ASSOCIATION BETWEEN CHRONONUTRITION AND NUTRITION QUALITY OF LIFE (NQoL) AMONG UNDERGRADUATE STUDENTS AT UNIVERSITI SAINS MALAYSIA.

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LIST OF ABBREVATION

BMI	Body Mass Index
CPQ-M	Chrononutrition Profile Questionnaire – Malay Version
HREC	Human Research Ethics Committee
ICC	Intraclass Correlation Coefficient
NQoL	Nutrition Quality of Life
SPSS	Statistical Package for the Social Sciences
USMKK	Universiti Sains Malaysia Health Campus

HUBUNGAN ANTARA KRONONUTRISI DAN KUALITI HIDUP PEMAKANAN (NQoL) DALAM KALANGAN PELAJAR PRASISWAZAH DI UNIVERSITI SAINS MALAYSIA

ABSTRAK

Krononutrisi merujuk kepada masa, kekerapan dan keteraturan pengambilan makanan berkaitan dengan ritma sirkadian badan, semakin mendapat perhatian disebabkan oleh potensinya dalam mempengaruhi hasil kesihatan. Walau bagaimanapun, bukti mengenai hubungannya dengan Kualiti Hidup Berkaitan Pemakanan (Nutrition Quality of Life, NQoL) dalam kalangan pelajar universiti masih terhad. Oleh itu, kajian ini bertujuan untuk menilai profil krononutrisi, menentukan NQoL, dan menilai hubungan antara parameter profil krononutrisi dengan NQoL dalam kalangan pelajar prasiswazah di Universiti Sains Malaysia. Kajian keratan rentas telah dijalankan terhadap 100 orang pelajar prasiswazah berumur 18 hingga 25 tahun yang direkrut menggunakan kaedah persampelan mudah bukan kebarangkalian. Data dikumpulkan menggunakan Soal Selidik Profil Krononutrisi versi Bahasa Melayu (Chrononutrition Profile Questionnaire-Malay version, CPQ-M) dan soal selidik Kualiti Hidup Berkaitan Pemakanan versi Bahasa Melayu. Statistik deskriptif digunakan untuk menerangkan profil krononutrisi dan NQoL, manakala analisis varians satu hala (ANOVA) digunakan untuk menilai hubungan dengan membandingkan skor min NQoL merentasi kategori bagi setiap parameter krononutrisi. Skor min keseluruhan NQoL ialah 3.72 ± 0.43, dengan 65.0% peserta diklasifikasikan mempunyai NQoL yang baik. Kebanyakan peserta menunjukkan tingkah laku tempoh pengambilan makanan dan pengambilan makanan pada waktu malam yang baik, manakala tingkah laku melangkau sarapan kebanyakannya berada dalam kategori buruk dan pengambilan makanan pada

waktu petang kebanyakannya berada dalam kategori sederhana. Tiada perbezaan yang signifikan dalam skor min NQoL didapati merentasi kategori bagi semua parameter krononutrisi yang dinilai (semua $p > 0.05$). Kesimpulannya, tiada hubungan yang signifikan didapati antara parameter profil krononutrisi dengan NQoL dalam kalangan pelajar prasiswazah di Universiti Sains Malaysia. Kajian lanjut yang melibatkan populasi yang lebih besar dan pelbagai adalah disyorkan untuk memahami dengan lebih lanjut hubungan antara krononutrisi dan NQoL.

ASSOCIATION BETWEEN CHRONONUTRITION AND NUTRITION QUALITY OF LIFE (NQoL) AMONG UNDERGRADUATE STUDENTS AT UNIVERSITI SAINS MALAYSIA

ABSTRACT

Chrononutrition refers to the timing, frequency, and regularity of food intake in relation to the body's circadian rhythm, has gained increasing attention due to its potential influence on health outcomes. However, evidence regarding its relationship with Nutrition Quality of Life (NQoL) among university students remains limited. Therefore, this study aimed to assess chrononutrition profiles, determine NQoL and assess the association between chrononutrition profile parameters and NQoL among undergraduate students at Universiti Sains Malaysia. A cross-sectional study was conducted among 100 undergraduate students aged 18 to 25 years recruited using non-probability convenience sampling. Data were collected using the Chrononutrition Profile Questionnaire-Malay version (CPQ-M) and the Malay version of the Nutrition Quality of Life questionnaire. Descriptive statistics were used to describe the chrononutrition profiles and NQoL, while one-way analysis of variance (ANOVA) was used to assess the association by comparing mean NQoL scores across the categories of each chrononutrition parameter. The mean overall NQoL score was 3.72 ± 0.43, with 65.0% of participants classified as having good NQoL. Most participants demonstrated good eating window and night eating behaviours, whereas breakfast skipping behaviour was predominantly poor and evening eating behaviour was mainly fair. No significant differences in mean NQoL scores were observed across the categories of all assessed chrononutrition parameters ($p > 0.05$). In conclusion, no significant association was

found between chrononutrition profile parameters and NQoL among undergraduate students at Universiti Sains Malaysia. Further studies involving larger and more diverse populations are recommended to better understand the relationship between chrononutrition and NQoL.

