



UNIVERSITI PUTRA MALAYSIA

***NUTRITIONAL STATUS AND BLOOD PRESSURE LEVEL
ACCORDING TO HUMAN CHRONOTYPE AMONG
UNDERGRADUATE STUDENTS IN
UNIVERSITI PUTRA MALAYSIA***

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This project entitled “Nutritional status and blood pressure level according to human chronotype among undergraduate students in Universiti Putra Malaysia” was prepared by Siti Fatimah Razali and submitted to the Faculty of Medicine and Health Sciences as a partial fulfillment of the requirement for the degree of Bachelor of Science (Nutrition and Community Health) from the Faculty of Medicine and Health Sciences, Universiti Putra Malaysia.



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Abstract

NUTRITIONAL STATUS AND BLOOD PRESSURE LEVEL ACCORDING TO HUMAN CHRONOTYPE AMONG UNDERGRADUATE STUDENTS IN UNIVERSITI PUTRA MALAYSIA

Siti Fatimah binti Razali

Previous studies suggest that human chronotype plays an important role in maintaining individual's health. Human chronotype is a characteristic indicating which time of the day a person prefers for rest and performs activity, in which it is categorized as a morning, intermediate or evening person. Evening types are often shown to practice poorer health behaviors such as consuming less vegetables, fruits and fish as well as often being physically inactive as compared to morning types, that might be related to negative health outcomes such as overweight and obesity and hypertension. Therefore, this cross-sectional study examined differences in sociodemographic background, nutritional status and blood pressure level according to human chronotype among undergraduate students in Universiti Putra Malaysia. A total of 226 undergraduate students (75.7% female and 24.3% male) aged 20.41 ± 1.23 years from three randomly selected programs participated in this study. They completed a self-administered questionnaire including sociodemographic characteristics, human chronotype and meal patterns. Anthropometry measurements and blood pressure level were measured. A 24-hour dietary recall was conducted through a face-to-face interview. Results showed that the prevalence of overweight and obesity was 19.0% and 12.4%, respectively. About 40.4% of the respondents had high body fat percentage and 21.1% were classified as hypertension. Majority of the respondents had poor dietary intake and skipped main meals (85%). Majority of the students were intermediate type (78.3%), followed by morning type (15.9%) and evening type (5.8%). Moreover, more morning types were freshmen compared to intermediate and evening types. Morning type had significantly higher zinc intake ($p=0.013$), diastolic blood pressure ($p=0.001$) and systolic blood pressure ($p=0.031$) as compared to evening type. Furthermore, body composition, macronutrient, micronutrients, meal timing and meal pattern except breakfast skipping ($p=0.001$) were not significantly differed according to human chronotype. In conclusion, this study suggested that evening types were prone to have unhealthy eating behaviors such as breakfast skipping and had lower blood pressure level. Health promotion programs should highlight the importance of healthy eating and weight management by taking their chronotype into consideration.

Abstrak

STATUS PEMAKANAN DAN TAHAP TEKANAN DARAH BERDASARKAN KRONOTAIP MANUSIA DALAM KALANGAN PELAJAR PRASISWAZAH DI UNIVERSITI PUTRA MALAYSIA

Siti Fatimah binti Razali

Kajian lepas telah menunjukkan bahawa kronotaip manusia memainkan peranan penting dalam mengekalkan kesihatan seseorang. Kronotaip manusia adalah satu ciri yang menunjukkan seseorang memilih masa berehat dan melakukan aktiviti, dan dikategorikan sebagai orang pagi, pertengahan atau petang. Individu yang menjurus ke arah petang cenderung untuk mengamalkan tingkah laku kesihatan yang kurangsihat seperti kurang pengambilan sayur-sayuran, buah-buahan dan ikan serta tidak aktif secara fizikal berbanding dengan individu yang menjurus ke arah pagi, di mana ia mungkin berkaitan dengan hasil kesihatan yang negatif seperti berat badan berlebihan dan tekanan darah tinggi. Justeru itu, kajian ini bertujuan untuk membandingkan faktor sosiodemografi, status pemakanan dan tahap tekanan darah mengikut kronotaip manusia dalam kalangan pelajar prasiswazah di Universiti Putra Malaysia (UPM). Seramai 226 pelajar (75.7% perempuan dan 24.3% lelaki) berumur 20.41 ± 1.23 tahun dari tiga program yang dipilih secara rawak mengambil bahagian dalam kajian ini. Mereka melengkapkan borang soal selidik yang terdiri daripada ciri sosiodemografi, kronotaip manusia dan corak pemakanan. Pengukuran antropometri dan tahap tekanan darah telah diukur. Ingatan diet 24 jam dilakukan melalui temu ramah secara bersemuka. Hasil kajian menunjukkan bahawa prevalensi berat badan berlebihan dan obesiti adalah 19.0% dan 12.4%. Sebanyak 40.4% responden mempunyai peratusan lemak badan yang tinggi dan 21.1% dikategorikan sebagai hipertensi. Sebilangan besar responden mempunyai pengambilan makanan yang teruk dan melangkau makanan utama (85%). Majoriti pelajar adalah jenis pertengahan (78.3%), diikuti oleh jenis pagi (15.9%) dan jenis petang (5.8%). Lebih ramai pelajar jenis pagi merupakan pelajar tahun satu berbanding jenis pertengahan dan petang. Jenis pagi mempunyai pengambilan zink yang lebih tinggi ($p=0.013$), tekanan darah diastolik ($p=0.001$) dan tekanan darah sistolik ($p=0.031$) berbanding dengan jenis malam. Selanjutnya, komposisi badan, makronutrien, mikronutrien, waktu makan dan corak makan kecuali sarapan pagi ($p=0.001$) tidak berbeza mengikut kronotaip manusia. Kesimpulannya, kajian ini menunjukkan bahawa jenis malam cenderung mempunyai tingkah laku makan yang tidak sihat seperti skip sarapan pagi dan mempunyai tekanan darah yang lebih rendah. Program promosi kesihatan harus dilakukan dengan menekankan kepentingan pengurusan makanan dan berat badan yang sihat dengan mempertimbangkan faktor kronotaip.

CHAPTER 1

INTRODUCTION

1.1 Background

Chronotype is defined as an expression of circadian rhythmicity in an individual and is categorized under three categories, namely morning types, evening types and intermediate types (Adan et al., 2012; Toktas et al., 2017). It is a phase where individual reflects how the circadian system sets itself into a 24-hour day (Roenneberg, 2007). Circadian rhythm is regulated by external signals which are responsible for setting the clock each day (Garaulet & Antonio, 2015). Circadian rhythm in human is shown in many behavioral variables such as feeding, sleeping and mating and in biological variables such as cardiovascular activity, endocrine function, body temperature and hepatic metabolism (Panda, 2016).

Morningness-eveningness is a characteristic that indicates which time of the day a person prefers for rest and activity (Haraszti et al., 2014). According to Adan et al. (2012), people prefer to perform physical and mental activities at the respective time of the day. For example, morning types prefer to do activities during morning, while evening types prefer to do it during the evening. Morning types go to bed, wake up and show the best performance during the early hours of the day, meanwhile evening types prefer to go to bed late and wake up late (Tonetti et al., 2015). Evening types show the best performance mentally and physically in the afternoon and during the evening hours. Morningness-eveningness forms a normal distribution in the population, where extreme morning and

evening types are rare, while intermediate types are common (Adan et al., 2012; Haraszti et al., 2014). Although circadian preference has a strong genetic and biological basis, it varies according to some sociodemographic characteristics such as sex and age (Tonetti et al., 2015). Evening types are more prevalent in adult men (Tonetti et al., 2015), while morning preference are more frequent before 10 and after 50 years of age (Randler & Truc, 2014).

Several cross-sectional studies have examined human chronotype among undergraduate students. For instance, Acet et al. (2018) showed that the percentages of morning type, intermediate type and evening type were 9.1%, 66.5% and 24.4%, respectively among 351 medical students in Trakya University of Medicine in Turkey. Teixeira et al. (2017) conducted a study among 721 undergraduate students in a public university in Brazil revealed that 21% of the students were morning type, 62% were intermediate type and 17% were evening type. Inconsistent finding was found in Malaysia, in which Lai and Say (2013) showed that none of the 1118 students in the University Tunku Abdul Rahman were categorized into morning type or intermediate type but 82% of them were definitely evening type and 18% were moderately evening type.

Life changing transition typically occurred during the period of leaving high school to start university or working life and living parental home to establish an independent living arrangement (Stock et al., 2018). Living in college or university was the critical period regarding unhealthy changes in dietary behaviors among students (Deliens et al., 2014). University students may exhibit unhealthy eating behaviours due to the high cost of healthy foods and the ease of availability of fast food (Gan et al. 2011), reduced availability, affordability and accessibility of healthy food in university or

surrounding food outlets (Ganasegeran, 2012) and higher perceived stress (El Ansari & Berg-Beckhoff, 2015). Evidence showed that human chronotype (morningness, intermediate and eveningness) displayed different dietary behaviors among university students. Evening types were prone to skip breakfast and become obesity (Teixeira et al., 2017), consumed alcoholic drinks, eat less whole-grain products, vegetables, fruits and fish compared to morning types (Kanerva, 2012). Therefore, by studying human chronotype among undergraduate students, it helps the researchers to identify the differences in nutritional and health status according to different human chronotype.

1.2 Problem Statement

Human chronotype is one of the circadian preferences, in which an individual is categorized as a morning, intermediate or evening person (Vitale & Weydahl, 2017). There was accumulating research showing that chronotype influenced individual's health. Eveningness was associated with determinant that might contribute to negative health outcomes such as worsen dietary pattern, higher risk of getting type 2 diabetes and arterial hypertension (Merikanto et al, 2013). Furthermore, studies also showed that individuals with higher preference for evening hours in daily activities (eveningness) practiced adverse health behaviours such as consuming more alcoholic drinks, consuming less whole-grain products, vegetables, fruits and fish (Kanerva, 2012) as well as often being physically inactive (Maukonen et al., 2016) compared to morning type. These findings suggested that human chronotype plays an important role in shaping behaviour maintaining individual's health.

The prevalence of overweight and obesity has become a worldwide issue nowadays. According to the World Health Organization (2018), more than 1.9 billion adults aged 18 and above were overweight while 650 million were obese in 2016. The National Health and Morbidity Survey (NHMS) 2019 reported that the prevalence of overweight among Malaysian adults was 30.4% and the prevalence of obesity was 19.7% (IPH, 2020). The rates of obesity have increased regardless of ages, sexes, geographical locality, ethnicity or socioeconomic status (Chooi, Ding & Magkos, 2018). In university population, a recent cross-sectional study carried out by Gan, Chin and Law (2019) among 270 university students in UPM found that 24.9% of the students were overweight and obese. Overweight and obesity was becoming a nutritional problem that need to be highlighted among university students in Malaysia.

Evidence showed that university students are prone to have unhealthy dietary behaviors such as low frequency of meals, low water intake, high consumption of fried food, skipped breakfast, frequent snacking, and had low intake of daily fruits and vegetables (Ganasegeran et al. 2012; Gan et al., 2011; Yun, Ahmad & Quee, 2018). Furthermore, Hakim, Muniandy, and Danish (2012) found that more than half of the university students did not meet the Malaysian Recommended Nutrient Intake (RNI) for energy, protein (female only), calcium and iron (female only). Koo et al. (2019) also reported that total consumption of dietary fiber and some micronutrients among Malaysian university students such as calcium, zinc, vitamin C, thiamine, riboflavin, niacin and zinc were below the recommended levels. These studies suggested that university students were practicing unhealthy dietary behaviors that need urgent attention.

Hypertension was associated with high morbidity and mortality. The national prevalence of hypertension plateau from 32.6% in 2011 (IPH, 2011), 35.3% in 2015 (IPH, 2015) and 30.0% in 2019 (IPH, 2020). The prevalence of hypertension and prehypertension among 4649 university students in seven ASEAN (Association South East Asian Nations) countries (Malaysia, Indonesia, Laos, Philippines, Myanmar, Thailand and Vietnam) were reported to be 6.7% and 19.0%, respectively (Peltzer et al, 2017). Specifically, Peltzer et al. (2017) reported that 11.5% and 3.2% of Malaysian university students were having prehypertension and hypertension, respectively. Furthermore, a study done by Cheah, Majorie and Helmy (2018) showed that the prevalence of hypertension among 354 undergraduate students in a public university in Malaysia was 8.2%. These findings indicated that hypertension could be one of the health problems among university students that warrants further research.

Inconsistent findings were found in previous studies in term of the differences in nutritional status according to human chronotype. Some studies reported that low body mass index (BMI) in morning types (Arora & Taheri, 2015; Zhang et al., 2017), but some found the opposite, in which high BMI in morning types (Merikanto et al., 2014; Whittier et al., 2014). Nonetheless, some other studies found that there was no difference in BMI of different human chronotypes (Acet et al., 2018; Johnsen, Wynn & Bratlid, 2013; Toktaş, Erman, & Mert, 2017). Similarly, inconsistent findings were also found in blood pressure level and human chronotype. For instance, Yu et al. (2015) observed a higher systolic blood pressure (SBP) among morning types, while Roeser et al. (2012) and McMahon et al. (2018) found that morning types had significantly lower SBP. Thus, further research is needed to confirm these findings.

There was only two published study in Malaysia examining human chronotype in undergraduate students (Lai & Say, 2013; Schiess et al., 2020), in which it focused on sleep quality, cognitive performance and human chronotype but not on nutritional status and blood pressure level. Nutritional status and blood pressure level should be a concern as more and more university students have the problems of overweight/obesity (Cheah et al., 2018; Gan & Yeoh, 2017; Gan, Chin & Law, 2019) and hypertension (AlWabel et al., 2018; Cheah et al., 2018; Peltzer et al., 2017). Hence, the current study aimed to compare sociodemographic background, nutritional status and blood pressure level according to human chronotype among undergraduate students in Universiti Putra Malaysia (UPM). This study was conducted to answer the research questions below:

1. What is the major human chronotype among undergraduate students in UPM?
2. Is there any difference in sociodemographic characteristics, nutritional status and blood pressure level according to different human chronotypes among undergraduate students in UPM?

1.3 Significance of the Study

No published study has been done about nutritional status and blood pressure level according to human chronotype among university students in Malaysia. This proposed study would give benefits on several aspects. Firstly, this study could add to the body of knowledge on human chronotype as well as provide latest and updated information about nutritional status and blood pressure level among undergraduate students. Human chronotype can be one of the factors that may influence individual's health and associate with the determinants of adverse health behaviors. Therefore, it is important to assess

nutritional status and blood pressure level between morning, intermediate and evening chronotype among undergraduate students. By understanding the possible differences in nutritional status and blood pressure level according to human chronotype, it could help nutritionists and health promotion planners to develop appropriate intervention or health promotion programs in improving nutritional and health status of undergraduate students depending on their chronotypes. Furthermore, the findings of this study could serve as baseline data for other researchers.

1.4 Research Objectives

1.4.1 General Objective

To compare nutritional status and blood pressure level according to human chronotype among undergraduate students in UPM.

1.4.2 Specific Objectives

1. To examine sociodemographic characteristics (age, sex, ethnicity, program, year of study, current living arrangement and monthly personal allowance) of undergraduate students.
2. To examine nutritional status (body composition and dietary behavior) of undergraduate students.
3. To examine blood pressure levels among undergraduate students.
4. To identify human chronotype (morningness, intermediate and eveningness) of undergraduate students.
5. To compare sociodemographic characteristics, nutritional status and blood pressure

level according to human chronotype among undergraduate students.

1.5 Research Hypotheses

1. There were significant differences in sociodemographic characteristics between different human chronotypes among undergraduate students.
2. There was a significant difference in nutritional status between different human chronotypes among undergraduate students.
3. There was a significant difference in blood pressure level between different human chronotypes among undergraduate students.

1.6 Research Framework

Figure 1.1 shows the research framework of this study. Previous studies have shown differences in nutritional status and blood pressure level according to different human chronotype. Human chronotype (morningness, intermediate and eveningness) is a characteristic that indicates which time of the day the person prefers for rest and perform activity (Haraszi et al., 2014). Lai and Say (2013) found that none of the Malaysian undergraduate students were morning type or intermediate type, but all were evening type. In contrast, Whittier et al. (2013) showed that 14.9% of the 2581 undergraduate students were morning type, 75% were intermediate type and 9.9% were evening type in Peru.

Sociodemographic factors such as age and sex were found to be difference between different human chronotype (Juan & Zaida, 2017; Tonetti et al., 2015; Whittier et al., 2014). Morningness-eveningness changes significantly during the life span. At the primary school level (up to the age of 10 years), most children are morning oriented.

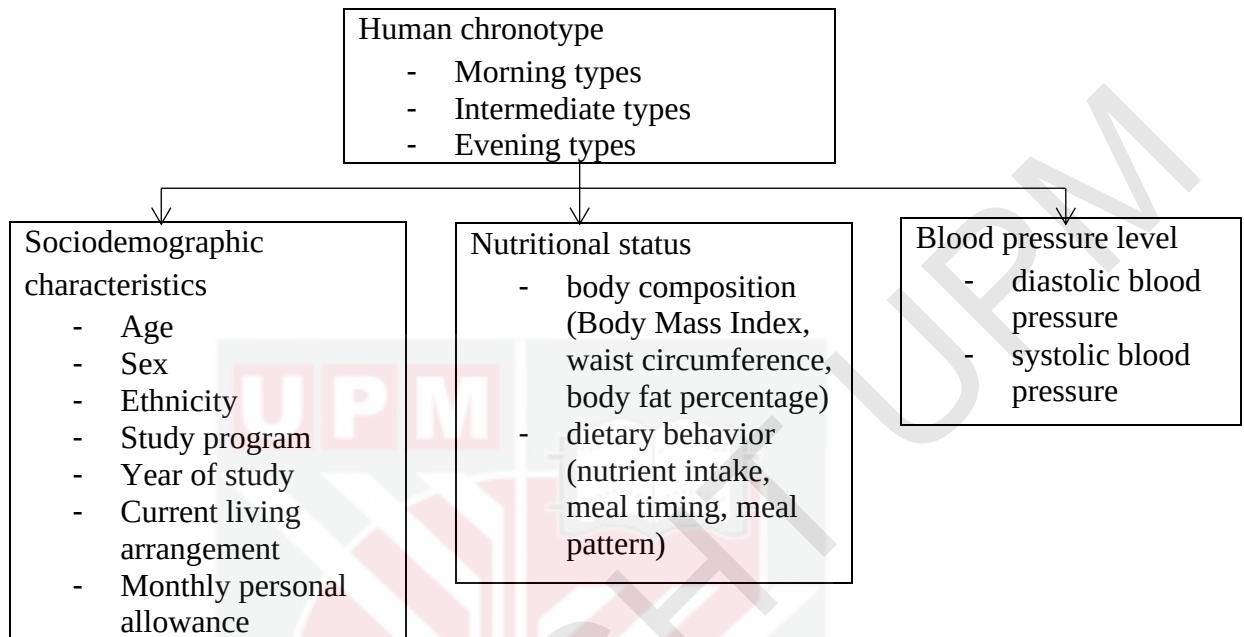


Figure 1. 1: Research framework of this study

Percentage of morningness is lower during 12 to 15 years of age (Randler, 2011). During adolescence, young people tend to shift toward eveningness (D'íaz-Morales & Gutierrez, 2008). At the end of adolescence, a shift toward morningness occurs, which is viewed as a marker for the end of adolescence (Roenneberg et al., 2004). A study conducted by Whittier et al. (2014) among 2581 undergraduate students in Peru showed that there was a statistically difference in females and males according to different human chronotype ($p=0.019$), where female was found to be more morning types than male. Furthermore, Randler (2011) reported that men were more evening oriented than women, while women reported to be more morning oriented than men.

Nutritional status of an individual was found to be difference between different human chronotype. A cross-sectional study conducted by Teixeira et al. (2017) among

Brazilian undergraduate students reported that morning types having breakfast and lunch earlier than intermediate and evening types. They also found that the prevalence of skipping breakfast was higher among evening types with higher consumption of calories, carbohydrate and fats (Teixeira et al., 2017). Furthermore, it revealed that there were no significant differences in waist circumference and BMI between different human chronotype (Teixeira et al, 2017). However, a study conducted Zhang et al. (2018) on 616 medical students from Chongqing Medical University in China found that morning chronotypes had lower BMI than evening and intermediate-type.

Evening type individuals were found to have a significantly later meal timing compared to the morning-types (Gangwar et al., 2018; Lucassen et al., 2013; Teixeira et al, 2017). In term of energy intake, several studies found differences in energy intake between different chronotypes (Lucassen et al.; 2013; Teixeira et al, 2017; Toktas et al., 2018). Toktas et al. (2018) reported that evening type adults consumed significantly more energy, protein and fat than morning type adults. On the other hand, blood pressure level was found to be difference between different human chronotype. Yu et al. (2015) found that evening types were significantly associated with lower SBP in Korean males. However, Guo and Stein (2003) reported that there was a higher SBP among morningness types.

CHAPTER 2

LITERATURE REVIEW

2.1 Overview of Human Chronotype

Human chronotype is defined as an expression circadian rhythm of an individual and is categorized into three types, namely morningness, intermediate and eveningness (Adan et al., 2012; Toktas et al., 2017). Roenneberg (2016) defined chronotype as psychological personality trait associated with preferred daily times for different activities such as sleep, food intake or exercise. He also stated that chronotype has relationship between the internal day and the external day. Internal day is defined as 24-h structure of an individual's circadian clocks meanwhile external day is defined as 24-h structure of the environment such as day, night and temperature changes (Roenneberg, 2016).

Chronotype is derived from different phenotypes depending on exogenous (for example: light exposure) and endogenous (for examples: regulation of temperature and melatonin secretion) circadian response characteristics (Roenneberg, 2016). This system works to allow measuring time, predict environmental daily changes and adjust physiology and behavior of an individual (Saini, Brown, & Dibner, 2015). Justice (2007) stated that internal clocks or biological clock controls all the circadian rhythm in humans and influences the neurobehavioral, hormonal, physiological and behavioral functions.

Everyone's circadian rhythm is different. Preference of morning or evening hour to perform daily activities depend on an individual's behavioral trait (Partonen, 2015). Partonen (2015) defined chronotype as "early birds" (morning-type) or "night owls"

(evening-type). The endogenous circadian clock of morning-type tracks earlier hour meanwhile evening-type tracks later hour. Morning types go to bed, wake up and show the best performance during the early hours of the day, meanwhile evening types prefer to go to bed late and wake up late (Tonetti et al., 2015). Whereas, intermediate type is defined as both or neither morning type or evening type and not being clearly categorized within parameters of morning or evening types (Horne & Ostberg, 1976).

