

**THE ASSOCIATION BETWEEN SUGAR-SWEETENED
BEVERAGES (SSB) CONSUMPTION, BODY MASS INDEX (BMI)
AND BODY FAT PERCENTAGE AMONG UNDERGRADUATE
STUDENTS IN USMKK**

By

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

July 2024

CERTIFICATE

This is to certify the dissertation entitled “THE ASSOCIATION BETWEEN SUGAR-SWEETENED BEVERAGES (SSB) CONSUMPTION, BODY MASS INDEX (BMI), AND BODY FAT PERCENTAGE AMONG UNDERGRADUATE STUDENTS IN USMKK” is the bona fide record of research work done by Ms. ANIS SURAYA BINTI ADNAN during the period from under my supervision. I have read this dissertation, and, in my opinion, it confirms to acceptable standard scholarly presentation and is fully adequate, in scope and quality, as a dissertation to be submitted in partial fulfillment for the Bachelor of Health Sciences (Honours) (Dietetics).

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DECLARATION

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



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ACKNOWLEDGEMENT

First and foremost, I am grateful to The Almighty God, praise be to Allah for giving me the opportunity to complete my journey as an undergraduate student of Dietetics with good health and wellbeing. I would also like to express my gratitude to Universiti Sains Malaysia Health Campus for providing me with all necessary facilities during preparation for this research.

Next, I would like to express my sincere thanks to my supervisor, Madam NurZetty Sofia Binti Zainuddin for her support, help, and encouragement along my journey in completing my research. Without her share in expertise, I could not complete my research and thesis writing. Despite her busy schedule, madam had always answered to my inquiries, pray for me and guide me throughout the end.

I would like to take this opportunity to thank my parents, Adnan Bin Junid and Rokiah Binti Mawah for the non-stop encouragement given, prayers and help throughout my journey as a student. Without their care, my study journey would be much harder.

Lastly, I would like to express my gratitude to my fellow comrades Umi Aliyah Binti Mohd Zulkifli, Siti Najihah Binti Rozmi, and Shaherah Binti Abd Khedir for their support and help in completing this study. Their willingness to help me, ease the journey of completing this study. Without their help, I would not be able to overcome the obstacles and complete this study.

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LIST OF ABBREVIATIONS

BMI	Body Mass Index
SSB	Sugar-sweetened Beverages
SSCB	Sugar-sweetened Carbonated Beverages
USMKK	University Sains Malaysia, Health Campus
NCD	Non-communicable Disease
MOH	Ministry of Health
WHO	World Health Organization
BIA	Bioelectrical Impedance Analysis
SPSS	Statistical Package for Social Sciences
JEPeM	Human Research Ethics Committee USM
PPSP	School of Medical Sciences
PPSG	School of Dental Sciences
PPSK	School of Health Sciences
CVD	Cardiovascular Disease
DXA	Dual-energy X-ray Absorptiometry
FM	Fat Mass
ALM	Appendicular Lean Mass
FFQ	Food-frequency Questionnaire

**PERKAITAIN ANTARA PENGAMBILAN MINUMAN BERGULA,
INDEKS JISIM TIBUH (IJT), DAN PERATUS LEMAK BADAN
DALAM KALANGAN PELAJAR PRASISWAZAH USMKK**

ABSTRAK

Minuman bergula menyebabkan peningkatan dalam IJT dan peratus lemak badan. Bukan itu sahaja, peningkatan dalam pengambilan IJT boleh dikaitkan dengan peningkatan risiko menghidap penyakit tidak berjangkit. Objektif kajian adalah untuk menentukan perkaitan di antara pengambilan minuman bergula, IJT dan peratus lemak badan dalam kalangan pelajar prasiswazah di USMKK menggunakan pensampelan rawak mudah. Satu set soal selidik yang telah disahkan berkenaan sosiodemografik, corak pengambilan minuman bergula, BEVQ-15, dan ukuran IJT dan peratus lemak badan digunakan dalam kajian ini. Kebanyakan peserta terdiri daripada peserta perempuan (83.1%) dan berbangsa Melayu (70.2%). Peserta mempunyai berat badan yang normal (58.4%) serta peratus lemak badan yang ideal bagi kedua-dua lelaki (53.5%) dan perempuan (60.4%). Secara keseluruhan, peserta dalam kajian ini mempunyai pengambilan minuman bergula yang rendah (<250mL/ hari) dimana teh manis (bergula) dicatatkan sebagai minuman bergula yang paling banyak diambil. Sementara terdapat perkaitan signifikan di antara pengambilan minuman bergula dan IJT ($p=0.004$), manakala tiada perkaitan signifikan di antara pengambilan minuman bergula dan peratus lemak badan ($p=0.112$) dalam kajian ini. Kesimpulannya, kajian ini memberikan pandangan tentang kesan pengambilan minuman bergula kepada pelajar universiti. Maka, adalah penting bagi kita untuk merancang intervensi bagi mengurangkan pengambilan

minuman bergula agar kita dapat mengekalkan IJT yang normal dan peratus lemak badan yang ideal, serta mengurangkan risiko mendapatkan penyakit tidak berjangkit.

