THE RELATIONSHIP BETWEEN SUGARY-SWEETENED BEVERAGES (SSB) INTAKE, ANTHROPOMETRIC INDICES AND FASTING BLOOD GLUCOSE (FBG) LEVEL AMONG MALE AND FEMALE STUDENTS FROM UNIVERSITI TUNKU ABDUL RAHMAN (UTAR) KAMPAR

By

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ABSTRACT

THE RELATIONSHIP BETWEEN SUGAR-SWEETENED BEVERAGES (SSB) INTAKE, ANTHROPOMETRIC INDICES AND FASTING BLOOD GLUCOSE (FBG) LEVEL AMONG MALE AND FEMALE STUDENTS FROM UNIVERSITI TUNKU ABDUL RAHMAN (UTAR) KAMPAR

YEO YEE TENG

Currently, there is a high prevalence of sugar-sweetened beverage (SSB) consumption among young adults especially teenager students and its added sugar contents would contribute to various chronic diseases especially diabetes. Therefore, it is very crucial to understand the factors associated with SSB intake in relation with anthropometric indices and fasting blood glucose (FBG) levels. The objective of this study was to determine the relationship between SSB intake, anthropometric indices and FBG among male and female students from Universiti Tunku Abdul Rahman (UTAR) Kampar. A cross-sectional study was conducted and 200 eligible UTAR Kampar students were recruited using a quota sampling method. Respondents were needed to complete survey comprised of sociodemographic data, frequency and amount of beverages intake through validated Beverage Intake Questionnaire (BEVQ-15), anthropometric measurement and fasting blood glucose test. Kruskal Wallis test and Mann-Whitney test were used to examine the comparison while spearman correlation determined the relationship between SSB,

anthropometrics with FBG. This study had revealed that UTAR students had a low SSB intake (<1 time per day), normal anthropometric measurements and FBG levels. Male consumed a significantly higher amount of SSB thane female students (p=0.001). A significant difference of BMI, waist circumference, body fat percentage and FBG. Male students had a significantly higher BMI, WC and FBG whereas only body fat percentage was higher in female students. No correlation between BMI and body fat percentage with FBG. A positive correlation between SSB and WC with FBG (r=0.189, p=0.007) and (r=0.151, p=0.033), respectively. Lastly, there was a significant difference (p=0.014) of FBG between different BMI categories. To conclude, the SSB intake of UTAR students was not concerning. However, there is still few students having the risk of prediabetes especially among those who were overweight. Therefore, further educational interventions are needed to be implemented to prevent the onset of diabetes.

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DECLARATION

I hereby declare that this final year project report is based on my original work except for quotations and citations which have been duly acknowledged. I also declare that it has not been previously or concurrently submitted for any other degree at UTAR or other institutions.

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YEO YEE TENG

APPROVAL SHEET

This final year project report entitled "**THE RELATIONSHIP BETWEEN SUGAR-SWEETENED BEVERAGES (SSB) INTAKE, ANTHROPOMETRIC INDICES AND FASTING BLOOD GLUCOSE (FBG) LEVEL AMONG MALE AND FEMALE STUDENTS FROM UNIVERSITI TUNKU ABDUL RAHMAN (UTAR) KAMPAR**" was prepared by YEO YEE TENG and submitted as partial fulfilment of the requirements for the degree of Bachelor of Science (HONS) Dietetics at Universiti Tunku Abdul Rahman.

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PERMISSION SHEET

It is hereby certified that **YEO YEE TENG** (ID No: **19ADB02734**) has completed this final year project/ dissertation/ thesis* entitled "**THE RELATIONSHIP BETWEEN SUGAR-SWEETENED BEVERAGES (SSB) INTAKE, ANTHROPOMETRIC INDICES AND FASTING BLOOD GLUCOSE (FBG) LEVEL AMONG MALE AND FEMALE STUDENTS FROM UNIVERSITI TUNKU ABDUL RAHMAN (UTAR) KAMPAR**" under the guidance and supervision of ENCIK MUHAMMAD ZULHUSNI BIN SUHAIMI from the Department of Allied Health Sciences, Faculty of Science.

I hereby give permission to the University to upload the softcopy of my final year project in pdf format into the UTAR Institutional Repository, which may be made accessible to the UTAR community and public.

Yours truly

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(YEO YEE TENG)

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LIST OF ABBREVIATIONS

BEVQ	Beverage Questionnaire
BIA	Bioelectrical Impedance Analysis
BMI	Body Mass Index
COVID-19	Coronavirus disease
CDC	Centers for Disease Control and Prevention
CFS	Centre for Foundation Studies
FAS	Faculty of Arts and Social Science
FBF	Faculty of Business and Finance
FEGT	Faculty of Engineering and Green Technology
FICT	Faculty of Information and Communication Technology
FSC	Faculty of Science
FBG	Fasting Blood Glucose
RNI	Recommended Nutrient Intake
SD	Standard Deviation
SPSS	Statistical Packages for Social Sciences
SSB	Sugary-sweetened beverages
UTAR	Universiti Tunku Abdul Rahman
WC	Waist Circumference
WHO	World Health Organization

CHAPTER 1

INTRODUCTION

1.1 Research background

Diabetes is a major health concern in Malaysia and it contributes significantly to health consequences such as obesity, cardiovascular disease and hypertension. Based on the research from International Diabetes Federation (IDF), 9.3 % (463 million) of adults worldwide were diagnosed with diabetes in year 2019. The number is more likely to rise to 10.2 % (578 million) of adults by the year of 2030, and to 10.9% (700 million) by year 2045 when there is no effective prevention and treatment are carried out. (Akhtar et al., 2022). In fact, the current statistic of diabetes in Malaysia had increased from 12.1% in 2011 to 19.0% in 2021. On the other hand, the number of prediabetes patient is estimated to reach 374 million which is equivalent to 7.5% of the global population in year 2019 and it is expected to increase to 8.0% with 450 million population by 2030 and 8.6% with 548 million by year 2045. In Malaysia, it has the high prevalence of diabetes as it increased from 11.2% in year 2011 to 18.3% in year 2019. Besides, the national survey report has claimed that there are 3.6 million adults with 18 and above years diagnosed with diabetes and a 3.7 million with 49.0% of the diabetes cases were undiagnosed. This makes Malaysia the country with highest rate of diabetes in Western Pacific region and it is predicted to involve 7 million of Malaysian adults that aged 18 and older in 2025 if the effective treatment and prevention

method has not implemented to solve this critical health issues among Malaysian (Akhtar et al., 2022).

The consumption of sugary-sweetened beverage (SSB) has been a part to the diabetes epidemic as the sugary-sweetened beverage contained the added sugars in its content. The SSB consumption has positive association with the anthropometric indices of body mass index (BMI), waist circumference (WC) and body fat percentage (%) and fasting blood glucose (FBG) level. Increased SSB consumption can lead to a long-term weight gain with increased BMI value, high WC and high body fat percentages as the added sugar is the primary source of simple carbohydrates. The simple carbohydrates can be break down rapidly and quickly utilized for energy by the body due to its simple chemical structure (Holesh, Aslam and Martin, 2021). This further increases the blood glucose quickly and raise the insulin secretion from pancreas and thus cause the negative health effects for human body. This leads to a high prevalence of diabetes mellitus, obesity and heart attack. Besides that, high dietary glycemic load would result in inflammation, insulin resistance and impaired B-cell function to raise the blood glucose level as well as promote the accumulation of visceral adiposity, dyslipidemia and ectopic fat deposition that caused by the increased hepatic de no lipogenesis (S Malik et al., 2011). Hence, the frequent consumption of sugary-sweetened beverages increases the anthropometric indices as there is weight gain on an individual.

Furthermore, this added sugar contained sugar sweetened beverage has an impact of nutritional status and increases the prevalence of metabolic

abnormalities such as impaired fasting glycemia among the younger generation. Hence, the blood glucose level especially the fasting blood glucose must be monitored in order to prevent the diabetes disease. Fasting blood glucose test is more accurate, reliable and screen for diabetes compared to the random blood glucose as it includes the fasting method for a time period of 8 to 12 hours prior to the blood testing (Sung et al., 2017). The fasting blood glucose level is the level that falls between the meals and offer an insight on how the body manages the sugars in the body. A high level of fasting blood glucose showed that the body was not able to reduce the blood sugar levels in the body and it indicates the insulin resistance and inadequate insulin production. This would further lead to a more chronic state which is the diabetes in an individual (Cronkleton, 2022).

There are several factors which leads to the higher rate of sugary-sweetened beverage consumption. For instance, it is due to the lifestyle factor. The university students always busy with their academic commitments such as midterm test, assignments, homework and final year project. They would feel overwhelmed and stress for handling so many tasks at one moment. Hence, they would be craving for the sweet foods as sweet foods would give positive effect on mood and increase the serotonin levels in the body. They would feel satisfied after they consume the sweet foods and drinks especially sugary-sweetened beverages and high calories foods and drinks. These high sugar foods and drinks can increase body weight and further causes the lipid biosynthesis and results in impaired blood glucose levels. The lifestyle factors that commonly seen in university students are problematic eating behaviors

such as stress eating, poor eating habits, irregular time of eating, high fast foods consumption and high calories foods with drinks. Moreover, the sociability factor is one of the factors that causes the higher rate of sugary-sweetened beverage consumption. Students at school or university are primarily influenced by their peers. According to a study, university students will consume the sugary-sweetened beverages in order to socialize with their peers and they often have a higher tendency to consume soft drinks when their peers do (Abu Bakar, 2020).

Therefore, in order to develop effective treatment and prevention method to solve and curb the health issues, this study determines the pattern and frequency of sugary-sweetened beverages consumption and its relationship with body mass index and the fasting blood glucose among university student in UTAR Kampar, Malaysia. This can also raise the awareness and encourage the younger generation to reduce and cut down the consumption of sugary-sweetened beverages in daily life as this can prevent the chronic health disease and metabolic syndrome. By doing this, one can maintain his or her health status well.

1.2 Problem statement

This study is carried out as there is a high prevalence of chronic disease especially diabetes among Malaysian nowadays. According to the National Health and Morbidity Survey 2019, approximately 3.9 million Malaysian were diagnosed with the disease of diabetes and it's prevalence rate was increased from 12.1% in 2011 to 19.0% in 2021. By this, Malaysia has also been given

the title of “Sweetest Nation in Asia” with the diagnosed patient of 1 in 5 adults in the country (International Diabetes Federation, 2021). This finding reveals a concern and the real problem as the incidence of diabetes is expected to increase in Malaysia. Therefore, this study may assist in educating Malaysian on the improvement of FBG, maintain a normal and healthy BMI.

Apart from that, there was some research gaps from the related previous studies and lacking similar study in Malaysian population on the relationship between SSB intake, anthropometric indices and FBG levels. This is because the prior studies conducted were all focused among the public university students in Malaysia. More attentions are needed to focus on private university students in Malaysia. Hence, the finding of this study will look into anthropometric measurements and blood glucose with the consumption of SSB in Malaysia.

1.3 Significance of study

This present study determines the relationship of SSB intake, anthropometric indices and FBG level among university students in Malaysia. Besides that, this study aims to understand the incidence of SSB consumption among university students. It provides clear and better understanding with the relationship of SSB, anthropometrics and FBG with the risk of diabetes among university students. Furthermore, this study may be beneficial in raising awareness and implement a more strategic intervention program of healthy dietary pattern and lifestyle by reducing the SSB intake in order to improve the

anthropometric measurement and FBG level among university students or younger adults. This can provide an insight for the needs to the public health practitioners for the development and initiation of certain health strategies for the improvement of blood glucose levels and healthy weight status in the future.

1.4 Study objective

1.4.1 General objective

To determine the relationship between sugary-sweetened beverages (SSB) intake, anthropometric indices and fasting blood glucose (FBG) among male and female students from Universiti Tunku Abdul Rahman (UTAR) Kampar.

1.4.2 Specific objectives

1. To determine the sugary-sweetened beverages (SSB) intake, anthropometric indices and fasting blood glucose (FBG) among UTAR male and female students.
2. To compare the sugary-sweetened beverages (SSB) intake, anthropometric indices and fasting blood glucose (FBG) between UTAR male and female students.
3. To study the relationship between the sweetened beverages intake, anthropometric indices with fasting blood glucose (FBG) among UTAR male and female students.
4. To compare the fasting blood glucose (FBG) between different body mass index (BMI) categories.

1.5 Research hypothesis

1. UTAR female students will have a healthier dietary pattern with low consumption of SSB, better BMI, WC and body fat percentages (%) values and constant FBG as compared to male students.
2. There are significant differences between SSB intake, BMI, WC and body fat percentage (%) with FBG among UTAR male and female students.
3. There is a significant relationship between SSB intake and anthropometric indices of BMI, WC and body fat percentages (%) with FBG between UTAR male and female students.
4. There are significant differences of FBG level between different BMI status.

1.6 Research questions

1. What is the prevalence of SSB intake, BMI and FBG level among UTAR male and female students?
2. What is the difference in SSB intake, BMI and FBG level between UTAR male and female students?
3. What is the relationship between SSB intake, BMI and FBG level among UTAR male and female students?
4. What is the difference of FBG level in different BMI categories?