CHAPTER 1 INTRODUCTION

1.1 Background of Study

University life is the starting point where students start to live independently. During this period, students start making their own daily decisions. As young adults are adjusting to their new lifestyle along with their busy schedules, they often struggle to maintain good eating habits, as most of them often skip meals, engage in late-night eating, and have a high intake of processed food. Over time, these poor dietary practices can negatively impact physical health, mental health, and even academic success (Almoraie *et al.,* 2024). A recent cross-sectional study among Malaysian university students revealed that 53.4% were overweight or obese, while 7.1% of them were underweight (Varma *et al.,* 2024). Similarly, Almoraie *et al.* (2024) found that 8–12% of students were underweight. These high numbers are concerning as they indicate rising nutritional imbalances among young adults and university students.

Malnutrition can be caused by many factors, including individual chrononutrition behaviour. In recent years, chrononutrition has emerged as an important determinant of health outcomes. Chrononutrition refers to the study of how meal timing interacts with circadian rhythms, which influence metabolism and overall health (Juliana *et al.,* 2023). Good chrononutrition has been shown to improve overall diet quality, weight regulation, and cardiometabolic health, while poorer chrononutrition is linked with circadian misalignment, altered appetite-regulating hormones, higher adipose tissue storage, a higher risk of cancer, hypertension and diabetes mellitus, and elevated high-sensitivity C-reactive protein (Juliana *et al.,* 2023; Wang *et al.,* 2024).

Beyond chrononutrition, Nutrition Quality of Life (NQoL) is also an important construct in understanding how dietary habits can influence overall wellbeing. NQoL refers to self-perceived satisfaction, functioning, and wellbeing related to dietary intake, eating behaviours, nutritional status, and the ability to maintain a healthy diet in daily life

(Lua, Wan Putri Elena, & Shahril Mohd Razif, 2012). NQoL is a multidimensional measure of how nutrition affects overall quality of life. It involves multiple domains, including food impact, self-image, psychological factors, interpersonal factors, physical functioning, and self-efficacy related to nutrition. A study by Dalbudak, Yiğit, and Yılmaz (2020) in Turkey demonstrated that eating behaviours such as cognitive restraint, uncontrolled eating, and emotional eating were significantly associated with students' quality of life across psychological and social domains, highlighting the multidimensional nature of NQoL.

A growing number of studies have shown that poor chrononutrition behaviours are associated with lower quality of life. A multi-country study conducted in Ecuador and Italy in 2023 among students found that late meal timing had a 34% higher chance of reporting poor wellbeing scores and lower food choice satisfaction compared to those who did not (Reytor-González *et al.,* 2023). Another study supported this relationship. A study conducted among Spanish university students found that evening chronotype and late eating habits were related to higher obesity risk and lower wellbeing (López-Minguez, Gómez-Abellán, & Garaulet, 2021). In addition, research by Haszeri Nudin and Rostam (2023) involving 409 college students also found that late-night eating and breakfast skipping were strongly associated with poorer wellbeing. It was reported that individuals with irregular eating schedules had 27% lower nutrition-related quality of life scores.

Despite the rising interest, several limitations were found within the existing studies. Firstly, there is a lack of validated chrononutrition tools in Malaysian student populations. Earlier studies used simple questions such as "Do you skip breakfast?" instead of using validated instruments such as the Chrononutrition Profile Questionnaire (CPQ). As a result, the studies may not fully capture other detailed aspects of meal timing, including the eating window, first meal timing, and snacking after dinner. Additionally, most chrononutrition studies in Malaysia and globally have studied BMI,

sleep, metabolic biomarkers, or diet quality. Only a limited number of studies have explored the effects of chrononutrition on NQoL. With increasing patterns of meal skipping, irregular schedules, and obesity among Malaysian university students, this study aims to close the gap by examining the association between chrononutrition and nutrition quality of life among university students.

1.2 Problem Statement

Unhealthy eating behaviours including breakfast skipping, irregular meal timing and late-night eating were very common among university students despite being linked to poor health and reduced wellbeing (Varma *et al.,* 2024; Almoraie *et al.,* 2024; Karyadi *et al.,* 2023). There has been emerging evidence that meal timing is as important as food choice. Chrononutrition, which is the study of meal timing and circadian rhythm, has been found to be linked to sleep disturbance, metabolic dysregulation and lower overall health (Juliana *et al.,* 2023; Wang *et al.,* 2024; López-Mínguez *et al.,* 2021). Despite these findings, only a few studies have examined Nutrition Quality of Life (NQoL), a construct of perceived wellbeing and satisfaction with dietary behaviour, as an outcome of chrononutrition among Malaysian university students (Lua *et al.,* 2012; Haszeri Nudin & Rostam, 2023; Gan *et al.,* 2023). In addition, most existing studies only use non-validated single items to measure eating timing, which fail to capture the complex behaviours of chrononutrition such as eating window, first meal timing and last meal timing.