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ABSTRACT

Sugar-sweetened beverages (SSB) consumption led to an increase in BMI and body fat percentage. Furthermore, increase in SSB consumption could also be related to increases in risk of contracting non-communicable disease (NCD). The objective of this study was to determine the association between SSB, BMI and body fat percentage among undergraduate students in USMKK using simple random sampling method. Validated set of self-administered sociodemographic background, pattern of SSB consumption, BEVQ-15, and measurement for BMI and body fat percentage were utilized in this study. Majority of the participants were female (83.1%) and from Malay ethnicity (70.2%). Participants have a normal body weight (58.40%), with ideal body fat for both male (53.5%) and female (60.4%). Overall, the participants had a low SBB consumption (250mL/ day) with sweet tea (with sugar) being the most consumed. While there was a significant association between SSB consumption and BMI, there was no association for SSB consumption and body fat percentage in this study. In conclusion, this study provides insight into the effect of SSB consumption to university students. Thus, it is important to plan an intervention to reduce SSB consumption so we can maintain a normal BMI and body fat percentage, as well as reducing the risk of contracting NCD.

CHAPTER 1: INTRODUCTION

1.1 Background of Study

Sugars are carbohydrate that provides energy and are commonly used to elevate the taste of the foods or beverages (MOH, 2020). Sugar found in sugar-sweetened beverages (SSB) mainly compose of glucose, a simple sugar found in carbohydrates. According to Rahman et al. (2021), glucose that was converted to glycogen, fatty acids and triglycerides by insulin and glycogen are store as energy for times of deficit. SSB are beverages that became the primary source of added sugars in the diet. According to World Health Organization, SSB are defined as all beverages containing free sugars including carbonated or non- carbonated soft drink, 100% fruit or vegetable juices, liquid and powder concentrates, flavoured water, energy and sports drink, ready-to-drink tea and coffee, and flavoured milk (WHO, 2015). SSB does not provide any nutritional value thus, indicating no significant use to the human's nutritional need. It is also one of the major factors that lead to unhealthy weight gain resulting to positive energy balance (Teng et al., 2020). The consumption of SSB has been linked to obesity, type 2 diabetes mellitus, cardiovascular diseases, and cancers (Malik & Hu, 2022).

The intake of SSB among students has been increasing over the past few years. This might be due to the increased sales from beverages companies, availability of the drinks, the affordable price, social and environmental changes. From a study conducted on the consumption of SSB among the university students in Kuala Nerus, Terengganu by Aliah et al. (2020), it was found that 71.1% of the respondents consumed one cup of SSB daily. In comparison, another similar study conducted by Ahmad et al. (2019) among university students in Selangor found that 89.3% of the

respondents took more than one cup of SSB in daily basis. Both studies showed that the intake of SSB among university students is in alerting value.

The Malaysian Dietary Guidelines 2020 has stated that the intake of sugars in foods and beverages should be limited. The Key Recommendation 2 highlighted the need to limit the intake of sugar in beverages where it is recommended to limit the intake of ultra-processed beverages such as carbonated and non-carbonated sugar-sweetened beverages, limit intake of beverages with added sugar and condensed milk, limit the intake of beverages with sugars listed as the first ingredient in the ingredients list, avoiding consuming sugary beverages during morning and afternoon snack, choosing beverages low in sugar by reading the food labels and always opt for plain water (MOH, 2020). According to WHO (2015), the intake of free sugars should not exceed 10% of total energy intake as evidence by the relationship between consumption of sugars with body weight as well as dental carries.

Body Mass Index (BMI) is a simple index that was commonly used to classify whether the individual was overweight or obese. It measured the weight and height of the individual by dividing the individual's weight in kilogram by the square of his height in meters (kg/m^2). According to WHO (2021), overweight and obesity were defined as the excessive accumulation of fat which led to other health implications. BMI greater than or equal to 25 is classify as overweight, and BMI greater than or equal to 30 is classify as obesity. According to a study among 1380 Malaysian adults in Selangor, Malaysia, it was found that the prevalence for obesity was 18.6% with female participants (21.1%) being higher as compared to the male participants (14.2%) (Mohd-Sidik et al. 2021). Malaysia was recorded as one of the countries

with the highest obesity cases as compared to other countries in the region (Kasiry & Wahid, 2020). According to Pital & Ghazali (2022), the increase in the prevalence of overweight and obesity among adults across the countries increase the risk of mortality rate. The consumption of sugar led to medical problems such as obesity, diabetes, tooth decay, and deficiency of other nutrients in foods or drinks rich in sugar. Factors associated with these medical issues include the availability of sugar which can be gain at affordable price and related to addiction to the taste of sugar (Azaïs-Braesco et al., 2017).