CHAPTER 2

LITERATURE REVIEW

2.1 Background of sugary-sweetened beverage (SSB)

2.1.1 Definition and recommended daily intake of sugary-sweetened beverage

Sugary-sweetened beverage (SSB) is defined as the beverage that contains additional sugar or extra caloric sweeteners, such as sucrose, high fructose corn syrup, brown sugar, raw sugar, fruit juice concentrate, corn sweetener, maltose, molasses, raw sugar, honey, fructose, dextrose, glucose, lactose, sucrose, and malt syrup (Brand-Miller and Barclay, 2017). These are the high sugary beverages that people frequently include in their daily diets. Besides that, SSB commonly have 25 calories per 8 ounces of fluid. The most popular sugars or sweeteners used to flavour SSB are sucrose and high fructose corn syrup (Malik and Hu, 2019). Examples of the sugary-sweetened beverages include regular soda (not sugar-free), fruit drinks, sports drinks, energy drinks, sweetened waters, and coffee and tea drinks that has the inclusion of sugars like honey, lactose, malt syrup, maltose, molasses, raw sugar, and sucrose (Centers for Disease and Prevention, 2022). However, finding from Sousa et al. (2020) claimed that drinks that known as naturally occurring sugar or artificial sweeteners such as diet soda and 100% fruit juice are not categorised as SSB.

In addition, the study from World Health Organization (2015) proved that it is important to restrict the daily sugar intake to approximately less than 10.0% of

the daily energy intake from free sugar which is equal to 50g or 12 teaspoons of sugar. This limitation of the sugar is proved and exerts the benefits on the prevention of diabetes mellitus and obesity. Correspondingly, the Recommended Nutrient Intakes (RNI) Malaysia has also recommended that an individual must practice a good habit with limitation of an intake of less than 10.0% of daily energy intake of free sugar in each day. Furthermore, Malaysian Healthy Plate along with the recommended beverages such as plain water, unsweetened milk or soy products are all encouraged to replace the consumption of SSB in each day. Moreover, Malaysian Dietary Guidelines (2020) has also indicated that the limitation of sugar intake from each beverage is one of the important key messages for a better health among Malaysian.

2.1.2 The trend of sugary-sweetened beverage intake

The consumption of sugary-sweetened beverages (SSB) is one of the major factors that leads to the higher rate of diabetes all around the world. This problem is gradually growing more concerning as it has a number of detrimental effects on human health. Frequent consumption of SSB is linked to weight gain, diabetes, heart disease, and other metabolic syndromes (Centres for Disease Control and Prevention, n.d.).

According to the Centers for Disease and Prevention (n.d.), they revealed that there are 63.0% of people who are 18 or older regularly drink sugary-sweetened beverages with one or more in daily diet. Besides that, there is a research that focusing on the SSB intake among adult population stated that the average daily intake for an individual of 20 years of age and older was 0.58

servings per day in 187 countries. Furthermore, the population in Caribbean region was having the greatest SSB consumption while population in East Asia was having the lowest SSB intake. According to the statistics from the National Health and Nutrition Examination Survey (NHANES), it is proven that half of the American adults (49.3%) consumed at least one SSB in each day with the average of 149 kcal.

Apart from that, there was a limited data on the SSB intake among Malaysian population nowadays. However, both of the findings of National Health and Morbidity Survey, NHMS (2019) and Malaysian Adult Nutrition Survey, MANS (2014) found that there is a high occurrence of SSB intake among Malaysians. Examples of beverages that added with sugars such as tea, coffee and malted drinks are the most popular SSB among Malaysian. According to the MANS (2014), it stated that tea with sugar (70.3%) is the most consumed SSB among Malaysian in each day, followed by malted drinks (59.1%) and coffee (53.2%). Similarly, NHMS (2019) also reported that 53.2% of Malaysian consume drinks with added sugar per day in their daily life.

2.2 Sugary-sweetened beverages intake among university students

In addition, the age group of university students is between 18 to 25 years old. This age group has the higher prevalence on consuming sweetened beverage intake. Besides, there is a study from Bleich and Wang (2011) has shown that the younger adult (aged 20-44) especially college students consumed more SSBs than older adults (Kwan et al., 2021). Studies has also revealed that when the students are under stressful circumstances, they might tend to alter their

eating patterns, choosing meals and drinks with high calorie content and high palatability. This situation occurs more frequently during the COVID-19 epidemic in Malaysia, when the lockdown measures are taken and have an impact on the closure of universities, movement restriction and restaurant closure. This further affect the access of foods and drinks, location of consuming the meals as well as the foods preparation method of the meals (Cheng and Lau, 2022). Based on the research study from Cheng and Lau (2022) with 100 students from University of Nottingham Malaysia, the most popular beverage consumed by university students was milk (59.0%), followed by tea or coffee with added cream and sugar (56.0%) and soft drink (44.0%). On average, one-tenth of the students drank tea or coffee every day with cream or sugar. The majority of students (99.0%) reported of not drinking any energy drinks in a week, which makes this particular energy drink as the least popular beverage among university students.

2.3 Relationship between sugary-sweetened beverages intake between male and female students

The National Health Survey 2017-18 from the Australian Bureau of Statistics' (ABS) reveals that men are more likely to consume sugary-sweetened beverages than women. Males were twice as likely as females to regularly consume sugary-sweetened drinks daily which is 12.0% of men against 6.0% of women. Furthermore, the director of the ABS asserted that 44.0% of men and 28.0% of women regularly consume SSB with at least once per week. The average daily intake of SSB intake for male is 3.3 cups which is equal to 825 ml or 2.2 cans of soda, or around 19 teaspoons of sugar with 1401 kcal. The

average daily intake for female is 2.2 cups of SSB consumption which is equal to 625 ml or 1.7 cans of soft drink with approximately 14 teaspoons of sugar or 1061 kcal.

In addition, there was a research showed that the populations with the population with the highest prevalence and propensity for the consumption of sugary-sweetened beverages were young adults and adolescents in Malaysia. Next, the added sugar intake is at 9.0% for children and 28.4% for adults in Malaysia (Teng et al., 2019). This demonstrated that in the Asia Pacific area, Malaysian consume the most sugary-sweetened beverage intake in Asia Pacific region. In 187 countries, adults consumed 137.2 milliliters of sugary-sweetened beverages per day. Studies reported that men and younger adults were the world population to consume most of the sugary-sweetened beverage intake (Singh et al., 2015). Moreover, there is likewise a review from Bleich and Wang (2011) revealed that men consumed significantly more SSBs than women.

2.4 Relationship between sugary-sweetened beverages intake with body mass index

The body mass index (BMI) is a measurement to determine the health risk of an individual by using the ratio of weight and height. BMI helps us to detect early sign of our health and initiate early treatment to overcome the disease. It does not measure directly on the body fat but it uses an equation to make an approximation in order to determine an individual is at the state of unhealthy of healthy weight (Pletcher, 2016).

Sugary-sweetened beverages (SSB) that added with sugar contained additional calories to an individual's diet. Overconsumption of SSB will cause excess sugar remained in body and lead to weight gain that further results in obesity. People who are at high risk for diabetes frequently have modest overweight, central obesity and being physical inactive in their daily life (Abu Bakar et al., 2020),

Besides, the sugary-sweetened beverages mainly contained simple sugars found in carbohydrates. This glucose component gives energy supply to our body. While excess glucose will be stored in liver for later energy use. But due to the limited storage capacity, the glucose will further convert and stored as fat in the body. As a result, the excessive intake of sweetened beverages causes higher fat storage in body and lead to weight gain and increased BMI. Findings from Abu Bakar et al. (2020) showed that the students with excessive sweetened beverages intake have a higher BMI than those with less sweetened beverages intake.

According to S Malik et al. (2011). It also showed a favorable correlation between increased consumption of sugary-sweetened beverages (SSB) and increased body weight as well as obesity in both children and adults. Additionally, there is a strong and positive correlation between weight gain and soft drinks that people consumed it as the sweetener drink. According to the research, an individual who has consumed more than 1 serving of soft drinks per day was linked to an annual weight gain of 0.10 kg (95% CI) (González-Morales et al., 2020).

2.5 Relationship of sugary-sweetened beverages intake with waist circumference

Waist circumference is the measurement taken around the abdomen at the level of umbilicus (belly button). It is important as it acts as a best indicator for the prediction of obesity-related chronic disease in male and females compared to body mass index (BMI). Waist circumference also helps to screen for possible health risks that come with overweight and obesity. Measuring waist circumference can help to determine the location of fat that located on the body. A high risk of diagnosing type 2 diabetes mellitus or heart disease if there are more fat located around the waist than around the hips of an individual (Frey, 2022).

Visceral fat is known as the hidden fat that stored deep inside the belly which surrounded the abdominal organs in the body (Frysh, 2021). An individual with a larger waist circumference was also strongly associated with a high visceral fat percentage. Too much of visceral fat are danger for human as it lies underneath our skin that known as subcutaneous fat which can possibly increase the risk of metabolic syndrome. The visceral fat can make certain proteins to inflame our body's tissues and organs in order to narrow our blood vessels. This further increases the blood pressure and leads to hypertension, stroke or cardiovascular disease. Furthermore, the good measurement for visceral fat is the measurement of waist circumference.

According to English et al. (2022), the increased consumption of sugary-sweetened beverage (SSB) results in increases of waist circumference. SSB is the main source of added sugar for all age groups and account for a sizeable portion of total calorie intake due to their higher SSB intake. The study showed that the increases of SSBs would result in the increases of waist circumference among Mexican adolescents. 1 – 2 servings of SSBs intakes per day had an approximately 2.49cm increases in waist circumference. While the waist circumference and body fat percentage would be decreased in adolescents who cut back on their SSB consumption.

Moreover, there is a study showed that there is a positive correlation between the intake of SSBs and waist circumference in adult population. The study revealed that the intake of SSBs can increase the waist circumference by 14.0% in adult population. With the increased consumption of SSB, the risk of obesity and obesity-related disorders might be raising among adult population (Ardeshirlarijani et al., 2021).

In addition, one study from Francis et al. (2009) reported that a high waist circumference was positively associated with the high SSB consumption among Jamaican adolescents. Furthermore, this study also reported that a high waist circumference is more prevalent among female adolescents and is related to low consumption of fruits and vegetables.

2.6 Relationship between sugary-sweetened beverages intake with body fat percentage

Body fat percentage is important as the measurements of body fat able to determine fitness of a body. Carrying too much of fat can lead to obesity and increase the risk of diagnosing chronic disease such as cardiovascular disease, diabetes and stroke. There are two types of body fat in the body which are fat-free mass (FFM) and fat mass (FM). Fat-free mass is known as the essential fat which is lies under the bones, liver, kidneys, intestines and muscles. The fat that located in these areas are used for the body to function normally in daily life. While fat mass is known as the stored fat where it is found under adipose tissues. This type of fat is used for the energy supply to the body. It just located under our skin and surrounded our body organs. It also helps to insulate and cushion the body and conduct daily activity normally (Ratini, 2021).

Apart from that, the study from English et al. (2022) also claimed that increased body weight and fatness or weight gain might be resulted from increased SSB intake. This demonstrated that the increased body fat percentage is linked to higher SSB consumption. The body fat percentage was 2.72% greater in adolescents who consumed more than 2 servings of SSB each day.

Increasing the consumption of SSB without decreasing the total calories intake in the body can results in an improvement of body's energy balance. In fact, the calories intake from liquids or beverages are seems to have lower satiety to human when compared to whole foods consumption. This is due to the SSB have a low fiber content, protein and several micronutrients that can fulfill

human’s satiety. Hence, people tend to drink more in order to have a satiety feeling. Besides that, SSB have a high glycemic index (GI) which would lead to a sharp increase and drop in blood glucose levels. As a result, it will lead to the individual may having more intense food cravings as well as eating too many high-energy meals like simple carbohydrates in daily life. Long-term excess consumption of high-fructose meals and drinks are also associated with a higher chance of developing insulin resistance, impaired metabolism, resistance, increased body weight and fatness.

2.7 Relationship between fasting blood glucose with sugary-sweetened beverages intake

A fasting blood glucose test is a measurement of amount of glucose that circulated in an individual’s blood. Diabetes is a condition that can lead to excessive amount of sugar in blood. According to Cronkleton (2022), blood glucose testing is the blood test to check the glucose levels in the body by pricking the finger to draw a small drop of blood. This blood test can assess the diabetes disease on a person and evaluate whether a person is healthy or not. The blood sugar will be on peak about an hour after eating and declines after one hour. A high fasting blood sugar levels indicate that there is a possibility of insulin resistance or diabetes of a person. While an abnormal low fasting blood sugar levels are more possibly caused by a diabetes medications (Cronkleton, 2022). Blood glucose testing helps to manage diabetes disease by looking at the signs and symptoms of blood sugar in the body.

A high SSB consumption is positive correlated with high FBG levels. From the findings of Centers for Disease Control and Prevention (n.d.), type 2 diabetes mellitus with high FBG levels would be happened when there is a higher SSB intake among university students. According to Fletcher (2021), the high sugar added sweetened beverages contained the simple carbohydrates content which can be broken down and this may further result in a rapid spike of blood glucose levels in the body. Eventually, an increased insulin production will be occurred from the pancreas in order to help regulate blood glucose. Over time, the increased demand for insulin can lead to insulin resistance, which it is a condition that body become less responsive to insulin, resulting in higher FBG levels (Tseng et al., 2021; Wang et al., 2015).

In addition, SSB intake was also defined as high and energy-dense beverages. They do not contain or has a little nutritional value to meet the nutritional requirements for the body. Study from Seloka et al. (2021) proven that high consumption of SSB would be associated with metabolic syndrome (MetS). Mets is known as a cluster of abnormalities related to metabolic health that raises the onset of diabetes mellitus. The finding of Seloka et al. (2021) was also shown that increased SSB intake is positive correlated with adverse metabolic health complications especially high blood glucose levels. Furthermore, a previous study of James et al. (2016) revealed that greater sweetened beverages consumption was also positive correlated with increased fasting glucose concentration. Another finding of McKeown et al. (2017), was also claimed that high SSB intake would lead to a high FBG levels with each additional serving of SSB intake was associated with higher FBG. According

to the research study of Cheng and Lau (2022), the mean daily sugar intake from SSB was 59.14 ± 51.28 g/day which is equivalent to 12 teaspoons of sugar. There is also a few study claimed that high SSB consumption had a higher insulin resistance and this eventually lead to a high risk of diabetes (Deshpande, Mapanga, and Essop, 2017; Dhingra et al., 2007; Lana, Rodriguez-Artalejo, and Lopez-Garcia; 2014; Ma et al., 2016).

