

ASSOCIATION BETWEEN SNACKING PATTERNS, VENDING
MACHINE USES AND BODY MASS INDEX (BMI) AMONG
UNDERGRADUATE STUDENTS IN UNIVERSITI SAINS
MALAYSIA, HEALTH CAMPUS

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UNIVERSITI SAINS MALAYSIA

2025

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By

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Dissertation submitted in partial fulfilment
of the requirements for the degree
of Bachelor of Health Sciences (Honours) (Dietetics)

July 2025

DECLARATION

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



Nur Amni Binti Mohd Suhaimy

Date: 30th June 2025

ACKNOWLEDGEMENT

First and foremost, I would like to express my sincere gratitude to Associate Prof. Dr. Shariza Binti Abdul Razak, my supervisor. This dissertation would not have been feasible to finish without her involvement and help. She is understanding and willing to take time to proofread my work, and she has given me invaluable counsel and direction as I prepare this dissertation. She is my constant source of support.

In addition, I would like to express my gratitude to my family members, seniors and friends for their unwavering support and encouragement. I am especially thankful to my cousin, who always provides invaluable assistance and fruitful ideas. Their continuous support has been essential for me to persevere through my degree program, when I felt helpless. Moreover, I would like to extend my utmost appreciation to my friends, Faris, Ahlami, Sofia, Maisarah, Aiman, Sharifah and Natasha, who patiently answered my queries throughout the dissertation preparation, especially when handling the SPSS software. They are patient in sharing their opinion and knowledge, which is helpful for my result analysis. They are patient in sharing their opinion and knowledge which is helpful for my result analysis. Furthermore, I extend my heartfelt thanks to my respondents who willingly participated in this study. Without their cooperation, I would not have been able to complete my survey smoothly. Thank you once again to all the people who directly or indirectly assisted me during the writing of my dissertation.

Lastly, I would like to take a moment to acknowledge my determination and resilience throughout this journey. The countless hours of work, dedication, and personal growth have shaped not only this thesis but also my character. I am proud of my persistence I have shown, and I am grateful for the opportunity to challenge myself in ways I never thought possible.

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HUBUNGAN ANTARA CORAK PENGAMBILAN SNEK DAN PENGGUNAAN MESIN LAYAN DIRI DAN INDEKS JISIM BADAN DALAM KALANGAN PELAJAR DI UNIVERSITI SAINS MALAYSIA, KAMPUS KESIHATAN.

ABSTRAK

Tabiat pemakanan pelajar universiti, terutamanya tabiat pengambilan snek, telah menjadi isu penting berkaitan kesihatan mereka. Kajian ini bertujuan untuk menilai hubungan antara corak pengambilan snek, penggunaan mesin layan diri dan indeks jisim badan (BMI) dalam kalangan pelajar prasiswazah di Kampus Kesihatan Universiti Sains Malaysia (USM). Reka bentuk kajian keratan rentas telah digunakan dengan soal selidik atas talian yang diisi sendiri oleh 236 pelajar. Soal selidik ini mengumpulkan maklumat sosiodemografi, kekerapan dan waktu makan, jenis makanan, penggunaan mesin layan diri, serta ketinggian dan berat badan yang dilaporkan sendiri. Sebanyak 56.8% peserta (n = 134) melaporkan mengambil snek sekali-sekala, biasanya satu hingga dua kali seminggu, manakala 50% (n = 118) memilih waktu antara 4:00 hingga 5:00 petang sebagai waktu pengambilan snek paling digemari. Hasil kajian menunjukkan bilangan pelajar yang tidak menggunakan mesin layan diri (n = 144, 61%) adalah lebih tinggi berbanding pengguna (n = 92, 39%). Kebanyakan peserta berada dalam kategori BMI normal (n = 128, 54.2%). Analisis statistik menggunakan ujian Pearson Chi-square telah dijalankan untuk menilai hubungan antara pemboleh ubah. Terdapat hubungan yang signifikan antara penggunaan mesin layan diri dan corak pengambilan snek ($\chi^2 = 2$, $p < 0.05$), terutamanya dari segi kekerapan dan waktu pengambilan makanan dan minuman tinggi tenaga seperti kerepek, gula-gula, mi segera, teh ais, susu berperisa dan sebagainya. Faktor utama yang mempengaruhi corak pengambilan snek ialah tekanan, rasa lapar, kemudahan akses, dan rasa makanan yang menarik. Aktiviti pasif seperti menonton televisyen atau menggunakan telefon pintar sering dikaitkan dengan peningkatan pengambilan snek tidak sihat. Namun begitu, tiada hubungan yang signifikan ditemui

antara corak pengambilan snek dan BMI ($\chi^2 = 6$, $p = 0.166$; $\chi^2 = 9$, $p = 0.437$), mahupun antara penggunaan mesin layan diri dan BMI ($\chi^2 = 3$, $p = 0.378$). Dapatan ini mendapati bahawa walaupun mesin layan diri mungkin mempengaruhi tabiat pengambilan snek pelajar, namun ia bukanlah penentu langsung kepada BMI. Kajian ini turut meneliti ciri utama yang mempengaruhi pembelian dari mesin layan diri, termasuk kemudahan akses, rasa lapar, dan kecenderungan untuk snek antara waktu makan. Kajian ini menekankan keperluan strategi khusus untuk meningkatkan kualiti pemakanan dalam pilihan makanan mesin layan diri di institusi pengajian tinggi. Seramai 41.4% peserta juga melaporkan kadang-kala menyedari nilai pemakanan snek yang diambil. Kajian masa depan perlu melibatkan populasi yang lebih besar dan lebih pelbagai serta meneroka perubahan tingkah laku pengambilan snek secara longitudinal.