Given the rising nutritional imbalance and irregular eating behaviours among Malaysian undergraduates, a study on the association between chrononutrition and NQoL using validated tools (CPQ-M and NQoL Malay Questionnaire) is needed. The findings from this study may deepen the understanding of student wellbeing and could also support future targeted interventions in university settings.

1.3 Study Objectives

1.3.1 General Objectives

To assess the association between chrononutrition and Nutrition Quality of Life among undergraduate students at Universiti Sains Malaysia.

1.3.2 Specific Objectives

1. To assess the chrononutrition profiles among undergraduate USM students using the CPQ-M questionnaire.

2. To determine the Nutrition Quality of Life among undergraduate USM students using the NQoL questionnaire.

3. To assess the association between chrononutrition parameters and Nutrition Quality of Life (NQoL) among undergraduate students at Universiti Sains Malaysia?

1.4 Study Hypothesis

Null Hypothesis (H_0)

There is no significant association between chrononutrition and Nutrition Quality of Life among undergraduate students at Universiti Sains Malaysia.

Alternative Hypothesis (H_A)

There is a significant association between chrononutrition and Nutrition Quality of Life among undergraduate students at Universiti Sains Malaysia.

1.5 Research Questions

1. What are the chrononutrition profiles among undergraduate students at Universiti Sains Malaysia?

2. What is the level of Nutrition Quality of Life (NQoL) among undergraduate students at Universiti Sains Malaysia?

3. Is there a significant association between chrononutrition parameters and Nutrition Quality of Life (NQoL) among undergraduate students at Universiti Sains Malaysia?

1.6 Significance of Study

This study aims to contribute to a deeper understanding of how chrononutrition behaviours influence NQoL among undergraduate university students. As previous studies focused on the effects of meal timing on physical health outcomes, including body mass index and sleep quality, limited research has examined the relationship between meal timing and students' perceived nutritional wellbeing. Therefore, by investigating this association, the knowledge gap in nutrition and public health can be filled, particularly among Malaysian university students.

The findings from this study will also help increase awareness of the importance of practising good meal timing and regular eating patterns, which may encourage healthier daily routines among young adults in Malaysia. It will also help students understand how chrononutrition affects NQoL. As a result, it may motivate them to adopt consistent eating habits, which may improve their dietary satisfaction, psychological wellbeing, and overall quality of life during their academic years.

Meanwhile, for healthcare professionals and university health services, the findings of this study may benefit them by providing evidence-based information that can be used to develop targeted nutrition education programmes and student wellness

interventions. Furthermore, this study will benefit researchers and future scholars by contributing local data on chrononutrition and NQoL among Malaysian university students using validated tools (CPQ and NQoL). The findings may serve as useful references for future studies and support the development of policies that promote healthier eating behaviours in university settings.

CHAPTER 2 LITERATURE REVIEW

2.1 Eating Behaviours and Nutritional Status Among University Students

University students frequently adopt unhealthy eating behaviours due to irregular schedules, financial status and independent living (Almoraie *et al.,* 2024). In Malaysia, eating behaviours including breakfast skipping, irregular meal timing, late-night eating, and consumption of convenience foods were reported to be frequent among university students (Gan *et al.,* 2023; Varma *et al.,* 2024). These eating behaviours are alarming as they have been linked with poor nutritional status among Malaysian university students. Nutritional status reflects the balance between energy intake and the body's physiological demands, and it is commonly assessed using weight-related indicators such as underweight, overweight, and obesity (Varma *et al.,* 2024). In Malaysia, a study by Varma *et al.* (2024) found that 53% of undergraduates were overweight or obese, while 7.1% were underweight. Similarly, global findings reported that poor eating behaviours among university students were associated with fatigue, stress, and decreased academic performance (Karyadi *et al.,* 2023). These findings highlighted that nutrition problems are not solely influenced by nutrient quality and quantity but also by individual eating behaviours, as irregular eating patterns may disrupt appetite regulation, energy balance, and daily functioning (Juliana *et al.,* 2023; López-Mínguez *et al.,* 2021).

2.2 Chrononutrition and Its Relationship with Health

Chrononutrition refers to the study of meal timing in relation to the body's internal biological clock. Meal timing may influence glucose regulation, energy metabolism and body weight (Juliana *et al.,* 2023). Poor chrononutrition behaviours may disrupt circadian rhythms and affect appetite regulation. These behaviours may also increase the risk of weight gain and cardiometabolic problems (McHill & Wright, 2019; Wang *et al.,* 2024). Among university students, chrononutrition behaviours may be affected by late study

hours, irregular daily routines, and psychosocial stress. In Malaysia, irregular meal timing and late eating have been associated with poorer sleep quality and higher stress levels among university students (Gan *et al.,* 2023). Therefore, understanding meal timing is important in addition to assessing what students eat.

