot of evidence came out to see the relationship between metabolism and the circadian system. Based on nutritional genomics perspective, genetics variants in clock genes can influence both metabolic health and modify individual response to diet.

With the involvement of clocks in various peripheral tissues, the circadian rhythms, (circa = around) (dies = one day), occur at the centre and control the variety of behavioural and biochemical processes throughout day and night cycle. Additionally, the circadian clock machinery can be modulated by nutrient and energy input. A complex and mutually linked together between the circadian clock system and metabolism has been determined, as a result, most likely it has impact on each other (Franzago et al., 2023).

One study shows that more than half of 148 respondents (55.4%) ate fast food every month. (Isa et al., 2022). Another study made by Department of Food Sciences, Faculty of Science and Technology, Universiti Kebangsaan Malaysia in 2021, patterns, knowledge, attitude, practice (KAP) and barriers in breakfast consumption were observed in that study through questionnaires, 396 students of Universiti Kebangsaan Malaysia participated in this study. The results show that only 35.9% of students take breakfast between 6 to 7 days per week. (Jayaveloo et al., 2021).

Chrononutrition definition is the study of human biological rhythms and nutrition with relationship of human health that includes energy distribution, meal frequency and regularity. Chrononutrition is a new study how food can affect individual body's circadian rhythm. 6 things that most likely to

influence a person chrononutrition are eating at night, breakfast eating, restricted time feeding, timing of largest meal, time between eating and sleep time and time of evening eating. Also assessing mealtime patterns is important for food intake regulation and body metabolism to make sure nutritional status and wellbeing status is optimum. It was reported that most people who are unable to adhere to a healthy diet was shown by people with late chronotype.

Furthermore, this group has a habit of delaying the eating time, often skipping breakfast, have a high preference for sweet food and drinks, lack of fruits a vegetables consumption and drinks alcohol. Moreover, those people who consumed high-calorie intake during late night are exposed to the risk of obesity. This happened because the process of lipogenesis and adipose tissues accumulation tend to take place during the interval of last meal. In addition, people who skip breakfast will experience a longer time period of lipolysis and lipogenesis process due to their eating habits. Circadian rhythm disruption will lead to the development of morbidities or metabolic diseases such as hypertension, abdominal obesity and dyslipidaemia. Therefore, choronoutrition may affect the quality of life of a person who has misalignment interaction between dietary intake and meal timing (Hairudin et al., 2022).

1.2 PROBLEM STATEMENT

Circadian rhythm disturbances among university students often happened due to bad lifestyle habits such as irregular sleep patterns, late night eating and skipping breakfast. Exposure to artificial light, also one of the bad lifestyle habits. These disruptions often linked to metabolic dysfunction, hormonal imbalance and obesity. Body mass index and body fat percentage not only results of circadian misalignment but also can further impair the circadian regulation itself, that creates a malignant cycle (Franzago et al., 2023). Despite of abundance evidence of these associations, research

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of direct relationship between BMI, body fat percentage, and circadian rhythm disturbances remains limited. The rise of prevalence of obesity and circadian misalignment in these recent years, this study aims to explore more to see the prevalence of undergraduate students of USM Kubang Kerian with circadian rhythm disturbances and its association and also to contributes more on strategies to lessen the obesity levels and metabolic syndrome among undergraduate students by analysing their lifestyle pattern (skipping breakfast, meal timing, late night snacks, sleep quality).

1.3 RESEARCH QUESTION

1. What is the prevalence of circadian rhythm disturbances among undergraduate students in USM Kubang Kerian?

2. Is there any significant association between BMI and circadian rhythm disturbances among undergraduate student in USM Kubang Kerian?

3. How does body fat percentage associated with circadian rhythm disturbances among undergraduate students in USM Kubang Kerian?

1.3 RESEARCH OBJECTIVE

1.3.1 GENERAL OBJECTIVE

To examine the association between Body Mass Index (BMI), body fat percentage, and circadian rhythm disturbances.

1.3.2 SPECIFIC OBJECTIVES

1. To assess the prevalence of circadian rhythm disturbances among undergraduate students in USM Kubang Kerian.

2. To evaluate the association between BMI and circadian rhythm disturbances among undergraduate students in USM Kubang Kerian.

3. To identify the association between body fat percentage and circadian rhythm disturbances among undergraduate students in USM Kubang Kerian.

1.4 RESEARCH HYPOTHESIS

    1.4.1 Null hypothesis (Ho)

I.   There is no association between BMI and Circadian Rhythm Disturbances among undergraduate students at Universiti Sains Malaysia, Kubang Kerian.