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ABSTRACT

University students' eating habits, particularly their snacking habits, have been a significant issue as a factor of their health. This study aimed to assess the association between snacking patterns, vending machine use and body mass index (BMI) among undergraduate students at the Universiti Sains Malaysia (USM) Health Campus. A cross-sectional design was employed using an online self-administered questionnaire completed by 236 students. Sociodemographic information, eating frequency and timing, food kinds, vending machine usage, and self-reported height and weight were all gathered through the questionnaire. Snacking was reported by 56.8% of the 236 participants (n = 134), usually once or twice a week and 50% of the respondents (n = 118) indicated that 4:00 to 5:00 p.m. was the most preferred time to snack. The results showed that non-users (n = 144, 61%) of vending machines outnumbered users (n = 92, 39%). Most of the participants in this study were categorised in the normal BMI (n = 128, 54.2%). To investigate correlations between variables, statistical analyses were performed using Pearson's Chi-square tests. A significant association was found between vending machine usage and snacking patterns ($\chi^2 = 2$, $p < 0.05$), particularly with the frequency and timing of consumption of energy-dense snacks and beverages such as chips, sweets, instant noodles, iced tea, flavoured milk and more. Stress, hunger, convenience, and the appealing flavour of snacks were the primary factors influencing students' snacking pattern. Passive activities like watching television or using smartphones were most frequently linked to increase unhealthy consumption of snacks. However, no significant association was observed between snacking patterns and BMI ($\chi^2 = 6$, $p = 0.166$), ($\chi^2 = 9$, $p = 0.437$) or vending machine use and BMI ($\chi^2 = 3$, $p = 0.378$). These findings

suggested that while vending machines may influence students' snacking behaviours, they are not a direct predictor of BMI. This study also looked at the main characteristics that affected participants' purchases from vending machines, such as accessibility, hunger, and the desire to snack between mealtimes. The study highlighted the need for targeted strategies to improve the nutritional quality of vending machine offerings in university settings. A noteworthy 41.4% of participants reported occasionally being aware of the nutritional value of snacks. Future research should include larger and more diverse populations and explore longitudinal changes in snacking behaviour.

CHAPTER 1: INTRODUCTION

1.1 Background of Study

University students often modify their food habits as a result of lifestyle changes. Frequent snacking and reliance on vending machines are two examples. Many students struggle with a lack of understanding about nutrition, academic stress, and financial strain, which increases their likelihood of eating unhealthy meals. (Almoraie *et al.*, 2024). The campus food environment significantly affects how students eat since their decisions are impacted by the accessibility and convenience of specific items (Hasan *et al.*, 2021b). Vending machines are very common in campus dining, and they usually provide a wide variety of unhealthy snacks and drinks. More than 85% of the food products bought from vending machines were unhealthy, with unhealthy beverages making up 49% to 80% of the selection, according to research done in Australia (Grech *et al.*, 2016).

Young adults encounter several challenges when attempting to maintain a healthy diet, including the low cost of unhealthy foods, time constraints, a lack of cooking facilities, peer and family pressure, and a lack of nutritional awareness. Their eating patterns and health may suffer as a result of this ignorance (Stok *et al.*, 2018). Additionally, studies revealed that college students were more likely to eat fast food and snack frequently due to its palatability, availability and convenience (Tam *et al.*, 2016).

Poor eating habits can negatively affect health and well-being. An elevated risk of chronic conditions including heart disease and Type 2 diabetes has been associated with rising obesity rates among college students (Munt *et al.*, 2016). A poor diet can also lead to poorer academic performance and mental health problems such as depression and anxiety (Escoto *et al.*, 2012). Determining the association between students' snacking

patterns and vending machine usage with their body mass index (BMI) was crucial. Obtaining Body Mass Index as a nutritional assessment may help to find any links between vending machine usage and weight-related health outcomes. It provides useful information that helps campus counsellors and medical experts address the particular challenges that students confront, such as how stress, emotional eating, and poor time management may contribute to unhealthy eating behaviours. This information can also guide the creation of targeted initiatives and preventative actions to promote healthier choices on campus.