Chronotype, as an ordinal variable, was associated with all-cause of mortality and CVD mortality, such that increasing eveningness was associated with greater mortality (Knutson & Schantz, 2018). Eveningness was associated with determinant that contributed to negative health outcomes such as worsen dietary patterns, and increased risk of getting type 2 diabetes and arterial hypertension (Merikanto et al, 2013). Furthermore, studies also showed that individuals with higher preference for evening hours in daily activities (eveningness) practiced adverse health behaviours such as consuming more alcoholic drinks, consuming less whole-grain products, vegetables, fruits and fish (Kanerva, 2012) as well as often being physically inactive (Maukonen et al., 2016) compared to morningness type.

Several questionnaires have been used to measure human chronotype such as the Morningness-Eveningness Questionnaire (MEQ) (Horne & Ostberg, 1976), the Composite Scale of Morningness (CSM) (Smith et al., 1989), and the Munich Chronotype Questionnaire (MCTQ) (Roenneberg, 2003). Levandovski, Sasso and Hidalgo (2013) reviewed the advances, limitations and applicability of these questionnaires used to assess human chronotype in the literature. They stated that each questionnaire evaluated different aspects of chronotype, in which the MEQ evaluates the phase preferences of individual

behavior over a 24-hour day, while the MCTQ measures the phase of sleep positions for both free and workdays (Levandovski et al., 2013). The CSM is similar to the MEQ but is more sensitive to measure shift work (Levandovski et al., 2013). The MEQ is the gold standard scale for self-rating of chronotype (Partonen, 2015). Thus, in this study, the MEQ was used to measure human chronotype among undergraduate students.

2.2 Chronotype in University Students

Studies assessing chronotype of university students have documented high prevalence of evening chronotype (Acet et al., 2018; Lai & Say, 2013; Schneider et al., 2011; Teixeira et al., 2017). For instance, Acet et al. (2018) showed that the percentages of morning type, intermediate type and evening type were 9.1%, 66.5% and 24.4%, respectively among 351 medical students in Trakya University of Medicine, Turkey. In Brazil, a study conducted by Schneider et al. (2011) among 372 students reported that the percentages of morning, intermediate and evening types were 4.6%, 55.9% and 39.5%, respectively.

On the other hand, some studies found the opposite, in which university students were in the morning types (Beşoluk et al., 2011; Schiess et al., 2020; Teixeira et al., 2017; Whittier et al., 2013; Zhang et al., 2018). For instance, Schiess et al. (2020) found that 17.5% of the medical students from Perdana University, Malaysia were morning types, 68.0% were intermediate types and 14.5% were evening types. Similarly, Beşoluk, et al. (2011) revealed that 19.1% of the 1471 university students in the Faculty of Education, Sakarya, Turkey were morning types, whereas 66.1% had no particular diurnal preference, and 14.8% were evening types. In Peru, Whittier et al. (2013) showed that 14.9% of the

2581 undergraduate students were morning type, 75% were intermediate type and 9.9% were evening type. Teixeira et al. (2017) revealed that the percentages of morning type, intermediate type and evening type were 21%, 62% and 17%, respectively among 721 undergraduate students in a public university in Brazil. Zhang et al. (2018) showed that among 616 medical students from the Chongqing Medical University, China, 22.9% of them were morning type, whereas 62.8% were intermediate type and 14.3% were evening type.

In contrast, a local study conducted by Lai and Say (2013) showed that none of the 1118 students in the University Tunku Abdul Rahman were categorized into morning type or intermediate type but 82% of them were definitely evening type and 18% were moderately evening type. Eveningness among Malaysian students might be caused by the local eating environment in Malaysia and the availability of longer operation hours of hawker or stall, such as the 24 hours restaurants, which were mostly owned by Muslim Indians ethnic, locally known as “mamak stall” (Ali & Abdullah, 2012). These restaurants allowed students to take meal late at night, watch sports game, and chat with friends. Thus, the students will arrive home or college late at night, have shorter sleeping hours and wake up late in the next morning (Ali & Abdullah, 2012).

2.3 Sociodemographic Characteristics According to Human Chronotype

A cross-sectional study conducted by Acet et al. (2018) among 351 students in Turkey showed that there was no statistically significant difference in age groups between different chronotype groups ($p=0.858$). In contrast, a study conducted by Juan and Zaida (2017) in Spain among 4175 Spanish aged 12-59 years old revealed that morningness

increased with age among women but over 40 years old men were found to be more morningness oriented than women. Compared to Roenneberg et al. (2007) and Tonetti et al. (2008), they observed a different interaction between age and sex: although women were earlier chronotypes than men up to the age of 30, there was reversed in age groups older than 45, where no significant sex differences were found from 30 to 45 years of age.

Previous studies have shown a greater prevalence of eveningness in men compared to women who exhibited greater morningness (Lehnkering & Siegmund, 2007; Robinson et al. 2014). A study conducted by Whittier et al. (2014) among 2581 undergraduate students in Peru showed that there was a statistically difference in females and males according to different human chronotype ($p=0.019$), where female was found to be more morning types than male. Contradict finding was observed in the study by Robinson et al. (2014) on 2410 students of the University of Gondar and Haramaya, Ethiopia, where there was no statistically difference in females and males according to different human chronotype. Likewise, a local study conducted by Lai and Say (2013) also showed no significant difference in the MEQ scores between sexes (Females= 25.50 ± 5.11 vs. Males= 25.88 ± 4.82 ; $p=0.212$). A recent study done by Schiess et al. (2020) also showed that no significant difference in the chronotype scores between male and female students.

Maukonen et al. (2018) conducted a study among 1097 participants from the DILGOM 2014 (Dietary Lifestyle and Genetic Determinants of Obesity and Metabolic Syndrome) and the national FINDIET 2007 studies in Finland. Results showed that there was a significant difference in high education level between different human chronotypes ($p=0.01$), in which evening types (41%) were more likely to have higher education level

than morning types (34%). Similar finding was reported by Maukonen et al. (2017) among 1854 participants from the National FINRISK 2007 and FINDIET 2007 in Finland, in which results showed that evening types were more significantly associated with higher education levels ($p < 0.001$) than morning types.

Schantz et al. (2015) conducted a cohort study to assess the distribution and heritability of diurnal preference (chronotype) among 825 individuals in a small town in Minas Gerais, rural Brazil. The findings of the study revealed that morningness was significantly higher in the rural (70.2 ± 9.8) than in the municipal zone (62.6 ± 11.1) (unpaired t-test, $p < 0.0001$). The most likely strongest determinant of this difference was the differential exposure to natural light during the day (particularly during the advancing window of the phase response curve) and artificial light (from indoor or outdoor sources) during the night (particularly during the delaying window of the phase response curve). Furthermore, a greater prevalence of hard physical labour in rural than in metropolitan areas was shown. A rural individual with limited formal education (or even none at all) and limited experience of the outside world, may be unable to think abstractly about a life of leisure when answering questions such as preferred rise and bedtime if they were completely free to plan their day. Furthermore, morningness was significantly higher ($p = 0.025$) in male (64.6 ± 10.9) than in female (62.8 ± 11.2) participants. The morning type was high as 50% of them were classified as extreme morningness by the age of 50 years (Schantz et al. 2015).

A recent study done by Schiess et al. (2020) reported no significant difference between ethnicity (Malay, Chinese and Indian) according to human chronotype among medical students in Malaysia's private university ($p=0.721$). Paine, Gander and Travier

(2006) conducted a study to investigate the influences of age, sexes, ethnicity and socioeconomic factors on morningness and eveningness among 2526 New Zealand adults aged 30 – 49 years. The results showed that there were no significant differences in mean MEQ scores by ethnicity (Maori 58.32 ± 9.08 and Non-Maori 57.92 ± 9.15) and sexes (men 58.36 ± 9.15 and women 57.89 ± 9.54). This study also found that MEQ scores decreased (more likely to be evening type) significantly with age 30-34 ($p < 0.0001$), after controlling the ethnicity, gender and socio-demographic factors. Furthermore, results showed that eveningness was significantly associated with self-reported night work ($p < 0.05$), unemployment ($p < 0.01$), and poor/fair general health ($p < 0.01$). Therefore, Paine et al. (2006) suggested that sociodemographic characteristics such as sex, age, ethnicity and educational levels might be differed according to different human chronotype.

2.4 Nutritional Status According to Human Chronotype

2.4.1 Body weight status

More than 1.9 billion adults aged 18 and above in the world were overweight while 650 million were obese in 2016 (WHO, 2018). According to the NHMS 2019, 1 in 2 (50.1%) Malaysian adults were overweight (30.4%) and obesity (19.7%) (IPH, 2020).

Previous studies have shown that university students faced the problem of malnutrition (Cheah et al., 2018; Gan & Yeoh, 2017; Gan, Chin & Law, 2019; Hasanain, Faisal & Ghazi, 2017; Peltzer et al., 2014; Robinson et al. 2014; Whittier et al. 2014). A recent cross-sectional study conducted by Jordan et al. (2020) reported that none of the students in Guyana were underweight, while 40.4% of them were overweight and 33%

were obese. A cross-sectional study carried out by Peltzer et al. (2014) in 22 countries including Asian countries such as Singapore, Philippines, Laos and Thailand among 6773 university students reported that 22% of the students were overweight or obese, in which men (24.7%) had higher prevalence of overweight or obese compared to women (19.3%). Whittier et al. (2014) reported that prevalence of overweight and obesity were 24.7% and 4.2%, respectively and prevalence of underweight was 4.3% among 2581 undergraduate students in Peru. In contrast, a cross-sectional study conducted by Robinson et al. (2014) found that among 2817 students in Ethiopia, more students were underweight (39%) than overweight (1.4%).

In Malaysia, a recent local study conducted by Elyani et al. (2020) reported that 17.5% of the university students were overweight, 8.0% were obese and 15.9% were underweight. Another recent local study conducted by Kumar et al. (2020) found that 18.9% students in private universities in Malaysia were overweight, 10.9% were obese and 18.4% were underweight. Besides that, Qaiser et al. (2020) conducted a study among 365 undergraduate students in Universiti Malaysia Sabah reported that 25.2% of the respondents were overweight, 9.0% were obesity and 18.4% were underweight.

Another local cross-sectional study carried out by Gan et al. (2019) among 270 university students in a public university in Selangor revealed that 24.9% of the students were overweight and obese and 14.5% were underweight. Another cross-sectional study carried out by Cheah et al. (2018) found that among 354 university students in University of Malaysia Sarawak, 40.7% were classified as overweight and or obese and 11.6% were underweight. Hasanain et al. (2017) reported that 21.5% of 410 university students in a

private university in Shah Alam were overweight, 18.3% were obese, and 17.6% were underweight.

Maukonen et al. (2018) conducted a population-based 7 years follow up study among 1097 adults in Finland to determine whether evening types associated with weight and BMI compared to morning types. Findings showed that mean weight gain in evening types (+ 2.3 kg) was higher than morning types (+ 0.3 kg, $p=0.016$). Evening types (0.7 kg/m^2) also showed increased in BMI than morning types (-0.1 kg/m^2 , $p=0.024$). Findings also showed that the proportion of individuals who gained weight >5% over the 7 years follow up tended to be higher in evening types (37%) than morning types (22%).

Arora and Taheri (2015) aimed to determine associations of late chronotype, BMI and dietary behaviors among 511 UK young adolescents (11–13 years) from eight secondary schools across the Midlands region. Results showed a significant mean difference between chronotypes and BMI z-score ($F=3.03$, $p=0.029$). Bonferroni post hoc test demonstrated a significant mean difference between definitely evening chronotypes (0.14 ± 1.06) who had higher mean BMI z-score compared to definitely morning chronotypes (-0.36 ± 0.81 ; $p=0.04$). Definitely evening chronotype was positively associated with BMI z-score compared to definitely morning chronotypes ($\beta=0.51$, $p<0.01$), after adjustment for dietary behavior, parental obesity, daytime sleepiness, depression and anxiety.

In contrast, some previous studies showed that there was no difference in BMI between different human chronotypes (Kanerva et al., 2012; Maukonen et al., 2016; Toktaş, Erman, & Mert, 2017). For instance, Maukonen et al. (2016) showed that there was no difference between BMIs of morning types (BMI: $28.2 \pm 5.9 \text{ kg/m}^2$) and evening

types (BMI: 28.5 ± 6.1 kg/m²; $p=0.715$). Likewise, Toktas et al. (2017) also found no difference between BMIs of morning types (BMI: 22.60 ± 2.41 kg/m²) and evening types (BMI: 22.09 ± 1.83 kg/m²). Therefore, more studies are needed to compare body weight status between different human chronotypes as inconsistent findings were reported.

2.4.2 Waist circumference

Previous studies showed that the prevalence of abdominal obesity was increasing among university students. A cross-sectional study conducted by Gan et al. (2019) reported that 20.1% of the university students in UPM were at risk of having abdominal obesity. Similarly, Gan and Yeoh (2017) showed that 17.4% of the university students in UPM were at risk of experiencing abdominal obesity, in which 7.0% of them were males and 20.2% were females.

A cross-sectional study done by Teixeira et al. (2017) among 789 undergraduate students from the Federal University of Uberlandia, Brazil showed that there was no significant difference ($p=0.75$) in waist circumference and abdominal fat ($p=0.24$) according to different human chronotypes. Maukonen et al. (2018) conducted a population-based 7 years follow up study among 1097 participants in Finland showed that the mean increase in waist circumference was 2.2 cm by both morning and evening types ($p=1.00$). There was no significant difference for waist circumference according to human chronotype but the proportion of individuals who had increased in waist circumferences more than 5% over 7 years follow up showed that evening types (39%) increased more than morning (33%) (Maukonen et al. 2018).

Yu et al. (2015) conducted a study among 1620 adults aged 47-59 years from the Korean Genome and Epidemiology Study to examine whether late chronotype was related to metabolic disorder and body composition in middle-aged adults. Findings from this study revealed that waist circumference ($p=0.739$) and visceral obesity ($p=0.405$) were not significantly difference according to human chronotype. Similarly, Lucassen et al. (2013) found that there was no significant difference between waist circumference ($p = 0.510$) according to human chronotype among 126 adults in USA. Contradict finding was shown in a prospective study by Johnsen, Wynn and Bratlid (2013) among 6413 participants aged 30-65 years in northern Norway, in which abdominal obesity (male waist circumference ≥ 102 cm; female waist circumference ≥ 88 cm) was significantly differed according to human chronotypes ($p<0.001$).

2.4.2 Body fat percentage

Evidence showed that the percentage of body fat percentage among university is at alarming state. Cheah et al. (2018) reported that 43% of the public university students had high or very high body fat; meanwhile, 13.8% of the respondents had high or very high visceral fat. Similarly, Gan and Yeoh (2017) found that among 333 university students, 30% of them have unhealthy range (too high) of body fat percentage, in which 27% of them were male and 31% were female.

A cross-sectional study conducted by Maukonen et al. (2016) among 4421 adults aged 25–74 years in Finland showed that there was no significant different found between human chronotype and body fat percentage ($p>0.05$). Similarly, McMahon et al. (2018) carried out a study among 430 healthy men and women residing in Columbia showed that

body fat percentage was not significantly difference according to human chronotype ($p=0.94$). Another study conducted by Yu et al. (2015) in Korea also showed that total body fat mass (g) was not significantly difference between morning and evening types ($p = 0.739$).

2.4.4. Waist-to-Height Ratio

Previous studies showed that the prevalence of increase risk of obesity was increasing among university students. A study done by Gyamfi et al. (2018) reported that 17.4% of the students in Ghana were classified as increased risk of obesity (≥ 0.5) by measuring waist-to-height ratio (WHtR). Similarly, McMahon et al. (2018) also reported that 22% of the healthy young adults in Columbia were classified as increased risk of obesity (>0.5). A local study conducted by Gan et al. (2011) found that 12.5% of the university students were classified as increased risk of obesity (>0.5). There is a lack of study comparing WHtR according to human chronotype. The only study conducted by McMahon et al. (2014) reported that WHtR was not significantly differed according to human chronotype among healthy adults in Columbia ($p=0.64$).

2.4.5 Nutrient intake

University students were prone to have unhealthy dietary behaviors such as low intake of plain water, high consumption of fried food, and had low intake of daily fruits and vegetables (Ganasegeran et al. 2012; Gan et al., 2011; Yun, Ahmad & Quee, 2018). Peltzer et al. (2014) found that among 6773 university students in 22 countries, only 22%

of the students consumed fruits and vegetables (<5 times/day) and 25% of them avoid consuming food containing high fat and cholesterol.

Furthermore, Hakim, Muniandy, and Danish (2012) found that more than half of the university students did not meet the Malaysian Recommended Nutrient Intake (RNI) for energy, protein (female only), calcium and iron (female only). Koo et al. (2019) also reported that total consumption of dietary fiber and some micronutrients among Malaysian university students such as calcium, zinc, vitamin C, thiamine, riboflavin, niacin and zinc were below the recommended levels.

Previous studies have shown that evening types were more prone to have unhealthy eating behaviors than morning types (Kanerva et al., 2012; Mota et al., 2016; Sato-Mito et al., 2011). For instance, a cross-sectional study conducted by Kanerva et al. (2012) among 4493 adults from the National FINRISK 2007 study found that there were substantial differences in food and nutrient intake between adults who preferred morningness compared with those preferred eveningness. There was a negative association between evening chronotype with unhealthy nutrient intake as those who had tendency toward eveningness consumed more alcoholic drinks, such as beer and wine compared with those who had tendency toward morningness. This study also revealed that no significant difference between chronotype in total energy intake ($p=0.39$) and calcium intake ($p=0.11$). Furthermore, adults with tendency toward eveningness consumed less wholegrain products especially rye ($p=0.007$), lower intake of carbohydrate ($p=0.014$), vegetables ($p=0.002$), fruits ($p=0.025$), fish ($p=0.025$), and more chocolate ($p=0.001$) and soft drinks ($p=0.015$) than those morningness.

Another cross-sectional study conducted by Sato-Mito et al. (2011) among 3304 young Japanese females aged 18-20 years old found that dietary intake of some nutrients and foods differed significantly by chronotype. A late midpoint of sleep (eveningness) was associated negatively with the percentage of energy from protein ($p=0.0010$), calcium ($p < 0.0001$), magnesium ($p=0.0012$), iron ($p=0.0031$), zinc ($p=0.0003$) and vitamin D ($p=0.0003$). Moreover, a study conducted by Mota et al. (2016) among medical residents in Finland, revealed that evening type were significantly associated with daily energy intake ($p = 0.02$), carbohydrate ($p = 0.03$), protein ($p = 0.04$) and cholesterol intake ($p = 0.04$).

Toktas et al. (2017) assessed nutritional habits according to human chronotype and nutritional status of morningness and eveningness. Findings showed that evening chronotype was associated with inadequate dietary habits and status such as high daily energy (2450 kcal $\pm$ 625 vs. 1723 kcal $\pm$ 543, $p < 0.001$), fat (99.3 g $\pm$ 26.7 vs. 69.7 g $\pm$ 18.9, $p < 0.001$) and carbohydrate intakes (301.7 g $\pm$ 105.3 vs. 198.1 g $\pm$ 81.7, $p = 0.02$), low protein intake (12.5% $\pm$ 3.8 vs. 15.6% $\pm$ 2.8, $p = 0.04$) and skipped meals.

The FINRISK Study was conducted by Maukonen et al. (2016) on 4421 individuals of Finland population aged between 25- 74 years. Results showed that total daily energy intake did not differ between morning and evening types ($p=1.00$) but protein intakes of evening types ($p=0.017$) were found to be lower as compared to morning types. During weekend, evening types had higher total daily intake of fat ($p=0.045$) than morning types (Maukonen et al., 2016).

In contrast, contradicted findings were reported in other studies (Lucassen et al., 2013; Maukonen et al., 2017; Munoz et al., 2017 & Reutrakul et al., 2013). For instance, Munoz et al. (2017) conducted a study among 171 staffs of the Catholic University of

Murcia, Spain showed that none of both human chronotype showed significant different for energy intake but they observed the total energy intakes among evening type were higher (3026 ± 222 kcal) than morning type (2861 ± 168 kcal). Furthermore, this study also reported that no significant differences in carbohydrate, protein and fat intake between chronotype among overweight participants. Overweight/obese participants from both chronotypes showed lower energy intakes at breakfast compared with normal-weight subjects. Evening chronotype was associated with unhealthy snacking, inadequate fruit and vegetable intake and consumed caffeine at night time.

Similarly, Maukonen et al. (2017) found that there was no significant different between energy intake with chronotype, but they observed evening type (2814.53 ± 38.0 kcal) had higher energy intake than morning type (2771.7 ± 31.1 kcal) among 1854 participants from the National FINRISK 2007 and FINDIET 2007 in Finland. Besides, Lucassen et al. (2013) also reported that there was no significant difference between total energy intake ($p=0.373$) with human chronotype among obese adults in the United States. Another study conducted by Reutrakul et al. (2013) reported the similar finding as no significant differences found in total energy intake according to human chronotype among patient with type 2 diabetes mellitus in United States.

Vera et al. (2018) conducted a study among 2126 adults in Spain, revealed that evening type (193.78 ± 3.18 g) consume significantly less carbohydrate than morning type (204.59 ± 3.07 g) ($p=0.017$). This study also found that total energy intake ($p=0.121$), fat ($p=0.677$) and protein ($p=0.729$) were not significantly differed according to human chronotype. Consistent finding was reported on a study conducted by Ruiz-Lazano et al. (2016) among post bariatric surgery patients in Spain, in which no significant differences

were found in total daily calories ($p= 0.807$), carbohydrate ($p= 0.601$), protein ($p= 0.881$) and fat ($p= 0.655$) intake between human chronotypes. There is a lack of study comparing micronutrient intake between different chronotypes (Fatin Hanani et al., 2019). Overall, nutrient intake might be differed according to different human chronotypes.

2.4.6 Meal timing and meal pattern

University students are found to have low frequency of meals, skipped breakfast and frequent snacking (Ganasegeran et al., 2012; Gan et al., 2011; Yun, Ahmad & Quee, 2018). Peltzer et al. (2014) reported that 22.5% of the university students skipped breakfast, most of the students consumed 3 meals per day and snacking twice a day. Higher prevalence of breakfast skipping can be observed among university students (Ackua-Dogbe et al., 2014; Awang Damit et al., 2019; Samah & Naglo, 2019; Sun et al., 2013). Awang Damit et al. (2019) reported that the prevalence of breakfast skipping was 76.5% among university students in Brunei. Similarly, Samah and Naglo (2019) reported that 87.6% university students in Egypt skipped breakfast. Ackua-Dogbe et al. (2014) also reported higher prevalence of breakfast skipping (71.9%) among university students in Ghana and Sun et al. (2013) also reported that 71.1% of the university students in China skipped breakfast.

In contrast, several studies reported lower prevalence of breakfast skipping among university students (Moy et al., 2009; Musaiger et al., 2016; Neslisah & Emine, 2011; Seedat & Pillay, 2019); Zainab & Ayesha, 2017). Moy et al. (2009) reported that 29.2% of the university students in Malaysia skipped breakfast. Zainab and Ayesha (2017) reported that 37.7% of the university students skipped breakfast. Raessa and Kirthee

(2019) and Neslisah and Emine (2011) reported the prevalence of breakfast skipping among university students in Kwazuku-Natal and Turkey was 49.3% and 47.7%, respectively.