II.   There is no association between Body Fat Percentage and Circadian Rhythm Disturbances among undergraduate students at Universiti Sains Malaysia, Kubang Kerian.

    1.4.2 Alternative hypothesis (HA)

I.   There is an association between BMI and Circadian Rhythm Disturbances among undergraduate students at Universiti Sains Malaysia, Kubang Kerian.

II.   There is an association between Body Fat Percentage and Circadian Rhythm Disturbances among undergraduate students at Universiti Sains Malaysia, Kubang Kerian.

1.5 JUSTIFICATION OF STUDY

The findings of this study will provide a valuable information regarding circadian rhythm disturbances, focusing on BMI, Body Fat percentage among undergraduate students at USM Kubang Kerian. By doing a study on how BMI, and body fat percentage, we can see how both of these factors are affected by circadian rhythm disturbances and how circadian rhythm affects these two factors. It has interlinked association. BMI and body fat percentage are often associated with metabolic and cardiovascular disorders, and these often contributed by circadian rhythm disturbances. By doing a study on these associations, it can fill a significant gap in individuals understanding how these factors interact to circadian rhythm disturbances, especially in Malaysia where research is limited. This resulting to undergraduates' students able to manage meal time pattern, to not skip breakfast and avoid eat during late nights. This led undergraduate students to able to improve the health outcomes. In short, it helps in enhancing the quality of life for these individuals especially in reducing the obesity prevalence.

1.6 CONCEPTUAL FRAMEWORK

This framework highlights the importance of how circadian rhythm disturbances affect BMI, Body Fat Percentage also at the same time how BMI, Body Fat Percentage affects Circadian rhythm disturbances. Other factors like exposure to artificial lighting are also contributes to circadian rhythm disturbance but they are not part of this study. In this research project, circadian rhythm disturbances are independent variable meanwhile BMI and Body Fat Percentage are dependent variables. By focusing on BMI, Body Fat Percentage this study aims to provide insight into how body composition and meal timing may affect our body clock.

Body Mass Index

Body Fat Percentage

• Artificial lighting

Circadian rhythm

• Age
• Gender
• Ethnicity
• Course
• Residential

→ Investigated in this study.