1.2 Problem Statement

Academic pressures and major lifestyle changes are commonplace for college and university students, and they can significantly influence their eating habits. It is now a public health concern that this group is increasingly exhibiting unhealthy eating habits, especially in settings where quick and easy snack options were the norm (Almoraie *et al.*, 2024). Students regularly purchase snacks and beverages from vending machines, which are known as high in sugar, fat, and sodium (Byrd-Bredbenner *et al.*, 2012). Studies reported an average gain of 3.38 kg in the first year of tertiary study due to poor diet choices and snacking more frequently (Vadeboncoeur *et al.*, 2015). The vending machine industry has started to evolve from traditional machines to connected machines with touchscreen controls, video and cashless payment. The utilization of vending machines can be enhanced due to the increased convenience they provide (Mansor *et al.*, 2018).

There is little data on students' snacking patterns, frequency of vending machine usage, and body mass index (BMI) at the Health Campus of Universiti Sains Malaysia (USM). The dearth of data amply illustrates the pressing necessity to look into the direct effects of vending machine offerings on students' eating habits and general health. In order to encourage students to make healthier nutritional choices, we must give this research top priority. These practices need to be addressed since unhealthy eating patterns formed at college can persist into adulthood and may have long-term health consequences. Significant changes in food habits, social lifestyles, mental, emotional, and physical lifestyles are also linked to this period (Xiang and Lian, 2021).

1.3 Study Rationale

The rationale of the study was to find out how frequently college students use vending machines, what kinds of snacks they usually select, and how they feel about the snacks' nutritional content. It also examines the nutritional worth of the most well-liked products and the connection between convenience, dietary choices, and health. The study will closely examine different consumption patterns to fully investigate the nutritional effects linked with using vending machines.

The study's findings were meant to assist university policymakers in establishing a healthier campus dining environment. This involved offering more nutrient-dense vending machine alternatives, like fruits, low-sugar snacks, and whole-grain goods, as well as implementing educational initiatives to encourage healthier snacking patterns. Students could utilise vending machines more sensibly if they could better understand nutritional labels. This study aimed to make an impact on students' health by encouraging the adoption of healthier snacking patterns. By fostering a greater awareness of nutritional choices and providing guidance on what constitutes a healthy snack, this initiative may contribute to a decrease in the prevalence of overweight and obese students.

By addressing the primary causes of students' snacking patterns, this study also seeks to develop targeted and effective interventions that promote balanced eating habits. In the end, the study helps to improve the students' well-being and cultivates a campus culture that prioritises long-term health and nutrition. The stakeholders can learn more about the present usage of vending machines thanks to this discovery. It can design some amiable treatments to improve the nutritional value of the products provided and promote the consumption of healthier foods by comprehending these habits.

1.4 Research Question

1. Is there any association between vending machine use and snacking patterns among undergraduate students in Universiti Sains Malaysia Health Campus?
2. Is there any association between snacking patterns and body mass index (BMI) among undergraduate students in Universiti Sains Malaysia Health Campus?
3. Is there any association between vending machine use and body mass index (BMI) among undergraduate students in Universiti Sains Malaysia Health Campus?

1.5 Research Objectives

1.5.1 General Objectives

To determine the association between snacking patterns, vending machine use, and body mass index (BMI) among undergraduate students in Universiti Sains Malaysia Health Campus.

1.5.2 Specific Objectives

1. To determine the snacking patterns among Universiti Sains Malaysia Health Campus students.
2. To determine vending machine use among Universiti Sains Malaysia Health Campus students.
3. To determine Body Mass Index (BMI) among Universiti Sains Malaysia Health Campus students.
4. To determine the association between vending machine use and snacking patterns among Universiti Sains Malaysia Health Campus students.

5. To determine the association between snacking patterns and body mass index (BMI) among Universiti Sains Malaysia Health Campus students.

6. To determine the association between vending machine use and body mass index (BMI) among Universiti Sains Malaysia Health Campus students.

1.6 Research Hypothesis

Hypothesis I:

Null Hypothesis (H_0): There is no association between vending machine use and snacking patterns among undergraduate students in Universiti Sains Malaysia Health Campus.

Alternative Hypothesis (H_1): There is an association between vending machine use and snacking patterns among undergraduate students in Universiti Sains Malaysia Health Campus.

Hypothesis II:

Null Hypothesis (H_0): There is no association between snacking patterns and body mass index (BMI) among undergraduate students in Universiti Sains Malaysia Health Campus.

Alternative Hypothesis (H_1): There is an association between snacking patterns and body mass index (BMI) among undergraduate students in Universiti Sains Malaysia Health Campus.

Hypothesis III:

Null Hypothesis (H_0): There is no association between vending machine use and body mass index (BMI) among undergraduate students in Universiti Sains Malaysia Health Campus

Alternative Hypothesis (H_1): There is an association between vending machine use and body mass index (BMI) among undergraduate students in Universiti Sains Malaysia Health Campus.