According to a study on the relationship between BMI with percentage body fat and obesity in Singaporean adults, BMI and body fat percentage has an association in which at lower BMI, participants will have a higher body fat percentage (Chen et al., 2021). Another study conducted on the association of SSB with body composition among Mexican adolescents stated that there were positive association between SSB intake and body fat percentage (English et al., 2022). According to the study, 55% of the respondents that decreased their SSB intake over a two-year period had a decreased in body fat percentage (English et al., 2022). Meanwhile, another study conducted among female students from Umm Al-Qura University, Makkah, Saudi Arabia to evaluate the impact of sugar-sweetened carbonated beverages (SSCB) consumption on adiposity parameters reported the association between SSB consumption and body fat percentage were found to be significant ($p < 0.001$) which indicates that the increase of SSB consumption resulting in increase of body fat percentage (Azzeh & Hamouh, 2022).

1.2 Problem Statement

The consumption of sugar-sweetened beverages (SSB) among children and adults' remarks on weight gain. A systematic review and meta-analysis conducted on the relation between SSB and body weight in children and adult by Malik et al., (2013) stated that there was an association between SSB consumption and weight gain. It is further strengthened by the evidence from prospective cohort studies to determine the SSB consumption and body weight among adults, where 1 serving of SSB per day results in the increase in body mass index (BMI) by 0.06 unit over a 1-year period among children and additional weight gain of 0.12 to 0.22 kg over a 1-year period for adults. SSB contained 35.0-37.5 g of sugar per 12-oz which contain approximately 140-150 calories. These calories not only promote weight gain, but in fructose-sweetened beverages, it promotes the development of visceral adiposity and ectopic fat deposition which lead to the increase in body fat percentage (Stanhope et al., 2009).

The intake of sugars in foods and beverages not only led to weight gain, but it also increased risk of other non-communicable disease (NCD) such as obesity, diabetes mellitus, teeth related issues, and even nutrient deficiency (Qi & Tester 2019). According to Teng et al. (2019), the increase intake of SSB also lead to hypertension, cardiovascular disease, depression, and cancers. SSB such as carbonated drinks contain a high sugar as well as acidic. This could lead to the enamel erosion and further lead to dental carries and tooth decay (Eklund et al., 2001).

1.3 Rationale of Study

The participants for this study consisted of students studying in Universiti Sains Malaysia Kubang Kerian, Kelantan (USMKK). They are categorized as young adults with the range of 18-21 years old. According to a study conducted in Australia by Miller et al. (2020), the consumption of sugar-sweetened beverages (SSB) was frequently taken among the young adults in Australia. The prevalence of SSB intake led to an increased risk of comorbidities cause by sugar intake in the drinks. Therefore, the information gain from this study and to provides the current status intake of SSB among students in USMKK. Moreover, this study presented prevalence of obesity using body mass index (BMI) and body fat percentage among students in USMKK.

The information obtained from this study help to create an effective intervention programme as well as strengthen the already existing intervention programmes. This study highlighted the alarming rise in the intake of sugar sweetened beverages among students in Malaysia which indicates to the increased risk of getting non-communicable disease (NCD). The population in this study which is university students are population that are in high risk of getting the NCD. Given that the tendency of university students in consuming sugar sweetened beverages is very likely, the major factors that lead to this problem would be the availability of the SSB, the affordable price and the increase on advertisements for SSB. University students get invested with the taste and later become addicted to it. university students in USMKK will later become a health science graduate which are proficient in healthcare field. There are responsible to lead the way to a healthier lifestyle as well as educating people on healthy food choices. Thus, this study helps to increase the

awareness and knowledge among students in USMKK about the limitation of sugary beverages and the association of the intake of Sugar sweetened beverages, body mass index, and body fat percentage.

The findings of the study provide necessary information and confirmed the association between the sugar sweetened beverages (SSB) consumption, body mass index (BMI), and Body Fat Percentage among students in USMKK. This helped us to plan an intervention programmes as preventive measures as well as to reduce the mortality rate due to non-communicable disease.

1.4 Research Questions

1. What is the sugar-sweetened beverages (SSB) intake level of undergraduate students in USMKK?
2. What is the body mass index (BMI) status of undergraduate students in USMKK?
3. What is the body fat percentage status of undergraduate students in USMKK?
4. Is there any association between sugar-sweetened beverages (SSB) consumption and body mass index (BMI) among undergraduate students in USMKK?
5. Is there any association between sugar-sweetened beverages (SSB) consumption and body fat percentage among undergraduate students in USMKK?