To conclude, higher SSB intake may cause an elevated FBG levels in the body. The regular consumption of high sugar added beverages can lead to increased blood glucose over time, especially when it is consumed in excessive amounts.

2.8 Relationship between fasting blood glucose with body mass index

A higher blood glucose level is positively associated with higher BMI (Sepp et al., 2014). The glucose content from the sugary foods and beverages will synthesize the fatty acid that constitute to body fat content. This causes the increased blood glucose level and further results in the increased BMI and body weight by increased lipid biosynthesis. The beta cells of islets of Langerhans from pancreas secrete the insulin which acting on the specific cell receptor of insulin sensitive cells and eventually increasing the glucose uptake into the cell. The insulin which acts as an anabolic hormone results in energy conservation and signals the body to produce body fat. This shows that when the BMI increases, the insulin resistance also increases and leads to the rising blood glucose level (Agrawal et al., 2017). This demonstrates a significant positive correlation between FBG and BMI (Agrawal et al., 2017).

The normal and healthy blood glucose level is the ability of insulin secretion by pancreas and ability of glucose cells by target. Studies from Kamalaja and Rajeswari (2020) revealed that higher mean blood glucose levels were found in obese individual. This can be explained by insulin resistance increases due to the higher BMI value. The increased insulin resistance will further lead to increased blood glucose level in the body. Hence, the BMI is positively correlated with FBG.

In addition, there is also another study showed that there is positive correlation between FBG levels and BMI in Indian population. A high BMI can be seen in an overweight and obese diabetic patients (Patil et al., 2012). Furthermore, there is a significant positive correlation was obtained between BMI and FBG levels in overall participants in Malaysian adults. Male participants whereas female participants (DoustJalali et al., 2020).

2.9 Relationship between fasting blood glucose with waist circumference

Waist circumference can be a good predictor on predicting the insulin resistance and diabetes. A body size has shown with a greater impact on blood glucose levels. For instance, an obese person with high waist circumference would have an accumulation of an excessive amount of body fat that can cause the development of insulin resistance and increase the risk of type 2 diabetes mellitus (Klein et al., 2022).

Furthermore, the study from Veghari et al. (2014) showed that there is a positive correlation between fasting blood glucose (FBG) level and waist circumference among adult population in the north of Iran. The study showed the findings of mean of FBG in women (98.3 ± 40.1 mg/dl) was higher than the FBG levels in men (94.6 ± 32.2 mg/dl). While the mean of waist circumference in women was also showed higher value with 4.5 cm higher than men.

Besides that, the study also reported that the FBG levels increased up to 2.82 mg/dl in each 10 cm of waist circumference with the highest rate in 35–45 year-age group of male adult in Iran. While the FBG levels were increased up to 3.48 mg/dl in each 10 cm of WC with the highest rate in 25–35 year-age group of female. It is shown that as men aged, the regression coefficients remained constant. While there was a declining trend in women's waist circumference and fasting blood glucose levels with age (Veghari et al., 2014).

In addition, there is another study showed that there is positive correlation between FBG levels and WC in Indian population. The study also showed that high WC can be seen in the overweight and obese diabetic patients. Hence, this showed that WC can be used as a predictors of type 2 diabetes mellitus (Patil et al., 2012).

2.10 Relationship between fasting blood glucose with body fat percentage

Body fat content of an individual is associated with an increase of blood glucose concentration. One study found a significant and positive correlation

between FBG and body fat percentage as well as the fat mass in the body. As blood glucose concentration increases, the body fat content would also increase in the body (Majili and Kinabo, 2015).

Aside from that, there was another study showed that trunk fat was positively correlate with FBG levels. FBG and HbA1c had a strong positive relationship with trunk fat amount per lean mass. This study also found that increasing trunk fat increased the risk of hyperglycemia in high community adult participants (Lin et al., 2020).

CHAPTER 3

MATERIALS AND METHODS

3.1 Study design

This study used an observational study design, which is classified as a descriptive study. This study was a cross-sectional study which conducted at UTAR Kampar. All the respondents were solely based on the inclusion and exclusion criteria. The main objective of the study was to determine the relationship between sugary-sweetened beverages intake, anthropometric indices and fasting blood glucose among UTAR Kampar students. This study also aimed to determine the levels of each variables and identify the relationship between them. The participants were recruited using a quota sampling method at UTAR Kampar campus.

3.2 Study location

This study was carried out at UTAR Kampar Campus. The data collection was started from 28th November 2022 to 5th December 2022 through a physical data collection with handout questionnaire, anthropometric assessment and fasting blood glucose finger blood prick test.

3.3 Study population

The target population of this study is the university students from different faculties at Universiti Tunku Abdul Rahman (UTAR). The target sample of this study has included the students from UTAR Kampar campus only.

3.4 Sampling method

The sampling design of this study was quota sampling method which is a non-probability sampling which involves the random selection of a predetermined number or proportion of units of the participants. Quota sampling is more preferable for this study as it is simple with equal sample size between 2 groups and it can reduce bias during the data collection of the study (Simkus, 2023).

3.5 Inclusion criteria

All the respondents must be the students who are studying at UTAR Kampar only. The students from UTAR Kampar students which included the foundation and undergraduate students are all allowed to become the respondents of this study. The respondents should be aged between 18 to 25 years old. Besides that, an individual should be non-smoker to obtain an accurate result. This is because nicotine of the cigarette smoking will increase the blood glucose levels in the body of smokers and they might need a larger dose of insulin to keep their blood glucose to their target levels (Centers for Disease Control and Prevention, 2022).

3.6 Exclusion criteria

Individual with a regular intake of medications such as antidepressants, corticosteroids, metformin, sulfonylureas, and thiazolidinediones (TZDs) were excluded from the study (American Diabetes Association, n.d.). This is because these medications may interfere with blood glucose level by increasing and lowering the blood glucose during blood glucose test. Furthermore, individuals

who diagnosing from disease like liver disease, renal disease and heart disease were also excluded. Individual who is pregnant are also excluded from this study. Overall, the respondents who have the habits which mentioned above must be excluded in this study as these behaviors may affect the accuracy of health assessment.

3.7 Sample size calculation

The sample size is calculated and determined by using Cochran's sample size formula (1963) for finite population as stated below:

$$Sample\ size, n = \frac{\frac{z^2 \times p(1-p)}{e^2}}{1 + \left(\frac{z^2 \times p(1-p)}{e^2 N}\right)}$$

z = z-score

N = Population size

e = margin of error

p = population proportion

The inputs of this equation are:

z-score = 1.96 (95% confidence interval with ±5% precision),

N = 12300 (Total number of students from UTAR Kampar Campus),

e = margin of error

= 0.08 (8%)

p = expected proportion referred to prior study

= 0.19

According to Uivarosan et al. (2019), there were 19% of young adults who consumed more than 8 servings of SSBs per week had the prevalence of impaired fasting glucose.

$$Sample\ size, n = \frac{\frac{1.96^2 \times 0.19(0.81)}{0.06^2}}{1 + \left(\frac{1.96^2 \times 0.19(0.81)}{0.06^2\ (12300)}\right)}$$

= 164.242

= 164 respondents

164 respondents + 20% dropout rate = 196

= **200 respondents**

A minimum of 200 participants were recruited after the inclusion of 20% dropout rate to prevent any inaccuracy or invalid data. In this study, a total of 236 respondents have completed the questionnaire and anthropometric measurements from physical data collection in campus after inviting and distributing them to 300 students through different platforms such as WhatsApp, Microsoft Team and Instagram. However, only 200 responses were eligible and meet the requirements of my study. These 200 responses were completed by 100 male and 100 female respondents and they were chosen for data analysis after eliminating the questionnaires and physical data collection with messing data or mistakes.

3.8 Data collection

The data collection was conducted by distributing a Google Form questionnaire and anthropometric or health assessment to the target population at UTAR Kampar. A total of 2 sections were included in the questionnaires on

sociodemographic data and the types and frequency of SSB by the targeted population. Besides that, there were practical anthropometric measurements to be conducted for the respondents in order to obtain their measurements of anthropometric and their fasting blood glucose level. Data of anthropometric indices such as BMI, WC and body fat percentage were collected with the assist of bioelectrical impedance analysis (BIA). While FBG were measured with blood glucometer after 8 to 12 hours fasting.

A total of 4 sections listed below were included in the data collections.

Section A: Sociodemographic information

Section B: Beverage intake Questionnaire (BEVQ)

Section C: Anthropometric measurement

Section D: Fasting blood glucose test (Finger prick blood test)

3.8.1 Sociodemographic information

The first part of this questionnaire focused on sociodemographic information such as gender, age, body weight, height, ethnicity, faculty and course of study. In this section, age of the respondents must be included as this can ensure that the age of participants is within the range stated in the inclusion criteria which is 18 to 25 years old.

3.8.2 Beverage intake Questionnaire (BEVQ)

On top of that, section B focused on the frequency and amount intake of SSBs by collecting the dietary information through the beverage intake questionnaire (BEVQ) that has been validated by using the development and scoring systems.

(Hedrick et al, 2010). There was a total of 15 beverages included in the questionnaire. Only 6 of the beverages were SSBs. Other than that, the rest of the remaining beverages were non-SSBs, which included plain water, whole milk, reduced fat milk, low fat milk, artificially sweetened drink, tea or coffee without cream or sugar, beers, hard liquor, and wine were all excluded from total SSB. Furthermore, the participants were allowed to report their SSB intake if the particular SSB they consumed were not included in the questionnaire sheet.

In addition, this section was also required the respondents to indicate the frequency and amount consumed each time for each beverages. The frequency intake that is subsequently based on past month followed by the serving size of the drinks and the number of servings. There were 7 options for the feedback of frequency of beverage intake which included “never or less than 1 time per week”, “1 time per week”, “2 to 3 times per week”, “4 to 6 times per week”, “1 time per day”, “2 times per day” and “3 or more times per day”. While for the amount of each SSB consumption, the participants may be required to fill in the number of consumptions in fl oz or cup. The options of response for amount of SSB intake consumed each time was listed in multiple choices which are “less than 6 fl oz” (3/4 cup), “8 fl oz” (1 cup), “12 fl oz” (1 ½ cup), “16 fl oz” (2 cup) and “more than 20 fl oz” (2 ½ cup). Moreover, participants were not required to fill up the amount consumed each time for the beverage if they had the SSB intake of “never or less than one time per week”.

By filling up the BEVQ (APPENDIX 2), the usual drinking habits and history can be assessed from the respondents. Then, the nutrient intake of the respondents can be determined by referring to the Malaysia Food Composition Database.

The result of the variables would be categorized as daily frequency and daily amount of total SSB intake. The daily frequency of each beverage was obtained by dividing the weekly frequency by 7, as shown in **Table 3.1**.

Table 3.1: Conversion of weekly frequency of sugary-sweetened beverage consumption into daily frequency

Frequency of SSB consumption	**Daily frequency of SSB consumption**
Never or less than 1 time per week	0 time per day
1 time per week	$\frac{1}{7}$ times per day
2 to 3 times per week	$\frac{2.5}{7}$ times per day
4 to 6 times per week	$\frac{5}{7}$ times per day
1 time per day	1 time per day
2 times per day	2 times per day
3 or more times per day	3 or more times per day

The daily frequency of total SSB consumption was obtained through the summation of daily frequency of total SSB consumption for each beverage of SSBs. The classification of SSB was divided into 3 groups which are low, moderate and high intake (as shown in Table 3.2) (Ahmad et al., 2019). Furthermore, daily amount of total SSB intake was obtained through Σ (daily

frequency of SSB consumption x amount consumed each time for each SSB intake).

Table 3.2: Classification of sugary-sweetened beverage consumption by daily frequency of total sugary-sweetened beverage consumption

SSB consumption	Daily frequency of total SSB consumption
Low	0 SSB consumption/ Less than 1 time per day
Moderate	1 to 2 times of SSB consumption per day
High	3 or more times of SSB consumption per day

3.8.3 Anthropometric measurement

3.8.3.1 Body mass index (BMI)

Height and weight were recorded to nearest 0.5 cm and 0.5 kg, respectively. Height was measured in standard standing position without shoes by using a tape meter, while keeping shoulders in erect position. Body mass index (BMI) was calculated by the formula weight (kg) divided by height squared (meter). Subjects with a BMI of 18-22.9 kg/m2 were classified as normal weight, 23.0-24.9 kg/m2 were classified as overweight and those with a BMI greater than or equal to 25 kg/m2 were defined as obese.

3.8.3.2 Waist circumference (WC)

First of all, the individual must stand straightly. The measurer is then placing a tape measure around the middle of an individual, just above his or her hipbones. The tape must be in a horizontal line around the waist. The tape is then kept snug around the waist but not compressing the skin. The individual's waist circumference is measured just after he or she breathes out.

3.8.3.3 Body fat percentage

Body fat composition of the respondents were measured through bioelectrical impedance analysis (BIA) machines with its percentages.

3.8.4 Fasting blood glucose test (Finger prick blood test)

A finger prick blood test was carried out for blood sample collection. FBG measurement was done in morning after 8-12 hours of fasting by using blood glucometer. A FBG level above 126 mg/dl (7 mmol/L) was known as diabetic.