CHAPTER 2: LITERATURE REVIEW

2.1 Literature Review

2.1.1 Definition and Prevalence of Snacking Patterns among Students.

A snack is a small portion of food eaten between meals. Common snack choices often include cakes, chocolate, potato chips, and other sweet or salty treats. People also frequently snack on bread, milk, soft drinks, and caffeinated beverages. These options tend to be calorie-dense because of their high fat, carbohydrate, or protein content (Kirchoff *et al.*, 2022). Healthy snack options like fruits, vegetables, grains, legumes, and nuts are recommended by the food pyramid because they are less fat and salt, and higher in nutrients. Unfortunately, these healthier alternatives are often less popular due to their higher cost to their higher cost or difficulty in finding (Munt *et al.*, 2016).

Young adults are considered to have some of the worst eating habits of any age group. Along with eating a lot of fast food and sugary drinks, they typically don't meet the recommended daily intake of fruits and vegetables (Ng *et al.*, 2018). For instance, young individuals who put in extended hours often grab meals while on the go, leading to a higher intake of fast food and sugary drinks, but their consumption of fruits and vegetables declines due to convenience and time limitations (Escoto *et al.*, 2012). Any individual who frequently consumed unhealthy snacks more than 3 times per week was considered to have unhealthy snacking behaviour (Mithra *et al.*, 2018).

A survey conducted in secondary schools in Kuala Lumpur found that more than half of the students (64.7%) snacked at least once a day. Snacking while watching films was the most popular cause (59.6%), followed by boredom, social pressure, or stress management. Students typically ate three main meals and two snacks each day (23.1%), according to Boon and Sedek (2012).

2.1.2 Use of Vending Machines among Students

Vending machines' emphasis on offering high-energy, low-nutrient foods such as chips, chocolates, confectionery, sweets, biscuits with few healthy options has led to widespread recognition that they play a substantial role in obesity. 98% of college students snack every day, on average four times a day (Ng et al., 2018). Students choose sugary drinks, chocolates, and processed foods because they are readily available, reasonably priced, and convenient. Students choose these snacks due in large part to hunger and time restrictions. Increased snacking frequency and consumption are closely associated with their desirable flavours and textures (Park and Papadaki, 2015).

While healthier options like fruits, vegetables, and whole-grain snacks offer significant nutritional benefits, they are frequently overlooked. Vending machines are strategically placed in high-traffic areas on campus, such as academic buildings, residence halls, cafeterias, gyms, and laundry rooms. Different flavours and serving sizes are effectively categorised as distinct items, with clear product information provided, including brand names, container sizes, and prices (Ng *et al.*, 2018).

A thorough investigation by Hasan *et al.* (2021) that sampled 1,250 staff and students revealed serious problems with vending machines. About 34.3% of respondents complained about the lack of diversity, and more than half (53.7%) said the food alternatives were too expensive. Students' lunch choices are greatly influenced by the relative expense of healthier vs less nutritious options, which further supports their inclination for less nutrient-dense selections. It was obvious that resolving these issues may result in better eating practices among students.

2.1.3 Body Mass Index (BMI)

Body Mass Index (BMI), formerly known as the Quetelet Index, a widely used measurement to assess weight status and associated health risks in adults. It was defined as a person's weight in kilograms divided by the square of their height in metres (kg/m^2). The BMI is classified into four categories, which are underweight ($<18.5 \text{ kg}/\text{m}^2$), normal weight (18.5 to $22.9 \text{ kg}/\text{m}^2$), overweight (23.0 to $27.4 \text{ kg}/\text{m}^2$), and obese ($>27.5 \text{ kg}/\text{m}^2$) (World Health Organisation: WHO, 2010).

University students are young adults navigating a transformative phase in their lives, where they embrace newfound independence and begin shaping their futures. They often face greater freedom and self-responsibility in deciding on various issues (Low *et al.*, 2015). A study reported that the collection involving body mass index data from five local universities in Malaysia revealed the highest percentage of overweight and obesity among undergraduate students (23%, 17.6%) as compared to the Masters (21.9%, 14.3%) and PhD students (17.8%, 18.4%) (Radzi *et al.*, 2019). Stress and the demands of university frequently cause students to make convenience-driven choices, which raises the intake of processed snacks and sugary drinks (Almoraie *et al.*, 2024).

2.1.4 Vending Machine Use and Snacking Patterns among Students.

Vending machines are great and convenient inventions that can dispense all sorts of items. Purchasing snacks from vending machines are adaptable and acceptable since it works twenty-four hours, seven days a week (Mansor *et al.*, 2018). The increased availability of unhealthy food from vending machines causes the development of an obesogenic environment. Vending machines often contribute to unhealthy lifestyles and poor diets by offering unhealthy food and beverages (Rosi *et al.*, 2017). The habit of consuming unhealthy food is rising as vending machine food is currently in demand and rapidly growing in the market. It has become an accessible and acceptable food source in

the university environment (Ali *et al.*, 2015). University students tended to snack often and consumed fast food more frequently. The reasons that affect poor food choices among university students include time constraints, budgetary restrictions, and the availability of food choices on campus (Mehmood *et al.*, 2020).