Several studies have examined chrononutrition behaviours among university students in Malaysia. Juliana *et al.* (2023) studied the chrononutrition profile of 409 college students. Only 33.0% of the students consumed breakfast daily. Lunch was the largest meal of the day for 75.8% of the students. The mean frequency of snacking after the last meal was 3.23 ± 2.01 days per week. Most students (70.9%) did not wake up at night to eat. The study also found significant associations between BMI and eating window, evening latency, evening eating, and night eating. Underweight students had poorer behaviours in these four chrononutrition domains. These findings suggest that meal timing behaviours may be related to nutritional status among Malaysian college students (Juliana *et al.,* 2023).

Another Malaysian study by Khairina & Nudin (n.d.) examined chrononutrition behaviours among 336 university students. The study found that 45.2% of students had a good eating window. However, breakfast skipping was common, with 61.9% of students classified as having poor breakfast-skipping behaviour. In addition, 65.5% of students had fair evening-latency behaviour. In contrast, night-eating behaviour was generally good, with 88.1% of students classified as having good behaviour. Lunch was the largest meal for most students, while only 3.6% of students reported breakfast as their largest meal. These findings indicate that although some chrononutrition behaviours were favourable, breakfast skipping and some unfavourable meal-timing behaviours were common among Malaysian university students (Khairina & Nudin, n.d.).

Similar findings have been reported among university students outside Malaysia. Muntean *et al.* (2026) conducted a prospective observational study involving 921 university students aged 18–24 years. The study found that 29.8% of students consumed

breakfast daily, while 70.2% were breakfast skippers. However, breakfast skipping was not significantly associated with BMI trajectory. The study also found no significant difference in BMI trajectory according to late eating. These findings suggest that although unfavourable chrononutrition behaviours were common, their relationship with changes in BMI may differ between student populations (Muntean *et al.,* 2026).

When comparing the findings, breakfast skipping appears to be a common chrononutrition behaviour among university students. In Malaysia, only 33.0% of students in the study by Juliana *et al.* (2023) consumed breakfast daily. Similarly, 61.9% of students in the study by Nudin and Rostam (2023) had poor breakfast-skipping behaviour. Among Romanian university students, 70.2% were breakfast skippers (Muntean *et al.,* 2026). However, other chrononutrition behaviours showed different patterns. For example, night-eating behaviour was generally favourable among Malaysian students. In contrast, eating window and evening-related behaviours were less favourable among some students. These differences may reflect variations in student populations and eating patterns.

Overall, the evidence indicates that unfavourable chrononutrition behaviours are common among university students. Breakfast skipping appears to be one of the most commonly reported behaviours across Malaysian and international studies. Malaysian research has also shown relationships between several chrononutrition behaviours and BMI, while international evidence has reported inconsistent findings regarding BMI. In addition, irregular meal timing and late eating have been associated with sleep quality and stress among Malaysian university students. Therefore, chrononutrition may have important implications for students' nutritional status and overall health.

2.3 Nutrition Quality of Life (NQoL)

Nutrition Quality of Life (NQoL) is a multidimensional concept that describes how diet and nutrition influence overall wellbeing, satisfaction, and daily functioning (Lua *et al.,* 2012). NQoL includes six domains, namely food impact, self-image, psychological functioning, social relationships, physical functioning, and self-efficacy in managing nutrition. Higher NQoL has been associated with healthier eating behaviours and better psychological wellbeing (Livingstone *et al.,* 2020; Wahl & Gross, 2021). In contrast, emotional eating, uncontrolled eating, and irregular eating habits have been associated with lower NQoL and poorer life satisfaction (Dalbudak *et al.,* 2020).

NQoL is an important concern among university students due to changes in lifestyle and eating habits during university life. Vázquez-Aguilar *et al.* (2026) reported that university students commonly showed high consumption of ultra-processed foods, low adherence to healthy dietary patterns, irregular meal timing, and frequent snacking. These dietary and lifestyle behaviours may increase nutritional risks and negatively affect wellbeing. In contrast, healthier dietary patterns may support energy levels, psychological wellbeing, and healthier lifestyle behaviours (Vázquez-Aguilar *et al.,* 2026).

Evidence from Malaysia also suggests that NQoL varies among university students. Lua *et al.* (2012) assessed NQoL among Malaysian undergraduates aged 18 to 24 years and reported a mean total NQoL score of 3.52. This score was used to classify students into poor and good NQoL groups. The findings indicate that poor NQoL exists among Malaysian university students and highlight the need to identify factors that may influence their nutrition-related wellbeing.

Eating behaviours and meal timing may be important factors related to NQoL. Demirel *et al.* (2026) found that disrupted circadian rhythms were associated with higher emotional eating, while poor meal timing was associated with less favourable nutrition attitudes. The study also reported an association between cortisol dysregulation and poorer psychological functioning. These findings suggest that the timing of food intake may influence both eating behaviours and psychological aspects of nutrition-related wellbeing.