3.9 Flowchart of study

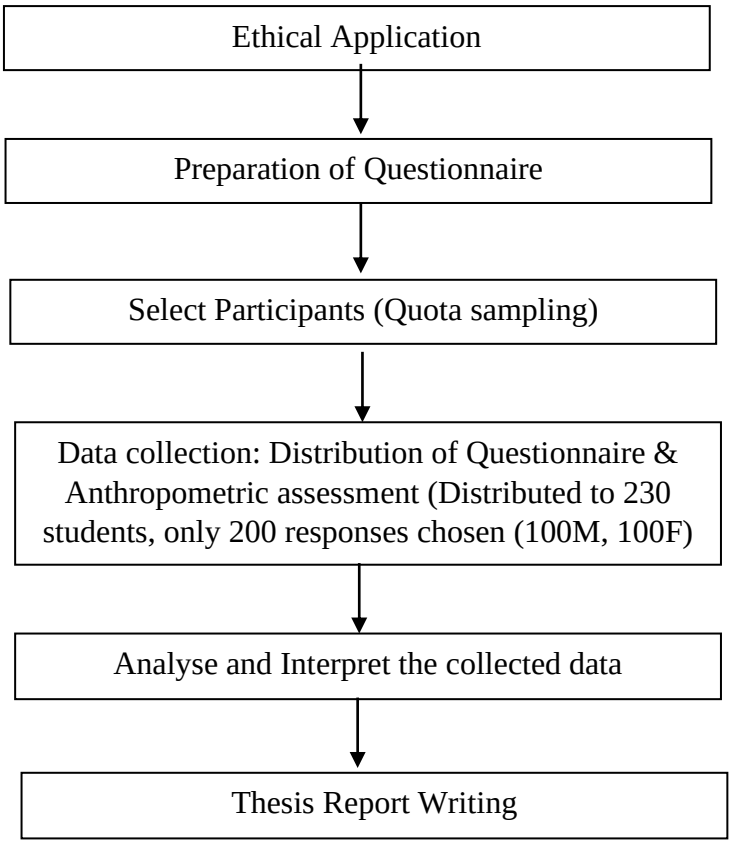

Figure 3.1: Flow Chart of the Study

3.10 Data entry and Statistical analysis

In this study, the collected data was analyzed by using the IBM Statistical Package for the Social Science (SPSS) Statistic Software Version 26. The data were presented as mean and standard deviation (SD) and P-value that less than 0.05 value which it is considered as a statistically significant value. The consumption of SSB of UTAR students that represented by beverage intake questionnaire (BEVQ) score, anthropometric indices values and FBG level were presented by descriptive analysis that included the mean and standard deviation which can be showed in the form of histogram.

3.10.1 Mann-Whitney Test

Mann-Whitney test, which is a non-parametric test was used to compare the mean of two different or independent groups. This was used as the data of the study was not normally distributed during the checking of normality test. This test used to determine if there is a significant difference mean of two independent groups. In this study, this test was used to compare the mean score difference of BEVQ, BMI, WC, body fat percentage and FBG between UTAR male and female students.

3.10.2 Spearman-correlation Test

A correlation test was used to determine and evaluate the strength of relationship between two different variables which is two quantitative continuous variables. It measures the strength and direction of a linear relationship between two variables and assess a possible linear association between two continuous variables in a research study. A Spearman correlation

test was used to measure the strength of relationship as the data is not normally distributed. In this study, spearman correlation test measured the relationship between SSB with FBG as well as the relationship between anthropometric indices with FBG levels among UTAR male and female students.

3.10.3 Kruskal Wallis Test

Kruskal Wallis test is a non-parametric test which it was used to compare the mean of three or more categorical or independent groups. This test was used as the data of the study was not normally distributed. This test used to determine if there is a significant difference mean of three or more categorical or independent groups. In this study, this test was used to compare the FBG between different BMI categories among UTAR male and female students.

3.11 Approval by Research and Ethnic Committee

The ethical approval of this study had been approved by UTAR Scientific and Ethical Review Committee, in short, SERC in 2022.

CHAPTER 4

RESULT

4.1 Sociodemographic Information

4.1.1 Gender

The number of male and female respondents from UTAR students involved in the study is clearly shown in **Table 4.1** and **Figure 4.1.** There was a total of 200 respondents with 50.0% of male and 50.0% of female UTAR students.

Table 4.1 indicated the analysis of frequency and percentage of gender.

Gender	Number of Respondents (n)	Percentage (%)
Male	100	50.0
Female	100	50.0

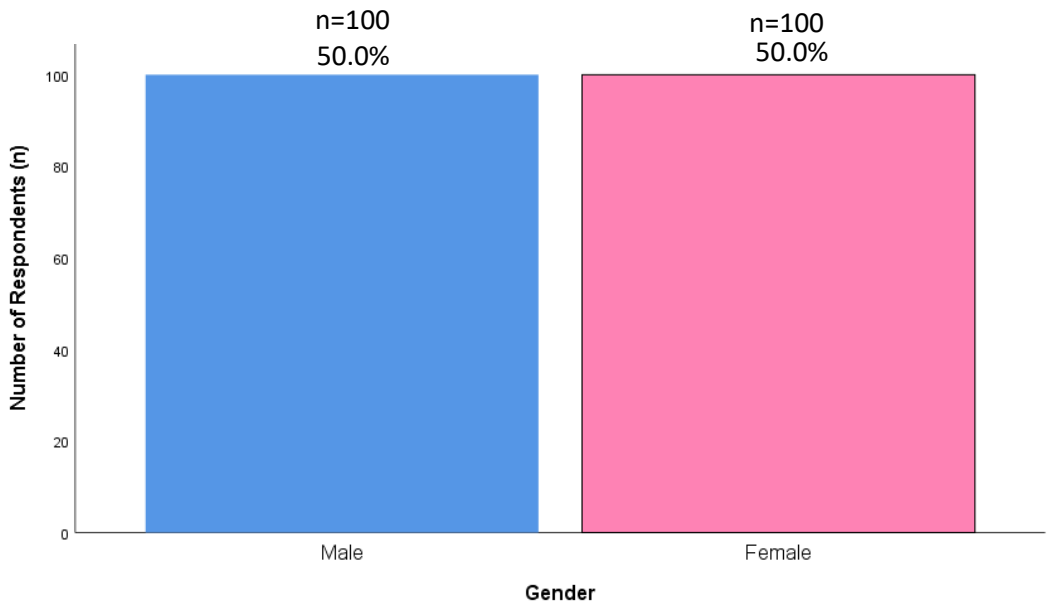

Figure 4.1: Number of Respondents According to Gender.

4.1.2 Age Group

The age group of all the 200 respondents is displayed in **Figure 4.2** and **Table 4.2**. The majority of the respondents which is 54 of them were aged 21 with a percentage of 27.0%, followed by the age of 18 years old with n=42 and 21.0 % of them. Next, 37 students (18.5 %) are 19 years old, 36 students (18.0 %) are 20 years old, 21 students (10.5 %) are 22 years old. Additionally, only minority of them were fell under the age of 23 years old, 24 years old and 25 years old that contributed to 2.5%, 2.0% and 0.5% with the frequency of 5, 4 and 1 respondents respectively. However, there is no respondents fell in the age group of 25 years old.

Table 4.2: Frequency and Percentage Analysis for Age Group of Respondents

Age	Number of Respondents (n)	Percentage (%)
18	42	21.0
19	37	18.5
20	36	18.0
21	54	27.0
22	21	10.5
23	5	2.5
24	4	2.0
25	1	0.5

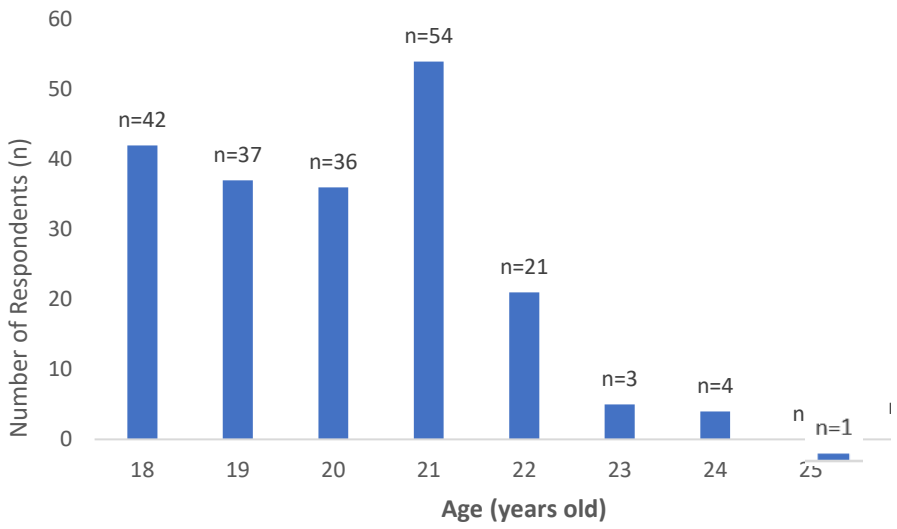

Figure 4.2: Number of Respondents According to Age Group

4.1.3 Ethnicity

The ethnicity of all the 200 participants was depicted in **Table 4.3** and **Figure 4.3.** It was noted that almost all participants were Chinese (n=186, 93.0%), 11 (5.5%) were Indians. A minority of the respondents were Malays, Burmese and Punjabi (n=1, 0.5%) as shown in Table 4.3 and Figure 4.3.

Table 4.3: Ethnicity of Respondents

Ethnicity	Number of Participants (n)	Percentage (%)
Burmese	1	0.5
Chinese	186	93.0
Indian	11	5.5
Malay	1	0.5
Punjabi	1	0.5

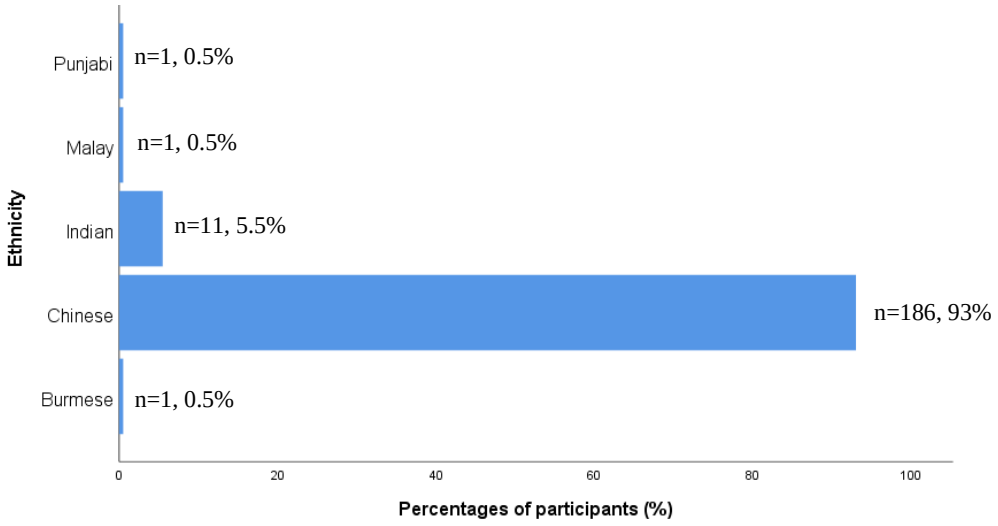

Figure 4.3: Number and Percentage of Respondents According to Ethnicity

4.1.4 Faculty

Looking into the faculty, FSc recorded the highest respondents (n=87, 43.5%), followed by CFS (n=57, 28.5%), FBF (n=22, 11%), FICT (n=15, 7.5%), FAS (n=13, 6.5%). Additionally, a minority of the respondents were from ICS and FEGT recorded the same proportion (n=3, 1.5%) as shown in **Table 4.4** and **Figure 4.4**.

Table 4.4: Respondents distribution by Faculty

Faculty	Number of Participants (n)	Percentage (%)
CFS	57	28.5
FAS	13	6.5
FBF	22	11.0
FEGT	3	1.5
FICT	15	7.5
FSC	87	43.5
ICS	3	1.5

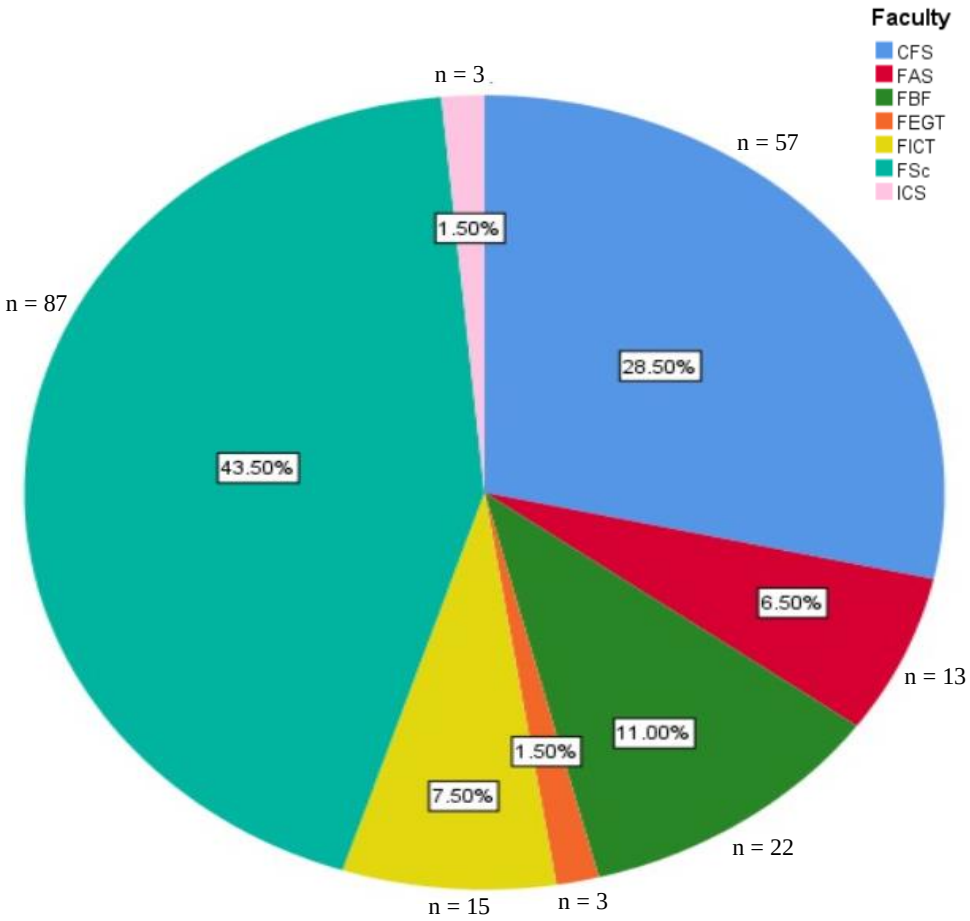

Figure 4.4: Number and Percentage of Respondents According to Faculty

4.2 Prevalence of sugary-sweetened beverages intake among UTAR students

UTAR students had SSB intake of 0.35 times (± 0.12 times) SSB and 6.75 fl oz (± 3.81 fl oz) equivalent to 202.5ml (± 114.3ml) of SSB in a day. According to the **Table 4.5**, majority of the respondents (n=172, 86.0%) had a low SSB consumption. Next, it is followed by 12% (n=24) of the participants which had 1 to 2 times of SSB intake which defined as moderate intake of SSB. However, only a minority of them (n=4, 2.0%) had high SSB intake which indicated as 3 or more times of SSB intake in a day. Therefore, taken together, the results

indicating UTAR students had a low SSB intake which indicated that daily intake of SSB of UTAR students was not concerning nowadays.