Additionally, vending machine use has been associated with impulsive snacking patterns, where students prioritise convenience over nutritional quality. Vending machines are easily accessible sources of food and beverages. However, easy access to vending machines was associated with increased snack consumption and snacking frequency. Frequent consumption of vending machine foods has been linked to obesity in university campus (García *et al.*, 2018). This pattern of behaviour can contribute to long-term unhealthy eating habits, raising concerns about its implications for students' overall health and well-being.

2.1.5 Snacking Patterns and Body Mass Index (BMI) among Students

Students who often grab unhealthy snacks from vending machines tend to develop less-than-great dietary habits, mainly due to the high amounts of saturated fats, sugars, and salts in those snacks. Snacking too frequently can lead to an unbalanced intake of nutrients and excess calories, which might result in long-term health issues like heart disease, type 2 diabetes, and obesity (Almoraie *et al.*, 2024). According to a study conducted in the United Arab Emirates, many students said that after starting college, they gained weight (43.4%) and made worse food choices (53.4%) (Hasan *et al.*, 2021). Students frequently eat more than they would want to because of the stress of extended study sessions and late-night cram sessions.

Many students find it challenging to eat well because many campuses lack inexpensive, nutritious food options (Munt *et al.*, 2016). Unhealthy snacking can have

negative effects on mental health and physical health, including fatigue, difficulty focusing, and insomnia.

Making healthy decisions can seem considerably more difficult as a college student. It's a period of rising stress, juggling many obligations, and developing independence. The university need to focus on creating healthy snack options to help students make better food choices. By providing tasty alternatives and encouraging wholesome eating habits, it can reduce the long-term risks connected to poor eating (Sogari *et al.*, 2018).

2.1.6 Vending Machine Use and Body Mass Index (BMI) among Students

Vending machine-dispensed goods are frequently heavy in sugar, caffeine, and saturated fats and low in fibre and other necessary nutrients (Carrad *et al.*, 2015). These items, which are commonly found in public spaces like schools and universities, provide convenient access to food and beverages, particularly for students and employees with busy schedules. Snacking makes up an average of 24.4% of daily caloric intake and accounts for 18.7%, 26.6%, and 23.7% of daily intake for protein, carbs, and fats, respectively (Boon and Sedek, 2012). Consequently, students turn their ways to purchase foods or snacks from vending machines, especially during midnight as its offer 24-hour's service (Mansor *et al.*, 2018b).

The nutritional value of vending machine options at four major Australian colleges was assessed by Whatnall *et al.* (2020), who found that 83% of the snacks and drinks served were high in calories due to their high sugar, salt, and saturated fat content. This nutritional imbalance may promote unhealthy eating patterns, increasing the risk of weight gain and associated diseases like diabetes, insulin resistance, and heart disease. As worries about the nutritional content of vending machine offerings have grown, some

organisations have started initiatives to provide better options. These approaches include price reductions and awareness campaigns to promote the consumption of healthy snacks. However, youth awareness of and readiness to make healthy choices are critical to the success of these programs.

2.2 Conceptual Framework

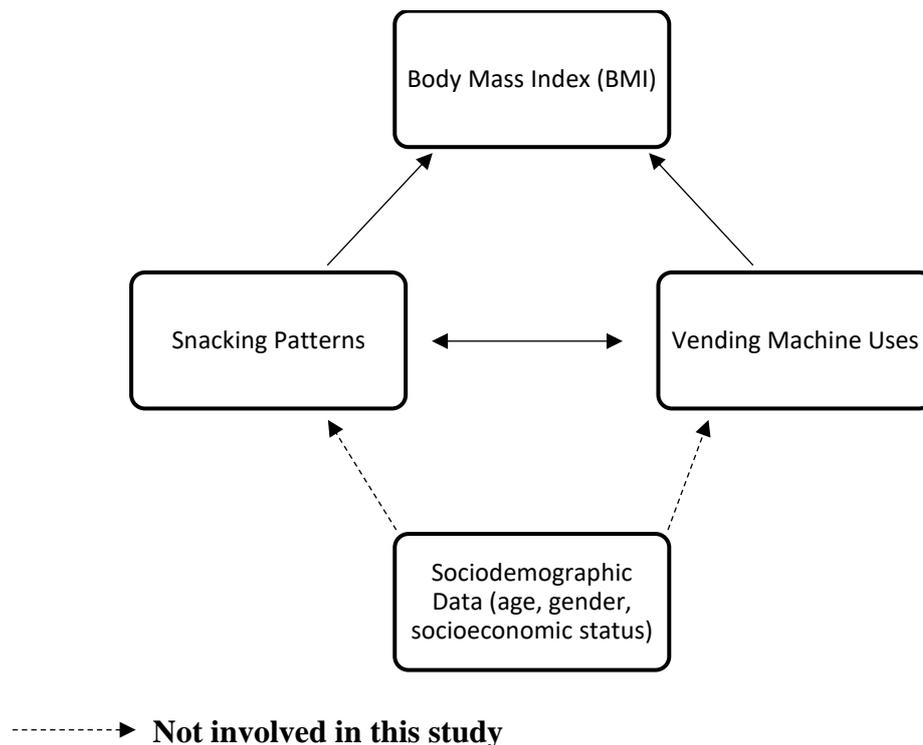


Figure 1: Conceptual Framework of the Study

The purpose of this study was to provide a comprehensive analysis of the association between snacking patterns, vending machine use and body mass index (BMI) among university students at the USM Health Campus. This conceptual framework highlights the association of each variable. This study identifies vending machine use and snacking patterns as the independent variables. The study's dependent variable is body mass index (BMI). The influence of vending machines has direct effects on BMI, where