┈┈► Not included in the study

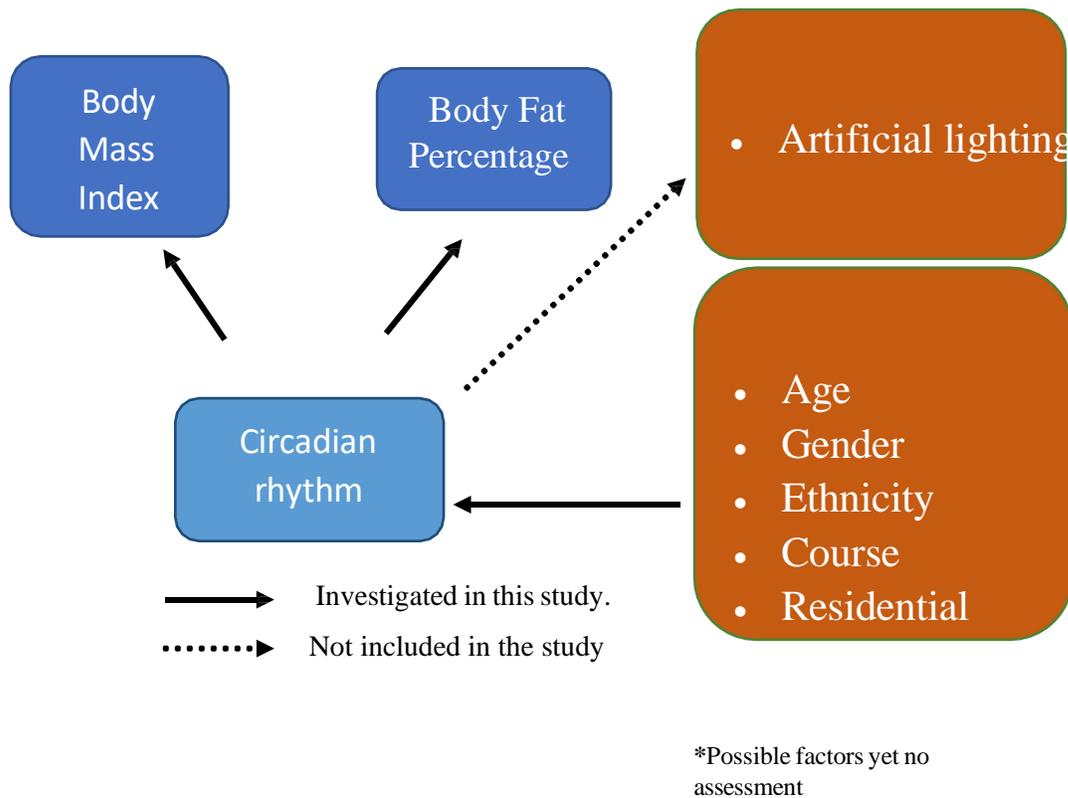*Possible factors yet no assessment

Figure 1. Conceptual framework of association related to Body Mass Index (BMI), body fat percentage and circadian rhythm disturbances among undergraduates' students at Universiti Sains Malaysia, Kubang Kerian.

CHAPTER 2: LITERATURE REVIEW

2.1   DEFINITION AND CONCEPT OF CIRCADIAN RHYTHM

Circadian rhythm is a biological clock that is built in our brain throughout the function of every individual for day and night processes, as per 24- hour clock. It is also a self-control system that regulates our eating habits and body function. The source of word "Circa" means "around" and "diem" means "day", in a single word will be "around the day". The human body became active from awake and also goes through a frame of 24 hours in a day. In this period, individuals would experience many emotions, behavioral and biological nature such as sleeping, hungry, thirsty, resting, and urine passing. When a human body has that kind of pattern for a continuous duration, the body gets synchronized to that experienced (Senthilnathan & Sathiyasegar, 2019).

2.2 THE CIRCADIAN RHYTHM PATTERNS AMONG UNDERGRADUATE STUDENTS

One study reported that 400 undergraduate students in Klang Valley, which came from UPM, UKM and UM has 50.2% of low sleep quality and only 10% has high sleep quality. It is reported that among shift workers have sleep disorders, psychiatric conditions and metabolic diseases. Up to 90% of individuals with major depressive disorder (MDD) report that they have difficulties in sleeping, that circadian misalignment becomes a trigger to depressive symptoms (Anandavelu et al., 2022). Another study stated that circadian misalignment is linked to metabolic disorders like type 2 diabetes, insulin resistance and obesity. Glucose homeostasis and lipid metabolism are regulated by circadian body clocks in skeletal muscle and liver (Tharumalay et al., 2020).

2.2 ASSOCIATION BMI AND CIRCADIAN RHYTHM DISTURBANCES

Research has been made, research found out those people who is overweight or obesity on average often sleep in later midpoint of time during weekend, a later chronotype, have a longer time delay between dinner. The study also compares earlier chronotype and later chronotype in general

had a late sleep timing, and their meal schedule for breakfast, lunch and dinner is late (Xiao et al., 2019).

2.3 ASSOCIATION BODY FAT PERCENTAGE AND CIRCADIAN RHYTHM DISTURBANCES

Body's internal clock regulated by the circadian rhythm, it controls sleep-wake cycles and also other processes. It can be influenced by light, social cues and environmental factors. Effects of disruption include metabolic diseases such as obesity, diabetes and cardiovascular issues. Hormonal imbalances like leptin and ghrelin levels also happened. Cognitive performance among individuals is also one of the effects which can lead to sleep deprivation and circadian misalignment that negatively affect memory, attention span and learning abilities. Not only on physical aspect, it also affects mental health which is linked to mood disorders such as depression and bipolar disorder. (Tharumalay et al., 2020). It also affects the molecular mechanism, for example clock gene (BMAL1, PER, CRY, CLOCK) helps in regulation of key metabolic processes such as energy balance and lipid metabolism. Most of the time, it is due to genetic mutations but environmental disruptions also can affect these genes that can exacerbate metabolic disorders and adiposity (Guan, 2023)

Central clock SCN and the peripheral clocks in peripheral tissues interact with each other in response to light, food and sleep to maintain the circadian rhythms in all cells and tissues. The suprachiasmatic nucleus (SCN) is a group of small nerve cells in the hypothalamus that controlling a body's circadian rhythms and sleep-wake cycle. A lot of biological processes, like glucose and lipid homeostasis, hormone secretion and energy expenditure process are regulated by circadian clock. The SCN usually entrain with light signals while peripheral clocks regulate by food, temperature, sleep and hormonal cues. Abnormal expression by circadian genes, environmental such as abnormal light and dark cycles and activities that can encourage circadian disruption could contribute to obesity and

also, obesity-related metabolic disorders. For instance, animals with genetic circadian disruption such as mutation of CLOCK and deletion of BMAL1 are susceptible to obesity and metabolic syndrome (Peng & Chen, 2023).