1.5 Study Objectives

1.5.1 General Objectives

To determine the association between sugar-sweetened beverages (SSB) consumption, body mass index (BMI), and body fat percentage among undergraduate student in USMKK.

1.5.2 Specific Objectives

1. To determine the percentage of the intake of sugar-sweetened beverages (SSB) among undergraduate student in USMKK.
2. To determine the percentage of the body mass index (BMI) among undergraduate students in USMKK.
3. To determine the percentage of the body fat percentage among undergraduate students in USMKK.
4. To determine the association between sugar-sweetened beverages (SSB) consumption and body mass index (BMI) among undergraduate students in USMKK.
5. To determine the association between sugar-sweetened beverages (SSB) consumption and body fat percentage among undergraduate students in USMKK.

1.6 Research Hypothesis

1.6.1 Null Hypothesis (H_0)

1. There is no significant association between the sugar-sweetened beverages (SSB) consumption and body mass index (BMI) among undergraduate students in USMKK.
2. There is no significant association between sugar-sweetened beverages (SSB) consumption and body fat percentage among undergraduate students in USMKK.

1.6.2 Alternating Hypothesis (H_a)

1. There is significant association between sugar-sweetened beverages (SSB) consumption and body mass index (BMI) among undergraduate students in USMKK.
2. There is a significant association between sugar-sweetened beverages (SSB) consumption and body fat percentage among undergraduate students in USMKK.

CHAPTER 2: LITERATURE REVIEW

2.1 Definition of Sugar-sweetened Beverages (SSB)

According to WHO (2017), sugar-sweetened beverages (SSB) is defined as all beverages containing free sugars such as carbonated or non-carbonated beverages, 100% fruit or vegetables juices, liquid, and power concentrates, flavoured water, sports drink, tea, coffee, and flavoured milk. Monosaccharides and disaccharides are known as free sugar and naturally presence in honey, syrup, fruit juices, and fruit concentration. These free sugars are often added to food or beverages (WHO, 2015). According to Huang et al. (2014), SSB have a high calorie and sugar content. However, it provides little to no other nutrients at all. Another definition of SSB by Miller et al. (2013) is that any beverages containing sugar either when purchased or added after purchase which was different from other definition of SSB that defined SSB as beverages with added sugar prior to purchase.

The recommendation for added sugar according to the World Health Organization (WHO, 2015) should not exceed 10% of the total energy intake. It is also recommended to reduce the intake of free sugars by less than 5% of total energy (WHO, 2015). The intake of SSB lead to various non-communicable disease (NCD) such as obesity, type 2 diabetes mellitus and cardiovascular risk in adults (Malik & Hu, 2015). According to Qi et al. (2019), other than causing obesity and diabetes, the intake of sugar could also lead to teeth related issues and deficiency of other nutrients in sugar dense foods and beverages. Furthermore, overweight and obesity cause by the excessive intake of SSB could also lead to various health issues such as hypertension, depression, and various type of cancers (Teng et al., 2019).

2.2 Prevalence of Sugar-sweetened Beverages (SSB) Consumption

Sugar-sweetened beverages (SSB) such as coffee, *teh tarik*, chocolate beverages, and cordial syrup were recorded as the major contributor to the high SSB intake among the adults in Malaysia (Norimah et al., 2008). It was in line with another finding by Ahmad et al. (2019) which stated that sweetened coffee, tea, and 3-in-1 sachet drinks as the most popular SSB in Malaysia. The intake for sweetened coffee or tea, flavoured milk and fruit juices, 3-in-1 sachet drinks and sport drinks were recorded at 68.1%, 57.9%, 57.6 % and 23.4% respectively. Meanwhile, the daily SSB intake recorded daily was 89.3% and the intake of three or more intake of SSB daily was recorded at 51.6% (Ahmad et al., 2019). Moreover, according to the study conducted by Norimah et al. (2008) among adults aged 18 to 59 years old in Malaysia, the intake for coffee, *teh tarik*, chocolate beverages, and cordial syrup are 47%, 28%, 23% and 11% respectively on daily basis. Another study conducted among university students in Sarawak stated that 83.6% of their respondents consume at least one SSB daily and 72.1% consumed more than three times SSB a week (Cheah et al., 2023). From this study, the SSB consumption among students is considerably high with the highest SSB consumption being sweetened coffee and tea.

Globally, the prevalence of the intake of sugar-sweetened beverages (SSB) differs. A study conducted among university students in a Caribbean country recorded the prevalence of 86% of SSB consumption which were energy drinks (Reid et al., 2015). Another study conducted among college students in Jordan recorded that 60% of the students consumed SSB daily (Bawadi et al., 2019). Furthermore, the university students in Bangladesh recorded an intake of SSB of 95.4% with 53.6% had SSB consumption of more than two days per week (Bipasha et al., 2017). From this study, the prevalence of SSB consumption among university students was at an alarming

rate. Thus, proper intervention should be carried out to overcome the rising number of SSB consumption.