increased reliance on vending machines for unhealthy snacks could lead to weight gain (Sowers, 2018). Similarly, snacking patterns can directly impact BMI, with unhealthy snacking patterns contributing to higher BMI (Prapkree *et al.*, 2023). This suggests that BMI is influenced by snacking patterns and vending machine use (Park and Papadaki, 2015). For example, frequent consumption of energy-dense snacks purchased from vending machines might result in higher BMI values among students. This framework also illustrates a bidirectional relationship between vending machine use and snacking patterns, indicating that vending machines affect snack choices. Sociodemographic data such as gender, age, and socioeconomic status were collected to provide background information on the study population. However, these variables were not included in the study's main analysis, but they were considered potential confounding factors that might influence snacking patterns and vending machine use.

By illuminating this association, the study hopes to provide insightful information that could guide programs meant to encourage university students to make healthier dietary choices and maintain a healthy BMI.

CHAPTER 3: METHODOLOGY

3.1 Research Design

Structured questionnaires were used in this study to collect data from individuals using cross-sectional methodologies. This particular design was selected to examine the connection between USM Health Campus undergraduate students' snacking patterns, the usage of vending machines and the results of their body mass index (BMI), as a determining factor. Self-report questionnaires had some benefits that make data collection more successful, convenient, and economical. The cross-sectional design streamlines the research process by taking a brief overview of data at a single point in time, in contrast to longitudinal studies that necessitate continuous follow-up with participants over a long period (Setia, 2016). Cross-sectional research makes it possible to compare group differences and gather data from a large number of people. This simultaneous collection provides valuable insights into the current dietary patterns and behaviours of the students.

3.2 Study Area

The study was carried out at the Health Campus of Universiti Sains Malaysia in Kubang Kerian, Kelantan. The Health Campus of Universiti Sains Malaysia consists of School of Medical Sciences (PPSP), School of Dental Sciences (PPSG), and School of Health Sciences (PPSK). All participants in this study participated online, and the researcher gave them an online questionnaire to complete to gather data. The rationale for selecting this area is that most college students aged 19 to 25 tend to consume snacks and sugary drinks, living in an environment that promotes obesity (Munt *et al.*, 2016). In this campus, there were a total of 22 vending machines, each offering a variety of snacks and beverages. The examples for snacks were chocolate bars, chips, cookies, sweets, nuts,

and instant noodles. Meanwhile, for beverages were soda, coffee, iced tea, energy drinks, flavoured milk, fruit juice and flavoured water bottles.

3.3 Study Population

The study population included undergraduate students from Universiti Sains Malaysia, Health Campus, Kubang Kerian, Kelantan, encompassing students in the first to fifth years of study. The target sample was selected since they are more conveniently available to engage in this study as compared to postgraduate or other populations. This study also involves international students as participants.

3.4 Selection Criteria

3.4.1 Inclusion Criteria

The selection of subjects was

- Aged between 19 to 25 years
- Currently enrolled as an undergraduate student at Universiti Sains Malaysia Health Campus

3.4.2 Exclusion Criteria

- Currently having underlying health concerns or suffering from chronic diseases such as Diabetes Mellitus, Hypertension and Cardiovascular disease.

3.5 Sample Size Estimation

3.5.1 Sample Size Estimation for Specific Objective One

The first objective was to identify unhealthy snacking patterns among undergraduate students at the USM Health Campus. According to a study conducted among university

students in UiTM Cawangan Kelantan, the prevalence of students who had the habit of snacking between meals is 82.9% (Mehmood *et al.*, 2020).

$$n = [(Z/\Delta)^2 p (1 - p)]$$

n = estimated sample size

Z= standard value at 95% confidence interval = 1.96

Δ = margin error set at 5% = 0.05

p = estimated proportion of snacking patterns among university students is 0.83

$$n = \left[\left(\frac{1.96}{0.05} \right)^2 0.83(1 - 0.83) \right] = 214.6$$

$$n = 214.6 + 10\% \text{ (dropout rate)}$$

$$n = 236 \text{ respondent}$$

Thus, 236 students were needed to assess the unhealthy snacking patterns among undergraduate students in USM Health Campus.