3.0 METHODOLOGY

3.1 RESEARCH DESIGN

Research design used in this research is cross-sectional design. This design is a type of observational study or known as descriptive research. It involves by analyzation of information regarding population at specific point of time. This design can measure the prevalence of the outcome based on our interest in a defined population. It also can be used to assess the prevalence of both outcomes and exposures, determination of relationships among variables and create hypotheses regarding causal connection between BMI, body fat percentage, and Circadian Rhythm to be explored in this design. Aims to describe a variable and not measure the variable. Cross-sectional studies are also unique designs as researchers are able to look at many characteristics at once. The advantages of utilizing this research design are simple and inexpensive. These studies are cheap, quick and easy to do as follow-ups are not needed with subjects as can be done through self-report surveys. Also, variables are all analyzed at one time and the data does have to be collected multiple times. This can lead to fewer mistakes as a higher level of control is achievable. Also, multiple variables and outcomes can be compared at once. Not only are those researchers able to have a look at a variety of characteristics like age, gender, ethnicity, and education level in just one study. Causal relationships also can be explored in more depth. Compared to longitudinal studies, longitudinal studies involve observation of a population for extended period while cross sectional studies observed characteristics of a population at a time in specific point. Longitudinal studies also require more time and a lot of resources are needed and might be less valid, as sometimes participants might quit the study before the data has been fully collected. (Simkus, 2023). Since this research only focused on association, using cross sectional studies is sufficient.

3.2 STUDY AREA

For this study, it conducted at Universiti Sains Malaysia (USM) Health Campus, Kubang Kerian, Kelantan. USM Health Campus comprises three schools, which are School of Health Sciences (PPSK), School of Dental Sciences (PPSG), and School of Medical Sciences (PPSP). This study will be run both offline and online for all participants. In offline settings, Body Mass Index (BMI) and body fat percentage measurement will be taken around Desasiswa Murni and Desasiswa Nurani area. For online settings, data will be collected through the e-questionnaire form given by the researcher using google Forms. The reasons why the area has been chosen, because most undergraduate students, aged between 19 to 25, are using social media in their daily life. Also, most google forms can be spread through WhatsApp and Telegram, where most students alerted to any information given through group chats in both apps.

3.3 STUDY POPULATION

Participants are mostly from undergraduate students at USM Health Campus, which consists of School of Health Sciences (PPSK), School of Medical Sciences (PPSP), and School of Dental Sciences (PPSG). Participants also need to meet both inclusion and exclusion criteria, from the first year to the fourth year. Before their involvement in this study, each participant will be given an informed consent form and expected to join voluntarily. A detailed explanation of the objectives, purposes, and advantages will be given.

3.4 SUBJECT CRITERIA

3.4.1 INCLUSION CRITERIA

1. Undergraduate student at USM Health Campus

2. Aged between 19 to 25 years old

3. Literate in English

4. Active in using social media especially using WhatsApp application

5. Willing to participate in this study

6. Able to fill in the online questionnaire

3.4.2 EXCLUSION CRITERIA

1. Have any acute or chronic condition that would limit the ability to physically participate in the study (Eg: Unable to walk properly and asthma).

2. Refuse to complete the consent form.

3.5 SAMPLE SIZE CALCULATION

3.5.1 Sample size for first objective:

Using Δ value of 0.1 and confidence level of 95% for the study, the Z-score will be 1.96. The first objective is to assess the prevalence of circadian rhythm disturbances among undergraduate students in USM Kubang Kerian. Based on one study conducted, it determines that around 38.6% of students were engaging with Night eating Syndrome (NES) based on Night Eating Diagnostic Questionnaire (NEDQ) conducted (Kwan et al., 2021). Thus, the anticipated population proportion is 0.386. The sample size calculation also will be performed using the one proportion formula.

$$n = [\frac{1.96}{0.07}]^2 \ 0.386 \ (1- 0.386)$$

$$n = 784 \times 0.386 \times 0.614$$

$$= 185.8 \approx 186 \text{ subjects}$$

To account for potential dropouts, 10% dropout rate is applied to the sample size:

$$n = [\frac{1.96}{0.07}]^2 \ 0.386 \ (1- 0.386) + 10 \ \%$$

$$= 186 + 19$$

$$= 205 \text{ subjects}$$

3.5.2 Sample size for second objective:

For the second objective which is evaluate the association between BMI and circadian rhythm disturbances among undergraduate students in USM Kubang Kerian, in undergraduate students, one

proportion calculation is used to estimate the sample size. The formula for one proportion calculation is as shown below:

$$n = \left[\frac{Z}{\Delta}\right]^2 p\,(1-p)$$

n = sample size

Z = value representing the desired confidence level.