Table 4.5: Prevalence of SSB intake of UTAR students

Total SSB intake	n (%)	Value[a]
Low	172 (86.0%)	0.35 (0.12)
Moderate	24 (12.0%)	
High	4 (2.0%)	

[a]Mean (SD)

Besides that, there was a total of 16 categories of beverages intake from BEVQ questionnaires to access the frequency of sugary-sweetened beverages (SSB) intake of the respondents. According to **Figure 4.5** and **Table 4.6**, the SSB with the highest mean frequency intake value was water with the mean frequency intake value of 2.89, followed by whole milk (0.33) and tea or coffee with cream and/or sugar (0.29). While the hard liquor has the lowest mean frequency value of 0.10. Therefore, water is considered as a drink that daily consumed by all the respondents from UTAR. This indicated that the beverages that high in sugar such as soft drinks, sweetened juice, tea or coffee with sugar, sport drinks and sweetened tea were not high and not in an alarming level among this population.

Table 4.6: Mean Frequency Intake and Standard Deviation for all the beverages groups among UTAR students

Variable	Value[a]
Water[b]	2.89 (0.36)
100% Fruit Juice	0.16 (0.37)

Sweetened Juice Beverage/ Drink (fruit ades, lemonade, punch, Sunny delight)	0.18 (0.27)
Whole Milk[b]	0.33 (0.54)
Reduced Fat Milk (2%) [b]	0.10 (0.28)
Low Fat/ Fat Free Milk (Skim, 1%, Buttermilk, Soymilk) [b]	0.15 (0.32)
Soft Drinks, Regular	0.16 (0.27)
Diet Soft Drink/ Artificially Sweetened Drinks (Crystal Light)[b]	0.06 (0.14)
Sweetened Tea	0.12 (0.22)
Tea or Coffee, with cream and/or sugar (includes non-dairy creamer)	0.29 (0.46)
Tea or Coffee, black, with/ without artificial sweetener (no cream or sugar)[b]	0.18 (0.30)
Beer, Ales, Wine Coolers, Non-alcoholic or Light Beer [b]	0.02 (0.10)
Hard Liquor (shots, rum, tequila, etc.) [b]	0.02 (0.06)
Wine (red or white) [b]	0.01 (0.08)
Energy & Sports Drinks (Red Bull, Rockstar, Gatorade, Powerade, etc.)	0.01 (0.31)
Other [b]	0.01 (0.10)

[a]Mean (SD)

The beverages labelled with [b] were categorised as non-SSB intake

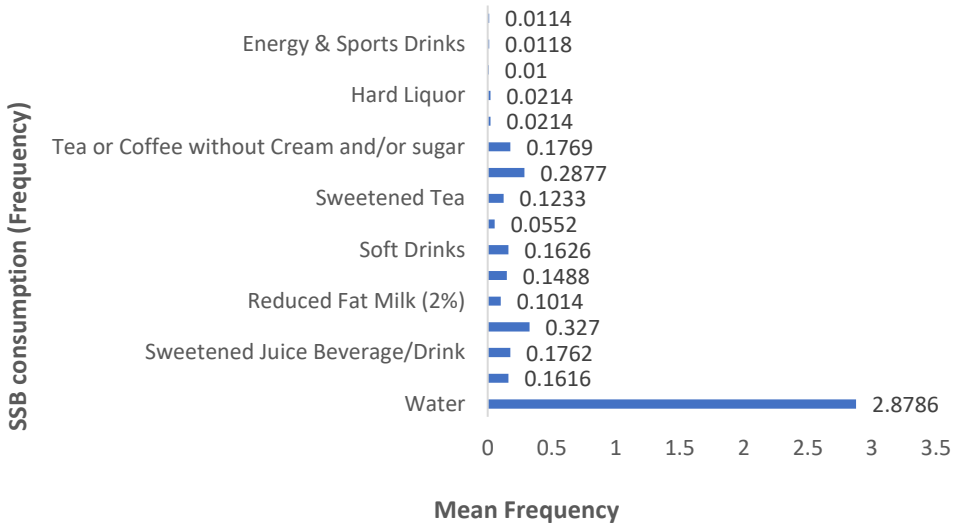

Figure 4.5: Mean Frequency Intake Analysis for SSB consumption

4.2.1 Amount of sugary-sweetened beverages intake consumed each serving among UTAR students

There was a total of 16 categories of beverages from BEVQ questionnaire. The mean amount of SSB intake (fl oz) each serving of all the beverages group were illustrated in **Figure 4.6.** According to **Figure 4.6** and **Table 4.7**, the beverage with the highest intake of amount was water with the mean amount intake of 17.62 value, followed by whole milk (7.66) and tea or coffee with cream and/or sugar (7.60). While the category of 'other' item has the lowest mean amount of intake value with 4.12 fl oz. Therefore, water is considered as the drink that has the largest intake by all the respondents from UTAR. While the beverage that high in sugar was not frequently drink by UTAR students in daily.

Table 4.7: Mean Frequency Intake and Standard Deviation for amount of sugary-sweetened beverages (SSB) consumption (fl oz) among UTAR students

Variable	Value[a] (fl oz)
Water[b]	17.62 (4.43)
100% Fruit Juice	7.08 (3.84)
Sweetened Juice Beverage/ Drink (fruit ades, lemonade, punch, Sunny delight)	6.92 (3.71)
Whole Milk[b]	7.66 (4.79)
Reduced Fat Milk (2%) [b]	5.78 (3.56)
Low Fat/ Fat Free Milk (Skim, 1%, Buttermilk, Soymilk) [b]	6.16 (3.56)
Soft Drinks, Regular	7.42 (4.08)
Diet Soft Drink/ Artificially Sweetened Drinks (Crystal Light)[b]	5.32 (2.78)
Sweetened Tea	6.28 (3.34)
Tea or Coffee, with cream and/or sugar (includes non-dairy creamer)	7.60 (4.26)
Tea or Coffee, black, with/ without artificial sweetener (no cream or sugar)[b]	6.96 (3.97)
Beer, Ales, Wine Coolers, Non-alcoholic or Light Beer [b]	5.16 (3.17)
Hard Liquor (shots, rum, tequila, etc.) [b]	4.44 (1.96)
Wine (red or white) [b]	4.58 (2.35)
Energy & Sports Drinks (Red Bull, Rockstar, Gatorade, Powerade, etc.)	5.18 (2.99)
Other [b]	4.12 (0.79)

[a]Mean (SD)

The beverages labelled with [b] were categorised as non-SSB intake

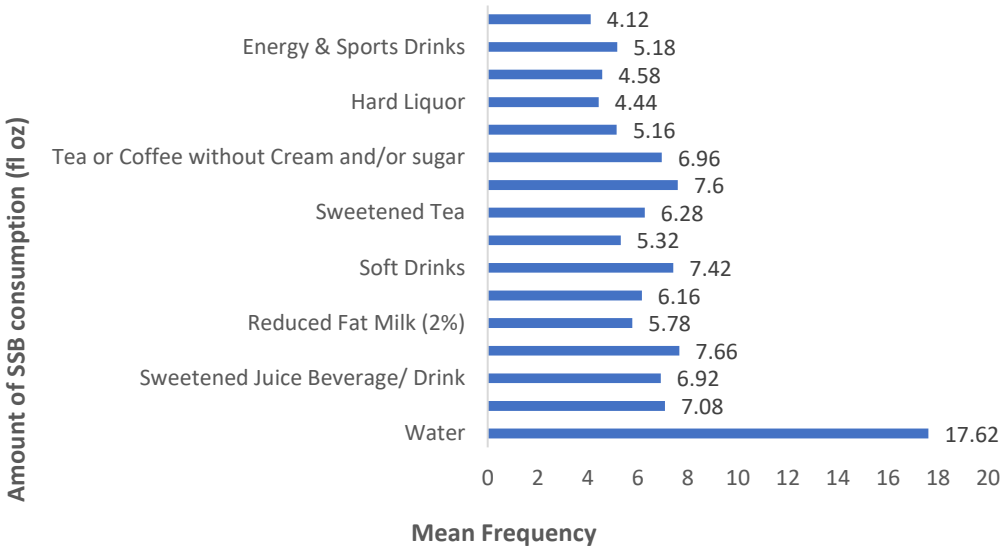

Figure 4.6: Mean Frequency Intake Analysis for amount of sugary-sweetened beverage consumption (fl oz)

4.2.2 Sugary-sweetened beverage intake VS non-sugary-sweetened beverage intake among UTAR students

In this present study, the daily frequency of total SSB intake was obtained by summation of daily frequency of each SSB intake. Besides that, the daily amount of total SSB intake was obtained by ∑ (daily frequency of SSB intake x amount consumed each time) for each SSB. (Ahmad et al., 2019). Overall, UTAR students had a low SSB intake which indicated that SSB consumption was not prominent among this study population.

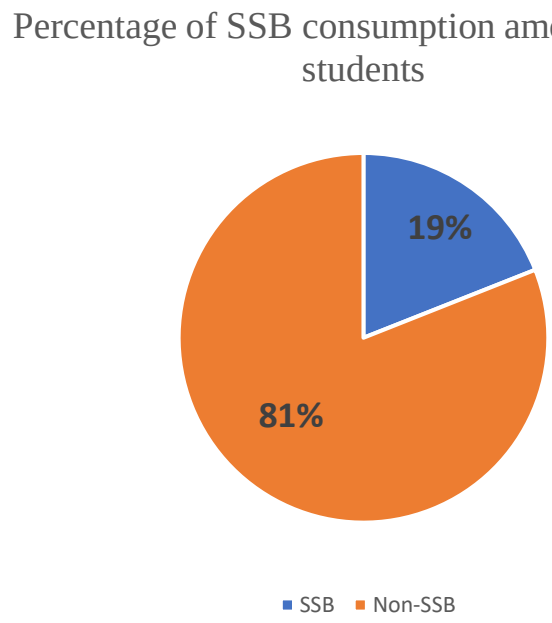

Figure 4.7: Percentage of SSB consumption among UTAR students

4.3 Anthropometric indices among UTAR students

Overall, based on the present study, UTAR students have normal BMI, WC and body fat percentages.

Table 4.8: Mean Frequency Intake and Standard Deviation for anthropometric indices among UTAR students

Anthropometric Indices	Value[a]
Body Mass Index (BMI), kg/m^2	21.25 (4.05)
Waist Circumference (WC)	73.69 (10.16)
Body Fat Percentage (%)	22.71 (7.78)

[a]Mean (SD)

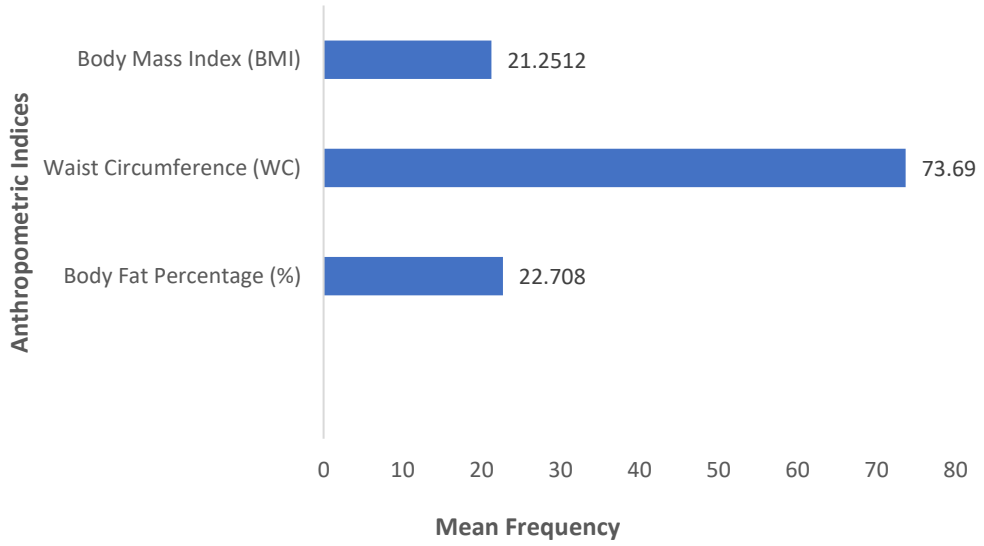

Figure 4.8: Mean Frequency Intake Analysis for anthropometric indices.