2.3 Factors of Sugar-sweetened Beverages (SSB) Consumption

2.3.1 Sociodemographic Factor (Gender)

Men has a higher intake of sugar-sweetened beverages (SSB) as compared to women. Various study had proven the significant difference in the intake of SSB between men and women. According to a study by Ahmad et al. (2019) among undergraduate students in a public university in Malaysia, men with lower family income were two times more likely to increases their SSB intake compared to women. The percentage of high SSB intake between men and women in this study were 60.3% and 49.8% respectively. It is in line with another study conducted among Mexican adolescents, where in this population, men had a higher median daily SSB intake (342.9 mL) compared to women (268.6 mL) (English et al., 2022). Moreover, it was further supported that men had a higher intake of SSB compared to women. According to a study conducted by Miller et al. (2020) among Australian population, men have a double intake of regular soda, three times more intake of energy drinks, and five times more intake of sports drink compared to women. The differences could be due to greater concern in women about body weight issues, appearance, and the essentiality of knowledge in food choices than men (Ranjit et al., 2010).

2.3.2 Sociodemographic Factor (Household Income)

Household income had a significant impact on the sugar-sweetened beverages (SSB) consumption. According to a study conducted among undergraduate students in Malaysia, it was found that individuals coming from a lower family household

income has a higher SSB consumption (Ahmad et al., 2019). It was further strengthened by a study conducted among Mexican adolescents where adolescents coming from a lower socioeconomic background had a higher SSB consumption (English et al. 2022). However, the association of household income with SSB consumption were inconsistent with another study conducted by Hassan et al. (2015) among university students in Selangor, Malaysia. The finding from this study stated that family incomes influenced the student's eating behaviour where the more the money the students have, the more money they will spend on foods from restaurants or food stalls.

2.3.3 Sociodemographic Factor (Ethnicity)

The sugar-sweetened beverages (SSB) consumption was influenced by the different ethnicities. According to a study conducted by Cheah et al. (2023) among university students in Sarawak, it was found that Malays and other ethnic groups (Bumiputra Sabah, Sarawak, Indian, and others) had a higher SSB intake compared to Chinese. A study conducted in the U.S. by Miller et al. (2013), stated that non-Hispanic black and Mexican American adults had a greater sugar intake which is 209 kcal/ day, and 217 kcal/ day respectively compared to non-Hispanic white adults. This was due to the cultural differences that influence the dietary pattern and practices of an ethnic (Cheah et al., 2023).

2.3.4 Sociodemographic Factor (Living Status)

The living status affect the sugar-sweetened beverages (SSB) consumption among students. Students either lives in the dormitory inside the campus or live outside the

campus (home). Students living away from home has a greater SSB consumption compared to those staying at home. A study conducted among university students in Puncak Alam, Malaysia recorded the percentage of 69.7% of students that consume SSB in the campus (Teng et al., 2019). Another finding from a study conducted among college students living in dormitory by Alghamdi et al. (2018) stated that the respondents in the study that lived in the dormitory have an unhealthy eating behaviour, which included the higher SSB consumption. This could be due to the role of parents as the primary food decision-maker were displaced by the students living away from home (Bernardo et al., 2017).

2.3.5 Availability and Price of Sugar-sweetened Beverages (SSB)

The availability, accessibility, and the lower price of sugar-sweetened beverages (SSB) had become one of the factors that contributed to the increased in SSB intake. According to a study conducted among university students in Puncak Alam, Selangor, because of the limited access to food preparation facilities, the students that lived in the campus tend to buy foods and drinks from outside (Teng et al., 2019). It was in line with the finding of another study conducted among university students in Kuala Nerus, Terengganu, Malaysia where 71.1% of the respondents had an intake of more than one cup of SSB daily which were cause by the availability and accessibility of SSB at the cafeteria located at the campus (Abu Bakar et al., 2020).

2.4 Ways to Overcome Intake of Sugar-sweetened Beverages (SSB)

Various approaches had been taken to reduce the sugar-sweetened beverages (SSB) consumption as well as to lower the risk of getting non-communicable disease

(NCD) caused by the excessive intake of SSB. According to a systematic review of an association between water consumption and body weight, increasing the intake of plain water could lower the SSB consumption (Muckelbauer et al., 2013). Not only water induce the feeling of satiety, but it also helped to reduce the total energy intake which makes water a suitable substituent of SSB to prevent overweight cases (Muckelbauer et al., 2013).