Meal pattern was found to be differed according to human chronotype. Evening types had different nutritional habits such as breakfast skipping, consuming food in bigger portions, and also consuming foods of low quality (Mota et al., 2016). Toktas et al. (2017) showed that 11.1% of morning types did not skip meal, 14.6% of intermediate did not skip meal but all evening types skipped a meal. Most frequently skipped meal was breakfast as they claimed that they forgot or could not get an opportunity to have breakfast and did not like to eat during morning (Toktas et al., 2017). Furthermore, Meule et al. (2012) stated that significantly more evening type (53.6%) skipped breakfast compared to morning type (8.8%) ($p<0.001$). Maukonen et al. (2017) found that evening types had irregular meal times. A study conducted by Vera et al. (2018) reported that evening type were significantly higher frequency in skipping breakfast than morning type ($p=0.02$).

Another study conducted by Robbach et al. (2017) among 223 participants in Germany found that regular breakfast skipping was highest in eveningness (16%), follow by intermediate (8.6%) and morning types (1.7%). Besides, Silva et al. (2016) reported that breakfast skipping significantly differ according to chronotype, in which evening type were prone to skip breakfast with 1.7 times more likely compared to morning type ($p=0.02$). Furthermore, Teixeira et al. (2017) showed that the prevalence of breakfast skippers among morning type was 6.7%, intermediate type was 83.3% and evening type was 10%.

In terms of meal timing, Maukonen et al. (2017) found that cumulative energy intake of evening types was lower from beginning of the day until 10 p.m. The highest

energy intakes among evening types were at 7 p.m., whereas the highest energy intakes for morning types were at 8 a.m., 12 a.m. and 5 p.m. Maukonen et al. (2017) also found that morning types consumed breakfast and lunch earlier than evening types. Similar findings were shown in another study conducted by Maukonen et al. (2018), in which results showed that the highest percentage of total energy intake among evening types was after 8 p.m.

A study conducted by Nimitphong et al. (2018) found that adults with an evening preference had a significantly later breakfast ($p<0.001$), lunch ($p=0.032$) and dinner ($p=0.031$) time than those with a morning preference. Similarly, Ruiz-Lazano et al. (2016) demonstrated that patients with tendency toward eveningness had significantly delayed meal timing during lunch ($p=0.017$) and dinner ($p<0.001$) compared to morningness patients.

Another study conducted by Teixeira et al. (2017) reported that morning types had breakfast ($p<0.001$) and lunch ($p<0.001$) earlier than other chronotypes. Furthermore, Lucassen et al. (2013) reported that eveningness ate significantly breakfast later than morningness during working days ($p<0.001$) and non-working days ($p=0.075$) among obese individuals in the United States.

Gangwar et al. (2018) found that majority of evening type (75.3%) among medical undergraduates in India consumed significantly later dinner ($p<0.001$) compared to intermediate and morning types. In Japan, Sato-Mito et al. (2011) revealed participants with evening chronotype were significantly associated with delayed meal timing during breakfast ($p<0.001$), lunch ($p=0.002$) and dinner ($p=0.007$). Overall, meal pattern and meal timing were found to be different according to different human chronotype.

2.5 Blood Pressure Level According to Human Chronotype

The NHMS 2019 found that the prevalence of hypertension among adults was 30.0%, with 15.9% were known hypertension (IPH, 2020). In West Africa, specifically Sierra Leone, the prevalence of hypertension was 12% among 345 undergraduate students (Lebbie, 2017). Baig et al. (2015) conducted a study in Jeddah, Saudi Arabia found that among 610 male university students, 7.5% of them were hypertensive. Moreover, 7.7% of the students in Ethiopia were classified as hypertensive (Tadesse & Alemu, 2014).

Humaidan et al. (2018) reported that 14.6% of the students in Saudi Arabia were diagnosed as hypertension. Gyamfi et al. (2018) stated that only 2.2% of 540 students were diagnosed as hypertensive in Ghana. Besides, in seven ASEAN countries (Malaysia, Indonesia, Laos, Philippines, Myanmar, Thailand and Vietnam) the prevalence of hypertension among university population was 6.7% (Peltzer et al., 2017). In addition, Peltzer et al. (2017) also stated that the prevalence of hypertension among Malaysian undergraduate students was 11.5%. Furthermore, Cheah et al. (2018) found that the prevalence of hypertension among 354 undergraduate students of a public university in Malaysia was 8.2%, in which the mean SBP was 119.1 mmHg (SD=14.36 mmHg) and the mean DBP was 72.6 mmHg (SD=9.73 mmHg).

There is lack of study comparing blood pressure level between different chronotype among undergraduate students. Yu et al. (2015) conducted a study to examine whether late chronotype was related to metabolic abnormalities and body composition among 1620 adults aged 45-59 years from the Korean Genome and Epidemiology Study. They found that there was no significant difference between blood pressure levels according to different chronotype but they observed a higher SBP among morning types

(117.7 ± 0.9 mmHg) than evening types (111.3 ± 2.2 mmHg). In contrast, Roeser et al. (2012) conducted a study among 471 students of University of Wurzburg, German to investigate the relationship between morningness and eveningness and cardiovascular responses to mental health at different times of day. They found that morning types (99.31 ± 7.19 mmHg) had significantly lower SBP than evening types (103.79 ± 9.69 mmHg).

However, a cross-sectional study conducted Muñoz et al. (2017) among 177 staffs of the Catholic University of Murcia, Spain showed that DBP was higher in morning type (73 ± 8 mmHg) than evening type (69 ± 9 mmHg). Contradict finding was reported by McMahon et al. (2018) among adults, in which chronotype was not significantly differed by chronotype ($p=0.10$) but participants with both morning chronotype and sleep latency ≥ 12 min were 1.90 times more likely to have elevated SBP (95% CI: 1.15–3.16)

Ritonja, Tranmer and Aronson (2019) conducted a study among 325 full and part-time female hospital employees of an acute-care hospital in Southeastern Ontario, Canada to determine the association between night work parameters and cardiometabolic risk factors. Findings showed that night workers were prone to evening-oriented chronotype and had higher SBP than day workers. Findings also showed that current night workers had higher SBP (112.6 ± 13.3 mmHg) and DBP (72.31 ± 8.2 mmHg) in comparison to current day workers: SBP (111.6 ± 13.5 mmHg) and DBP (70.36 ± 8.4 mmHg). Overall, more studies are needed in comparing blood pressure level according to different human chronotype among university students.

CHAPTER 3

METHODOLOGY

3.1 Study Design

This was a cross-sectional study aimed to compare sociodemographic characteristics, nutritional status and blood pressure according to human chronotype among undergraduate students in UPM.

3.2 Study Location

The study was conducted in UPM, Serdang, Selangor which was approximately 30 km south of the capital city of Kuala Lumpur. There are 15 faculties and 10 institutes in UPM Serdang with a total number of 11891 undergraduate students (Official Portal of Universiti Putra Malaysia, 2018).

3.3 Respondents

The respondents of this study were undergraduate students in UPM. They were selected based on the inclusion and exclusion criteria as stated in Table 3.1.

Table 3. 1 Inclusion and exclusion criteria for selection of respondents

Inclusion criteria	Exclusion criteria
• Malaysian • Undergraduate students • Female or male • Age 19-25 years old	• Physically disable • Presence of chronic disease such diabetes mellitus, chronic kidney disease and cardiovascular disease which might affect dietary behaviors

3.4 Sample Size Determination

A Two Population Proportions formula (Lemeshow, Hosmer, Klar, & Lwanga, 1990) was used to calculate sample size of this study as shown in Table 3.2.

$$n = \frac{\left\{ Z_{1-\alpha/2} \sqrt{2P(1-P)} + Z_{1-\beta} \sqrt{P_1(1-P_1) + P_2(1-P_2)} \right\}^2}{(P_1 - P_2)^2}$$

Where

$Z_{1-\alpha/2}$ = z score for level of significance α in two-sided test

$Z_{1-\beta}$ = z score for power of the test

P_1 = estimated proportion in group 1

P_2 = estimated proportion in group 2

P = average proportion of group 1 and 2, $P = (P_1 + P_2)/2$

Table 3.2: Sample size calculation

Independent variables	Proportion value	Sample size, n
Proportion of evening type among male (Robinson et al., 2014)	$P_1 = 0.90$	$n = \frac{\left\{ 1.96 \sqrt{2(0.8)(1-0.8)} + 0.84 \sqrt{0.9(1-0.9) + 0.7(1-0.7)} \right\}^2}{(0.9 - 0.7)^2}$ $n = 61.5 \times 2$ $n = 123$
Proportion of evening type among female (Robinson et al., 2014)	$P_2 = 0.70$	
Proportion of overweight with morning chronotype (Whittier et al., 2014)	$P_1 = 0.75$	$n = \frac{\left\{ 1.96 \sqrt{2(0.5)(1-0.5)} + 0.84 \sqrt{0.75(1-0.75) + 0.25(1-0.25)} \right\}^2}{(0.75 - 0.25)^2}$ $n = 14 \times 2$ $n = 28$
Proportion of overweight with evening chronotype (Whittier et al., 2014)	$P_2 = 0.25$	

Table 3.2: Sample size calculation (cont.)

Independent variables	Proportion value	Sample size, n
Proportion of meal skipping among morning chronotype (Robbach et al. 2017)	$P_1 = 0.02$	$n = \frac{\{1.96\sqrt{2(0.09)(1 - 0.09)} + 0.84\sqrt{0.02(1 - 0.02) + 0.16(1 - 0.16)}\}^2}{(0.09 - 0.16)^2}$
		$n = 61 \times 2$
		$n = 122$
Proportion of meal skipping among evening chronotype (Robbach et al. 2017)	$P_2 = 0.16$	
Proportion of elevated SBP with morning chronotype (Yu et al., 2015)	$P_1 = 0.3$	$n = \frac{\{1.96\sqrt{2(0.18)(1 - 0.18)} + 0.84\sqrt{0.3(1 - 0.3) + 0.06(1 - 0.06)}\}^2}{(0.3 - 0.06)^2}$
		$n = 39 \times 2$
		$n = 78$
Proportion of elevated SBP with evening chronotype (Yu et al., 2015)	$P_2 = 0.06$	

The highest number of sample size was selected as the sample size of this study, which was 123 respondents based on Table 3.2. Additional adjustment was done in computing the required sample size (Table 3.3).

Table 3. 3: Additional adjustment in computing the sample size

Criteria	Adjustment	Sample size, n
Adjust for the estimated sample effect	nadj * DEFF DEFF = 1.3 (Aday & Cornelius, 2006)	160
Adjust for the expected proportion response rate	response rate = 0.80 (Arora & Taheri, 2015)	200
Adjust for the expected proportion eligible	% Eligible = 0.90	223

After consideration of design effect, response rate and expected proportion of eligibility, the final sample size required in this study was 223 respondents.

3.5 Sampling Design

As shown in Figure 3.1, multistage sampling design was used in this study. A total of 15 faculties in UPM Serdang are categorized based on three fields of study, which are Arts and Social Sciences, Sciences and Technical. One faculty was randomly selected from each field of study. One program was then randomly selected from each faculty. All undergraduate students from first year until final year were invited to participate in this study (N=694). However, with the implementation of Movement Control Order (MCO) began on 18 March 2020 due to the Covid-19 pandemic that restricted face-to-face data collection, 226 students participated in this study, yielding a low response rate of 32.6%

3.6 Study Instruments

The respondents of this study answered an English version self-administered questionnaire on sociodemographic characteristics, human chronotype and meal patterns. Weight, height, body fat percentage, waist circumference and blood pressure level were measured by the researcher. A 24-hour dietary recall was conducted by the researcher.

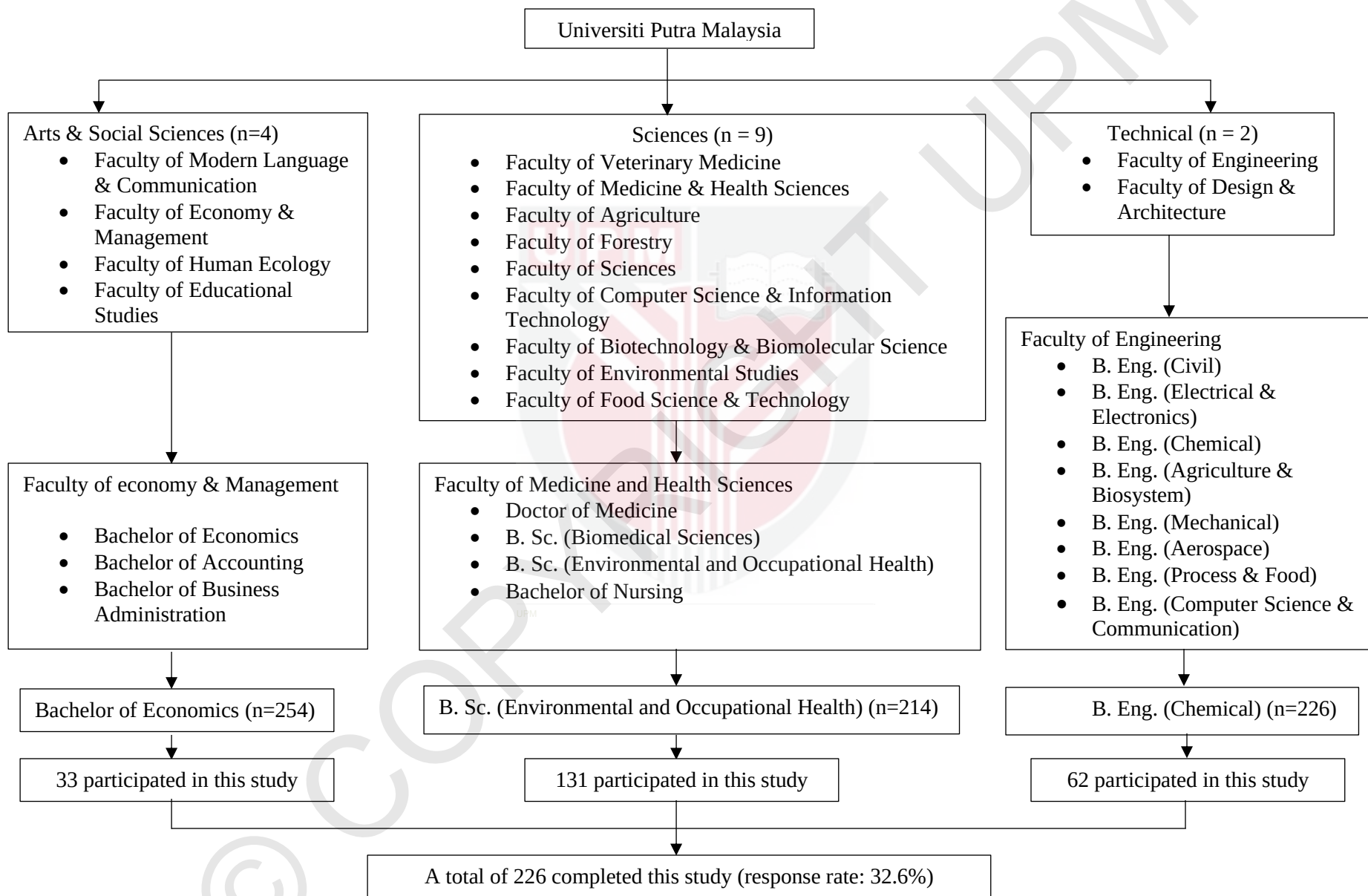


Figure 3. 2: Sampling design of this study

3.6.1 Self-Administered Questionnaire

3.6.1.1 Socio-demographic characteristics

This section contained respondent's sociodemographic characteristics: age, sex, ethnicity, program, year of study, current living arrangement and monthly personal allowance which was self-reported by the respondents.

3.6.1.2 Human chronotype

The Horne-Ostberg Morningness Eveningness Questionnaire (MEQ) (Horne & Ostberg, 1976) was used to assess human chronotype of the respondents in this study. It was a gold standard scale for self-rating of chronotype (Partonen, 2015). This questionnaire assessed individual differences in daytime preference to do various activities such as wake up, sleep and physical activity. It consisted of 19 items, with each answer of the items had certain number of points. The total points for every item were summed up and become a total score for the MEQ. Scores ranged from 16 to 86. Higher scores were indicative of a stronger morning chronotype preference. Respondents were further classified into three categories: evening types (scores of 41 and below), intermediate types (scores between 42 and 58), and morning types (scores of 59 and above). The MEQ has been validated among student population aged 18 to 35 years old (Horne & Ostberg, 1976). It showed good internal consistency reliability with a Cronbach's alpha of 0.85 (Zhang et al. 2018). It has been used in Asian countries such as Malaysia (Lai & Say, 2013), China (Zhang et al. 2018; Yu et al. 2015) and Japan (Acet et al. 2018). The Cronbach's alpha value for MEQ in this study was 0.541.

3.6.1.3 Meal pattern

The Eating Behavior Questionnaire (EBQ) (Chin & Mohd Nasir, 2009) was used to assess meal pattern of the respondents. The respondents reported the number of days in a week that they had their main meals and snacks.

Besides, the Youth Risk Behavior Survey by the Centers for Disease Control and Prevention (2019) was adapted to assess specific types of food groups the respondents eat or drink for the past 7 days. This questionnaire consisted of 12 questions. The respondents reported how many times she/he drinks or eats 100% of fruit juices, fruits, vegetables, bread/rice/mi/bihun, meat/chicken, fish, legume, soft drinks, sport drinks, plain water and milk. Each question consisted of 7 options of answer: never drink/eat this food in a week; 1-3 times in a week; 4-6 times in a week; 1 time daily; 2 times daily; 3 times daily and 4 times daily. The answers were further regroup into two categories, which were no consumption for the past week (option of “never drink/eat this food in a week”) and 1 or more consumption for past week (options of 1-3 times in a week; 4-6 times in a week; 1 time daily; 2 times daily; 3 times daily and 4 times daily) (Burns, 2019).

3.6.2 Anthropometric Measurements

3.5.2.1 Body Mass Index

Body weight and height of the respondents were measured in order to calculate their Body Mass Index (BMI). Body weight was measured by using a TANITA Digital Weight Scale HD-319 (TANITA Corporation, Arlington Height, IL, USA) to the nearest 0.1 kg. A SECA Portable Stadiometer 213 (SECA, Hamburg, Germany) was used to measure height of the respondents to the nearest 0.1 cm. Before weighing their weight,

they were asked to remove the shoes, watch, bracelet or any heavy items on their body.

The BMI was calculated by using formula as below:

$$\text{Body Mass Index (BMI)} = \frac{\text{body weight (kg)}}{\text{height (m}^2\text{)}}$$

The classification of BMI was shown in Table 3.4 below based on the WHO classifications (WHO, 2000).

Table 3. 4: Classifications of BMI (WHO, 2000)

Classification	BMI (kg/m²)
Underweight	< 18.5
Normal weight	18.5 - 24.9
Overweight	25.0 – 29.9
Obesity Class I	30.0- 34.9
Obesity Class II	35.0 -39.9
Obesity Class III	> 40.00

3.5.2.2 Body fat percentage

The Omron Body Fat Monitor HBF-302 (Omron Matsusaka Co. Ltd, Matsusaka, Japan) was used to measure body fat percentage of the respondents. The classifications of body fat percentage were shown in Table 3.5 below (Nieman, 2003).

Table 3. 5: Classifications of body fat percentage of individuals aged 18 years and above

Classification	Males	Females
unhealthy (too low)	≤ 5%	≤ 8%
acceptable (lower end)	6 – 15%	9 - 23%
acceptable (upper end)	16 - 24%	24 - 31%
unhealthy (too high)	> 25%	> 32%

3.5.2.3 Waist circumference

Waist circumference was measured by using a Lufkin Executive Thinline Tape W606PM (Cooper Hand Tools, Raleigh, North Carolina, USA) to the nearest 0.1 cm to determine abdominal obesity of the respondents. The measurements were taken by measuring the distance between the smallest area below the ribcage and above the umbilicus. The tape had to be snug and not compress to the skin. A waist circumference of 90 cm and greater for male and 80 cm and greater for female was associated with increased risk of abdominal obesity (WHO/IOTF/IASO, 2000).

3.5.2.4 Waist-to-height ratio

Waist-to-height ratio (WHtR) is an indicator used to measure distribution of body fat. The higher values of WHtR indicated higher risk of getting obesity-related cardiovascular disease and abdominal obesity (Ashwell & Hsieh, 2005). A value of > 0.5 indicated increased risk and > 0.6 indicated substantially increased risk of obesity (Ashwell & Hsieh, 2005).

$$WHtR = \frac{waist(cm)}{height(cm)}$$

3.6.3 Dietary intake

Dietary intake of the respondents was assessed by using a 2-day 24-hour dietary recall (one weekday and one weekend). Researcher asked the respondents to recall all foods and beverages consumed in the past 24 hours from midnight to midnight the previous day. Detailed data about food preparation methods, ingredients used in mixed dishes, and the brand name of commercial products were required. The recall was

obtained with the aid from household measurements such as bowls, standard measuring cups, glasses and spoons to estimate the portion size and quantities of food consumed. The Malaysian Food Composition Table (Tee et al., 1997) was used as a reference to analyse the nutrient intake. Total energy and nutrient intake such as carbohydrate, protein and fat were analysed by using the Nutritionist Pro (First Data Bank Inc., 2011) software. The mean intake of energy and nutrients of the respondents were compared with the Recommended Nutrient Intake (RNI) for Malaysia (NCCFN, 2017) to determine nutrient adequacy. The recommended range for percentage of energy from carbohydrate was 50-65%, protein was 10-20% and fat was 25-30% (NCCFN, 2017).

3.6.4 Blood pressure level

Blood pressure level of the respondents was measured by the researcher using an Omron automatic blood pressure monitor HEM-7121 (Omron Corporation, Kyoto, Japan). Respondents were requested to rest at least 1 minute before the measurement. Blood pressure was measured, and higher reading was taken. At least two times readings must be taken as suggested in the Clinical Practice Guideline on Management of Hypertension 2018. The two measurements of blood pressure were taken in 1-2 minutes interval within the measurements in the same arm with the respondent in the same position. The classification of blood pressure in adults was based on the American Heart Association (AHA, 2017) guidelines (Table 3.6).

Table 3. 6: Classification of blood pressure level in adults according to American Heart Association (AHA, 2017)

Blood pressure category	Systolic (mmHg)		Diastolic (mmHg)
Normal	<120	and	<80
Elevated	120-129	and	<80
Hypertension: Stage 1	130-139	and/or	80-89
Hypertension: Stage 2	≥140	and/or	≥90

3.7 Study Approval

Ethics approval was sought from the Ethics Committee for Research Involving Human Subjects Universiti Putra Malaysia (JKEUPM; Reference No.: JKEUPM-2019-395; see Appendix A) prior to data collection. Permission from the deans of the selected faculties were also obtained (see Appendix B).