4.4 Fasting blood glucose among UTAR students

On average, the current finding showed that UTAR students have a normal and healthy fasting blood glucose level.

Table 4.9: Mean Frequency Intake and Standard Deviation for fasting blood glucose (mmol/L) among UTAR student

Variable	Value[a]
Fasting blood glucose (mmol/L)	4.97 (0.53)

[a]Mean (SD)

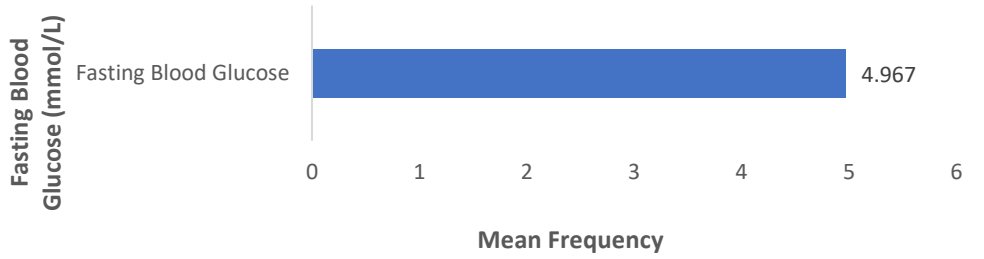

Figure 4.9: Mean Frequency Intake Analysis for fasting blood glucose level

4.5 Comparison between two variables

4.5.1 Comparison in the frequency of types of sugary-sweetened beverage intake between male and female UTAR students

The difference in median and IQR of every beverages items between male and female students were displayed in **Table 4.10.** In terms of the SSB intake between gender, male students showed higher consumption of most of the SSB items including sweetened juice regular soft drinks, artificial soft drinks, tea or coffee with cream and/or sugar, and energy & sports drinks.

Apart from that, male and female students have also showed the same frequency of the consumption in some beverages items. For instance, They have the same consumption of water, 100% fruit juice, reduced fat milk (2%), low fat or fat free milk, sweetened tea, beer (ales, wine coolers, non-alcoholic or light beer), hard liquor, wine and others.

In addition, the *p* value of every beverages items was also shown in the same **Table 4.10.** The data showed that the consumption of seven beverages items which are whole milk, regular soft drinks, diet soft drinks or artificial soft drinks, tea or coffee with cream and/or sugar, tea or coffee (black) with/ without artificial sweetener, beer (ales, wine coolers, non-alcoholic or light beer) and energy & sport drinks were significant. The *p* value of these seven groups were less than 0.05, therefore the result is significant and there is significant difference in these SSB items between gender.

Table 4.10: Comparison in the frequency of SSB items between male and female students

Variable	Median (IQR)		Z	*p*
	Male	Female	**statistics**	**value***
Water[b]	3.00 (0.00)	3.00 (0.00)	-0.44	0.66
100% Fruit Juice	0.00 (0.14)	0.00 (0.14)	-0.09	0.93
Sweetened Juice Beverage/ Drink (fruit ades, lemonade, punch, Sunny delight)	0.14 (0.36)	0.14 (0.14)	-0.61	0.54
Whole Milk[b]	0.14 (0.71)	0.00 (0.36)	-2.12	0.03
Reduced Fat Milk (2%) [b]	0.00 (0.00)	0.00 (0.00)	-0.24	0.81
Low Fat/ Fat Free Milk (Skim, 1%, Buttermilk, Soymilk) [b]	0.00 (0.14)	0.00 (0.14)	-0.15	0.88
Soft Drinks, Regular	0.14 (0.36)	0.00 (0.14)	-2.98	0.00
Diet Soft Drink/ Artificially Sweetened Drinks (Crystal Light)[b]	0.00 (0.14)	0.00 (0.00)	-3.54	0.00
Sweetened Tea	0.00 (0.14)	0.00 (0.14)	-0.32	0.75
Tea or Coffee, with cream and/or sugar (includes non-dairy creamer)	0.14 (0.36)	0.00 (0.36)	-3.15	0.00
Tea or Coffee, black, with/ without artificial sweetener (no cream or sugar) [b]	0.14 (0.36)	0.00 (0.14)	-2.82	0.01
Beer, Ales, Wine Coolers, Non-alcoholic or Light Beer [b]	0.00 (0.00)	0.00 (0.00)	-2.32	0.02
Hard Liquor (shots, rum, tequila, etc.) [b]	0.00 (0.00)	0.00 (0.00)	-1.93	0.05
Wine (red or white) [b]	0.00 (0.00)	0.00 (0.00)	-1.17	0.24

Energy & Sports Drinks (Red Bull, Rockstar, Gatorade, Powerade, etc.)	0.00 (0.14)	0.00 (0.00)	-4.32	0.00
Other [b]	0.00 (0.00)	0. 00 (0.00)	0.00	1.00

***** Mann-Whitney test, $p < 0.05$.

The beverages labelled with [b] were categorised as non-SSB intake

4.5.2 Comparison in the amount of sugary-sweetened beverage intake consumed each serving among UTAR students (fl oz)

The difference in median and IQR of every amount of beverages items was shown in **Table 4.11** consumed between male and female students. Among the male students, most of them had showed higher amount consumption of SSB items including regular soft drinks, tea or coffee with cream and/or sugar, and energy & sports drinks.

Furthermore, male and female students have also showed the same amount of consumption in beverages items. For instance, they have the same consumption of sweetened juice or beverage and drink, reduced fat milk (2.0%), low fat or fat free milk, sweetened tea, beer (ales, wine coolers, non-alcoholic or light beer), hard liquor, wine and others.

In addition, the *p* value of every beverages items was also shown in the same **Table 4.11.** The data showed that the consumption of four beverages items which are whole milk, diet soft drinks or artificial soft drinks, tea or coffee with cream and/or sugar, and energy & sport drinks were significant. The *p*

value of these four groups were less than 0.05, therefore the result is significant difference in these amount of consumption beverages items between gender.

Table 4.11: Comparison in the amount of sugary-sweetened beverage items between male and female students

Variable	**Median (IQR)**		**Z**	***p***
	Male	Female	**statistics**	**value***
Water[b]	20.00 (0.00)	20.00 (4.00)	-1.19	0.24
100% Fruit Juice	4.00 (4.00)	8.00 (4.00)	-0.07	0.95
Sweetened Juice Beverage/ Drink (fruit ades, lemonade, punch, Sunny delight)	4.00 (4.00)	4.00 (4.00)	-0.06	0.95
Whole Milk[b]	8.00 (8.00)	4.00 (4.00)	-2.61	0.01
Reduced Fat Milk (2%) [b]	4.00 (4.00)	4.00 (4.00)	-0.56	0.57
Low Fat/ Fat Free Milk (Skim, 1%, Buttermilk, Soymilk) [b]	4.00 (4.00)	4.00 (4.00)	-0.13	0.89
Soft Drinks, Regular	8.00 (8.00)	8.00 (4.00)	-1.66	0.09
Diet Soft Drink/ Artificially Sweetened Drinks (Crystal Light)[b]	4.00 (4.00)	4.00 (0.00)	-2.99	0.00
Sweetened Tea	4.00 (4.00)	4.00 (4.00)	-1.73	0.08
Tea or Coffee, with cream and/or sugar (includes non-dairy creamer)	8.00 (8.00)	4.00 (4.00)	-3.34	0.00
Tea or Coffee, black, with/ without artificial sweetener (no cream	8.00 (4.00)	4.00 (4.00)	-1.60	0.11

or sugar) [b]				
Beer, Ales, Wine Coolers, Non-alcoholic or Light Beer [b]	4.00 (0.00)	4.00 (0.00)	-0.23	0.82
Hard Liquor (shots, rum, tequila, etc.) [b]	4.00 (0.00)	4.00 (0.00)	-0.89	0.37
Wine (red or white) [b]	4.00 (0.00)	4.00 (0.00)	-0.05	0.96
Energy & Sports Drinks (Red Bull, Rockstar, Gatorade, Powerade, etc.)	4.00 (4.00)	4.00 (0.00)	-3.38	0.00
Other [b]	4.00 (0.00)	4.00 (0.00)	-1.36	0.17

*Mann-Whitney test, $p < 0.05$

The beverages labelled with [b] were categorised as non-SSB intake

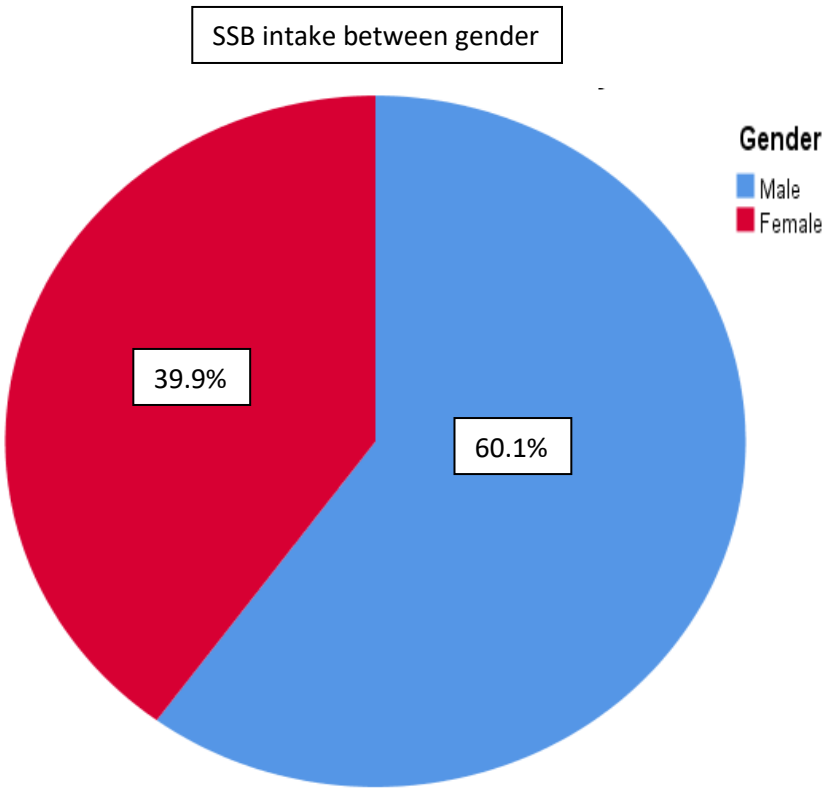

Figure 4.10: The SSB intake between male and female UTAR students

4.5.3 Comparison in body mass index between male and female students

The **table 4.12** showed the difference in median and IQR of body mass index between male and female students. Among the 100 male students, their BMI are significant higher when compared to 100 female students. From this **table 4.12**, the significance value of p=0.028 indicated that there is a significant difference in the BMI between male and female students.

Table 4.12: Comparison in the body mass index between male and female students

Variable	Median (IQR)		Z statistic	*p* value*
	Male	Female		
Body Mass Index (BMI)	21.1000 (4.58)	19.6000 (4.80)	-2.204	0.028

*Mann-Whitney test, $p < 0.05$

4.5.4 Comparison in waist circumference between male and female students

According to the **table 4.13**, it displayed the difference in median and IQR of waist circumference between male and female students. Among the 100 male students, their WC are larger when compared to 100 female students. From this **Table 4.13**, the significance value of 0.000, which was lesser than 0.05 indicated that there is a significant difference in the WC between male and female students. In fact, the value of p=0.000 shows that it is highly statistically significant with the value less than 0.01. Therefore, it shows a statistically significant result with the WC of male students significantly higher than female students.

Table 4.13: Comparison in the waist circumference between male and female students

Variable	Median (IQR)		Z statistic	*p* value*
	Male	Female		
Waist Circumference (WC)	74.500 (10.8)	67.250 (9.3)	-6.478	0.000

*Mann-Whitney test, $p < 0.001$

4.5.5 Comparison in body fat percentage between male and female students

According to the **table 4.14**, it displayed the difference in median and IQR of body fat percentage between male and female students. Among the 100 male students, their body fat percentage are lesser when compared to 100 female students. From **Table 4.14**, the significance value of 0.000, which was lesser than 0.05 indicated that there is a significant difference in the body fat percentage (%) between male and female students. In fact, the value of p=0.000 shows that it is highly statistically significant with the value less than 0.01. Therefore, it shows a statistically significant result with the body fat percentage (%) of male students significantly lower than female students.

Table 4.14: Comparison in the body fat percentages between male and female students

Variable	Median (IQR)		Z statistic	*p* value*
	Male	Female		
Body Fat	16.550 (8.2)	28.100 (7.1)	-9.526	0.000

Percentage (%)	

*Mann-Whitney test, $p < 0.001$

4.5.6 Comparison in fasting blood glucose between male and female UTAR students

Based on **table 4.15** showed the difference in median and IQR of the fasting blood glucose between male and female students. Among the 100 male students, their fasting blood glucose levels are higher when compared to 100 female students. From **Table 4.15**, the significance value of p=0.006, which was less than 0.05 indicated the significant difference in the fasting blood glucose level between male and female students whereby the fasting blood glucose level of male students was significantly higher than female students.