Aside from substituting sugar-sweetened beverages (SSB) with plain water, the Implementation of tax on SSB had a significant impact which act as a preventive measure to reduce the SSB consumption and reduce the obesity trend and other non-communicable diseases (NCD) (Shyam et al., 2019). On 1st July 2019, the sugar tax was introduced with the rate of MYR 0.40 per litre of sweetened and soft drinks containing more than 5 g of sugar per 100 ml, flavoured Ultra-High-Temperature UHT milk-based drink containing 7 g of sugar per 100 ml, and fruit juices with more than 12 g of sugars per 100 ml (Mohamed Nor et al., 2021). A positive result was gain from this study where company like Nestle Malaysia absorbed the tax, and other company including Fraser Neave Holdings Bhd (F7N) reduced their sugar content in 70% of their products to avoid the tax. Another study conducted in Berkeley, California on the impact of the Berkeley excise tax on SSB consumption showed that the SSB consumption among low-income neighbourhood decreased by 21% while the water consumption increased by 63% than the comparison cities (Falbe et al., 2016). From these findings, we concluded that tax implementation had reduce the intake of SSB as well as acting as an excellent preventative measures against non-communicable disease (NCD) caused by the excessive SSB consumption.

2.5 Conceptual Framework

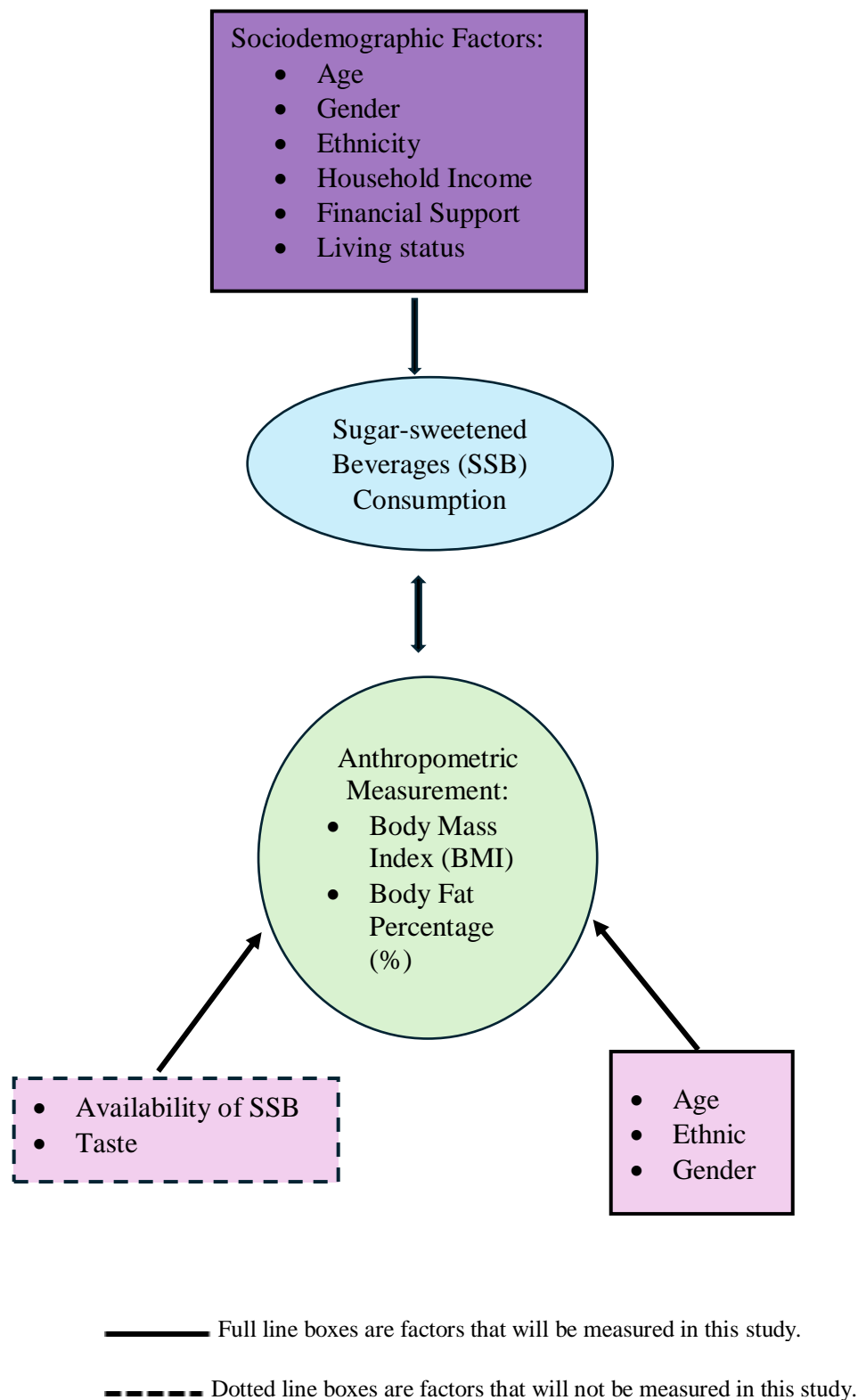


Figure 1.0: Conceptual Framework

Figure 1.0 shows the conceptual framework of the association between sugar-sweetened beverages (SSB), body mass index (BMI), and body fat percentage. The sociodemographic factors such as age, gender, ethnicity, household income, financial support, and living status were assessed as it affected the SSB consumption among the participants (Cheah et al., 2023). Anthropometric data, which is the BMI and body fat percentage also affected the SSB consumption. according to Syed et al. (2020), the consumption of carbonated drinks, which is a form of SSB, were high among obese participants. on the other hand, SSB consumption also affected the anthropometric data. The consumption of SSB had been proven to promote weight gain by incomplete compensation for liquid calories and hyperinsulinemia (Malik & Hu, 2022). Aside from that, there are a few factors that affect the BMI and body fat percentage such as age, ethnic, and gender (Zulfarina et al., 2022). These factors were measured in this study. Meanwhile, factors such as availability of SSB and taste (Abu Bakar et al., 2020) affected the BMI and body fat percentage but was not measured.

CHAPTER 3: METHODOLOGY

3.1 Study Design

This study utilized a cross-sectional study design, employing questionnaires to gather data. The data obtained represents the current information of the population and were utilized for subsequent analysis. This cross-sectional study utilized a set of questionnaires to collect data on sugar-sweetened beverages (SSB) consumption, body mass index (BMI), and body fat percentage among undergraduate students in USMKK. The cross-sectional study design was chosen because it allowed for simultaneous sample information collection at a single point in time, maximizing the completeness of essential data points by examining entire population groups at a specific moment. This method's appropriateness arose from its ability to gather information from samples in a short period and its low budgetary requirements as well as lack of need for follow-up, as there were no treatments administered to the study population.