3.8 Pre-test

Questionnaire was pre-tested among 30 students from the Faculty of Medicine and Health Sciences who met the required study eligibility. Respondents for pre-testing had similar characteristics as the study sample. These 30 students were excluded from the actual data collection. They spent about 45 minutes to complete the questionnaire. The clarity of instructions and understanding of questions from the questionnaire were assessed.

3.9 Data Collection

Data collection was conducted from February to April 2020. The Malaysian Government issued the Movement Control Order (MCO) effective from 18 March 2020 due to a rapid increase of COVID-19 cases in the country. Therefore, data collection of this study was affected. Data collection process of this study was divided into two phases (Figure 3.2).

The first phase was conducted from 24th February to 12th March 2020 before the MCO and a total of 196 respondents completed the study. The data collection was held in the lecture hall or tutorial room in the faculty. Information sheet which contained a brief explanation on the aims of the study was given to the respondents. Written informed consent was obtained from the respondents prior to the administration of the questionnaire. Respondents answered a self-administered questionnaire regarding information on sociodemographic characteristics, human chronotype and meal pattern. Height, weight, waist circumference, body fat percentage and blood pressure were measured by the researcher. Next, respondents were interviewed by researcher using a 24-hour dietary recall. Upon study completion, each respondent received a sachet of Nestle Brown Rice Cereal or Nestle Omega Plus for his/her participation.

The second phase of data collection was from 18th March to 10th April 2020, which was during the MCO period. An online questionnaire using Google Form was used. A total of 80 respondents completed the online survey, however 50 out of 80 respondents were excluded due to the incomplete anthropometry data and 24-hour dietary recall data. A total of 226 respondents were included in the final analysis.

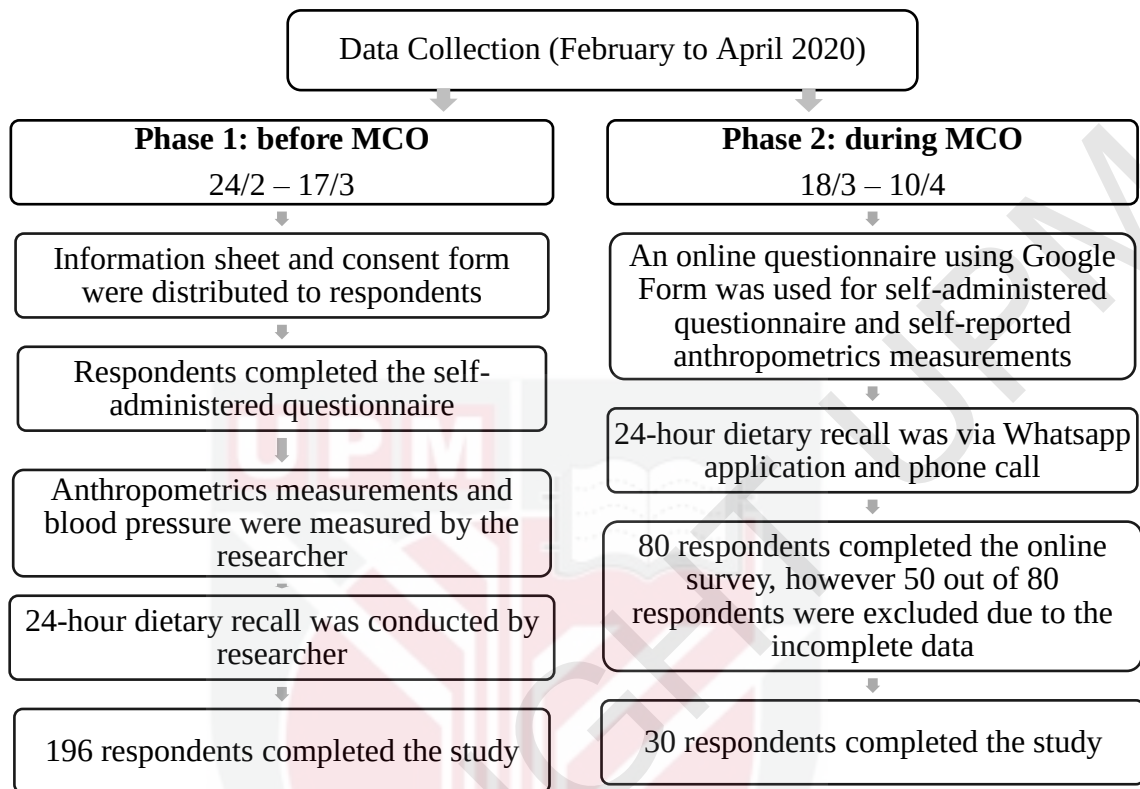


Figure 3. 4: Data collection process

3.10 Statistical Analysis

Statistical analysis was performed by using IBM SPSS Statistics 25 (IBM Corp., Armonk, NY). Results of the continuous variables were presented as means and standard deviations while categorical variables were presented as frequencies and percentages. Chi-square test of independence was used to determine differences between categorical variables. One-way ANOVA was used to determine any difference in continuous variables between different chronotypes (morningness, intermediate and eveningness types). Bonferroni multiple comparisons post hoc test was used if the result of the one-way ANOVA test was significant. Level of significance was set at $p < 0.05$.

CHAPTER 4

RESULTS AND DISCUSSION

4.1 Socio-demographic characteristics

Socio-demographic characteristics of the respondents in this study are shown in Table 4.1. A total of 226 students (75.7% females and 24.3% males) participated in the study. The mean age of the respondents was 20.41 ± 1.23 years, ranging from 19 to 25 years old. Majority of them were Malay (87.2%), studied Bachelor of Science Environmental and Occupational Health (58.0%), and were first year students (42.5%). Almost all respondents lived in campus dormitory (87.2%). The mean monthly personal allowance was RM 381.64 $\pm$ 253.27, in which 30.1% of them had less than RM 200 allowance per month.

Table 4. 1: Distribution of respondents by sociodemographic characteristics (n=226)

Characteristics	Mean $\pm$ SD	n (%)
Age (years)	20.41 $\pm$ 1.23	
19-20		132 (58.4)
21-23		90 (39.8)
24-25		4 (1.8)
Sex		
Male		55 (24.3)
Female		171 (75.7)
Ethnicity		
Malay		197 (87.2)
Chinese		10 (4.4)
Indian		12 (5.3)
Others		7 (3.1)
Faculty		
Faculty of Medicine and Health Sciences		131 (58.0)
Faculty of Engineering		62 (27.4)
Faculty of Economy and Management		33 (14.6)

Table 4. 2: Distribution of respondents by sociodemographic characteristics (n=226) (cont.)

Characteristics	Mean $\pm$ SD	n (%)
Courses of study		
B. Sc. (Environmental and Occupational Health)		131 (58.0)
B. Eng. (Chemical)		62 (27.4)
Bachelor of Economics		33 (14.6)
Year of study		
1 st year (Freshman)		96 (42.5)
2 nd year (Sophomore)		67 (29.6)
3 rd year (Junior)		40 (17.7)
4 th year (Senior)		23 (10.2)
Current living arrangement		
Dormitory		197 (87.2)
Rented house		15 (6.6)
Own house		14 (6.2)
Monthly allowance (RM)		
	381.64 $\pm$ 253.27	
≤ 200		68 (30.1)
201 - 300		44 (19.5)
301- 400		34 (15.0)
401 – 500		46 (20.3)
501 - 1000		32 (14.2)
≥ 1001		2 (0.9)

4.2 Nutritional status

4.2.1 Body composition

4.2.1.1 Body weight status

Anthropometric measurements of the respondents are described in Table 4.2. The mean BMI of the respondents was $23.75 \pm 5.31 \text{ kg/m}^2$ (male: $25.39 \pm 6.21 \text{ kg/m}^2$ and female: $23.22 \pm 4.89 \text{ kg/m}^2$). More than half (56.2%) of the respondents reported a normal BMI, while 19.0% were overweight, 12.4% were obese and 12.4% were underweight. Findings of this study were consistent with a recent local study conducted by Elyani et al. (2020), which reported that 58.6% of the university students having normal BMI, 17.5% were overweight, 8.0% were obese and 15.9% were underweight.

Table 4. 3: Distribution of respondents by anthropometric measurements

Variable	Mean $\pm$ SD / n (%)		
	Male (n=55)	Female (n=171)	Total (n=226)
Body Mass index (kg/m²)	25.39 $\pm$ 6.21	23.22 $\pm$ 4.89	23.75 $\pm$ 5.31
Underweight	4 (7.3)	24 (14.0)	28 (12.4)
Normal	27 (49.1)	100 (58.5)	127 (56.2)
Overweight	15 (27.3)	28 (16.4)	43 (19.0)
Obesity class I	5 (9.1)	16 (9.4)	21 (9.3)
Obesity class II	1 (1.8)	2 (1.2)	3 (1.3)
Obesity class III	3 (5.5)	1 (0.6)	4 (1.8)
	Male (n=49)	Female (n=144)	Total (n=193)
Body fat percentage (%)	22.89 $\pm$ 7.65	30.43 $\pm$ 7.01	28.51 $\pm$ 7.88
Unhealthy (too low)	0	0	0
Acceptable (lower end)	9 (18.4)	28 (19.4)	37 (19.2)
Acceptable (upper end)	20 (40.8)	58 (40.3)	78 (40.4)
Unhealthy (too high)	20 (40.8)	58 (40.3)	78 (40.4)
	Male (n=55)	Female (n=168)	Total (n=223)
Waist circumference (cm)	82.17 $\pm$ 13.91	71.07 $\pm$ 9.93	73.81 $\pm$ 12.00
At risk of abdominal obesity	11 (20.0)	31 (18.5)	42 (18.8)
Not at risk of abdominal obesity	44 (80.0)	137 (81.5)	184 (81.2)
Waist-to-height ratio	0.48 $\pm$ 0.08	0.46 $\pm$ 0.06	0.46 $\pm$ 0.70
Normal	39 (70.9)	134 (79.8)	173 (77.6)
Increased risk (>0.5)	11 (20.0)	31 (18.5)	42 (18.8)
Substantially increased risk of obesity (>0.6)	5 (9.1)	3 (1.7)	8 (3.6)
BMI classification: Underweight <18.5 kg/m ² , Normal 18.5-24.9 kg/m ² , Overweight 25-29.9 kg/m ² , Obesity $\geq$ 30 kg/m ² , Obesity Class I 30.0 – 34.9 kg/m ² , Obesity Class II 35.0 – 39.9 kg/m ² , Obesity Class III $\geq$ 40.0 kg/m ² (WHO, 2000)			
Body fat percentage classification for male: lower end (6–15%), upper end (16–24%), too high ($\geq$ 25%) (Lee & Nieman, 2013)			
Body fat percentage classification for female: lower end (9-23%), upper end (24-31%), too high ($\geq$ 32%) (Lee & Nieman, 2013)			
Waist circumference classification for male: $\geq$ 90 cm as increased risk of abdominal obesity (WHO/IASO/IOTF, 2000)			
Waist circumference classification for female: $\geq$ 80 cm as increased risk of abdominal obesity (WHO/IASO/IOTF, 2000)			
Waist-to-height-ratio: >0.5 indicated increased risk, >0.6 indicated substantially increased risk of obesity (Ashwell & Hsieh, 2005)			

Similarly, another recent local study conducted by Kumar et al. (2020) found that 51.7% of the students in private universities in Malaysia had normal BMI, 18.9% were overweight, 10.9% were obese and 18.4% were underweight. Besides, Qaiser et al. (2020) conducted a study among 365 undergraduate students in Universiti Malaysia Sabah reported that 59.5% of the respondents having normal BMI, 25.2% were overweight, 9.0% were obesity and 18.4% were underweight. Moreover, Gan et al. (2019) found that 60.6% of the university students in a public university in Selangor had normal BMI, 13.8% were overweight, 11.2% were obesity and 14.5% of them were underweight.

Furthermore, findings of this study that showed higher prevalence of overweight and obesity than underweight among university students, which were supported by local studies (Cheah et al., 2018; Elyani et al., 2020; Gan et al., 2019; Kumar et al., 2020; Qaiser et al., 2020) and oversea studies (Jordon et al., 2020; Peltzer, 2014; Whittier et al., 2014). For instance, Peltzer et al. (2014) reported 22% of university students were overweight and obese in 22 countries, including Malaysia. Whittier et al. (2014) reported the prevalence of overweight and obesity among undergraduate students in Peru was 24.7% and 4.2%, meanwhile, the prevalence of underweight was 4.3%. A recent cross-sectional study conducted by Jordan et al. (2020) reported that none of the students in Guyana were underweight, while 40.4% of them were overweight and 33% were obese.

In contrast, some previous studies found that underweight was more prevalent than overweight and obesity among university students (Gan et al., 2011; Musaiger et al., 2016; Robinson et al., 2014). For instance, Musaiger et al. (2016) reported that higher prevalence of underweight (20.5%) was reported compared to overweight (14.3%) and obesity (1.7%) among university students in Sudan. Likewise, Gan et al. (2011) found

that the prevalence of underweight was higher (19.0%) compared to overweight and obesity (12.8%) among 584 university students in Malaysia. Another cross-sectional study conducted by Robinson et al. (2014) found that 39% of 2817 university students in Ethiopia were underweight and 1.4% of them were overweight.

Despite inconsistent findings were reported in previous studies, the findings of these studies showed that university students are facing malnutrition problem, in which more nutrition related intervention programs need to be conducted in the university setting. Shahril et al. (2013) reported that a multimodal nutrition education intervention consisting of conventional lecture, 3 brochures as take-home message and 10 weeks of text messaging were found to be effective in improving dietary pattern of university students and body weight status of the students.

4.2.1.2 Body fat percentage

As shown in Table 4.2, the mean body fat percentage of the respondents was $28.51 \pm 7.88\%$. The mean body fat percentage in the present study was consistent with other local studies conducted by Cheah et al. (2018) and Yusoff et al. (2018), where they reported that the mean body fat percentage was $27.5 \pm 6.9\%$ and $28.5 \pm 7.9\%$, respectively. The current study showed that females had higher body fat percentage ($30.4 \pm 7.01\%$) compared to males ($22.89 \pm 7.65\%$). This finding was consistent with Yusoff et al. (2018), where they also reported that female students had higher percentage of body fat ($27.3 \pm 7.88\%$) than male students ($19.6 \pm 0.7\%$). Similarly, Zaccagni et al. (2014) reported that higher percentage of body fat was observed in female students ($26.6 \pm 5.2\%$) compared with male students ($17.3 \pm 4.9\%$) in Italy.

This study found that none of the respondents had low body fat percentage. About 40.4% of the respondents had unhealthy range (too high) of body fat percentage, with 40.8% in males and 40.3% in females. Consistent findings found in a study conducted by Cheah et al. (2018) which reported that 43% of the public university students had high or very high body fat. Similarly, Gan and Yeoh (2017) found 30% of university students had unhealthy range (too high) of body fat percentage. Chitme et al. (2018) revealed that 30.2% of the students in Oman had high body fat percentage and 48.0% of the students had very high body fat percentage. However, this study cannot be directly compared with other studies as different classifications of body fat percentage were used. Chitme et al. (2018) used the body fat classification from Omron Body Composition analyzer. Moreover, the percentage of body fat percentage was classified based on Wilmore et al. (1986) classification in the study conducted by Cheah et al. (2018), meanwhile this study adopted guidelines by Nieman (2003). Although different body fat classifications were used, university students were found to have a high body fat percentage.

4.2.1.3 Waist circumference

Waist circumference of the respondents are shown in Table 4.2. The mean waist circumference of the respondents was 73.81 ± 12.00 cm. Male students (82.17 ± 13.91 cm) had higher waist circumference compared to female students (71.07 ± 9.93 cm), which was supported by previous studies (Gan & Yeoh, 2017; Jordan et al., 2020; Neslisah & Emine, 2011; Zaccagni et al., 2014; Zamsad et al., 2018). For instance, Jordan et al. (2020) reported that male students had higher measurement of waist circumference (101.4 ± 2.3 cm) compared to female students (96.4 ± 1.6 cm) in University of Guyana. Similarly, a

study conducted by Zamsad et al. (2018) among 500 university students in Bangladesh, reported higher measurement of male students (81.25 ± 4.85 cm) than female students (78.6 ± 5.02 cm). A local study conducted by Gan and Yeoh (2017) also demonstrated that male students had higher measurements of waist circumference (77.28 ± 9.79 cm) than female students (72.62 ± 8.28 cm).

Nearly one in five of the respondents (18.8%) were at risk of abdominal obesity, with 20% in males and 18.5% in females. The findings were supported by a local study conducted by Gan and Yeoh (2017), in which they reported that 17.4% of university students were at risk of experiencing abdominal obesity. Similarly, Gan et al. (2019) reported that 20.1% of the university students had the problem of abdominal obesity. Zamsad et al. (2018) reported the prevalence of abdominal obesity was 15.2% in Ghana. The prevalence of abdominal obesity in this study was lower compared to a previous study conducted by Pengpid et al (2015), in which they reported the prevalence of abdominal obesity among 800 university students in Bangladesh was 32.0%. Similarly, Suara et al. (2020) demonstrated that 39.4% of female students in Ghana were classified as abdominal obesity.

The prevalence of abdominal obesity risk among male students (20%) was higher compared to female students (18.5%) in this study. Similarly, Hakim et al. (2015) reported that more male students had high risk of abdominal obesity (17.8%) compare to female students (12.7%). However, this finding was not consistent with a study conducted by Gan and Yeoh (2017), in which they found that prevalence of abdominal obesity risk was higher in female students (20.2%) compared to male students (7.0%). Similarly, Zamsad et al. (2018) revealed that female students were prone to have abdominal obesity (40.9%)

than male students (0.8%) in Ghana. Despite the inconsistent findings, this study showed that university students had high prevalence of abdominal obesity risk.

4.2.1.4 Waist-to-height ratio (WHtR)

As shown in Table 4.2, the mean WHtR of the respondents was 0.45 ± 0.07 , with males showed slightly higher WHtR (0.48 ± 0.08) compared to females (0.46 ± 0.06). These findings are not consistent with local study conducted by Gan et al. (2011), in which they reported that both male and female students had the same mean for WHtR (0.45 ± 0.05). Similarly, another local study conducted by Cheah et al. (2015) revealed that both male (0.5 ± 0.06) and female students (0.5 ± 0.07) had the same mean for WHtR. Zamsad et al. (2018) reported that the mean WHtR for males was 0.48 ± 0.03 and 0.51 ± 0.04 for females in Bangladesh.

In this study, 18.8% of the respondents had increased risk of obesity (>0.5) and 3.6% of the respondents had substantially increased risk of obesity (>0.6) according to WHtR. This finding was supported by a study done by Gyamfi et al. (2018), which reported that 17.4% of the students in Ghana were classified as increased risk of obesity (≥ 0.5). Similarly, McMahon et al. (2018) also reported that 22% of the healthy young adults in Columbia were classified as increased risk of obesity (>0.5). However, the prevalence of increase risk of obesity is higher compared to Gan et al. (2011), in which they found that 12.5% of the university students were classified as increased risk of obesity (>0.5).

The additional use of WHtR with BMI or WC appears to be helpful for screening those with obesity and higher cardiometabolic risk (Ashwell et al., 2012; Yoo, 2016). An

advantage of using WHtR is that a single cutoff can be used, and it does not require age-dependent cutoffs (Ashwell et al., 2012).

4.3 Blood pressure level

As shown in Table 4.3, the mean systolic blood pressure (SBP) and diastolic blood pressure (DBP) of the respondents were 114 ± 14 mmHg and 71 ± 11 mmHg, respectively. This study also showed higher SBP and DBP among male students (SBP: 123 ± 18 mmHg and DBP: 71 ± 10 mmHg) as compared to female students (SBP: 111 ± 11 mmHg and DBP: 70 ± 8 mmHg). These findings were supported by a local study conducted by Cheah et al. (2015), in which male students (SBP: 116.5 ± 13.3 mmHg and DBP: 70.2 ± 8.9 mmHg) had higher mean SBP and DBP compared to female students (SBP: 113.4 ± 12.1 mmHg and DBP: 69.7 ± 8.7 mmHg) in UNIMAS, Malaysia. Similarly, Ibrahim et al. (2014) reported that SBP was higher among male students (119 ± 5 mmHg) compared to female students (112 ± 9 mmHg) in Saudi Arabia.

One in five of the respondents (21.1%) in this study were classified as hypertension stage 1 (17.5%) and hypertension stage 2 (3.6%). These findings are consistent with the findings in the NHMS 2019, which found that the prevalence of hypertension among adults was 30.0%, with 15.9% were known hypertension (IPH, 2020). More male (39.5%) respondents were classified as hypertension than female students (15.1%) in the current study.

The prevalence of hypertension in the present study is higher as compared to other studies (Al-Majid & Sadek, 2012; AlWabel et al. 2018; Baig et al. 2015; Cheah et al. 2018; Gyamfi et al. 2018; Lebbie et al. 2017; Peltzer et al. 2017 & Tadesse and Alemu,

Table 4. 4: Distribution of respondents by blood pressure level (n=194)

Characteristics	Mean $\pm$ SD / n (%)		
	Men (n=48)	Women (n=146)	Total (n=194)
Systolic blood pressure (mmHg)	123.03 $\pm$ 18.16	110.79 $\pm$ 10.86	113.82 $\pm$ 14.05
Diastolic blood pressure (mmHg)	71.22 $\pm$ 10.43	70.15 $\pm$ 7.86	70.67 $\pm$ 10.85
Blood pressure level			
Normal	15 (31.3)	113 (77.4)	128 (66.0)
Elevated	14 (29.2)	11 (7.5)	25 (12.9)
Hypertension: Stage 1	13 (27.0)	21 (14.4)	34 (17.5)
Hypertension: Stage 2	6 (12.5)	1 (0.7)	7 (3.6)

Elevated: SBP 120-129 and DBP <80, Stage 1: SBP 130-139 or DBP 80-89, Stage 2: SBP 140 or higher or DBP 90 or higher (AHA, 2017)

2014). A local study conducted by Cheah et al. (2018) revealed that 8.2% of the university students were classified as hypertensive. Peltzer et al. (2017) stated that the prevalence of hypertension among Malaysian undergraduate students was 11.5%. The prevalence of hypertension in university students was found to be 2.2% in Ghana (Gyamfi et al., 2018), 7.0% in Kuwait (Libbie et al., 2017), 7.7% in Ethiopia (Tadesse & Alemu, 2014), and 14.6% in Saudi Arabia (AlWabel et al., 2018).