Table 4.15: Comparison in the fasting blood glucose between male and female students

Variable	**Median (IQR)**		**Z statistic**	***p* value***
	Male	Female		
Fasting Blood Glucose (mmol/L)	5.150 (0.6)	4.900 (0.6)	-2.768	0.006

*Mann-Whitney test, $p < 0.05$

4.6 Relationship between variables

4.6.1 Relationship between sugary-sweetened beverages intake and fasting blood glucose

As shown in **Table 4.16**, there is a significant correlation between the SSB intake with FBG (r=0.189, p=0.007). According to the r-value, it showed that the SSB of the UTAR students had a very weak positive correlation with fasting blood glucose level. Hence, there is a weak significant correlation between the WC of UTAR students with fasting blood glucose levels as shown in **Table 4.16.**

Table 4.16: Correlation between sugary-sweetened beverages (SSB) intake and fasting blood glucose

Variable	**Fasting Blood Glucose**	
	r	p value[a]
Sugary-sweetened beverages intake (SSB)	0.189	0.007

[a]Spearman-correlation, $p < 0.05$

4.6.2 Relationship between anthropometric indices and fasting blood glucose

As shown in **Table 4.17**, there is no significant correlation between the anthropometric indices (BMI) with fasting blood glucose (r=0.125, p=0.077). In addition, there is a significant correlation between the anthropometric indices (WC) with fasting blood glucose (r=0.151, p=0.033). According to the r-value, it showed that the WC of the UTAR students had a very weak positive correlation with fasting blood glucose level. Hence, there is a weak significant correlation between the WC of UTAR students with fasting blood glucose levels as shown in **Table 4.17.** Furthermore, there is no significant correlation

between the anthropometric indices (body fat percentage) with fasting blood glucose (r=- 0.077, p=0.280).

Table 4.17: Correlation between anthropometric indices and fasting blood glucose

Anthropometric Indices	**Fasting Blood Glucose**	
	r	*p* value[a]
Body Mass Index (BMI)	0.125	0.077
Waist Circumference (WC)	0.151	0.033
Body Fat Percentage (%)	-0.077	0.280

[a]Spearman-correlation, $p < 0.05$

4.7 Comparison between three or more groups

4.7.1 Comparison in the different body mass index and fasting blood glucose among UTAR students

The BMI value of the respondents was divided into five different categories which included underweight, normal, overweight, obesity class I, and obesity class II based on the WHO. The BMI status of all the respondents in this study were depicted in **Table 4.18**. The result showed that it is statistically significant with the p value of 0.014. Overall, there is a normal FBG levels in all the BMI categories. However, based on the result, the overweight students had the highest FBG levels among those 4 BMI categories. Lastly, it is noted that there is no student fell in the diabetes category.

Table 4.18: Comparisons of fasting blood glucose level between three different body mass index categories

Body Mass Index categories	**Median (IQR) Fasting Blood Glucose (mmol/L)**	**Chi square statistic (df)**	***p* value***
Underweight	5.000 (0.6)	10.606 (3)	0.014
Normal	4.900 (0.6)		
Overweight	5.200 (0.7)		
Obese Class 1	5.100 (0.5)		

* Kruskal Wallis Test, $p < 0.05$.

Post hoc analysis: Normal vs Obesity Class 1 – p value = 0.008.

Other pair comparisons $p > 0.05$.

CHAPTER 5

DISCUSSION

5.1 Sugary-sweetened beverages intake among UTAR students

The sugary-sweetened beverages intake was accessed by using Beverage Intake Questionnaire (BEVQ-15) which included 15 beverages items. This BEVQ-15 enables the assessment of habitual beverage intake of an individual and helps to determine the relationship of beverages intake with the health-related outcomes which includes BMI status and body fat percentage. Based on the result from this present study, the first three beverage items with a higher mean intake among university students were water, whole milk and tea or coffee with cream and/or sugar. The beverage item of water was the most frequently consumed beverage while the hard liquor was the least consumed beverage item. According to the findings, the SSB consumption was not in an alarming level and concerning among university (UTAR) students. As the SSBs which are sweetened juice drinks, regular soft drinks, sweetened tea and energy drinks as well as the coffee or tea with sugar and/or sweetened creamer are less consumed by UTAR students. As evidenced, the prevalence of daily intake of SSB (19.0%) among UTAR students was lower when compared with university students from other foreign country which are Jordan (60.0%) (Bawadi et al., 2019) and Saudi Arabia (67.1%) (Al-Otaibi et al., 2017).

When comparing the daily consumption of SSB among Malaysian University students, the current study revealed that majority of the UTAR students had a

low SSB consumption (an intake of no SSB intake per day). Only a small percentage of the students had a high SSB intake (an intake of three or more SSBs per day). On the contrary, there is a study from Ahmad et al. (2019) reported that 89.3% of students at Universiti Putra Malaysia (UPM) consumed SSB at least once per day, while 53.3% students from UPM consumed a high SSB intake. The disparities in these findings may be caused by some factors which include the level of the knowledges of university students, health consciousness, environmental factor and psychological factor that affect the choice of the students (Park et al., 2014; Sim et al., 2019; Ahmad et al., 2019).

From the result, majority of the UTAR students (43.5%) are students from faculty of science (FSc). Hence, they are more aware of some fundamental health issues and the harmful effect of SSB with a good knowledge and health awareness. Findings from Park et al. (2014) showed that a good knowledge about own health complications that influenced by consumption of SSB was positively linked with a low SSB intake in daily life. The study claimed that the individuals who had poor knowledge of the health complications regarding the SSB intake may had a 61.0% greater odd for SSB consumption. Moreover, study from Teng et al. (2020) also claimed that a low level of knowledge of drinking SSBs is significantly associated with higher intake of SSB.

In addition, according to the beverages preference of UTAR students from the current finding, it revealed the research participants were conscious about their health and practised a good habits on living a healthier lifestyle. As evidence, plain water with highest mean was most frequent consumed by UTAR students.

According to Ministry of Health (2022), Malaysians are encouraged to take six to eight glass of plain water every day. Malaysian Dietary Guidelines 2020 also recommended that a healthy adult should consume at least two litres of water a day to ensure sufficient water intake is obtained. The current study had proved that UTAR students had a good knowledge on consuming the right beverage and had adopted this good habit in daily life. Apart from that, literatures had showed that coffee and sweetened tea are more likely and regularly consumed by university students (Ahmad et al., 2019; Bawadi et al., 2019; Islam et al., 2020). However, in the present finding, it is shown that UTAR students were having a low SSB (sweetened tea and coffee) and in fact there is a high mean frequency and amount on the beverage items of unsweetened tea and coffee. Therefore, this can be clearly seen that an individual who practised a good attitude and action on daily beverages consumption would likely to have a low SSB intake. This statement was proved by the study of Cheng and Lau (2022). Hence, to take them all together, the current findings showed that the knowledge level and health consciousness are the reasons and factors that lead to a low SSB intake among UTAR students.

Furthermore, environmental factor or sociology factor was able to influence the SSB intake among university students. In the present study, the study populations were free to choose their accommodation outside of the university campus, whereas the study of Ahmad et al. (2019) was conducted among the students population who stay in a student dormitory in university. At this case, the students can only access to the facilities that held in university. The vending machine that can provide drinks for students was available everywhere

in university and this enables the students who stay at university dormitory can get and access to different SSB items easily. This leads to high SSB intake among that particular study population. Besides that, according to the study of Watts et al. (2018), there is a high SSB intake by peers associated with a great intake of SSB among university students. The university students would easily get influenced by their friends within the peer environment. Hence, having a peer who consume the healthy foods and drinks are important to live a healthier lifestyle. Not only that, the psychological factor would also affect the behaviour of consuming SSB intake. For instance, the study from Sim et al. (2019) claimed that increases in depressed mood were associated with an increased tendency of consuming more than 7 SSB per week. Thus, environment factor and psychological factor are crucial in playing the role to influence the SSB intakes among university students.

5.2 Anthropometric indices among UTAR students

The anthropometric indices among university students were assessed by collecting the body height, body weight, waist circumference and body fat percentage among university students.

5.2.1 Body mass index status among UTAR students

The body mass index status among UTAR students were assessed accordingly based on 5 different categories which are underweight, normal, overweight, obese class 1, obese class 2 and obese class 3. In this present study, it is clearly observed that there are 59.0% (n-118) of students were normal weight, followed by 24.5% (n-49) students were underweight. There are also 10.5% (n-

21) of students were overweight and 6.0% (n-12) of students were in obese class 1. This was similar to a recent study in Minia, Egypt that majority of the university student populations were normal weight (Hafez et al., 2022). Other articles conducted by Peltzer et al. (2014) also have reported the same findings on higher prevalence of normal body weight for both genders among the university students from 22 countries. Besides that, a study conducted among university students in Bangladesh also showed that there is a majority (67.2%) of students had a normal BMI (Mohammad et al., 2021). A similar finding from Yadav et al. (2015) also revealed that there is 74.1% of students were normal weight.

In contrast, most of the previous research had come out with a contradictory findings, in which university students are more prone to overweight and obese categories. There was an increased risk of overweight and obese of university students from different countries which includes northern Kosovo (13.0%) (Mitic et al., 2021), the Gaza Strip (18.0% and 20.8% of overweight and obese respectively) (Abu Hamad, 2017), students from Universiti Putra Malaysia, Malaysia (22.9% and 15.9% of the respondents were overweight and obese respectively) (Mohammad, Ahmad and Minhat, 2019) and Sarawak, Malaysia (14.3% and 10.1%, respectively) (Pitil and Ghazali, 2021). The discrepancies in these might be attributed to sociocultural lifestyle habits which included eating habits and the level of physical activity (Abu bakar et al., 2020; Grasdalsmoen et al., 2019; Gutierrez-Pliego et al., 2016; Wang et al., 2022; Xie et al., 2020).

The high prevalence of normal BMI and body weight among UTAR students was mostly due to the dietary habits. The study from Xie et al. (2020) reported that unhealthy eating patterns was the main reason that would lead to an increase rate of obesity worldwide. The researchers proved that an excessive intake of drinks that high in sugar and fast foods would influence and increase the BMI status of Chinese college students. Correspondingly, studies from Gutierrez-Pliego et al. (2016) showed that a healthy dietary patterns such as prudent pattern (high consumption of vegetables, legumes, nuts, seeds, fruits and whole grains) had a lower BMI status. Besides that, there are studies revealed that a higher SSB consumption would also lead to a higher BMI value (Abu bakar et al., 2020; Wang et al., 2022). In this present study, it was reported that UTAR students have a low SSB intake and hence this can be clearly seen that a healthy dietary patterns would lead to a higher prevalence of normal weight among UTAR students.

In addition, being physically active would show a low BMI status. This can be seen in studies of Grasdalsmoen et al. (2019) that low physical activity level would lead to an increased BMI value among Norweigian university students. Similarly, Tan, and Mat Ludin (2020) claimed that increased physical activity level would lead to decreased BMI value. In the present study, the study populations were having their accommodation outside university area. The students were mostly having increased physical activity level by cycling to campus and eating at the food stall. Cycling is a vigorous activity and this reduces the occurrence of overweight and high body fat percentages (Kesavachandran, Bihari and Mathur, 2009). Hence, taken together, healthy

dietary patterns and physically active would have a higher prevalence of normal weight with a lower rate of overweight and obese among university students.

5.2.2 Waist circumference among UTAR students

The waist circumference among university students were measured by using a measuring tape and placed it above the belly button of an individual. In this current study, the result had a waist circumference of 73.69 ± 10.16 cm among UTAR students. According to WHO, the cut off points of the waist circumference for individuals aged 20-59 years old are 94 cm of 37 inch (male) and 80 cm of 31.5 inch (female) for increased risk. While WC of 102 cm of 40 inch (male) and 88 cm of 34.6 inch (female) was stated as the substantially increased risk of metabolic complications. Thus, in the current study, it indicated that the study population of all female and male respondents were at a normal range of WC with the mean value and standard deviation of 73.69 ±10.16.

Correspondingly, there is a previous study conducted among university student in Malaysia and it indicated that the similar finding which are the study population were having a normal WC with 74.5 ± 11.0 mean and standard deviation value (Ibrahim Abdalla et al., 2020). Another findings also showed that there is 76.1 ± 11.45 with normal WC among the young adults (Peltzer and Pengpid, 2017).

Surprisingly, a few studies showed that there is a high WC among university students. For instance, a study of Raouf et al. (2022) from reported that its findings of 83.91 ± 12.53 of WC among male and female students in Minia University. This showed a slightly higher WC among the university students. Besides that, a study from Basu et al. (2015) claimed that there is 1.0% male and 9.0% female had a waist circumference of more than 102 cm & 88 cm respectively. Whereas 27.0% male and 30.0% female had waist circumference of more than 90 cm & 80 cm respectively. This showed a higher prevalence of WC among medical students of Kolkata.

In brief, the factors such as physical activity level and dietary pattern influence the WC among university students. For instance, the sedentary lifestyle can lead to a decrease in muscle mass and an increase in body, particularly in waistline. This statement was supported by a finding of Park et al. (2020) that there is a 3.1 increased in waist circumference associated with a 10% increase in the sedentary time. Furthermore, another study of Espana-Romero et al. (2015) also showed that higher prevalence of WC with a higher sedentary time. A study of Tigbe et al. (2017) also supported the finding of stronger correlation between more sedentary time and higher waist circumference. Besides that, a good dietary pattern may also show a low WC among university students. Study of showed that improvement in diet quality may protect against the increased of waist circumference and central adiposity (Cespedes et al., 2017). Moreover, a study also indicated more than 2 servings of SSB may associated with a 2.49cm increased in waist circumference when compared to individual with low SSB intake (English et al., 2022). As evidenced, UTAR students were

having a low SSB intake and this shows a good dietary habits and show a normal WC in the current study.

5.2.3 Body fat percentage among UTAR students

The body fat percentages among UTAR students were obtained during the body weight measurement with the use of bioelectrical impedance analysis devices. According to the present study, it indicated that the mean body fat percentages was 22.71±7.78 among UTAR students. According to the cut-off point of body fat percentages from World Health Organization (WHO), the cut-off points of body fat percentages for obesity are 25% for men and 35% for women. In the year of 2004, the WHO expert committee claimed that overweight ($\geq$ 25 kg/m^2) was in line with 31-39.0% (mean value of 35.0%) body fat in females and 18-27.0% (mean value of 22.0%) body fat in males. (Ho-Pham, Campbell and Nguyen, 2011). Besides that, another study also revealed that a healthy range of body fat for female is 20-25.0% while healthy range of body fat for male is 10-15.0% (Robergs and Roberts, 1997). Therefore, in the present study, it indicated that the study population were at a normal range with the mean value of 22.71 mean value.