3.2 Study Location

This study was conducted among undergraduate student in USMKK located in Kelantan, Malaysia. this location was chosen as it was a strategic place to conduct the research because of the presence of students from various backgrounds, ethnicities, and programmes that stay in the university's hostel. Thus, the data for this study were easily obtainable. Moreover, Kelantan which is located at the north-eastern of the Peninsular Malaysia, known for its culturally high intake of sugar in foods and drinks. According to a study conducted by Nantha (2014), Kelantan population recorded a mean sugar consumption of 11.8 grams/ 100 ml of warm tea and more than 80% consume sugar more than 2 teaspoons/ serving. Thus, it was a strategic approach to

conduct the study among undergraduate student in USMKK located in Kelantan as the data are obtainable, convenient, and minimize the cost to conduct the study.

3.3 Study Population

The study participants compromised the full-time undergraduate students between the ages of 20 until 35 years old who were currently enrolled at the Kubang Kerian Health Campus of the University of Science Malaysia, Kelantan.

3.4 Selection Criteria

3.4.1 Inclusion Criteria

1. Full-time undergraduate USMKK students.
2. Individual aged 20 until 35 years old
3. Able to understands and read English language.

3.4.2 Exclusion Criteria

1. Individuals undergoing any dietary interventions.
2. Individual taking any medications that could interfere with normal pattern of beverages consumption.
3. Pregnant and lactating mother.
4. Individuals diagnosed by medical doctor with pre-diabetes, diabetes mellitus type I or II.

3.5 Sample Size Calculation

3.5.1 Sample Size Estimation Based on Specific Objectives: Sugar-sweetened Beverages (SSB) Consumption:

Sample size calculation:

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

n = sample size

Z = value representing the desired confidence level, CI = 95% (z-score = 1.96)

Δ = precision, 0.05

p = anticipated population proportion

The Confidence Level is set at 95% with the Z-score of 1.96. the level of precision is set at 5% (0.05). From a study conducted by Cheah et al. (2023) among university in Sarawak, it is found that the prevalence of respondent that consumed sugar-sweetened beverages (SSB) at least once a day is 83.6% with the three most consumed SSB recorded were coffee, flavoured milk, and 3-in-1 sachet drink. Thus, the anticipated population proportion, p will be 0.836.

$$n = \left[\frac{1.96}{0.05} \right]^2 0.836 (1 - 0.836)$$

$$n = 211 + 20\%$$

$$n = 253$$

n = 253 samples (students in USMKK needed in this study)

3.5.2 Sample Size Estimation Based on Specific Objectives: Body Mass Index (BMI)

Sample size calculation:

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

n = sample size

Z = value representing the desired confidence level, CI = 95% (z-score = 1.96)

Δ = precision, 0.05

p = anticipated population proportion

Based on a study conducted by Hassan et al. (2015) among university students in Selangor, the prevalence of obesity is 12.7%. Thus, the anticipated population proportion, p will be 0.13.