The higher prevalence of hypertension found in the present study may be due to the different cut off points for hypertension were used. The classification of blood pressure in this study was based on the American Heart Association (AHA, 2017) guidelines, meanwhile other studies used The Seventh Report of the Joint National Committee on Prevention, Detection, Evaluation and Treatment of High Blood Pressure, National Institute of Health Publication (2004), Blood Pressure Guideline of National Heart, Lung and Blood Institute (2003) and Clinical Practice Guideline Management of Hypertension 5th edition (2018) . The classification of blood pressure for AHA has lower cut off point of hypertension (SBP: 130-139 or DBP:80-89) (AHA, 2017), meanwhile

other guidelines classified hypertension as SBP: ≥ 140 or DBP: ≥ 90 (Blood Pressure Guideline of National Heart, Lung and Blood Institute, 2003; CPG, 2018 & The Seventh Report of the Joint National Committee on Prevention, Detection, Evaluation and Treatment of High Blood Pressure). In general, the present study showed that university students have higher prevalence of hypertension and warrant further intervention programs should focus on hypertension prevention among university students.

4.4 Dietary Behaviors

4.4.1 Meal pattern

The frequency of meal consumption and eating behaviors of the respondents in this study are shown in Table 4.4. The proportions of the respondents who consumed breakfast, lunch and dinner daily were 23.5%, 65.9%, and 53.1%, respectively. Majority of the respondents skipped breakfast (76.5%), followed by dinner (46.9%) and lunch (34.1%). This finding was much higher as compared to another study conducted by Peltzer et al. (2014), in which they found that 22.5% of 6773 university students in 22 countries including Malaysia skipped breakfast. Several previous studies also showed higher prevalence of breakfast skipping among university students, for examples, 71.1% in China (Sun et al., 2013), 71.9% in Ghana (Ackua-Dogbe et al., 2014), 76.5% in Brunei (Awang Damit et al., 2019), and 87.6% in Egypt (Sofar & Hafeez, 2019). The higher prevalence of breakfast skipping among university students could be due by limited time to consume breakfast, lazy to prepare the food, no appetite during morning and not enough money to buy food (Damit et al., 2019).

Table 4. 5: Distribution of respondent by frequency of meal consumption and eating behavior (n=226)

Item	n (%)					
	Everyday	4-6 days a week	2-3 days a week	Once a week	1-3 times a month	Never/less than once a month
Main meals						
Breakfast	53 (23.5)	57 (25.2)	74 (32.7)	22 (9.7)	17 (7.5)	3 (1.3)
Lunch	149 (65.9)	43 (19.0)	24 (10.6)	7 (3.1)	3 (1.3)	0
Dinner	120 (53.1)	53 (23.5)	34 (15.0)	11 (4.9)	8 (3.5)	0
Snacks between meals						
Morning tea	12 (5.3)	25 (11.1)	57 (25.2)	36 (15.9)	38 (16.8)	58 (25.7)
Afternoon tea	15 (6.6)	14 (6.2)	58 (25.7)	38 (16.8)	51 (22.6)	50 (22.1)
Supper	10 (4.4)	41 (18.1)	62 (27.4)	48 (21.2)	44 (19.5)	21 (9.3)
Frequency of eating at hawker centers, coffee shops or other food stalls	21 (9.3)	43 (19.0)	76 (33.6)	26 (11.5)	52 (23.0)	8 (3.5)
Frequency of eating at western fast food restaurants	2 (0.9)	16 (7.1)	59 (26.1)	59 (26.1)	82 (36.3)	8 (3.5)
Frequency of eating at buying/take-away food from western fast food restaurants	3 (1.3)	14 (6.2)	53 (23.5)	59 (26.1)	77 (34.1)	20 (8.8)

However, there were studies reported lower prevalence of breakfast skipping among university students compared to the present study (Moy et al. 2009; Musaiger et al. 2016; Neslisah & Emine, 2011; Raessa & Kirthee, 2019). Moy et al. (2009) reported that one-third (29.2%) of the university students in Malaysia skipped breakfast. Similarly, Zainab and Ayesha (2017) reported that 37.7% of the university students skipped breakfast. Raessa and Kirthee (2019) and Neslisah and Emine (2011) reported the prevalence of breakfast skipping among university students in Kwazuku-Natal and Turkey was 49.3% and 47.7%, respectively. Inconsistent finding of breakfast skipping among university students might be due to the availability of food at the university cafeteria in the morning as Musaiger et al. (2016) mentioned that higher prevalence of daily breakfast consumption (85.5%) among Sudanese students was due to the majority of students consumed breakfast at university cafeteria.

Less than 10% of the respondents consumed snacks daily during morning tea (5.3%), afternoon tea (6.6%) and supper (4.4%). The prevalence of daily snack consumption in this study is lower compared to Musaiger et al. (2016) and Mithra et al. (2018). Musaiger et al. (2016) reported that 18.8% of the students consumed snacks during morning tea, 11.8% of them ate snacks during afternoon tea and 47.5% of them took supper. Mithra et al. (2018) reported that the prevalence of snacking in between meals was 54.3% among college students in South India, in which 6.2% of the students snacked during midmorning, 9.4% of them snacked on afternoon tea, 4.9% snacked after dinner and 78.7% of them did not have specific timing of snacking.

About 9.3% of the respondents reported that they ate at hawker centers, coffee shops or other food stall daily. In contrast, Gan et al. (2011) reported higher prevalence

of university students (31.2%) were eating at hawker center, coffee shops or other food stall daily. Furthermore, 64.1% of the respondents in this study ate at western fast food restaurants at least once a week. This finding was higher as compared to Gan et al. (2011), which reported that 41.6% of the respondents ate fast food at least once a week. The higher intake of fast food among university students may be due to the easy access of the restaurants (Seo et al., 2011) as fast food restaurants are available and nearer to the university in the current study.

Table 4.5 shows the frequency of food groups consumptions of the respondents. About two in five (39.8%) of the respondents drank 100% fruit juices 1-3 times per week. Moreover, only 19.8% of the respondents consumed fruits daily. This finding was consistent with a study conducted by Mariam et al. (2017) among university students in Canada, in which they reported that 19.7% of the students consumed fruits daily. Likewise, Ibrahim et al. (2014) also reported that only 17.8% out of 204 university students in Saudi Arabia consumed fruits daily. Fruit is important in reducing the risk of chronic diseases such as cardiovascular diseases, diabetes mellitus, and certain cancers and can promote overall health (Abolfazl et al. 2013; Al-Qtaibi et al. 2013 & WHO, 2014) as well as acts as sources of micronutrient, dietary fibre and phytochemicals which are essential to maintain health (Bibi Nabihah et al., 2018). The Malaysian Dietary Guideline 2010 recommended at least 2 servings of fruit (160g) per day (NCCFN, 2010) to maintain individual's health.

Furthermore, this study showed that 25.7% of the respondents consumed bread, rice, mi or bihun two times per day. This finding was supported by a previous study conducted by Gan et al. (2011), in which 26.9% of the university students consumed

Table 4. 6: Distribution of respondent by different food group consumption (n=226)

Foods/Beverages	n (%)						
	I did not drink/eat this food during the past 7 days	1-3 times during the past 7 days	4-6 times during the past 7 days	1 time/ glass per day	2 times/ glasses per day	3 times/ glasses per day	4 or more times/ glasses per day
100% fruit juices	85 (37.6)	90 (39.8)	25 (11.1)	10 (4.4)	7 (3.1)	7 (3.1)	2 (0.9)
Fruits	33 (14.6)	89 (39.4)	59 (26.1)	20 (8.8)	12 (5.3)	10 (4.4)	3 (1.3)
Bread, rice, mi, or mihun	12 (5.3)	24 (10.6)	57 (25.2)	28 (12.4)	58 (25.7)	19 (8.4)	28 (12.4)
Meat or chicken	7 (3.1)	29 (12.8)	72 (31.9)	29 (12.8)	39 (17.3)	29 (12.8)	21 (9.3)
Fish	54 (23.9)	59 (26.1)	42 (18.6)	22 (9.7)	27 (11.9)	16 (7.1)	6 (2.7)
Vegetables	19 (8.4)	55 (24.3)	50 (22.1)	27 (11.9)	38 (16.8)	25 (11.1)	12 (5.3)
Legumes	76 (33.6)	66 (29.2)	32 (14.2)	23 (10.2)	16 (7.1)	7 (3.1)	6 (2.7)
Soft drink	89 (39.4)	63 (27.9)	37 (16.4)	13 (5.8)	13 (5.8)	9 (4.0)	2 (0.9)
Sports drink	122 (54.0)	37 (16.4)	35 (15.5)	16 (7.1)	9 (4.0)	6 (2.7)	1 (0.4)
Plain water	20 (8.8)	14 (6.2)	24 (10.6)	12 (5.3)	14 (6.2)	24 (10.6)	118 (52.2)
Milk	57 (25.2)	54 (23.9)	37 (16.4)	28 (12.4)	31 (13.7)	14 (6.2)	5 (2.2)

bread/rice/mi twice a day. In term of vegetable intake, 45.1% of the respondents in this study consumed vegetables daily. The consumption of vegetable daily among university students in this study was higher compared to Mariam et al. (2017), in which they reported that 27.6% of the university students in Canada consumed vegetables every day. However, higher percentage of daily vegetable consumption was reported in a local study conducted by Gan et al. (2011), in which more than half (61.1%) of the university students consumed vegetables at least once daily. Similarly, Ibrahim et al. (2014) revealed that 59.3% of the university students in Saudi Arabia consumed vegetables daily.

This study revealed that 39.4% of the respondents did not drink any soft drinks for the past week. This finding is supported by a previous study conducted by Ibrahim et al. (2014), in which 29% of the university students in Saudi Arabia did not consume soft drinks for the past 7 days. Moreover, the percentage of never consume soft drink in this study is higher compared to a study conducted by Samah and Naglo (2019), in which only 8.5% of the students in Egypt never consumed soft drink in a week. On the other hand, 34.5% of the respondents in this study consumed milk daily. The prevalence of milk consumption in this study is higher compared to 24% reported by Gan et al. (2011).

4.4.2 Nutrient intake

Table 4.6 shows the underreporting of energy intake of the respondents. This study used Goldberg et al. (1991) cut off for underreporting of energy intake by determining the ratio of energy intake to estimated basal metabolic rate (EI: BMR). The cut off range for under-reported was <1.502 , normal reporter was $1.503-1.574$ and over-reporter was >1.575 . This study found that 78.8% of the respondents were under-reporters of energy

intake, with more female students (80.1%) were under-reporters than male students (74.6%). The under reporters were not excluded in this study as this study aimed to assess the dietary behavior of all university students. One of the reasons of the high prevalence of underreporting in this study was 2 days 24-hour dietary recall were conducted via online interviewed such as WhatsApp application and phone call during MCO period. The respondents might not be able to estimate the portion of their meals as they could not refer to the household measurement that were prepared by researchers.

Table 4. 7: Distribution of respondents by underreporting of energy intake

Characteristics	n (%)		
	Male (n=55)	Female (n=171)	Total (n=226)
Underreporting intake	41 (74.6)	137 (80.1)	178 (78.8)
Normal reporting intake	2 (3.6)	7 (4.1)	9 (4.0)
Overreporting intake	27 (21.8)	12 (15.8)	39 (17.2)

Table 4.7 shows average energy and nutrient intake by sex. The mean energy intake of the respondents was 1710 ± 514 kcal, with higher intake among male students (1918 ± 551 kcal) as compared to females (1643 ± 486 kcal). This finding was consistent with a recent local study conducted by Koo et al. (2019), in which male students (2280 ± 48.2 kcal) had higher energy intake than female students (1984 ± 76.8). Similarly, Hakim et al. (2012) also reported that the mean energy intake of male students (1938.5 ± 452.6 kcal) were higher compared to female students (1681 ± 382 kcal). Another local study by Gan et al. (2011) also demonstrated that male students (2120 ± 614 kcal) had higher energy intake than female students (1624 ± 506 kcal).

Table 4. 8: Distribution of respondent by energy and nutrient intakes (n=226)

Nutrients	n (%) / Mean $\pm$ SD		
	Male (n=55)	Female (n=171)	Total (n=226)
Energy (kcal)	1918 $\pm$ 551	1643 $\pm$ 486	1710 $\pm$ 514
<RNI	41 (74.5)	124 (72.5)	165 (73.0)
$\geq$ RNI	14 (25.5)	47 (27.5)	61 (27.0)
Protein (g)	76.0 $\pm$ 43.8	63.3 $\pm$ 25.4	66.4 $\pm$ 31.3
% of energy from protein			
< 10%	1 (1.8)	2 (1.2)	3 (1.3)
10-20%	49 (89.1)	155 (90.6)	204 (90.3)
>20%	5 (9.1)	14 (8.2)	19 (8.4)
<RNI	21 (38.2)	63 (36.8)	84 (37.2)
$\geq$ RNI	34 (61.8)	108 (63.2)	142 (62.8)
Carbohydrate (g)	220.1 $\pm$ 61.8	195.8 $\pm$ 66.9	201.7 $\pm$ 66.4
% of energy from carbohydrate			
< 50%	38 (69.1)	111 (64.9)	149 (65.9)
50-65%	15 (27.3)	54 (31.6)	69 (30.5)
>65%	2 (3.6)	6 (3.5)	8 (3.5)
Total fat (g)	86.9 $\pm$ 54.7	67.4 $\pm$ 27.4	72.1 $\pm$ 36.8
% of energy from fat			
< 25%	2 (3.6)	8 (4.7)	10 (4.4)
25-30%	6 (10.9)	24 (14.0)	30 (13.3)
>30%	47 (85.5)	139 (81.3)	186 (82.3)
Dietary Fiber, total (g)	4.0 $\pm$ 3.0	4.6 $\pm$ 4.1	4.5 $\pm$ 3.9
Sugar, total (g)	23.1 $\pm$ 18.4	28.3 $\pm$ 21.5	27.0 $\pm$ 20.9
<10%	46 (83.6)	128 (74.9)	174 (77.0)
$\geq$ 20%	9 (16.4)	43 (25.1)	52 (23.0)
Vitamin A (RE) (mg)	729.7 $\pm$ 386.2	557.3 $\pm$ 382.7	599.3 $\pm$ 389.8
<RNI	20 (36.4)	108 (63.2)	128 (56.6)
$\geq$ RNI	35 (63.6)	63 (36.8)	98 (43.4)
Vitamin C (mg)	48.3 $\pm$ 135.6	43.2 $\pm$ 58.6	44.6 $\pm$ 83.6
<RNI	50 (90.9)	144 (84.2)	194 (85.8)
$\geq$ RNI	5 (9.1)	27 (15.8)	32 (14.2)
Vitamin D (μg)	0.3 $\pm$ 0.6	0.2 $\pm$ 0.6	0.2 $\pm$ 0.6
<RNI	55 (100)	171 (100)	226 (100)
$\geq$ RNI			

Table 4.7: Distribution of respondent by energy and nutrient intakes (n=226) (cont.)

Nutrients	n (%) / Mean $\pm$ SD		
	Male (n=55)	Female (n=171)	Total (n=226)
Vitamin E (mg)	3.6 $\pm$ 2.4	3.5 $\pm$ 2.7	3.5 $\pm$ 2.6
<RNI	54 (98.2)	164 (95.9)	218 (96.5)
$\geq$ RNI	1 (1.8)	7 (4.1)	8 (3.5)
Thiamin (mg)	0.6 $\pm$ 0.6	0.6 $\pm$ 0.6	0.6 $\pm$ 0.6
<RNI	52 (94.5)	161 (94.2)	213 (94.3)
$\geq$ RNI	3 (5.5)	10 (5.8)	13 (5.75)
Riboflavin (mg)	0.9 $\pm$ 1.2	0.8 $\pm$ 0.5	0.8 $\pm$ 0.7
<RNI	53 (96.4)	149 (87.1)	202 (89.4)
$\geq$ RNI	2 (3.6)	22 (12.3)	24 (10.6)
Niacin (mg)	9.5 $\pm$ 6.5	7.9 $\pm$ 6.4	8.3 $\pm$ 6.4
<RNI	51 (92.7)	157 (91.8)	208 (92.0)
$\geq$ RNI	4 (7.3)	14 (8.2)	18 (8.0)
Folate (μg)	663.1 $\pm$ 33.3	63.5 $\pm$ 37.2	64.2 $\pm$ 36.2
<RNI	55 (100)	171 (100)	226 (100)
$\geq$ RNI			
Vitamin B12 (μg)	1.3 $\pm$ 1.3	1.6 $\pm$ 1.8	1.5 $\pm$ 1.7
<RNI	53 (96.4)	156 (91.2)	209 (92.5)
$\geq$ RNI	2 (3.6)	15 (8.8)	17 (7.5)
Sodium (mg)	3213 $\pm$ 1542	2779 $\pm$ 1267	2884 $\pm$ 1349
<RNI	6 (10.9)	25 (14.6)	31 (13.7)
$\geq$ RNI	49 (89.1)	146 (85.4)	195 (86.3)
Potassium (g)	1.2 $\pm$ 0.5	1.0 $\pm$ 0.4	1.1 $\pm$ 0.5
<RNI	55 (100)	171 (100)	226 (100)
$\geq$ RNI			
Calcium (mg)	339.5 $\pm$ 169.9	329.8 $\pm$ 199.7	332.1 $\pm$ 192.3
<RNI	55 (100)	169 (98.8)	224 (99.1)
$\geq$ RNI		2 (1.2)	2 (0.9)
Iron (mg)	15.5 $\pm$ 7.2	12.3 $\pm$ 7.4	13.1 $\pm$ 7.6
<RNI	28 (50.9)	165 (96.5)	193 (85.4)
$\geq$ RNI	27 (49.1)	6 (3.5)	33 (14.6)
Phosphorus (mg)	736.2 $\pm$ 315.7	609.1 $\pm$ 320.6	640.0 $\pm$ 323.3
<RNI	27 (49.1)	113 (66.1)	140 (61.9)
$\geq$ RNI	28 (50.9)	58 (33.9)	86 (38.1)
Magnesium (mg)	95.9 $\pm$ 67.3	87.2 $\pm$ 46.9	89.4 $\pm$ 52.6
<RNI	54 (98.2)	171 (100)	225 (99.6)
$\geq$ RNI	1 (1.8)		1 (0.4)
Zinc (mg)	4.7 $\pm$ 3.9	4.1 $\pm$ 3.7	4.2 $\pm$ 3.7
<RNI	50 (90.9)	121 (70.8)	171 (75.7)
$\geq$ RNI	5 (9.1)	50 (29.2)	55 (24.3)

Furthermore, this study showed that 74.5% of males and 72.5% females did not meet the RNI for energy intake. This finding was supported by Hakim et al. (2012), which reported that nearly three in four of the university students (72.2% out of 200 students) did not meet the RNI for energy intake. Koo et al. (2019) reported that all students in private university in Klang Valley did not meet the Malaysian RNI for energy. The mean macronutrient intake of the respondents in this study for protein, carbohydrate and fat were 66.38 ± 31.28 g, 201.71 ± 66.40 g and 72.11 ± 36.79 g, respectively.

This study showed that male students (protein: 76.0 ± 43.8 g, carbohydrate: 220.1 ± 61.8 g and total fat: 86.9 ± 54.7 g) consumed higher protein, carbohydrate and total fat as compared to female students (protein: 63.3 ± 25.4 g, carbohydrate: 220.93 ± 85.39 g and total fat: 67.4 ± 27.4 g). These findings were consistent with a recent local study conducted by Cheng et al. (2020), in which they reported that male students (protein: 90.68 ± 36.25 g, carbohydrate: 220.93 ± 85.39 g and total fat: 62.69 ± 23.07 g) had higher consumption of protein, carbohydrate and total fat as compared to female students (protein: 69.51 ± 22.88 g, carbohydrate: 195.8 ± 66.9 g and total fat: 56.98 ± 19.76 g). Similarly, Koo et al. (2019) reported that male students (protein: 65.8 ± 30.0 g, carbohydrate: 235.4 ± 74.2 g and total fat: 62.1 ± 26.7 g) had higher mean for protein, carbohydrate and total fat as compared to female students (protein: 57.9 ± 57.6 g, carbohydrate: 212.7 ± 64.2 g and total fat: 54.5 ± 23.5 g).

Moreover, results from this study showed that 62.8% of the respondents met the RNI for protein. The percentage of respondents who met the Malaysian RNI for protein in this study was lower compared to a local study conducted by Koo et al. (2019), in which 100% of the respondents met the RNI for protein. Furthermore, in term of the percentage

of energy from macronutrient, this study demonstrated that most of the respondents did not meet the recommended range for the percentage of energy from carbohydrate and fats, with 66% of the respondents achieved <50% of energy intake from carbohydrate and 82.3% achieved >30% of energy intake from fat.

Besides, more than half of the respondents did not meet the RNI for micronutrients such Vitamin A (56.6%), phosphorus (61.9%), zinc (75.7%), iron (85.4%), Vitamin C (85.8%), riboflavin (89.4%), niacin (92.0%), Vitamin B12 (92.5%), thiamin (94.3%), Vitamin E (96.5%), calcium (99.1%), and magnesium (99.6%). All the respondents in this study did not meet the RNI for Vitamin D, folate and potassium. Koo et al. (2019) also reported that all students did not meet the RNI for most of the micronutrients, including calcium, zinc, vitamin c, thiamin, riboflavin, niacin and folic acid. Overall, these findings indicate that university students are prone to have poor nutrient intake with more than half of them did not meet the RNI for macronutrients and micronutrients.

4.4.3 Meal timing

Table 4.8 shows the meal timing of the respondents. The mean meal timing for breakfast of the respondents during weekday was at 7:23±0:45 am, while during weekend it was at 7:35±0:39 am. Besides that, the mean meal timing for lunch during weekday and weekend were at 12:27±0:57 pm and 12:54 ±1:06 pm, respectively. As for the mean meal timing for dinner, mean meal timing for weekday was at 19:45±1:07 and weekend was 20:04±1:12. Overall, results showed that the meal timing during weekend was a bit later than weekday. There was limited study conducted to assess the meal timing of

Table 4. 9: Distribution of respondents by meal timing (n=226)

Characteristics	Mean $\pm$ SD
Weekday	
Breakfast	7:23 $\pm$ 0:45
Morning tea	9:39 $\pm$ 0:50
Lunch	12:27 $\pm$ 0:57
Afternoon tea	16:16 $\pm$ 1:00
Dinner	19:45 $\pm$ 1:07
Supper	21:16 $\pm$ 4:52
Weekend	
Breakfast	7:35 $\pm$ 0:39
Morning tea	9:26 $\pm$ 0:49
Lunch	12:54 $\pm$ 1:06
Afternoon tea	16:06 $\pm$ 1:19
Dinner	20:04 $\pm$ 1:12
Supper	21:16 $\pm$ 4:49

undergraduate students. Thus, this study was compared with the findings of adults' study.