Δ = absolute precision

p = anticipated population proportion

Using Δ value of 0.07 and confidence level of 95% for the study, the Z-score will be 1.96. According to the second objective, prevalence of overweight and obese in the undergraduate students used as the anticipated population proportion, which are 25.4% overweight and obesity based on BMI. So, proportion is 0.254 (Khairul Azhan et al., 2024).

$$n = \left[\frac{1.96}{0.07}\right]^2 0.254\,(1 - 0.254)$$

$$n = 784 \times 0.254 \times 0.746$$

$$= 148.56 \approx 149 \text{ subjects}$$

To account for potential dropouts, extra respondents are required to be enrolled in the study. Higher dropout rate is chosen because the study population is a high-risk population due to health issues. Therefore, 10% dropout rate is applied to the sample size:

$$n = [\frac{1.96}{0.07}]^2 \, 0.254 \, (1- 0.254) + 10 \, \%$$

Dropout rate $= 149 + 15 = 164$ subjects

The sample size of participants would be ranged from 164 subjects to 205 subjects. The second size was chosen which are 164 subjects, however only 125 (76.2%) subjects were validated at the end due to time constraints during data collection and because some participants did not complete the questionnaire.

3.6 SAMPLING METHOD

Sampling method used in this study is a convenience sampling method. Convenience sampling is a nonprobability technique whereby participants are selected to be in the sample because of ease of access and convenience to the researcher. Therefore, it is commonly applied for its ease, economy, and efficiency. The main disadvantages associated with it are the presence of possible biases in the sampling, unrepresentative nature, and restricted generalization of the results beyond the sampled section. Convenience sampling selects a sample based on persons with some common and predefined inclusion criteria that the researcher finds readily accessible. Often, the participant samples will involve some voluntarism. Common examples include qualitative studies, pilot studies, and hypothesis generation (Golzar et al., 2022).

3.7 STUDY INSTRUMENTS

For this study, a set of questionnaires has been validated and used as this study research tool to collect all information needed. It consisted of five sections which are Section A: Socio-demographic Information, Section B: Anthropometric Data, Section C: Malay version chrononutrition profile-questionnaire (CPQ-M). This questionnaire would not be a burdensome to the participants as it only required around 15 minutes to be completed.

3.7.1 SECTION A: SOCIO-DEMOGRAPHIC INFORMATION

Section A is a section where information like age, gender, school, academic programme and year of study will be collected. Personal information like name, matric number and IC number will not be collected in this section due to privacy and confidentiality.

3.7.2 SECTION B: ANTHROPOMETRIC DATA

This section will collect participants' weight in kg and height in meter. Using these data, BMI will be calculated using a formula; BMI = weight (kg)/(height x height) (m²). BMI then will be classify into underweight (<18.5 kg/m2), normal weight (18.5 to 22.9 kg/m2), overweight (23.0 to 27.4 kg/m2) and obese (≥27.5 kg/m2) (WHO, 1972). Height will be measured using Seca 213 portable stadiometer stadiometer while weight will be measured using Bioelectrical impedance analysis (BIA) device, Omron Karada HBF214. Body fat percentage also would be measured using the same BIA device.

3.7.3 SECTION C: MALAY VERSION CHRONONUTRITION PROFILE-QUESTIONNAIRE (CPQ-M)

The CPQ was generally designed to be an overall assessment of chrononutrition aspects, with no burden on the participants. The 18-item CPQ is meant to determine patterns of chrononutrition behaviors and chrononutrition preferences both on weekdays and weekend days. There are 4 domains of the CPQ, which ask about the following: 1) chrononutrition preferences; 2) frequency of certain chrononutrition behavior; 3) timing of eating events during workday; and 4) timing of eating events during a free day. The first and second domains consist of 4 items while the third and fourth 5 items each. Therefore, the present study sought to develop a Malay language translation of the CPQ and investigate the reliability and validity of this questionnaire among young adults in Malaysia. This is important because Malay language is the national language in Malaysia therefore, a Malay CPQ will be helpful for other generations or populations in Malaysia that might be illiterate in English. The Chrononutrition Profile-Questionnaire (CPQ) is an important tool to assess eating habits and meal timing that related to the body's circadian rhythms. The CPQ was adapted and translated into Malay language to create the Malay Version of the Chrononutrition Profile-Questionnaire (CPQ-M). This

version targets the Malay-speaking population and also considers their cultural and dietary practices