Chrononutrition may therefore be relevant to NQoL because it examines the timing and regularity of food intake in relation to the body's biological rhythms. It includes meal frequency, meal regularity, eating window, breakfast skipping, evening eating, night eating, and the timing of meals in relation to sleep. These behaviours reflect how individuals organise their eating patterns in daily life and may influence different aspects of nutrition-related wellbeing.

This issue may be particularly relevant among university students. A study among IIUM Kuantan students by Azahari (n.d.) reported that academic demands and late-night commitments may contribute to poor chrononutrition behaviours. The students commonly reported breakfast skipping and late evening eating. The study also found that most students had poor diet quality. However, no significant association was found between the measured chrononutrition profiles and diet quality (Azahari, n.d.). This suggests that the relationship between chrononutrition and nutrition-related outcomes may not be consistent and warrants further investigation.

A systematic review by Almahasneh *et al.* (2026) further reported that later meal timing and irregular eating patterns, including meal skipping, were associated with poorer sleep quality, later chronotype, and social jetlag in several studies. These patterns may be common among university students because of social activities and late-night academic commitments. Irregular eating may contribute to circadian misalignment and affect sleep, while poor sleep may also increase the likelihood of skipping breakfast. This

suggests a complex relationship between meal timing, eating behaviours, and wellbeing among university students.

Despite the importance of NQoL, previous studies have mainly examined its relationship with diet quality, nutrient intake, and eating behaviours rather than circadian-related eating patterns (Dalbudak *et al.,* 2020; Gan *et al.,* 2023)

2.4 Chrononutrition and Wellbeing

Previous studies have shown that poor chrononutrition behaviours can negatively affect individuals' wellbeing. A study in Ecuador and Italy reported that late meal timing lowered food satisfaction by 34% and increased the risk of poor wellbeing (Reytor González *et al.,* 2023). Similarly, a study conducted in Spain by López-Mínguez *et al.* (2021) among students found that later eating habits and evening chronotypes were linked to higher obesity risk and lower psychological wellbeing. In Malaysia, Haszeri Nudin and Rostam (2023) reported that late-night eating and skipping breakfast were linked to poorer wellbeing. Gan *et al.* (2023) also found that irregular meal timing was linked to higher stress and poorer sleep. However, these studies assessed general wellbeing or sleep and not specifically NQoL. Thus, it is clear that chrononutrition affects overall wellbeing; however, its link to NQoL is still under-studied.

2.5 Research Gap

Current literature reveals three main gaps. First, most chrononutrition studies in Malaysia focus on BMI, metabolic health, sleep, or stress instead of NQoL as an outcome (Gan *et al.,* 2023; Juliana *et al.,* 2023). Second, many studies use single items instead of using validated tools that measure full chrononutrition behaviours, such as the Chrononutrition Profile Questionnaire (CPQ). Third, to the best of the researcher's knowledge, there is no published study in Malaysia that has examined the link between

chrononutrition and NQoL using validated tools. Therefore, this study is needed to fill the gap by examining chrononutrition behaviours and NQoL using CPQ-M and validated NQoL instruments.