The mean meal timing of this study was earlier than the findings from a study conducted by Reid et al. (2014), in which the average meal timing for 7 days for breakfast, lunch and dinner were 9:37 $\pm$ 1:50, 13:32 $\pm$ 1:08 and 19:10 $\pm$ 2:05, respectively among healthy adults in Chicago. The earlier meal timing was reported in the current study because of the respondents of this study were university students, in which they have to wake up early for their morning classes. However, Reid et al. (2014) did not assess the meal timing between weekend and weekday. The findings of this study were similar with a study conducted by Sato-Mito et al. (2011), which revealed that the mean timing for breakfast was 7:41 $\pm$ 1:19, lunch was 12:26 $\pm$ 1:02 and dinner was 19:05 $\pm$ 2:13 among female adults in Japan.

4.5 Human Chronotype

The distribution of human chronotype among respondents is shown in Table 4.9. The mean total score of MEQ was 52.14 ± 6.69 , ranging from 16 to 86. Majority of the respondents were intermediate type (78.3%), followed by morning type (15.9%) and evening type (5.8%). This finding was in an agreement with the finding from a recent local study done by Schiess et al. (2020), in which they reported that 68% of the medical students in Perdana University, Malaysia were intermediate-type, 18% were morning type and 14% were evening type. Teixeira et al. (2017) revealed that majority of the undergraduate students in a public university in Brazil was intermediate type (62%), followed by morning type (21%) and evening type (17%). In addition, Beşoluk, et al. (2011) revealed that 19.1% of the 1471 university students in Turkey were morning type, whereas 66.1% were intermediate type, and 14.8% were evening type. Consistent finding also reported by Zhang et al. (2018), in which 22.9% of university students in China were morning type, whereas 62.8% were intermediate type and 14.3% were evening type.

However, a local study done by Lai and Say (2013) showed that none of the 1118 students in the University Tunku Abdul Rahman were categorized as morning type or intermediate type but all of them were evening type. Inconsistent finding was shown in the current study might be due to the timing of data collection as it was conducted early of the semester, in which students might not be occupied with busy schedules such as meeting deadlines for assignments and reports, thus most of the students were categorized as intermediate and morning types in the current study. Kabrita et al. (2014) suggested that chronotype interacts with the schedules of students and would affect their sleep quality and duration.

Table 4. 10: Distribution of respondents by human chronotype (n=226)

Variable	Mean $\pm$ SD/ n (%)		
	Male (n=55)	Female (n=171)	Total (n=226)
Human chronotype score	51.42 $\pm$ 6.55	52.37 $\pm$ 6.73	52.14 $\pm$ 6.69
Morning-type	9 (16.4)	27 (15.8)	36 (15.9)
Intermediate-type	43 (78.2)	134 (78.4)	177 (78.3)
Evening-type	3 (5.5)	10 (5.8)	13 (5.8)

4.6 Comparison of sociodemographic characteristics according to human chronotype

Table 4.10 shows the comparison of sociodemographic characteristics according to human chronotype. Results in this study showed that there was no significant difference between age groups ($\chi^2 = 4.655$, $p = 0.099$) according to human chronotype. This finding was consistent with previous studies (Acet et al., 2018; Teixeira et al., 2017). However, some other studies reported that age was significantly difference between different chronotypes (Robinson et al., 2014; Whittier et al., 2014). Whittier et al. (2014) revealed that age was significantly different with chronotype ($p < 0.001$) among Peruvian university students, with older age group was found to be prone toward morning type (21.5 $\pm$ 2.9 years old) than younger age group (20.5 $\pm$ 2.2 years old). Likewise, Robinson et al. (2014) also reported that there was a statistically significant difference in age between human chronotype ($p < 0.001$), with older age group (>22 years old) had higher mean score of MEQ, in which they were prone to morningness chronotype compared to younger age group (<22 years old).

Table 4.11: Results of chi-square test of independence of association between sociodemographic characteristics and human chronotype

Characteristics	n (%)			χ^2	p-value
	Morning-type (n=36)	Intermediate-type (n=177)	Evening-type (n=13)		
Age groups				4.655	0.099
19-21	32 (88.9)	143 (80.8)	8 (61.5)		
22-25	4 (11.1)	34 (19.2)	5 (38.5)		
Sex				0.020	1.000
Male	9 (25.0)	43 (24.3)	3 (23.1)		
Female	27 (75.0)	134 (75.7)	10 (76.9)		
Ethnicity				6.854	0.224
Malay	30 (83.3)	157 (88.7)	10 (76.9)		
Non-Malay	6 (20.7)	20 (11.3)	3 (10.3)		
Courses of study				0.964	0.618
Sciences	20 (55.6)	105 (59.3)	6 (46.2)		
Non-sciences	16 (44.4)	72 (40.7)	7 (53.8)		
Year of study				6.381	0.041
Freshman	22 (61.1)	68 (38.4)	6 (46.2)		
Sophomore/Junior/Senior	14 (38.9)	109 (61.6)	7 (53.8)		
Current Living Arrangement				0.137	0.934
Campus dormitory	31 (86.1)	155 (87.6)	11 (84.6)		
Off-campus	5 (13.9)	22 (12.4)	2 (15.4)		
Monthly allowance (RM)					
<RM 500	26 (72.2)	115 (65.0)	6 (46.2)	2.857	0.239
≥RM 500	10 (27.8)	62 (35.0)	7 (53.8)		

This study showed that no significant difference was found between sex ($\chi^2= 0.02$, $p= 1.00$) according to human chronotype, which was consistent with previous studies (Lai & Say, 2013; Robinson et al., 2014; Schiess et al., 2020; Teixeira et al., 2017). In contrast, Whittier et al. (2014) showed that there was a statistically difference in females and males according to different human chronotype ($p=0.019$), where more females were found to be in the morning type as compared to males.

There was no significant difference in ethnicity ($\chi^2=6.854$, $p=0.224$) according to human chronotype in this study. Similarly, Schiess et al. (2020) reported no significant difference between ethnicity (Malay, Chinese and Indian) according to human chronotype among Malaysian undergraduate students ($p=0.721$). Likewise, Paine et al. (2006) reported that there were no significant differences in mean MEQ scores by ethnicity (Maori 58.32 ± 9.08 and Non-Maori 57.92 ± 9.15) among adults aged 30 – 49 years in New Zealand.

This study showed that living arrangement ($\chi^2 = 0.137$, $p=0.934$) and monthly personal allowance ($\chi^2= 2.857$, $p=0.239$) were not significantly difference according to human chronotype. However, year of study was found to be differed according to human chronotype ($\chi^2= 6.381$, $p= 0.041$). Interestingly, more students who were in the morning type (61.1%) were among the freshmen (first-year university students) compared to students in evening type (46.2%). This might be due to the schedules of the first-year students are not occupied with many academic workloads such as assignments and reports when compared with other students. Kabrita et al. (2014) suggested that chronotype interact with schedules of students and affecting their sleep quality and duration. However, this finding is not consistent with a local study conducted by Schiess et al. (2020), where they reported no significant difference between year of study with human chronotype among medical students in Malaysia ($p= 0.146$).

4.7 Comparison of body composition according to human chronotype

Table 4.11 shows the comparison of body composition according to human chronotype among undergraduate students in this study. Consistent with previous studies

Table 4.12: Results of the comparison between body composition and human chronotype

Variable	Mean $\pm$ SD			<i>F</i>	<i>p</i> -value
	Morning-type (n=36)	Intermediate-type (n=177)	Evening-type (n=13)		
Body mass index (kg/m ²)	23.30 $\pm$ 4.23	23.92 $\pm$ 5.62	22.58 $\pm$ 3.29	0.537	0.585
Body fat percentage (%)	Morning-type (n=34)	Intermediate-type (n=150)	Evening-type (n=9)	1.028	0.360
	27.42 $\pm$ 6.63	28.92 $\pm$ 8.19	25.90 $\pm$ 6.71		
Waist circumference (cm)	Morning-type (n=35)	Intermediate-type (n=176)	Evening-type (n=12)	1.174	0.311
	72.86 $\pm$ 10.26	74.31 $\pm$ 12.55	73.81 $\pm$ 12.01		
Waist-to-height ratio	0.457 $\pm$ 0.061	0.465 $\pm$ 0.072	0.431 $\pm$ 0.032	1.396	0.250

(Maukonen et al., 2017; Robinson et al., 2014; Teixeira et al., 2017; Toktaş et al., 2017 & Whittier et al., 2014), there was no significant difference in BMI categories between different human chronotype ($F=0.537$, $p=0.585$) in this study. For instance, Toktas et al. (2017) found that there was no difference between BMI of morning types (22.60 $\pm$ 2.41 kg/m²) and evening types (22.09 $\pm$ 1.83 kg/m², $p=0.70$) among university students in Turkey. Whittier et al. (2014) reported that no significant difference in BMI according to human chronotype ($p=0.122$) among Peruvian university students. Teixeira et al. (2017) also reported the similar finding as BMI was not significantly differed with chronotype among Brazilian undergraduate students. One of the possible reasons might be due to the respondents of this study are young and mostly healthy, thus making them more resistant towards the effects of misalignment in sleep/wake timing (McMahon et al., 2019).

Furthermore, researchers found that studies which were conducted among the same population would usually report the same outcome, where the majority of their respondents had a healthy weight range (Saat et al., 2010; Yeng et al., 2012).

In contrast, Zhang et al. (2018) revealed that there was a significant difference between BMI and human chronotype among medical students in China ($p < 0.001$), where students with high chronotype score (tendency toward morningness) had lower BMI than students with low chronotype score. However, Zhang et al. (2018) stated that higher BMI among evening type was mediated by more caffeinated drinks consumption. Higher intake of caffeinated drinks will trigger addiction towards caffeinated drinks and will lead to increase sugar intake and promote weight gain. Thus, the stimulant from caffeinated drinks consumption associated with late chronotype and high BMI (Zhang et al., 2018).

Body fat percentage was also not significantly difference according to human chronotype ($F = 1.028$, $p = 0.360$) in this study, which was consistent with previous studies (De Amicis et al., 2020; Maukonen et al., 2016; McMahon et al., 2018; Yu et al., 2015). Similarly, this study also showed that there was no significant difference in waist circumference according to human chronotype ($F = 1.174$, $p = 0.311$). Teixeira et al. (2017) supported this finding, in which they showed no significant difference ($p = 0.75$) in waist circumference according to human chronotype among undergraduate students in Brazil. Likewise, De Amicis et al. (2020) reported that there were no differences in waist circumference between chronotype ($p = 0.19$) among European adults.

However, this finding was contradicted with a Korean study, where they reported that women adults with tendency toward eveningness (77.6 ± 0.8 cm) had a significantly higher waist circumference ($p = 0.004$) than morning type (75.8 ± 0.7 cm) (Yu et al., 2015).

Yu et al. (2015) explained that higher waist circumference was due to the increased risk of metabolic syndrome in women with evening type. Besides that, they also discussed that evening type had poor sleep quality and high prevalence of insomnia, less exercise and practiced unhealthy behavior pattern (smoking) as compared to morning type, in which these might increase their waist circumference. Inconsistent finding in the present study might be due to the waist circumference was mediated by other factors such as sleep quality, physical activity and unhealthy behavior. However, sleep quality, physical activity and unhealthy behavior were not assessed in this study.

This study showed that mean WHtR was not significantly different with human chronotype ($F=1.396, p=0.250$). Finding of this study is consistent with a study conducted by McMahon et al. (2014), which reported that WHtR was not significantly differed according to human chronotype among healthy adults in Columbia ($p=0.64$). There were limited study comparing WHtR between human chronotype, thus the mechanism cannot be clearly addressed. More studies are needed to confirm the finding.

4.8 Comparison of blood pressure level according to human chronotype

As shown in Table 4.12, this study found that there was a significant difference between SBP ($F=7.108, p=0.001$) and DBP ($F=3.541, p=0.031$) with human chronotype. There was limited study comparing blood pressure level and human chronotype among undergraduate students. Thus, this study was compared with the findings conducted among adults.

Post Hoc test further portrayed that there was a significant difference in DBP between morning type and intermediate type ($p=0.001$) in this study, in which morning

Table 4.13: Results of the comparison between blood pressure level and human chronotype

Characteristics	Morning -type (n=36)	Interme- diate- type (n=177)	Evening- type (n=13)	F-value	p-value
Diastolic blood pressure (mmHg)	71.56± 7.72 ^a	70.76± 8.51 ^b	60.33± 6.12 ^{a, b}	7.108	0.001
Systolic blood pressure (mmHg)	117.63± 11.91 ^c	114.14± 13.36	104.89± 6.37 ^c	3.541	0.031

Post Hoc Test (Tukey) showed significance difference between:

a = Morning type and evening type ($p=0.001$)

b = Intermediate type and evening type ($p=0.001$)

c = Morning type and evening type ($p=0.025$)

type (71.56±7.72 mmHg) had significantly higher DBP than evening type (60.33±6.12 mmHg). The result from this study is consistent with a study conducted by Munoz et al. (2017), in which they reported that DBP was higher in morning type (73±8 mmHg) than evening type (69±9 mmHg) among 177 staffs of the Catholic University of Murcia, Spain. Besides, the present study also showed that intermediate type and evening type were found to be differed in DBP, in which intermediate type (70.76 ± 8.51 mmHg) had higher DBP than evening type (60.33 ± 6.12 mmHg).

In term of SBP, results of this study showed that morning type (117.63 ± 11.91 mmHg) had significantly ($p=0.025$) higher SBP than evening type (104.89 ± 6.37 mmHg). This finding is supported by a previous study done by Yu et al. (2015), in which they observed a higher SBP among morning types (117.7 ± 0.9 mmHg) than evening types (111.3 ± 2.2 mmHg) among male adults in Korea. Similarly, Merikanto et al. (2013) reported that evening types had a lower SBP than morning types ($p < 0.01$) among adults in Finland.

Higher SBP in this study could be explained by there is a circadian rhythm in SBP and morning type (Merikanto et al., 2013) as higher SBP among morning type might be due to the timing of measurement. Morning types have earlier surges of SBP than evening type (Yu et al. 2015) due to the diurnal rhythm of SBP, in which lower during night and surging at time of waking up in the morning. Morning types are likely having higher SBP during earlier of the day and display greater cardiovascular activity in the morning session than the afternoon (Willis et al. 2005). As the timing of measurement might be one of the concerns, future studies should conduct a 24-hour ambulatory blood monitoring as this method observed the blood pressure level throughout the day and is useful for assessing the influence of behavioral factors and lifestyle modification (Burke et al., 2005). This finding was inconsistent with a study conducted by Roeser et al. (2012) among university students in Spain, which found that morning types (99.31 ± 7.19 mmHg) had lower SBP than evening types (103.79 ± 9.69 mmHg). Another recent study done Makarem et al. (2020) showed that there were no significant differences in SBP ($p = 0.890$) and DBP ($p = 0.570$) with chronotype groups among women adults in the United States.

4.9 Comparison of nutrient intake according to human chronotype

Table 4.13 shows comparisons of energy intake, macronutrient and micronutrient intake between different human chronotypes. None of the three chronotypes showed significant difference for energy intake ($p > 0.5$), but slightly higher total energy intake was observed among evening type (1799 ± 556 kcal) than morning type (1633 ± 428 kcal). This finding is supported by a study conducted by Munoz et al. (2017), in which no significant difference ($p = 0.55$) found in total energy intake according to human

Table 4. 14: Results of analysis of variance of energy intake, macronutrient and micronutrient intake and human chronotype

Characteristics	Mean $\pm$ SD			<i>F</i> - value	<i>p</i> - value
	Morning-type (<i>n</i> =36)	Intermediate-type (<i>n</i> =177)	Evening-type (<i>n</i> =13)		
Energy (kcal)	1633 $\pm$ 428	1719 $\pm$ 529	1799 $\pm$ 556	0.624	0.500
<RNI	27 (75.0)	123 (69.5)	8 (61.5)		
$\geq$ RNI	9 (25.0)	54 (30.5)	5 (38.5)		
Carbohydrate (g)	190.2 $\pm$ 62.0	203.0 $\pm$ 67.8	216.5 $\pm$ 57.6	0.738	0.479
% of energy from carbohydrate					
< 50%	26 (72.2)	116 (65.5)	7 (53.8)		
50-65%	10 (27.8)	54 (30.5)	5 (38.5)		
>65%	0 (0.0)	7 (4.0)	1 (7.7)		
Protein	61.0 $\pm$ 18.6	67.1 $\pm$ 33.4	71.3 $\pm$ 29.7	0.712	0.492
<RNI	16 (44.4)	63 (35.6)	5 (38.5)		
$\geq$ RNI	20 (55.6)	114 (64.4)	8 (61.5)		
% of energy from protein					
< 10%	0 (0.0)	3 (1.7)	0 (0.0)		
10-20%	35 (97.2)	157 (88.7)	12 (92.3)		
>20%	1 (2.8)	17 (9.6)	1 (7.7)		
Total fat (g)	67.3 $\pm$ 21.6	73.2 $\pm$ 39.6	72.1 $\pm$ 36.8	0.373	0.689
% of energy from fat					
< 25%	1 (2.8)	7 (4.0)	2 (15.4)		
25-30%	4 (11.1)	25 (14.1)	1 (7.7)		
>30%	31 (86.1)	145 (81.9)	10 (76.9)		
Dietary fiber (g)	4.1 $\pm$.6	4.5 $\pm$ 4.2	5.1 $\pm$ 2.9	0.351	0.704
Total sugar(g)	26.9 $\pm$ 19.4	26.9 $\pm$ 21.4	38.3 $\pm$ 18.8	0.170	0.844
< 10%	24 (66.7)	139 (78.5)	11 (84.6)		
$\geq$ 10%	12 (33.3)	38 (21.5)	2 (15.4)		

Table 4.13: Results of analysis of variance of energy intake, macronutrient and micronutrient intake and human chronotype (cont.)

Characteristics	Mean $\pm$ SD			F - value	p - value
	Morning-type (n=36)	Intermediate-type (n=177)	Evening-type (n=13)		
Vitamin A (RE) (mg)	562.7 $\pm$ 329.4	600.8 $\pm$ 408.0	680.6 $\pm$ 282.9	0.544	0.581
<RNI	22 (61.1)	101 (57.1)	5 (38.5)		
$\geq$ RNI	14 (38.9)	76 (42.9)	8 (61.5)		
Vitamin C (mg)	31.2 $\pm$ 24.0	48.2 $\pm$ 93.5	30.2 $\pm$ 20.9	0.841	0.433
<RNI	32 (88.9)	149 (84.2)	13 (100.0)		
$\geq$ RNI	4 (11.1)	28 (15.8)	0 (0.0)		
Vitamin D (μg)	0.15 $\pm$ 0.23	0.26 $\pm$ 0.65	0.05 $\pm$ 0.17	1.152	0.318
<RNI	36 (100.0)	177 (100.0)	13 (100.0)		
$\geq$ RNI					
Vitamin E (mg)	2.94 $\pm$ 1.84	3.60 $\pm$ 2.66	4.18 $\pm$ 3.29	1.270	0.283
<RNI	36 (100.0)	170 (96.0)	12 (92.3)		
$\geq$ RNI	0 (0.0)	7 (4.0)	1 (7.7)		
Thiamin (mg)	0.62 $\pm$ 0.76	0.58 $\pm$ 0.54	0.55 $\pm$ 0.20	0.084	0.920
<RNI	34 (94.4)	166 (93.8)	13 (100.0)		
$\geq$ RNI	2 (5.6)	11 (6.2)	0 (0.0)		
Riboflavin (mg)	0.95 $\pm$ 1.51	0.75 $\pm$ 0.45	0.81 $\pm$ 0.52	1.222	0.297
<RNI	33 (91.7)	159 (89.8)	11 (84.6)		
$\geq$ RNI	3 (8.3)	18 (10.2)	2 (15.4)		
Niacin (mg)	8.6 $\pm$ 7.3	8.3 $\pm$ 6.4	8.3 $\pm$ 3.8	0.049	0.953
<RNI	32 (88.9)	164 (92.7)	12 (92.3)		
$\geq$ RNI	4 (11.1)	13 (7.3)	1 (7.7)		
Folate (μg)	61.0 $\pm$ 41.8	64.0 $\pm$ 33.8	75.7 $\pm$ 50.4	1.183	0.308
<RNI	36 (100.0)	177 (100.0)	13 (100.0)		
$\geq$ RNI					

Table 4.13: Results of analysis of variance of energy intake, macronutrient and micronutrient intake and human chronotype (cont.)

Characteristics	Mean $\pm$ SD			F - value	p - value
	Morning-type (n=36)	Intermediate- type (n=177)	Evening-type (n=13)		
Vitamin B12 (μg)	1.55 $\pm$ 1.68	1.51 $\pm$ 1.61	1.88 $\pm$ 2.34	0.269	0.764
<RNI	33 (91.7)	164 (92.7)	12 (92.3)		
$\geq$ RNI	3 (8.3)	13 (7.3)	1 (7.7)		
Sodium (mg)	2860.1 $\pm$ 1381.8	2881.9 $\pm$ 1352.4	2983.1 $\pm$ 1300.9	0.020	0.980
<RNI	5 (13.9)	24 (13.6)	2 (15.4)		
$\geq$ RNI	31 (86.1)	153 (86.4)	11 (84.6)		
Potassium (mg)	1062.0 $\pm$ 459.8	1066.4 $\pm$ 465.7	1041.8 $\pm$ 426.2	0.045	0.956
<RNI	36 (100.0)	177 (100.0)	13 (100.0)		
$\geq$ RNI					
Calcium (mg)	349.0 $\pm$ 196.3	330.2 $\pm$ 192.3	310.9 $\pm$ 194.4	0.274	0.761
<RNI	36 (100.0)	175 (98.9)	13 (100.0)		
$\geq$ RNI	0 (0.0)	2 (1.1)	0 (0.0)		
Iron (mg)	12.3 $\pm$ 6.9	13.2 $\pm$ 7.8	13.2 $\pm$ 7.8	0.251	0.778
<RNI	33 (91.7)	150 (84.7)	10 (76.9)		
$\geq$ RNI	3 (8.3)	27 (15.3)	3 (23.1)		
Phosphorus (g)	0.61 $\pm$ 0.30	0.64 $\pm$ 0.33	0.71 $\pm$ 0.33	0.285	0.752
<RNI	23 (63.9)	109 (61.6)	8 (61.5)		
$\geq$ RNI	13 (36.1)	68 (38.4)	5 (38.5)		
Magnesium (mg)	88.78 $\pm$ 57.6	89.7 $\pm$ 52.3	86.0 $\pm$ 44.3	0.003	0.997
<RNI	36 (100.0)	176 (99.4)	13 (100.0)		
$\geq$ RNI	0 (0.0)	1 (0.6)	0 (0.0)		
Zinc (mg)	5.84 $\pm$ 7.14 ^a	3.90 $\pm$ 2.59 ^a	4.06 $\pm$ 2.40	4.172	0.017
<RNI	28 (77.8)	149 (84.2)	9 (69.2)		
$\geq$ RNI	8 (22.2)	28 (15.8)	4 (30.8)		

Post Hoc Test (Tukey) show significance difference between:

a = Morning type and intermediate type ($p=0.013$)

chronotype but they observed the total energy intake among evening type was higher (3026 ± 222 kcal) than morning type (2861 ± 168 kcal) among adults in Spain. Moreover, Lucassen et al. (2013) also reported that there was no significant difference between total energy intake with human chronotype ($p=0.373$) among obese adults in the United States. Similarly, Maukonen et al. (2017) found that there was no significant difference between energy intake with chronotype, but they observed evening type (2814.53 ± 38.0 kcal) had higher energy intake than morning type (2771.7 ± 31.1 kcal).