$$\begin{aligned} n &= \left[\frac{1.96}{0.05} \right]^2 0.13 (1 - 0.13) \\ n &= 174 + 20\% \\ n &= 209 \end{aligned}$$

n = 209 samples (students in USMKK needed in this study)

3.5.3 Sample Size Estimation Based on Specific Objectives: Body Fat Percentage

Sample size calculation:

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

n = sample size

Z = value representing the desired confidence level, CI = 95% (z-score = 1.96)

Δ = precision, 0.05

p = anticipated population proportion

Based on a study conducted by Yusoff et al. (2018) among undergraduate students in Terengganu, Malaysia, the prevalence of high body fat percentage 12.6%. Thus, the anticipated population proportion, p will be 0.13.

$$n = \left[\frac{1.96}{0.05} \right]^2 0.13 (1 - 0.13)$$

$$n = 174 + 20\%$$

$$n = 209$$

n = 209 samples (students in USMKK needed in this study)

3.5.4 Sample Size Estimation Based on Specific Objectives: Association between Sugar-sweetened Beverages (SSB) Consumption and Body Mass Index

Sample size calculation:

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

n = sample size

p = anticipated population proportion

α = significance level

$1-\beta$ = power of study

Based on a study conducted by Abu Bakar et al. (2020) among university students in Kuala Nerus, Terengganu, the prevalence of intake of sugar-sweetened beverages (SSB) is 49.4%. Thus, the anticipated population proportion, p will be 0.49.

Based on a study conducted by Teng et al. (2019) among university students in Puncak Alam, Selangor, the prevalence of overweight is 23.9%. Thus, the anticipated population proportion, p will be 0.24.

$$\begin{aligned} n &= \frac{0.49(1 - 0.49) + 0.24(1 - 0.24)}{(0.49 - 0.24)^2} (1.96 - 0.84)^2 \\ &= 54 + 20\% \text{ (dropout rate)} \\ &= 65 \text{ in each group, total sample size is 130.} \end{aligned}$$

Based on all the sample size calculations done for every specific objective of this study, the sample size ranged from 62 to 253. The highest sample size that has been added with 20% to account for the dropout rate, was selected. Thus, a total of 255 participants who fulfilled the inclusion criteria participated in this study.

3.6 Sampling Method and Subject Recruitment

Participant selection for this study was employed through a simple random sampling method. This method was chosen to ensure a representative sample from the target population of university students in USMKK. Simple random sampling involved assigning an equal probability of selection to each member of the population, eliminating any potential bias in the selection process. This method was widely used due to its fairness and unbiased nature. Simple random sampling method was particularly suited for this study as it ensured that the sample accurately reflects the characteristics of the broader population. Its implementation was relatively straightforward, making it a practical choice for the purposes of this research. Initially, a comprehensive list of students, including their respective email addresses, were acquired from the academic office of the School of Medical Sciences, Dental Sciences and Health Sciences via electronic mail, seeking formal authorization to undertake the research. The participants for this study were selected through a random number method, in which each individual was assigned a numerical value. The selection process was conducted using random number tables to ensure a truly random representation of the population. A representative from each year of study in the School of Medical Sciences (PPSP), Dental Sciences (PPSG), and Health Sciences (PPSK), were contacted with a list of selected students who participated in the study, and participants who voluntarily provided informed consent and met the established inclusion and exclusion criteria were recruited as participants for the study. Study participants were thoroughly informed about the research objectives, procedures, and potential risks through the provided information sheet and consent forms. They were required to complete the study questionnaire. A total of 255 participants were

randomly recruited from PPSP, PPSG, and PPSK. Participants were randomly recruited once again until the number of participants needed was achieved.

3.7 Research Tools

The data for this study were collected through the administration of a questionnaire comprising three sections. Each section comprised a range of questions that respondents had answered in an accurate and comprehensive manner. For Anthropometric measurement, this section was taken and filled by the researchers only. Participants completed the questionnaire in approximately 15 minutes. The questionnaire consisted of three different sections, which were outlined as follows:

3.7.1 Part 1: Sociodemographic Information

Sociodemographic data included a range of factors that included age, gender, ethnicity, year of study, nature of courses, living status, household income, and financial support during study. The English language was employed across the questionnaire due to its status as the most prevalent global language and the primary medium of instruction in numerous universities and in USMKK. Therefore, it was concluded that university students are proficient in English language and were adept at employing it within an academic context.

3.7.2 Part 2: Anthropometric Measurement

3.7.2.1 Body Mass Index (BMI)

Body Mass Index (BMI) was an index to determine whether an individual was underweight, normal weight, overweight, or obesity. The formula to calculate BMI was weight in kilogram (kg) divided by height in metres (m) squared (WHO, 2010).