2.6 Conceptual Framework

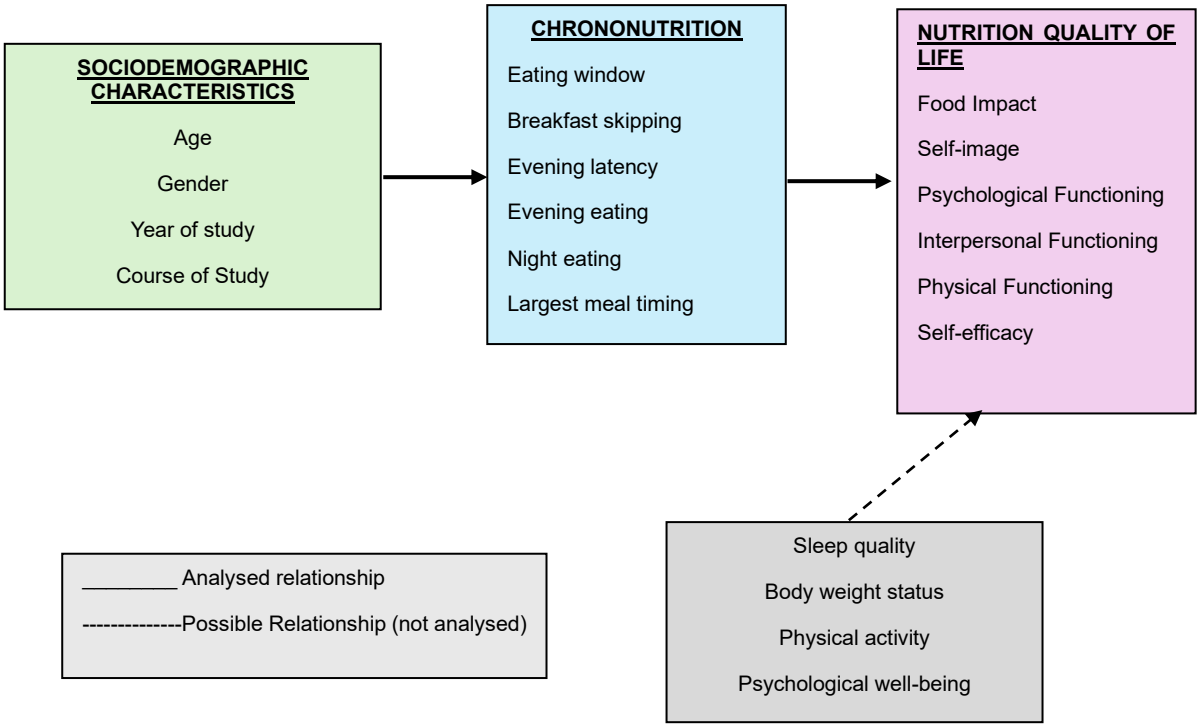

Figure 1: Conceptual Framework illustrating the Association between Chrononutrition and Nutrition Quality of Life

This conceptual framework shows how sociodemographic characteristics may influence the relationship between chrononutrition behaviours and Nutrition Quality of Life (NQoL) among undergraduate students. Chrononutrition behaviours, including eating window, breakfast skipping, evening latency, evening eating, night eating, and timing of the largest meal, serve as the independent variables (Juliana *et al.,* 2023). NQoL functions as the dependent variable, encompassing domains such as food impact, self-image, psychological functioning, interpersonal functioning, and physical functioning (Lua *et al.,* 2012). Sociodemographic factors, namely age, gender, year of study, and

course of study, are collected to describe the study population but only act as background factors that may indirectly influence students' chrononutrition behaviours and NQoL. These variables are not included in the main statistical analysis. Other factors such as sleep quality, body weight status, physical activity, and psychological well-being have also been shown to influence students' quality of life (Al-Jawarneh *et al.,* 2025; Gan *et al.,* 2009; Çiçek, 2018; Vasco *et al.,* 2025). However, these influences are not examined in the present study and are acknowledged as potential unmeasured confounders.

CHAPTER 3 RESEARCH METHODOLOGY

3.1 Study Design

This study applied a cross-sectional observational study design to examine the association between chrononutrition behaviours and Nutrition Quality of Life (NQoL) among university students. A cross-sectional design is suitable for studying the association between chrononutrition and Nutrition Quality of Life within a defined population at a single point in time, as it is time-efficient, practical, and suitable for identifying associations and providing a detailed overview of students' eating patterns.

3.2 Study Location

This study was conducted at Universiti Sains Malaysia (USM), Health Campus, Kubang Kerian, Kelantan. The Health Campus consists of students with different backgrounds and ethnicities, which may influence eating behaviours. Thus, it is a good setting to investigate chrononutrition behaviours and Nutrition Quality of Life among university students, as it provides a diverse student population. Additionally, Universiti Sains Malaysia students from the Health Campus are exposed to health and wellness topics; therefore, their perspectives may offer unique insights.

3.3 Target Population

The target population of this study consisted of selected undergraduate students from the School of Health Sciences, School of Dental Sciences, and School of Medical Sciences at Universiti Sains Malaysia (USM), Health Campus, specifically those aged 18–25 years.

3.4 Selection Criteria

3.4.1 Inclusion Criteria

1. Undergraduate students at Universiti Sains Malaysia, Health Campus, Kubang Kerian, Kelantan.

2. Age range between 18-25 years old.

3. Understand Malay language.

3.4.2 Exclusion Criteria

1. Students who were currently enrolled in Dietetics or Nutrition programmes.
2. Students with self-reported diagnosed medical conditions affecting eating patterns (e.g., eating disorders, endocrine disorders such as thyroid disease).
3. Students currently on medications that significantly alter appetite or circadian rhythm (e.g., corticosteroids, sleep medications).
4. Students who were pregnant or lactating.

3.5 Sampling Method

This study used a non-probability convenience sampling technique. This method was chosen to recruit eligible participants who were readily accessible and willing to participate from the target population of university students at the USM Health Campus. Convenience sampling was chosen as participants was selected based on their accessibility and willingness to participate. This method was considered suitable for this study as it provided a practical approach for recruiting participants within the available time and resources.

The poster and the questionnaire link were distributed to class representatives from the School of Medical Sciences, School of Dental Sciences, and School of Health Sciences via electronic communication. The class representatives then shared the poster and the questionnaire link to their respective class groups, allowing eligible students who were accessible through these groups to voluntarily participate in the study. Participants who voluntarily provided informed consent and met the established inclusion and exclusion criteria were recruited into the study. Prior to participation, study participants were thoroughly informed about the research objectives, procedures, and potential risks through the provided information sheet and consent form. They were also required to complete the study questionnaire.