However, contradicted findings were reported in other studies (Teixeira et al., 2017; Toktas et al., 2018). For instance, Teixeira et al. (2017) found that intermediate type (1734.2 kcal) consumed significantly higher total energy intake than morning type (1552.8 kcal) and evening type (1692.9 kcal; $p=0.007$). Toktas et al. (2018) reported that evening type (2450.4 ± 625.0 kcal) significantly had higher energy intake than morning type (1723.5 ± 543.3 kcal) among university students in Turkey ($p<0.001$). Evening type consumed higher energy intake might be because they eat at later times and skipped breakfast (Wang et al., 2013) as eating later of the day might lead to less satiety and higher total energy intake.

Furthermore, there were no significant differences between macronutrients intake such as carbohydrate ($F=0.738$, $p=0.479$), protein ($F=0.712$, $p=0.492$) and fat intakes ($F=0.373$, $p=0.689$) according to human chronotype in this study. Similarly, Munoz et al. (2017) reported that there were no significant differences in carbohydrate intake ($p=0.318$), total fat intake ($p=0.314$) and protein intake ($p=0.376$) according to different human chronotype. In contrary, Kanerva et al. (2012) revealed that evening types had lower intake of carbohydrate ($p=0.014$) compared to morning types. Toktas et al. (2018)

reported that protein was not significantly different with chronotype ($p=0.39$), but both carbohydrate ($p=0.02$) and fat intake ($p<0.001$) were significantly different with chronotype. They reported that evening type consumed significantly higher carbohydrate (morning: 198.1 ± 81.7 g, evening: 301.7 ± 105.4 g) and total fat (morning: 69.7 ± 18.9 g, evening: 99.3 ± 26.7 g) compared to morning type (Toktas et al. 2018).

Besides that, there were no significant differences found in micronutrients intake such as vitamin A ($F =0.544$, $p =0.844$), vitamin C ($F =0.841$, $p =0.433$), vitamin D ($F =0.1152$, $p =0.318$), vitamin E ($F =1.27$, $p =0.283$), thiamin ($F =0.084$, $p =0.92$), riboflavin ($F =1.222$, $p =0.297$), niacin ($F =0.049$, $p =0.953$), folate ($F =1.183$, $p =0.308$), sodium ($F =0.020$, $p =0.98$), potassium ($F =0.045$, $p =0.956$), calcium ($F =0.274$, $p =0.761$), iron ($F =0.251$, $p =0.778$), phosphorus ($F =0.285$, $p =0.752$) and magnesium ($F =0.003$, $p =0.997$) according to human chronotype in this study. Similarly, Toktas et al. (2018) also showed no significant differences were found in vitamin A ($p=0.92$), vitamin E ($p=0.44$), thiamin ($p=0.37$), riboflavin ($p=0.30$), vitamin C ($p=0.53$), sodium ($p=0.11$), potassium ($p=0.15$), calcium ($p=0.23$), phosphorus ($p=0.23$) and iron ($p=0.18$). In contrast, Kanerva et al. (2012) demonstrated that respondents in Finland with higher preference toward eveningness consumed lower intake of folate ($p<0.001$) and sodium ($p<0.001$). Sato-Mito et al. (2011) reported that potassium, calcium, magnesium, iron, vitamin A, vitamin D, thiamin, riboflavin and folate intake were lower among respondents with evening chronotype ($p<0.001$) compared to other chronotypes.

This study found that only zinc intake was significantly differed according to human chronotype ($F =4.172$, $p =0.017$). Post Hoc Test further portrayed that there was a significant difference in zinc intake between morning type and evening type ($p=0.013$),

in which morning type (5.84 ± 7.14 mg) consumed significantly higher zinc intake than evening type (3.90 ± 2.59 mg). This finding is supported by a study conducted by Sato-Mito et al. (2011), in which morning types (4.73 ± 0.68 mg) had higher zinc intake compared to evening types (4.49 ± 0.47 mg; $p=0.049$). In contrast, Toktas et al. (2018) found that zinc was not significantly differed with chronotype ($p=0.35$). However, the mechanism involved remains unclear. More studies are needed to confirm the findings.

4.10 Comparison of meal pattern according to human chronotype

Table 4.14 shows the comparison of meal pattern according to human chronotype. Breakfast skipping was found to be significantly differed according to human chronotype ($\chi^2=14.463$, $p=0.001$). Prevalence of breakfast skipping was higher among evening-type (92.3%) compared to intermediate-type (80.2%) and morning-type (52.8%). This finding was consistent with previous studies which also found that prevalence of breakfast skipping was higher among evening types (Meule et al. 2012; Reuteralhum et al. 2014; Robbach et al. 2017; Teixeira et al., 2017; Toktas et al., 2017). For instance, Toktas et al. (2017) reported that evening-type (60%) had higher prevalence of breakfast skipping compared to morning-type (33.3%) and intermediate (44.9%). Similarly, Teixeira et al. (2017) reported that evening-type (21.8%) had higher prevalence of breakfast skipping ($p=0.02$) compared to morning-type (15%) and intermediate-type (14.1%). Robbach et al. (2017) found that regular breakfast skipping was highest in eveningness (16%), followed by intermediate types (8.6%) and morning types (1.7%). Evening types seem to skip breakfast as their circadian rhythm are delayed, they do not consume breakfast as lack of signaling by biological clocks referring to the time that meal should be consumed (Silva

Table 4.15: Results of chi-square test of independence of association between frequency of meal consumption and eating behavior with human chronotype

Characteristics	n (%)			χ^2	p-value
	Morning -type (n=36)	Intermedi ate-type (n=177)	Evening- type (n=13)		
Main meal frequency				11.24	0.018
Never skip any meal	11 (30.6)	23 (13.0)	0 (0.0)		
Skipped at least 1 meal per day	17 (47.2)	110 (62.1)	12 (92.3)		
Skipped all 3 main meal	8 (22.2)	44 (24.9)	1 (7.7)		
Breakfast frequency				14.463	0.001
Consume breakfast everyday	17 (47.2)	35 (19.8)	1 (7.7)		
Skipped breakfast at least once per week	19 (52.8)	142 (80.2)	12 (92.3)		
Lunch frequency				0.333	0.846
Consume lunch everyday	25 (69.4)	115 (65.0)	9 (69.2)		
Skipped lunch at least once per week	11 (30.6)	62 (35.0)	4 (30.8)		
Dinner frequency				3.191	0.203
Consume dinner everyday	18 (50.0)	92 (52.0)	10 (76.9)		
Skipped dinner at least once per week	18 (50.0)	85 (48.0)	3 (23.1)		
Snacking				-	-
No snacking between meals/day	1 (2.8)	6 (3.4)	0 (0.0)		
Snacking between meals/day	35 (97.2)	171 (96.6)	13 (100.0)		

et al., 2016). Moreover, evening types may prefer to sleep a little longer in the morning than consumed breakfast or tend to wake up late to start daily activities, which make them skipped this meal (Teixeira et al., 2017).

Findings of this study showed that 30.6% of morning types did not skip meal, 13% in intermediate types but all evening types skipped a meal. This finding is supported by

Toktas et al. (2017), in which they reported that 11.1% of morning types did not skip meal, 14.6% of intermediate did not skip meal and all evening types skipped a meal.

Table 4.15 shows the pattern of consumption of food groups according to human chronotype. There was a significant difference between consumption of bread, rice, mi or bihun according to human chronotype ($\chi^2=11.24, p=0.018$), in which all the evening types (100%) consumed bread, rice, mi and mihun at least once a week compared to intermediate (96.6%) and morning type (83.3%). This finding is consistent with a previous study conducted by Sato-Mito et al. (2011), in which evening type ($p=0.03$) consumed higher intake of noodles than morning type. However, Sato-Mito et al. (2011) further reported that consumption of rice ($p=0.64$) and bread ($p=0.32$) was not significantly different between chronotypes.

There were no significant differences found between consumption of fruit juices ($\chi^2 = 2.916, p = 0.260$), fruits ($\chi^2 = 0.796, p = 0.724$), fish ($\chi^2 = 0.664, p = 0.739$), vegetables ($\chi^2 = 5.378, p = 0.051$), legumes ($\chi^2 = 0.255, p = 0.900$), soft drink ($\chi^2 = 0.447, p = 0.818$), sports drink ($\chi^2 = 1.884, p = 0.392$) and milk ($\chi^2 = 2.665, p = 0.274$) according to human chronotype in this study. These findings were inconsistent with a study conducted by Kanerva et al. (2012), in which they found that adults with tendency toward eveningness consumed less vegetables ($p=0.002$), fruits ($p=0.025$), fish ($p=0.025$), and soft drinks ($p=0.015$) than those morningness. Another cross-sectional conducted by Sato-Mito et al. (2011) among 3304 young Japanese females aged 18-20 years old found that dietary intake of some food groups such as noodles ($p=0.03$), vegetables ($p=0.026$) and fish ($p=0.0099$) were found to be differed with chronotype. Sato-Mito et al. (2011) also showed that morning types had significantly higher intake in vegetables (morning:

Table 4.16: Results of chi-square test of the association between different food group consumption and human chronotype

Food/beverages	n (%)			χ^2	p-value
	Morning-type (n=36)	Intermediate-type (n=177)	Evening-type (n=13)		
100% fruit juices				2.916	0.260
≥1consumption in past week	27 (75.0)	106 (59.9)	8 (61.5)		
No consumption in past week	9 (25.0)	71 (40.1)	5 (38.5)		
Fruits				0.796	0.724
≥1consumption in past week	31 (86.1)	152 (85.9)	10 (76.9)		
No consumption in past week	5 (13.9)	25 (14.1)	3 (23.1)		
Bread, rice, mi, or mihun				11.262	0.008
≥1consumption in past week	30 (83.3)	171 (96.6)	13 (100.0)		
No consumption in past week	6 (16.7)	6 (3.4)	0 (0.0)		
Meat or chicken				-	-
≥1consumption in past week	32 (88.9)	174 (98.3)	13 (100.0)		
No consumption in past week	4 (11.1)	3 (1.7)	0 (0.0)		
Fish				0.664	0.739
≥1consumption in past week	28 (77.8)	133 (75.1)	11 (84.6)		
No consumption in past week	8 (22.2)	44 (24.9)	2 (15.4)		
Vegetables				5.378	0.051
≥1consumption in past week	30 (83.3)	166 (93.8)	11 (84.6)		
No consumption in past week	6 (16.7)	11 (6.2)	2 (15.4)		
Legumes				0.255	0.900
≥1consumption in past week	25 (69.4)	116 (65.5)	9 (69.2)		
No consumption in past week	11 (30.6)	61 (34.5)	4 (30.8)		

Table 4.17: Results of chi-square test of the association between different food group consumption and human chronotype (cont.)

Food/beverages	n (%)			χ^2	p-value
	Morning-type (n=36)	Intermediate-type (n=177)	Evening-type (n=13)		
Soft drink				0.447	0.818
≥1consumption in past week	22 (61.1)	106 (59.9)	9 (69.2)		
No consumption in past week	14 (38.9)	71 (40.1)	4 (30.8)		
Sports drink				1.884	0.392
≥1consumption in past week	19 (52.8)	81 (45.8)	4 (30.8)		
No consumption in past week	17 (47.2)	96 (54.2)	9 (69.2)		
Milk				2.665	0.274
≥1consumption in past week	25 (69.4)	132 (74.6)	12 (92.3)		
No consumption in past week	11 (30.6)	45 (25.4)	1 (7.7)		

181.4±80.1 g and evening: 144.4±58.7 g) and fish intake (morning: 43.8± 21.5 g and evening: 37.0±18.8 g) compared to evening type. The insignificant findings found in the current study might be due to the small number of respondents who were evening types. Future studies with larger sample size are needed to confirm the findings.

4.11 Comparison of meal timing according to human chronotype

Table 4.16 shows meal timing of the respondents according to human chronotype. There were no significant differences between all meal timing with human chronotype. However, results showed that morning type (breakfast=7:18±0:38, morning tea=9:41±0:49, lunch= 12:20 ±0:54) consumed breakfast, morning tea and lunch earlier than

Table 4. 18: Results of comparison between meal timing and human chronotype

Characteristics	Mean $\pm$ SD			F-value	p-value
	Morning-type (n=36)	Intermediate-type (n=177)	Evening-type (n=13)		
Weekday					
Breakfast	7:18 $\pm$ 0:38	7:24 $\pm$ 0:47	8:00 $\pm$ 0:00	0.445	0.643
Morning tea	9:41 $\pm$ 0:49	9:36 $\pm$ 0:50	10:07 $\pm$ 0:52	1.444	0.240
Lunch	12:27 $\pm$ 0:54	12:24 $\pm$ 0:56	12:57 $\pm$ 1:02	1.665	0.192
Afternoon tea	16:32 $\pm$ 1:00	16:13 $\pm$ 1:00	16:20 $\pm$ 0:52	0.560	0.573
Dinner	19:48 $\pm$ 1:12	19:40 $\pm$ 1:06	19:32 $\pm$ 1:07	0.286	0.752
Supper	22:32 $\pm$ 1:07	21:19 $\pm$ 4:59	18:13 $\pm$ 7:39	1.924	0.153
Weekend					
Breakfast	7:32 $\pm$ 0:38	7:37 $\pm$ 0:39	7:20 $\pm$ 0:45	0.331	0.720
Morning tea	9:24 $\pm$ 0:41	9:27 $\pm$ 0:50	9:12 $\pm$ 0:45	0.247	0.781
Lunch	12:54 $\pm$ 1:07	12:57 $\pm$ 1:05	12:13 $\pm$ 0:59	2.316	0.101
Afternoon tea	15:36 $\pm$ 1:42	16:13 $\pm$ 1:15	15:54 $\pm$ 1:20	1.027	0.363
Dinner	20:18 $\pm$ 1:04	20:01 $\pm$ 1:13	20:02 $\pm$ 1:17	0.719	0.489
Supper	19:54 $\pm$ 6:51	21:56 $\pm$ 3:21	18:06 $\pm$ 9:40	1.840	0.169

evening types (breakfast=8:00 $\pm$ 0:00, morning tea=10:07 $\pm$ 0:52, lunch=12:57 $\pm$ 1:02). These findings were inconsistent with a study conducted by Nimitphong et al. (2018), in which adults with an evening preference had a significantly later breakfast time than those with a morning preference ($p<0.001$). Maukonen et al. (2017) found that morning types consumed breakfast and lunch earlier than evening types. Likewise, Teixeira et al. (2017) reported that morning types had breakfast ($p<0.001$) and lunch ($p<0.001$) earlier than other chronotypes. Lucassen et al. (2013) reported that eveningness ate later than morningness ($p<0.001$) among obese individuals in the United States. This might be due to the characteristics of evening types, in which they go to bed and wake up during the later hours of the day (Tonetti et al., 2015), thus they tend to consume meals later than morning type.

Another explanation is that evening chronotype has a more delayed release of ghrelin and leptin than morning chronotypes (Meule et al., 2012), leading them to consume meal later. Modification of these hormone could be influenced by circadian misalignment. Ghrelin is a peptide that plays an important role in short-term appetite regulation in which it promotes hunger, whereas leptin is considered as a satiety hormone that controls long-term energy balance (Adamska-Patrino et al., 2018). In other words, leptin decreases appetite, whereas ghrelin increases appetite and also plays a role in body weight. Overall, these findings highlight the differences in the eating patterns between chronotypes and also emphasize the importance of including meal timing in dietary assessments.

Although no significant differences between all meal timing with human chronotype were shown, this study further compared meal timing between weekday and weekend for different chronotype. Interestingly, results showed significant differences between weekday and weekend meal timing for intermediate type and morning type. As shown in Table 4.17, breakfast consumption among intermediate type was significantly differed during weekday and weekend ($t=-3.049$, $p=0.005$), in which breakfast consumption during weekday ($7:19 \pm 0:54$) was earlier than during weekend ($7:39 \pm 0:41$). Similarly, lunch consumption among intermediate type was significantly earlier during weekday ($12:25 \pm 0:58$) as compared to weekend ($12:59 \pm 1:03$; $t=-4.706$, $p< 0.001$). Besides that, dinner consumption was found to be differed among morning type during weekday and weekend ($t=-2.325$, $p=0.028$), where dinner consumption during weekday ($19:45 \pm 1:10$) was earlier than during weekend ($20:24 \pm 1:05$).

Table 4.19: Results of paired-samples t-test to compare meal timing between weekday and weekend for each of the chronotype

Characteristics	Chronotype	Mean $\pm$ SD		t-value	p-value
		Weekday	Weekend		
Breakfast	Morning	7:23 $\pm$ 0:39	7:25 $\pm$ 0:40	-0.153	0.881
	Intermediate	7:19 $\pm$ 0:54	7:39 $\pm$ 0:41	-3.049	0.005
Morning tea	Morning	9:36 $\pm$ 0:56	9:19 $\pm$ 0:35	1.041	0.318
	Intermediate	9:32 $\pm$ 0:51	9:27 $\pm$ 0:50	0.551	0.584
	Evening	9:30 $\pm$ 0:51	9:00 $\pm$ 0:51	1.000	0.423
Lunch	Morning	12:29 $\pm$ 0:55	12:47 $\pm$ 1:01	-1.352	0.187
	Intermediate	12:25 $\pm$ 0:58	12:59 $\pm$ 1:03	-4.706	<0.001
	Evening	12:57 $\pm$ 0:56	12:21 $\pm$ 0:56	1.203	0.260
Afternoon tea	Morning	16:21 $\pm$ 0:37	15:25 $\pm$ 1:08	1.797	0.122
	Intermediate	15:57 $\pm$ 0:54	16:10 $\pm$ 1:33	-0.666	0.512
	Evening	16:30 $\pm$ 1:04	16:03 $\pm$ 1:11	1.331	0.275
Dinner	Morning	19:45 $\pm$ 1:10	20:24 $\pm$ 1:05	-2.325	0.028
	Intermediate	19:48 $\pm$ 1:06	20:00 $\pm$ 1:12	-1.485	0.140
	Evening	19:42 $\pm$ 0:59	20:02 $\pm$ 1:17	-0.875	0.400
Supper	Morning	23:12 $\pm$ 1:02	22:27 $\pm$ 0:30	2.739	0.052
	Intermediate	21:35 $\pm$ 5:03	22:25 $\pm$ 1:10	-0.687	0.501
	Evening	21:17 $\pm$ 1:49	21:30 $\pm$ 2:07	-1.000	0.500

CHAPTER 5

CONCLUSION AND RECOMMENDATIONS

5.1 Conclusion

Human chronotype is a characteristic that indicates which time of the day the person prefers for rest and perform activity (Haraszti et al., 2014) and was categorized under three categories, namely morning types, evening types and intermediate types (Adan et al., 2012; Toktas et al., 2017). Everyone's circadian rhythm is different. Therefore, it is important to maintain circadian rhythm by going to bed and waking up at the same time. Disrupting circadian rhythm could result in negative health outcomes. The present study provides information on human chronotype among undergraduate students in UPM with majority of them were intermediate type (78.3%), followed by morning type (15.9%) and evening type (5.8%), as well as its differences in nutritional status and blood pressure level.

The findings of this study showed that undergraduate students had poor nutritional status with high prevalence of overweight (19.0%), obesity (12.4%), abdominal obesity (18.8%), body fat percentage (40.4%) and hypertension (21.1%). Furthermore, this study revealed that majority of the respondents had nutrient inadequacy and skipped main meals. Moreover, more morning type were freshmen compared to intermediate and evening types. Findings of this study further showed that morning type had significantly higher zinc intake, higher SBP and DBP and lower prevalence of breakfast skipping than intermediate and evening types. Furthermore, age, sex, study programs, current living

arrangement, body composition, macronutrient intake, and micronutrient intake were not significantly differed according to human chronotype. Intermediate type consumed breakfast and lunch earlier during weekday than during weekend. Morning type consumed dinner earlier during weekday than during weekend.

5.2 Limitations of the Study

This study has several limitations. First, the restrictions of face to face data collection occurred due to the MCO which was imposed by Malaysian authorities from 18 March 2020 to 9 June 2020. This condition would likely cause low response rate in this study. Second, the temporal relationship could not be established as cross-sectional study design was used in this study.

Besides that, self-reported measurements (height, weight and waist circumference) and blood pressure measurement were conducted among respondents who were approached via online questionnaire during MCO period. This condition highly depends on memory and honesty of the respondents. However, further analysis showed that there were no significant differences for all measurements between self-reported and face to face measurements in terms of weight ($t=0.36$, $p=0.719$), height ($t=-0.23$, $p=0.818$), waist circumference ($t=-1.198$, $p=0.232$), SBP ($t=0.411$, $p=0.682$), and DBP ($t=0.236$, $p=0.814$).

Furthermore, 24-hour dietary recall was highly dependent on the respondents' memory in recalling their dietary intake. Diet results should be interpreted with caution due to its high proportion of under-reporters of energy intake in this study. Thus, the findings might not reflect the actual dietary intake and eating habits of the respondents.

Additionally, findings of this study cannot be generalized to all undergraduate students in Malaysia as this study only involved undergraduate students in UPM.

5.3 Recommendations

Future studies should include undergraduate students from other universities so that the findings can be generalized to all undergraduate students in Malaysia. Besides that, longitudinal study should be conducted in future among university students to see the changes in the distribution of human chronotype and how it would affect the nutritional status, dietary intake and blood pressure level of the students. Nutritionists and health promotion planners should develop appropriate intervention or health promotion programs for undergraduate students by highlighting the importance of healthy eating and healthy weight management with consideration of their circadian typology. Furthermore, future studies regarding human chronotype should consider determining differences in other variables, such as physical activity, sleep quality, stress level and academic performance.

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**ETHICS COMMITTEE FOR RESEARCH INVOLVING HUMAN SUBJECTS
(JKEUPM)
UNIVERSITI PUTRA MALAYSIA**

Research title	: Nutritional Status and Blood Pressure Level According to Human Chronotype Among Undergraduate Student in Universiti Putra Malaysia.
Study Site	: Universiti Putra Malaysia
JKEUPM Ref No.	: JKEUPM-2019-395
Researcher	: Siti Fatimah Razali
Supervisor	: Assoc. Prof. Dr. Gan Wan Ying

Documents received and reviewed with reference to the above study:

1. Ethics Application Form, Version 1 dated 10/10/2019
2. Respondent Information Sheet & Consent (English), Version 2 dated 19/11/2019
3. Respondent Information Sheet & Consent (Malay), Version 2 dated 19/11/2019
4. Proposal (English), Version 1 dated 10/10/2019
5. Questionnaires/ Interviews (English), Version 1 dated 10/10/2019
6. Curriculum Vitae of:
 - a. Assoc. Prof. Dr. Gan Wan Ying

The University Research Ethics Committee, Universiti Putra Malaysia (JKEUPM) operates in accordance to the ICH-GCP Guidelines.