3.5.2. Sample Size Estimation for Specific Objective Two

The second objective of this study was to assess how frequently undergraduate students at USM Health Campus used vending machines. A study among students in UiTM Shah Alam revealed that 88.3% of undergraduate students in Malaysia reported using vending machines regularly (Mansor *et al.*, 2018b). When substituting:

$$n = [(Z/\Delta)^2 p (1 - p)]$$

n = estimated sample size

Z= standard value at 95% confidence interval = 1.96

Δ = margin error set at 0.05% = 0.05

p = estimated proportion of the using of vending machines among university students is 0.88

$$n = \left[\left(\frac{1.96}{0.05} \right)^2 0.88 - (1 - 0.88) \right] = 162.27$$

$$n = 162.3 + 10\% \text{ (dropout rate)}$$

$$= 179 \text{ respondent}$$

Thus, 179 students were needed to assess the utilization of vending machines among undergraduate students in the USM Health Campus.

3.5.3. Sample Size Estimation for Specific Objective Three

The third objective of this study was to determine the body mass index (BMI) among undergraduate students in Universiti Sains Malaysia, Health Campus. A study in Kuala Lumpur assessed that 4.5% of Malaysian students were obese (Boon and Sedek, 2012b).

When substituting:

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

n = estimated sample size

Z = standard value at 95% confidence interval = 1.96

Δ = margin error set at 0.05% = 0.05

p = estimated proportion of the obese students in Malaysia is 0.05

$$n = \left[\left(\frac{1.96}{0.05} \right)^2 0.05 - (1 - 0.05) \right] = 72.99$$

$$n = 72.99 + 10\% \text{ (dropout rate)}$$

= 80 respondent

Thus, 80 students were needed to assess BMI in the USM Health Campus.

3.5.3 Sample Size Estimation for Specific Objective Four

$$n = \frac{p_1(1 - p_1) + p_2(1 - p_2)}{(p_1 - p_2)^2} + (z_\alpha + z_\beta)^2$$

n = sample size

p = anticipated population proportion

α = significance level

1- β = power of study

$z_\alpha = 1.96$ ($\alpha = 0.05$)

$z_\beta = 0.84$ (80% power)

This sample has a 95% confidence level with a Z-score of 1.96 and a 5% (0.05) precision level with the power set at 80%.

p_1 = Anticipated population proportion of the use of vending machines among students in Malaysia is 0.88. It was reported that 88.3% of Malaysian students use vending machines regularly (Mansor *et al.*, 2018b).

p_2 = Anticipated population proportion of snacking patterns among students in Malaysia is 0.83. It was reported that 82.9% of students who had the habit of snacking between meals (Mehmood *et al.*, 2020).

$$n = \frac{0.88_1(1 - 0.88_1) + 0.83_2(1 - 0.83_2)}{(0.88_1 - 0.83_2)^2} + (1.96_\alpha + 0.84_\beta)^2 = 12.7$$

$$n = 12.7 + 10\% \text{ (dropout rate)}$$

$$n = 14.05 \times 2$$

$$n = 28.1 \sim 28 \text{ respondent}$$

Thus, 28 students were needed to determine vending machine use with snacking patterns among undergraduate students in the USM Health Campus.

3.5.4. Sample Size Estimation for Specific Objective Five

$$n = \frac{p_1(1 - p_1) + p_2(1 - p_2)}{(p_1 - p_2)^2} + (z_\alpha + z_\beta)^2$$

n = sample size

p = anticipated population proportion

α = significance level

$1-\beta$ = power of study

$$z_\alpha = 1.96 (\alpha = 0.05)$$

$$z_\beta = 0.84 (80\% \text{ power})$$

This sample has a 95% confidence level with a Z-score of 1.96 and a 5% (0.05) precision level with the power set at 80%.

p_1 = Anticipated population proportion of snacking patterns among students in Malaysia is 0.83. It was reported that 82.9% of students had the habit of snacking between meals (Mehmood *et al.*, 2020).

p_2 = Anticipated population proportion of obese students in Malaysia is 0.05 (Boon and Sedek, 2012b). It was reported that 4.5% of Malaysian students were obese.

$$n = \frac{0.83_1(1 - 0.83_1) + 0.05(1 - 0.05_2)}{(0.83_1 - 0.05_2)^2} + (1.96_\alpha + 0.84_\beta)^2 = 8.14$$

$$n = 8.14 + 10\% (\text{dropout rate})$$

$$n = 8.9 \times 2$$

$$n = 17.9 \sim 18 \text{ respondent}$$

Thus, 18 students were needed to determine the snacking patterns with body mass index (BMI) among undergraduate students in the USM Health Campus.