3.6 Sample Size Calculation

Sample size was calculated separately for each study objective. A 95% confidence level (Z = 1.96) and 80% statistical power (Zβ = 0.84) were applied, as recommended for health and nutrition research (Naing *et al.,* 2006; Pourhoseingholi *et al.,* 2013). A 10% allowance for non-response was added to each calculated sample size to account for incomplete or missing responses (Naing *et al.,* 2006). The largest calculated sample size was selected as the final minimum sample size for this study.

Objective 1: To assess the chrononutrition profiles among undergraduate USM students using the CPQ-M questionnaire.

For this descriptive objective, the sample size was estimated using the single-proportion formula for prevalence studies (Naing *et al.,* 2006):

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

Where:

n = required sample size

Z = 1.96 (95% confidence level)

p = anticipated prevalence

Δ = margin of error (precision)

A study among Malaysian university students reported that 31.8% of students skipped breakfast regularly (Jayaveloo *et al.,* 2021). Therefore, p = 0.318 was used for the calculation. A margin of error of ±10% (Δ = 0.10) was applied, which is acceptable for descriptive cross-sectional studies with feasibility constraints (Naing *et al.,* 2006).

$$n = \frac{(1.96)^2 \times 0.318 \times (1-0.318)}{(0.10)^2}$$

$$n = \frac{3.8416 \times 0.318 \times 0.682}{0.01} = \frac{0.833}{0.01} = 83.3 \approx 84$$

After adjusting for 10% non-response:

$$n_{adj} = \frac{84}{0.9} = 93.3 \approx 94$$

The sample size required for Objective 1 was 94 students.

Objective 2: To determine the Nutrition Quality of Life (NQoL) among undergraduate USM students using the NQoL questionnaire.

For this objective, the single-mean formula was used (Naing *et al.,* 2006):

$$n = \left(\frac{Z \times \sigma}{\Delta}\right)^2$$

Where:

Z = 1.96

σ = standard deviation of the NQoL score

Δ = margin of error around the mean

A Malaysian study among undergraduate students reported a mean total NQoL score of 3.52 with a standard deviation of 0.30 using a validated NQoL questionnaire (Lua *et al.,* 2012). Therefore, σ = 0.30 was used. A margin of error of ±0.20 was applied, which is appropriate for quality-of-life outcomes measured on a 1–5 Likert scale (Pourhoseingholi *et al.,* 2013).

$$n = \left(\frac{1.96 \times 0.30}{0.20}\right)^2 = (2.94)^2 = 8.64 \approx 9$$

After adjusting for 10% non-response:

$$n_{adj} = \frac{9}{0.9} = 10$$

The sample size required for Objective 2 was 10 students.

Objective 3: To assess the association between chrononutrition parameters and Nutrition Quality of Life (NQoL) among undergraduate students at Universiti Sains Malaysia.

For this analytical objective, the sample size was calculated using the comparison of two means formula, which provides a conservative and widely accepted estimate for detecting differences in mean outcome scores between groups (Naing *et al.,* 2006; Pourhoseingholi *et al.,* 2013):

$$n = \frac{2(Z_\alpha + Z_\beta)^2 \sigma^2}{\Delta^2}$$

Where:

Zα = 1.96 (95% confidence level)

Zβ = 0.84 (80% power)

σ = standard deviation of the NQoL score

Δ = minimum expected difference in mean NQoL score

Based on findings among Malaysian undergraduate students, the standard deviation of the total NQoL score was 0.30 (Lua *et al.,* 2012). A minimum expected difference (Δ) of 0.30 was used, representing a moderate and practically meaningful difference in NQoL scores between chrononutrition categories, which is commonly accepted in quality-of-life research (Pourhoseingholi *et al.,* 2013).

$$n = \frac{2(1.96 + 0.84)^2 (0.30)^2}{(0.30)^2}$$

$$n = \frac{2(2.80)^2 (0.09)}{0.09} = 15.68 \approx 16 \text{ students per group}$$

Thus, the total sample size required for two comparison groups was:

$$16 \times 2 = 32$$

After adjusting for 10% non-response:

$$n_{adj} = \frac{32}{0.9} = 35.6 \approx 36$$

The sample size required for Objective 3 was 36 students.

The largest calculated sample size, 94 students was used as the minimum required sample size for this study to adequately address all study objectives.

3.7 Study Instruments

This research used the Malay version of the Chrononutrition Profile Questionnaire (CPQ-M) and the Malay Nutrition Quality of Life (NQoL) questionnaire. Both questionnaires were administered through an online platform using Google Forms. The Google Form consisted of a participant information sheet, an electronic informed consent section, sociodemographic questions, the CPQ-M, and the NQoL questionnaire. After providing electronic informed consent, participants continued to complete the whole questionnaire.