Decision by JKEUPM:

- ☒ Approved
- ☒ **Permission MUST BE OBTAINED from the respective hospitals/ institutions before conducting the research**
- ☐ Disapproved

Please note that the approval is **VALID UNTIL 5 DECEMBER 2020**

Researchers should comply with the following:

- I. Complete a Study Final Report upon study completion (Form 3.2).
- II. Ethical approval is required in the case of amendments/ changes to the study documents/ study sites/ study team.



FAKULTI PERUBATAN DAN SAINS KESIHATAN
Faculty of Medicine and Health Sciences
Rujukan Kertas : UPM/PSK/PPH/PKK4999A/001
Tarikh : 25 Oktober 2019

Profesor Dr. Zamberi Sekawi
Dekan
Fakulti Perubatan dan Sains Kesihatan
Universiti Putra Malaysia

YBhg. Prof. Dr.,

**PERMOHONAN UNTUK MENJALANKAN PROJEK ILMIAH TAHUN AKHIR
(PKK4999A) PELAJAR BACELOR SAINS (PEMAKANAN DAN KESIHATAN
KOMUNITI) DI FAKULTI PERUBATAN DAN SAINS KESIHATAN**

Dengan segala hormatnya perkara di atas adalah dirujuk.

Sukacita dimaklumkan bahawa dua orang pelajar tahun akhir program Bachelor Sains (Pemakanan dan Kesihatan Komuniti) di bawah seliaan saya sedang mengikuti kursus PKK4999A Projek Ilmiah Tahun Akhir di Jabatan Pemakanan dan Dietetik. Sebagai memenuhi sebahagian daripada syarat bergraduat, mereka dikehendaki menyediakan satu penulisan ilmiah. Berikut adalah maklumat pelajar-pelajar tersebut:

Nama pelajar	: Siti Fatimah Bt Ramli
No Matrik	: 189848
Tajuk Penyelidikan	: <i>Nutritional Status and Blood Pressure Level according to Human Chromotype among Undergraduate Students in Universiti Putra Malaysia (UPM)</i>
Nama pelajar	: Wan Nurulita Bt Wan Zamalabidin
No Matrik	: 187180
Tajuk Penyelidikan	: <i>Factors Associated with Modified Eating among Undergraduate Students in Universiti Putra Malaysia (UPM)</i>

Untuk makluman, semua pelajar daripada Program Bachelor Kesihatan Persekitaran dan Pekerjaan merupakan subjek penyelidikan ini. Pelajar dikehendaki untuk melengkapkan satu borang soal selidik dan ukuran tinggi, berat, lilitan pinggang, peratusan lemak badan dan tahap tekanan darah akan disukur oleh penyelidik di dalam bilik tertutup. Ingatan diet 24-jam akan dijalankan oleh penyelidik.

Kajian ini dalam proses mendapat kelulusan etika daripada Jawatankuasa Etika Penyelidikan Melibatkan Manusia Universiti Putra Malaysia (JKEUPM). Kajian ini akan dijalankan dari bulan Disember 2019 hingga Mac 2020. Sekubangan ini, saya memohon jasa baik daripada pihak YBhg.

Tiada halangan
dgn sangat
mendapat
kelulusan
JKEUPM
Zamberi
25/10/2019



Appendix C

Information Sheet and Informed Consent



UPM
UNIVERSITI PUTRA MALAYSIA

**JAWATANKUASA ETIKA UNIVERSITI UNTUK
PENYELIDIKAN MELIBATKAN MANUSIA (JKEUPM)
UNIVERSITI PUTRA MALAYSIA, 43400 UPM SERDANG,
SELANGOR, MALAYSIA**

FORM 2.4: RESPONDENT'S INFORMATION SHEET AND INFORMED CONSENT FORM

Please read the following information carefully and do not hesitate to discuss any questions you may have with the researcher.

1. STUDY TITLE:

Nutritional Status and Blood Pressure Level According to Human Chronotype among Undergraduate Students in Universiti Putra Malaysia

2. INTRODUCTION:

Human chronotype is a characteristic indicating which time of the day the person prefers for rest and performs activity, in which it is categorized as a morning, intermediate or evening person. Previous studies suggest that human chronotype plays an important role in maintaining individual's health. Evening types are often shown to practice adverse health behaviors such as consuming more alcoholic drinks, consuming less whole-grain products, vegetables, fruits and fish as well as often being physically inactive compared to morning type. The prevalence of overweight and obesity as well as hypertension was increasing among university students. Therefore, this study aims to compare sociodemographic factors, nutritional status and blood pressure level according to human chronotype among undergraduate students in Universiti Putra Malaysia (UPM).

This study is part of the graduation requirement for Bachelor of Science (Nutrition and Community Health) from Faculty of Medicine and Health Sciences, UPM is expected to be completed within one year of study. A total of 223 students from UPM will participate in this study.

3. WHAT WILL YOU HAVE TO DO?

You need to read and understand about this study from this Respondent's Information Sheet. If you agree to participate in this study, you are required to sign the respondent's consent form in Page 3. Upon completing the respondent's consent form, please return it to the researcher.

During data collection, you need to answer a set of questionnaires including information on sociodemographic characteristics, human chronotype and meal pattern. Your body weight, height, waist circumference, body fat percentage, and blood pressure level will be measured by the researcher in a closed room. A 24-hour dietary recall will be conducted by the researcher.

You will take approximately 30 minutes to complete this study. Your participation in this study is voluntary. You have the right to withdraw from this study anytime without giving any reasons and no penalty will be applied upon your withdrawal.

4. WHO SHOULD NOT PARTICIPATE IN THE STUDY?

Students who are:

- a) Foundation or postgraduate students
- b) Physically disable
- c) Presence of chronic disease such as hypertension, diabetes mellitus, chronic kidney failure and cardiovascular disease

5. WHAT WILL BE THE BENEFITS OF THE STUDY:

(a) TO YOU AS THE SUBJECT?

You will know your body weight, height, BMI, body fat percentage, waist circumference and blood pressure level.

(b) TO THE INVESTIGATOR?

Findings of this study will provide information on human chronotype distribution as well as nutritional status and blood pressure level of undergraduate students. Findings of this study also will help nutritionists and health promotion planners to develop appropriate intervention and health promotion programs in improving nutritional and health status of undergraduate students depending on their chronotypes.

6. WHAT ARE THE POSSIBLE RISKS?

This study has minimal risk where it only involves anthropometry measurements (body weight, height, waist circumference, body fat percentage), blood pressure measurement, 24-hour dietary recall as well as filling up a questionnaire. If you have high blood pressure level, you will be referred to University Health Center for further medical check-up.

7.WILL THE INFORMATION THAT YOU PROVIDE AND YOUR IDENTITY REMAIN CONFIDENTIAL?

All information provided will be remained confidential and used for academic purposes only. Researchers will not disclose your name or any personal information to third parties. No individual description will be made on any parts of the study or publication.

8. WHO SHOULD YOU CONTACT IF YOU HAVE ADDITIONAL QUESTIONS DURING THE COURSE OF THE RESEARCH?

If you have any enquiries, you can contact as follows:

Researcher:
Siti Fatimah binti Razali
019-6086696
sitifatimahrazali.sf@gmail.com

Supervisor:
Assoc. Prof. Dr. Gan Wan Ying
03-97692469
wanying@upm.edu.my

Please initial here if you have read and understood the contents of this page_____

9. CONSENT

I Identity Card No.
address.....

... ..hereby voluntarily agree to take part in the
research stated above *(clinical /drug trial/video recording/ focus group/interview-based/
questionnaire-based).

I have been informed about the nature of the research in terms of methodology, possible adverse
effects and complications (as written in the Respondent's Information Sheet). I understand that
I have the right to withdraw from this research at any time without giving any reason whatsoever.
I also understand that this study is confidential and all information provided with regard to my
identity will remain private and confidential.

I* wish / do not wish to know the results related to my participation in the research

I agree/do not agree that the images/photos/video recordings/voice recordings related to me be
used in any form of publication or presentation (if applicable)

* delete where necessary

Signature Signature
(Respondent) (Witness)

Date : Name :
I/C No. :

I confirm that I have explained to the respondent the nature and purpose of the above-mentioned
research.

Date Signature
(Researcher)



**FACULTY OF MEDICINE AND HEALTH SCIENCES
DEPARTMENT OF NUTRITION AND DIETETICS**

QUESTIONNAIRE

“CONFIDENTIAL”

RESEARCH TITLE:

**NUTRITIONAL STATUS AND BLOOD PRESSURE LEVEL ACCORDING TO
HUMAN CHRONOTYPE AMONG UNIVERSITY STUDENTS IN SELANGOR**

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Date :

**Instruction: Questions in this questionnaire form are for academic purposes only.
All information collected is secured. Your involvement and cooperation are greatly
appreciated.**

SECTION A:

Instruction: Fill in the blank or tick (✓) in the space provided below.

No	Information	Choices
1.	Date of birth	___ / ___ / _____ (dd/mm/yyyy)
2.	Sex	☐ Male ☐ Female
3.	Ethnicity	☐ Malay ☐ Chinese ☐ Indian ☐ Others:
4.	Year of study	☐ 1 st year ☐ 2 nd year ☐ 3 rd year ☐ 4 th year ☐ 5 th year ☐ Others:
5.	Name of faculty	
6.	Program	
7.	Current living arrangement	☐ College dormitory ☐ Off campus, please specify:
8.	Monthly household income	RM _____
9.	Monthly personal allowance	RM _____

SECTION B

Instructions: For each question, please select the answer that best describes you by circling the point value that best indicates how you have felt in recent weeks.

- 1) Approximately what time would you get up if you were entirely free to plan your day?
 - 5) 5:00 AM – 6:30 AM (05:00–06:30 h)
 - 4) 6:30 AM – 7:45 AM (06:30– 07:45 h)
 - 3) 7:45 AM – 9:45 AM (07:45–09:45 h)
 - 2) 9:45 AM – 11:00 AM (09:45–11:00 h)
 - 1) 11:00 AM – 12 noon (11:00–12:00 h)
- 2) Approximately what time would you go to bed if you were entirely free to plan your evening?
 - 5) 8:00 PM–9:00 PM (20:00–21:00 h)
 - 4) 9:00 PM–10:15 PM (21:00–22:15 h)
 - 3) 10:15 PM–12:30 AM (22:15–00:30 h)
 - 2) 12:30 AM–1:45 AM (00:30–01:45 h)
 - 1) 1:45 AM–3:00 AM (01:45–03:00 h)
- 3) If you usually have to get up at a specific time in the morning, how much do you depend on an alarm clock?
 - 4) Not at all
 - 3) Slightly
 - 2) Somewhat
 - 1) Very much
- 4) How easy do you find it to get up in the morning (when you are not awakened unexpectedly)?
 - 1) Very difficult
 - 2) Somewhat difficult
 - 3) Fairly easy
 - 4) Very easy
- 5) How alert do you feel during the first half hour after you wake up in the morning?
 - 1) Not at all alert
 - 2) Slightly alert
 - 3) Fairly alert
 - 4) Very alert

- 6) How hungry do you feel during the first half hour after you wake up?
- 1) Not at all hungry
 - 2) Slightly hungry
 - 3) Fairly hungry
 - 4) Very hungry
- 7) During the first half hour after you wake up in the morning, how do you feel?
- 1) Very tired
 - 2) Fairly tired
 - 3) Fairly refreshed
 - 4) Very hungry
- 8) If you had no commitments the next day, what time would you go to bed compared to your usual bedtime?
- 4) Seldom or never later
 - 3) Less than 1 hour later
 - 2) 1-2 hours later
 - 1) More than 2 hours later
- 9) You have decided to do physical exercise. A friend suggests that you do this for one hour twice a week, and the best time for him is between 7-8 AM (07-08 h). Bearing in mind nothing but your own internal "clock," how do you think you would perform?
- 4) Would be in good form
 - 3) Would be in reasonable form
 - 2) Would find it difficult
 - 1) Would find it very difficult
- 10) At approximately what time in the evening do you feel tired, and, as a result, in need of sleep?
- 5) 8:00 PM–9:00 PM (20:00–21:00 h)
 - 4) 9:00 PM–10:15 PM (21:00–22:15 h)
 - 3) 10:15 PM–12:45 AM (22:15–00:45 h)
 - 2) 12:45 AM–2:00 AM (00:45–02:00 h)
 - 1) 2:00 AM–3:00 AM (02:00–03:00 h)
- 11) You want to be at your peak performance for a test that you know is going to be mentally exhausting and will last two hours. You are entirely free to plan your day. Considering only your "internal clock," which one of the four testing times would you choose?
- 6) 8 AM–10 AM (08–10 h)
 - 4) 11 AM–1 PM (11–13 h)
 - 2) 3 PM–5 PM (15–17 h)
 - 0) 7 PM–9 PM (19–21 h)
- 12) If you got into bed at 11 PM (23 h), how tired would you be?
- 0) Not at all tired
 - 2) A little tired
 - 3) Fairly tired
 - 5) Very tired
- 13) For some reason you have gone to bed several hours later than usual, but there is no need to get up at any particular time the next morning. Which one of the following are you most likely to do?
- 4) Will wake up at usual time, but will not fall back asleep
 - 3) Will wake up at usual time and will doze thereafter
 - 2) Will wake up at usual time, but will fall asleep again
 - 1) Will not wake up until later than usual
- 14) One night you have to remain awake between 4-6 AM (04-06 h) in order to carry out a night watch. You have no commitments the next day. Which one of the alternatives would suit you best?
- 1) Would not go to bed until the watch is over
 - 2) Would take a nap before and sleep after
 - 3) Would take a good sleep before and nap after
 - 4) Would sleep only before the watch
- 15) You have two hours of hard physical work. You are entirely free to plan your day. Considering only your internal "clock," which of the following times would you choose?
- 4) 8 AM–10 AM (08–10 h)
 - 3) 11 AM–1 PM (11–13 h)
 - 2) 3 PM–5 PM (15–17 h)
 - 1) 7 PM–9 PM (19–21 h)

- 16) You have decided to do physical exercise. A friend suggests that you do this for one hour twice a week. The best time for her is between 10-11 PM (22-23 h). Bearing in mind only your internal “clock,” how well do you think you would perform?
- 1) Would be in good form
 - 2) Would be in reasonable form
 - 3) Would find it difficult
 - 4) Would find it very difficult
- 17) Suppose you can choose your own work hours. Assume that you work a five-hour day (including breaks), your job is interesting, and you are paid based on your performance. At approximately what time would you choose to begin?
- 5) 5 hours starting between 4–8 AM (05–08 h)
 - 4) 5 hours starting between 8–9 AM (08–09 h)
 - 3) 5 hours starting between 9 AM–2 PM (09–14 h)
 - 2) 5 hours starting between 2–5 PM (14–17 h)
 - 1) 5 hours starting between 5 PM–4 AM (17–04 h)
- 18) At approximately what time of day do you usually feel your best?
- 5) 5–8 AM (05–08 h)
 - 4) 8–10 AM (08–10 h)
 - 3) 10 AM–5 PM (10–17 h)
 - 2) 5–10 PM (17–22 h)
 - 1) 10 PM–5 AM (22–05 h)
- 19) One hears about “morning types” and “evening types.” Which one of these types do you consider yourself to be?
- 6) Definitely a morning type
 - 4) Rather more a morning type than an evening type
 - 2) Rather more an evening type than a morning type
 - 1) Definitely an evening type

SECTION C

The following questions are about your dietary behavior. Please choose one of the choices and circle it.

- 1 = Everyday
- 2 = 4–6 days a week
- 3 = 2–3 days a week
- 4 = Once a week
- 5 = 1–3 times a month
- 6 = Never/less than once a month

No	Statements	Scales					
1a	How frequent do you consume <u>breakfast</u> ?	1	2	3	4	5	6
1b	How frequent do you consume <u>morning tea</u> ?	1	2	3	4	5	6
1c	How frequent do you consume <u>lunch</u> ?	1	2	3	4	5	6
1d	How frequent do you consume <u>afternoon tea</u> ?	1	2	3	4	5	6
1e	How frequent do you consume <u>dinner</u> ?	1	2	3	4	5	6
1f	How frequent do you consume <u>supper</u> ?	1	2	3	4	5	6
2	Please list out <u>3 types of foods or beverages</u> that you usually take in between of main meals (snacks, e.g. tea, milk, <i>kuih</i> , ais cream, fruits, <i>pisang goreng</i> etc.) and its <u>frequency</u> of consumption.						
	i.	1	2	3	4	5	6
	ii.	1	2	3	4	5	6
	iii.	1	2	3	4	5	6
3	How frequent do you eat at hawker centers, coffee shops or other food stalls?	1	2	3	4	5	6

4	How frequent do you eat at western fast food restaurants (e.g. KFC, McDonald's, Pizza Hut etc.)?	1	2	3	4	5	6
5	How frequent do you buy/take-away food from western fast food restaurants (e.g. KFC, McDonald's, Pizza Hut etc.)?	1	2	3	4	5	6

The next 11 questions ask about food you ate or drank during the past 7 days. Think about all the meals and snacks you had from the time you got up until you went to bed. Be sure to include food you ate at home, at university, at college, at restaurants, or anywhere else.

1. During the past 7 days, how many times did you drink 100% fruit juices such as orange juice, apple

- | | |
|--|----------------------------|
| A. I did not drink 100% fruit juice during the past 7 days | E. 2 times per day |
| B. 1 to 3 times during the past 7 days | F. 3 times per day |
| C. 4 to 6 times during the past 7 days | G. 4 or more times per day |

D. 1 time per day

juice, or grape juice? (Do not count punch, sports drinks, or other fruit-flavored drinks.)

2. During the past 7 days, how many times did you eat fruit? (Do not count fruit juice.)

- | | |
|---|----------------------------|
| A. I did not eat fruit during the past 7 days | E. 2 times per day |
| B. 1 to 3 times during the past 7 days | F. 3 times per day |
| C. 4 to 6 times during the past 7 days | G. 4 or more times per day |

D. 1 time per day

3. During the past 7 days, how many times did you eat bread, rice, mi, or mihun?

- | | |
|---|----------------------------|
| A. I did not eat bread, rice, mi, or mihun during the past 7 days | E. 2 times per day |
| B. 1 to 3 times during the past 7 days | F. 3 times per day |
| C. 4 to 6 times during the past 7 days | G. 4 or more times per day |

D. 1 time per day

4. During the past 7 days, how many times did you eat meat or chicken?

- | | |
|---|----------------------------|
| A. I did not eat meat or chicken during the past 7 days | E. 2 times per day |
| B. 1 to 3 times during the past 7 days | F. 3 times per day |
| C. 4 to 6 times during the past 7 days | G. 4 or more times per day |

D. 1 time per day

5. During the past 7 days, how many times did you eat fish?

- | | |
|--|----------------------------|
| A. I did not eat fish during the past 7 days | E. 2 times per day |
| B. 1 to 3 times during the past 7 days | F. 3 times per day |
| C. 4 to 6 times during the past 7 days | G. 4 or more times per day |

D. 1 time per day

6. During the past 7 days, how many times did you eat vegetables?

- | | |
|--|----------------------------|
| A. I did not eat vegetables during the past 7 days | E. 2 times per day |
| B. 1 to 3 times during the past 7 days | F. 3 times per day |
| C. 4 to 6 times during the past 7 days | G. 4 or more times per day |

D. 1 time per day

7. During the past 7 days, how many times did you eat legumes (e.g. lentils, peanuts, peas, beans)?

- | | |
|---|----------------------------|
| A. I did not eat legumes during the past 7 days | E. 2 times per day |
| B. 1 to 3 times during the past 7 days | F. 3 times per day |
| C. 4 to 6 times during the past 7 days | G. 4 or more times per day |

D. 1 time per day

8. During the past 7 days, how many times did you drink a can, bottle, or glass of soft drink, such as Coke, Pepsi, or Sprite? (Do not count sports drink)

- A. I did not drink soft drink during the past 7 days
- B. 1 to 3 times during the past 7 days
- C. 4 to 6 times during the past 7 days
- D. 1 time per day
- E. 2 times per day
- F. 3 times per day
- G. 4 or more times per day

9. During the past 7 days, how many times did you drink a can, bottle, or glass of a sports drink such as RedBull, 100Plus Isotonic Drink, Revive, Power Root, Isomax or Livita?

- A. I did not drink sports drinks during the past 7 days
- B. 1 to 3 times during the past 7 days
- C. 4 to 6 times during the past 7 days
- D. 1 time per day
- E. 2 times per day
- F. 3 times per day
- G. 4 or more times per day

10. During the past 7 days, how many times did you drink a bottle or glass of plain water? (Count tap, bottled, and unflavored sparkling water.)

- A. I did not drink water during the past 7 days
- B. 1 to 3 times during the past 7 days
- C. 4 to 6 times during the past 7 days
- D. 1 time per day
- E. 2 times per day
- F. 3 times per day
- G. 4 or more times per day

11. During the past 7 days, how many glasses of milk did you drink? (Count the milk you drank in a glass or cup, from a carton, or with cereal.)

- A. I did not drink milk during the past 7 days
- B. 1 to 3 glasses during the past 7 days
- C. 4 to 6 glasses during the past 7 days
- D. 1 glass per day
- E. 2 glasses per day
- F. 3 glasses per day
- G. 4 or more glasses per day

SECTION D (Fill by researcher)

Anthropometry Measurement

Measurement	Reading 1	Reading 2	Average
Weight (kg)			
Height (cm)			
Body Fat Percentage (%)			
Waist circumference (cm)			

Blood Pressure level

Measurement	Reading 1	Reading 2	Average
Diastolic blood pressure (mmHg)			
Systolic blood pressure (mmHg)			

24-Hour Dietary Recall (weekday)

Date of interview: _____		Name of respondent: _____		I/D No. _____	
<i>(circle the recall day)</i>					
Recall day	1. Monday	2. Tuesday	3. Wednesday	4. Thursday	5. Friday
	6. Saturday	7. Sunday			
Time / Location	Food/Drink	Quantity eaten	Details of food and drink		

24-Hour Dietary Recall (weekend)

Date of interview: _____		Name of respondent: _____		I/D No. _____	
(circle the recall day)					
Recall day	1. Monday	2. Tuesday	3. Wednesday	4. Thursday	5. Friday
					6. Saturday
					7. Sunday

Time / Location	Food/Drink	Quantity eaten	Details of food and drink

**END OF QUESTIONNAIRE THANK YOU
FOR YOUR PARTICIPATION AND COOPERATION**