3.5.5 Sample Size Estimation for Specific Objective Six

$$n = \frac{p_1(1 - p_1) + p_2(1 - p_2)}{(p_1 - p_2)^2} + (z_\alpha + z_\beta)^2$$

n = sample size

p = anticipated population proportion

α = significance level

$1 - \beta$ = power of study

$z_\alpha = 1.96$ ($\alpha = 0.05$)

$z_\beta = 0.84$ (80% power)

This sample has a 95% confidence level with a Z-score of 1.96 and a 5% (0.05) precision level with the power set at 80%.

p_1 = Anticipated population proportion of the use of vending machines among students in Malaysia is 0.88. It was reported that 88.3% of Malaysian students use vending machines regularly (Mansor *et al.*, 2018b).

p_2 = Anticipated population proportion of obese students in Malaysia is 0.05 (Boon and Sedek, 2012b). It was reported that 4.5% of Malaysian students were obese.

$$n = \frac{0.88_1(1 - 0.88_1) + 0.05_2(1 - 0.05_2)}{(0.88_1 - 0.05_2)^2} + (1.96_\alpha + 0.84_\beta)^2 = 8.06$$

$$n = 8.06 + 10\% \text{ (dropout rate)}$$

$$n = 8.8 \times 2$$

$$n = 17.7 \sim 18 \text{ respondent}$$

Thus, 18 students were needed to determine the vending machine use with body mass index (BMI) among undergraduate students in the USM Health Campus.

Therefore, a total of 236 students, who fulfilled the inclusion and exclusion criteria are required to participate in this study. The reason for using a larger sample size leads to stronger and more reliable results.

3.6 Sampling Method and Subject Recruitment

The participants were recruited using a non-probability approach convenience sampling method. Convenience sampling was a type of non-probability sampling. The purpose of this sampling technique was to enable the quick collection of data from Universiti Sains Malaysia students. All subjects are chosen voluntarily. Potential participants were approached through multiple channels, including distribution of online questionnaire via social media platforms. Prior to participation, all students were provided with detailed information about the study's objectives, procedures, and their rights as participants. Undergraduate students who satisfied the inclusion requirements, did not fulfil the exclusion criteria, were eager to participate, and were technically qualified to participate in the study. After reading the research information and agreeing to the consent form, they would complete the provided online questionnaire. Responses were gathered until 236 participants were reached.

3.7 Research Tools and Materials

A series of validated questionnaires was employed as a research method to gather all the necessary data for this study. The build-up questionnaire was obtained from Universiti Kebangsaan Malaysia (UKM) student's who conducted research earlier on snacking patterns and vending machine usage with nutritional status among university students in Lembah Klang (Boon and Sedek, 2012). Self-reported questionnaires,

consisting of four sections were used in this study. Section A contained socio-demographic data, Section B gathered anthropometric information, Section C included a questionnaire on snacking patterns, and Section D featured a questionnaire regarding vending machine usage. The questionnaire took about fifteen minutes to complete.

3.7.1 Section A: Socio-demographic Information

Section A of the questionnaire consists of socio-demographic information of the participants such as gender, age, race, academic program, and current year of study. The questionnaire also looked at the participants' living arrangements, either staying on campus or outside and any financial support received during the academic period.

The questionnaire purposefully avoided gathering any personally identifiable information, like names, phone numbers, or matriculation numbers, to respect the participants' privacy and confidentiality. This methodology ensured the anonymity of the responses and the protection of the participants' identities during the entire research process.

3.7.2 Section B: Anthropometric Data

Anthropometric measurements were calculated using the standard formula. Body mass index (BMI) was computed using the formula $BMI = \text{weight (kg)} / (\text{height} \times \text{height})$ (m^2). Participants calculated their own BMI by using the formula given and classified according to the range given. BMI of the participants were divided into four categories: underweight ($<18.5 \text{ kg}/m^2$), normal weight (18.5 to $22.9 \text{ kg}/m^2$), overweight (23.0 to $24.9 \text{ kg}/m^2$), and obese ($>25.0 \text{ kg}/m^2$).

3.7.3 Section C: Snack Consumption Questionnaire

The questionnaire used to evaluate university students' snacking patterns. The questionnaire asked the participants how many main meals they ate each day (2, 3, or more than 3), are they skipped any mealtime, and what kind of diet they normally follow (normal or vegetarian). The frequency of daily snack consumption was categorised as none (0 times/ week), rarely (1-2 times/week), frequently (>3 times/week) and the particular times when snacks were consumed mid-morning (10 am to 11 am), afternoon (1 p to 2 pm), tea-time (4 pm to 5 pm), supper (10 pm to 12 am) also assessed. The survey also looked at tasks like watching TV, playing video games, or finishing an assignment that was done while snacking. Hunger, peer pressure, media impact, affordability, availability, and seasonings showed to be the primary causes of snacking among participants. There were four levels of comprehension regarding snack nutritional value: never, sometimes, rarely, and always. The amount of money spent to buy snacks and snacks purchased during grocery shopping was being assessed.

3.7.4 Section D: The Use of Vending Machines

The last section of the questionnaire collected data on the variety and frequency of snacks and drinks bought from vending machines. Participants who had previously used vending machines were asked how frequently they purchased different meals and beverages from the machines, with three possible responses: "0 times per week," "1-2 times per week," or ">3 times per week." The variable of vending machine frequency was categorised into vending machine users for 1-2 times per week and >3 times per week and non-vending machine users for who did not use vending machines to easily analyse the difference. According to the study, a variety of factors, including hunger, convenience, time constraints, snacking between meals, and other related concerns, led