The sociodemographic questionnaire collected information on participants' age, gender, year of study, and course of study. The course of study included Audiology, Biomedicine, Forensic Science, Medical Radiation, Nursing, Environmental and Occupational Health, Speech Pathology, Exercise and Sport Science, Medicine, and Dentistry. The sociodemographic information was collected to describe the characteristics of the study participants.

CPQ-M, developed by Hairudin, Teng, and Juliana (2023), was used to assess students' chrononutrition behaviours. The CPQ-M is a culturally adapted and validated Malay version of the original Chrononutrition Profile Questionnaire developed by Veronda, Allison, Crosby, and Irish (2020). The CPQ was designed to assess the frequency of breakfast consumption, timing of first and last meals, eating window duration, regularity of meals, late-night eating, and post-dinner snacking. The CPQ-M is a validated and reliable tool for assessing chrononutrition behaviours in young adult and adult populations in Malaysia. Reliability testing of the CPQ-M demonstrated good to excellent test–retest reliability, with intraclass correlation coefficients (ICC) ranging from 0.50 to 0.90, while validity was established through expert review and factor analysis (Hairudin *et al.,* 2023). The CPQ-M is scored based on predefined cut-off values for each chrononutrition behaviour. Each behaviour is categorised into good, fair, or poor chrononutrition patterns according to established scoring guidelines by Veronda *et al.* (2020). Lower scores reflect better chrononutrition profiles, while higher scores reflect poorer chrononutrition profiles (Hairudin *et al.,* 2023; Juliana *et al.,* 2022).

Nutrition Quality of Life was assessed using the Malay NQoL questionnaire, which was originally developed by Schünemann *et al.* (2005) and adapted into Malay by Lua *et al.* (2012). There are six domains assessed by the NQoL, namely food impact, self-efficacy, social functioning, physical functioning, psychological functioning, and interpersonal functioning, which measure individuals' self-perceived satisfaction, functioning, and well-being related to nutrient intake. Validation of the Malay NQoL demonstrated acceptable to excellent internal consistency among Malaysian undergraduate health sciences students, with Cronbach's alpha values ranging from 0.217 to 0.908 across domains, and construct validity confirmed through factor analysis and domain-level correlations (Lua *et al.,* 2012). The NQoL was measured using a five-point Likert scale, with higher scores indicating better Nutrition Quality of Life.

Using these translated and validated versions of the questionnaires helped students understand the questions better and provided more accurate assessments of chrononutrition profiles and Nutrition Quality of Life (Lua & Wan Putri Elena, 2013).

3.8 Operational Definitions

3.8.1 Nutrition Quality of Life

Nutrition Quality of Life (NQoL) is defined as the multidimensional impact of dietary habits and nutritional status on physical, psychological, and social wellbeing. NQoL was measured using the Malay translated and validated version of the Nutrition Quality of Life Questionnaire (Lua *et al.,* 2012). The NQoL questionnaire captures six domains: interpersonal relationships (reflecting how food choices and dietary practices influence interactions with family, friends, and peers), physical functioning (capturing the effect of nutrition on energy levels, symptom burden, and the ability to perform daily activities), social functioning (assessing participation in social events and cultural practices involving food), psychological functioning (emotional wellbeing, satisfaction with eating habits, and perceived control over diet), self-image (body perception, confidence, and self-esteem shaped by nutritional status), and food impact (the direct influence of food on daily life, including enjoyment, satisfaction, and perceived adequacy of diet) (Lua *et al.,* 2012).

3.8.2 Chrononutrition

Chrononutrition is defined as the relationship between meal timing and circadian rhythms. Chrononutrition emphasises how the distribution of food intake across the 24-hour cycle can influence health outcomes. Chrononutrition was assessed using the Malay translated and validated version of the Chrononutrition Profile Questionnaire

(CPQ-M) by Juliana *et al.* (2023). Key indicators of the CPQ-M include breakfast skipping (frequency of omitting the morning meal), evening latency (the interval between the last meal and sleep onset), evening eating (consumption of food during late evening hours), night eating (intake of food after sleep onset or during nocturnal awakenings), and timing of the largest meal (the clock time at which the day's highest caloric intake occurs) (Juliana *et al.,* 2023).

3.9 Data Collection

This cross-sectional study involved undergraduate students from Universiti Sains Malaysia, Health Campus (USMKK), Kelantan. Data collection started only after obtaining ethical approval from the Human Research Ethics Committee (HREC/JEPeM) of Universiti Sains Malaysia. Permission to conduct the study was also obtained from the Dean of each respective school before data collection.

Following approval, the course representatives of each course and class were contacted. These representatives were given the research poster with the link to an online questionnaire created using Google Forms. The class representatives distributed the poster and questionnaire link through general class announcements. Participants for this study were not contacted personally. Participants voluntarily completed the questionnaire themselves if they provided consent and fulfilled the inclusion and exclusion criteria.

The online questionnaire began with a participant information sheet outlining the research background, objectives, study procedures, privacy, and confidentiality. Participants were informed that all information collected would be used solely for academic research purposes and that their identity would remain anonymous and confidential.