In comparing to the previous studies, there is a study showed that there is a high body fat percentage among school-going adolescents of urban Mysuru, Karnataka when compared with other population (Sathiarajan et al., 2023). In addition, there is also another study that shows a similar findings that there is a slowly increased and high body fat percentage for both genders among the Andrews university students population (Pribis et al., 2010). Furthermore,

another study also reported that there is also a high level of total fat mass and fat free mass among university student, and this is associated with irregular active and sedentary lifestyle (Mialich et al., 2014). Hence, we can conclude that a low or high body fat percentage may be dependent on several factors which are fitness level with sedentary lifestyle and unhealthy eating pattern.

For instance, a study from Tan, and Mat Ludin (2020) claimed that increased physical activity level would lead to decreased body fat percentages. Besides, that there is also a study that showed a similar findings in which higher fat mass was significantly associated with a lower rate of physical activity level among Chinese medical students (Li et al., 2022). Besides that, in terms of the dietary habits, a frequent consumption of unhealthy diet and foods that are higher in energy density and lower nutrient content are linked with higher percentage of body fat in adolescence and early adulthood (Schneider et al., 2017). Furthermore, a study also indicated more than 2 servings of SSB may associated with an approximately 2.72% higher body fat percentages when compared to individual with low SSB intake (English et al., 2022). Next, a study from Muniz et al. (2022) also concluded that unhealthy dietary pattern may lead to an excess body fat percentage.

In brief, university students with sedentary lifestyle and unhealthy eating tend to have a higher body fat percentage. While the study population (UTAR students) are physically active when in campus as majority of students were cycling to school and walking around in a campus that built on a 1300-acre piece of land. The students and university staff may need to walk from one

block to another block and this in turn increases their physical level. Besides that, in terms of the dietary pattern, the current study showed that there is a low SSB intake among UTAR students and this can be clearly seen that UTAR students may be aware of the dietary patterns and practiced a healthier lifestyle.

5.3 Fasting blood glucose level among UTAR students

The fasting blood glucose of the university students were assessed through finger pricking blood test. In current study, it is shown that the average FBG level was 4.97±0.53 mmol/L among UTAR students. According to the cut-off point of fasting blood glucose level from World Health Organization (WHO), the expected values for normal FBG are between 3.9 mmol/L and 5.6 mmol/L. There is a need for blood glucose monitoring and lifestyle changes when the FBG are between 5.6 to 6.9 mmol/L which it is classified as diagnosed with impaired FBG. While diabetes is diagnosed with the mean FBG of 7.0 mmol/L and above. Besides that, according to Medical Nutrition Therapy guideline of Diabetes Mellitus from Malaysia, the FBG level need to maintain at the range of 4.0-6.0 mmol/L. Therefore, in the present study, it indicated that the study population with all female and male respondents were at a normal range with the mean value of 4.97 mean value.

In contrast to the finding of this study, there is a slightly higher mean of fasting blood glucose levels among the university students. For example, a study of Mendis et al. (2014) showed that the students from university of Peradeniya encountered with a slightly higher FBG and 42.0% of them are diagnosed with impaired FBG with the mean of 4.6 to 6.6 mmol/L among the university

students. Next, the study conducted by Hao et al. (2014) showed a higher prevalence of impaired FBG among urban university population in Eastern China with mean of 6.0 mmol/L among the diabetes and impaired fasting blood glucose university applicants.

The FBG levels were influenced by dietary pattern, and body weight among UTAR students. For instance, the dietary pattern that high in sugar especially SSB would increase the fasting blood glucose levels (Lopez-Portillo et al., 2022). As evidenced, UTAR students had a low intake of SSB and this led to a normal fasting blood glucose levels. Besides that, being obesity and overweight can increase the risk of developing insulin resistance and elevated fasting blood glucose levels in the body (Akter et al., 2017). As evidenced, the BMI, WC and body fat percentages of UTAR students were normal and this normal body weight without the excess and accumulation of fat in the body would show a stable and normal fasting blood glucose level.

5.4 The comparison of sugary-sweetened beverages intake between male and female UTAR students

In comparing the sweetened beverages intake between male and female students, the Mann-Whitney test was used. There was a significant difference (p=0.001) between male and female students whereby the SSB intake of male (60.1%) was significantly higher than female students (39.9%). According to the study of Bawadi et al. (2019), it indicated that male students consumed more calories from SSBs when compared to female students in Jordan with its value (p=0.016). Besides, another earlier previous study from West et al. (2006)

was also stated that male students in an urban southern college were having more SSB consumption than female students. Furthermore, study of O'Leary et al. (2012) reported that male had more sugary drinks than female at university in which male having high consumption of carbonated soft drinks and fruit-based drinks (64.0%) whereas fruit and sweetened milk-based drink (68.0%) for female. Moreover, a study conducted of Bipasha, Raisa and Goon. (2017) also reported that male students having high prevalence of consuming SSB than female students (85.4% vs 14.5%).

The consumption of SSB was shown to be low in female students may be due to health concerns. It is noted that females may be more conscious and concerns of the health risks that linked with high SSB consumption such as obesity, diabetes and cardiovascular disease. They may be more motivated to make more healthier choices to prevent the adverse health effects. For instance, a findings of Barebring et al. (2020) showed that women are more health conscious than men in regard to their diet. This might have parallel effects where women eat healthier than men. At the same time, women may also have more concerns on body shapes and diet-related anxiety which lead them to have a healthier diet pattern. As evidenced, UTAR female students tend to have a low SSB intake in this present study. Besides, another finding that supported this finding was the study of Pop et al. (2021) which showed that female scored higher for the private body consciousness and public body consciousness scales. These aspects related to a healthy lifestyle factors among the particular study group (medical students).

5.5 The comparison of anthropometric indices between male and female UTAR students

5.5.1 The comparison of body mass index between male and female UTAR students

Regarding the BMI status between gender, a Mann-Whitney test was used. There was a significant difference (p=0.028) between male and female students whereby the BMI status of male was significantly higher than female students.

These findings were matched with the previous study discovered that male students were having a high BMI status when compared to female university students in Sarawak, Malaysia (Pitil and Ghazali, 2021). Another study of Yadav et al. (2015) also reported that there is a high prevalence of overweight and obesity in male than when compared to male students among undergraduate medical students from Medical College of Haryana. In addition, BMI was also assessed from the university student at university located in Enugu and Southeast Nigeria. The results also reported that more males are overweight and obese than female with (8.0% versus 4.0% and 7.0% versus 0.9%, respectively) (Nwachukwu et al., 2010). Additionally, a few local studies also reported the similar findings in which female was having a lower BMI value than male (Huda and Ruzita, 2010; Mohammad et al., 2019).

The factors that cause higher incidence of overweight and obesity in male might be attributed to self-esteem and dietary patterns between genders. Generally speaking, female was having a high self-esteem for having a better and good appearance (Golan, Hagay and Tamir, 2014). There is also a greater

body dissatisfaction in female than males (Quittkat et al., 2019). This showed that females are more concern on their body image when compared to males. Hence, female tend to consume foods with less calories to avoid gaining more body weight and have a healthy body weight. As evidenced, a study from Wardle et al. (2004) proved that there is a higher prevalence of avoiding high-fat foods on women. The study also indicated that women tend to eat more fruits, fiber-rich foods and practices a good habit with salt limitation. Another study also showed that women are more likely to focus on nutrition aspect as females were reported to avoid sugar, sweeting agents, saturated fat, salt, gluten, red meat, white flour, preservatives and colouring agents due to perceived unhealthiness (Barebring et al., 2020).

Nevertheless, another study from Yahia el al. (2008) also showed that female students from Lebanese university showed a healthier eating pattern compared to male students regarding on their daily breakfast intake and meal frequency. The findings of this study also showed the results that in line with the current study with 76.8% of female were normal weight which higher than normal weight male students (49.0%). A study from Shah et al. (2020) claimed that boys tend to consume more meat and calorie-dense foods when compared to girls who preferred to consume foods that low in energy and nutrient dense. Therefore, this showed that male may have a higher rate of obesity.

5.5.2 The comparison of waist circumference between male and female UTAR students

In comparing the waist circumference between male and female respondents, the Mann-Whitney test was used. There was a significant difference (p=0.000) between male and female students whereby the WC of male was significantly higher than female students. As mentioned earlier, according to the standard cut-off points from World Health Organization (WHO), the cut off points of the waist circumference for individuals aged 20-59 years olds are 94 cm (male) and 80 cm (female) for increased risk. While WC of 102 cm (male) and 88 cm (female) was stated as the substantially increased risk of metabolic complications. In comparing with the previous study, the current study showed the similar finding with female had a lower WC among the medical students of Minia University (Raouf et al., 2022). Besides that, the study of Astha et al. (2021) claimed that an increased WC and higher visceral adipose tissue was associated in males when compared to female among university students. In addition, with weight gain, male tend to show a larger increased WC when compared with female. The study also showed that increased WC associated with aging and influenced by gender (Stevens, Katz and Huxley, 2010).

In contrast, a few studies showed a contradictory finding of larger WC was associated with female. For instance, a study from Hadri et al. (2022) claimed that female had a significantly high waist circumference when compared to males with 83.08 ± 11.29 cm vs 78.64 ± 9.43 cm among the university students in Algeria. Another study of Castaneda et al. (2021) also showed that female is having a high WC when compared to male students in Peruvian University. Besides that, another study of Lazarevich, Irigoyen-Camacho and Velazquez-Alva (2013) also showed that an increased WC was associated with the female

gender among university students in Mexico city. Another study also reported that female students had a high WC when compared to males among university students in Kenya (Mbugua, Kimani and Munyoki, 2017).

In comparing the current study with the previous study, there are several factors that influence the differences in WC between genders. For instance, body composition and fat distribution, lifestyles factors such as diet pattern and physical activity level. Typically, females tend to have a higher proportion of body fat than males as female tend to carry fat in their hips, thighs and buttocks. A pear-shaped body shape can be seen among female group while males carry more fat in their abdominal region which can be called as the apple-shaped body shape. This difference in fat distribution and body composition lead to a differences in WC (Bredella, 2017). On the other hand, lifestyle factors such as sedentary lifestyle may lead to a decrease in muscle mass and an increase in body, particularly in waistline (Park et al., 2020). Besides that, a good dietary pattern may also show a low WC. For instance, English et al. (2022) shows that a SSB intake with more than 2 servings are associated with 2.49cm increased in waist circumference when compared to individual with low SSB intake (English et al., 2022). Hence, as evidenced by the present study, UTAR students were having an active lifestyle by cycling to campus, walking around from each block to another block in a campus that built on a 1300-acre piece of land. Furthermore, UTAR students, especially females were having a low SSB intake and this shows a good dietary habits and show a lower WC when compared to male in the current study.

5.5.3 The comparison of body fat percentage between male and female UTAR students

Considering the percentages of body fat between genders, a Mann-Whitney test was used to determine the significant level. There was a significant difference (p=0.000) between male and female students whereby the body fat percentage of female was significantly higher than male students. This study's findings revealed that female students exhibit significantly higher percentages of body fat when compared with male students. According to World Health Organization (WHO), female may have a higher body fat percentages than male. As mentioned before, the cut-off point of healthy range of body fat percentages for female is 20-25.0% while healthy range of body fat for male is 10-15.0% (Robergs and Roberts, 1997). Whereas World Health Organization (WHO) has also reported the cut-off points of body fat percentages for obesity which are 25.0% for men and 35.0% for women. Besides that, according to CDC (2022), women tend to have more body fat than men at the same BMI.

Similarly, the present study was in line and matched with the previous study which claimed that female have more body fat than male when the study focussed on sex differences in human adipose tissues (Karastergiou et al., 2012). Furthermore, a study from Misra et al. (2019) also reported that a younger female had higher body fat percentage in the comparison between male and female respondents among North Indian population. A study conducted from Blaak (2001) was also reported that there is a higher percentage of body fat on women would when compared to men. This researcher also claimed that women stored more fat in the gluteal-femoral

region whereas men stored more fat in the abdominal region. Besides that, a study from Bredella (2017) claimed that the body composition differs between male and female. Males have more lean mass while females have more fat mass than males. As mentioned, this study also supported by the finding that male will likely to accumulate their adipose tissue around the abdomen region and female will be more likely to accumulate adipose tissues around the hips and thigh. Correspondingly, there is also a study by Ojo and Adetola (2017) that body fat percentage was higher among female students in Bowen University.

Apart from that, factors like high amount of essential fat, body fat distribution and lifestyle factors are the leading factors that lead to a high body percentage among female group. Genetically, female may have more body fat and less muscle mass than men. The enzymatic production of long-chain polyunsaturated fatty acids (LC-PUFA) may be impacted by sex hormones, which might result in sex-specific changes in LC-PUFA. The study also discovered that the contribution of LC-PUFA in plasma lipids may be greater in females than in males population (Decsi and Kennedy, 2011). Hormones of estrogen may also cause the storage of more fat in female bodies. A study reported that the accumulation of subcutaneous fat may be regulated by estrogen. (Brown and Clegg, 2010). Nevertheless, the body fat distribution between both male and female are in a different pattern. Females have more adipose tissues in different body parts which are hips and thighs whereas male only has the collection of adipose tissue in abdominal region. Nonetheless, the fitness level between gender also can be a factor in which this finding

supported by the study of Vijiayalakshmi et al. (2017) that men perform a longer duration of exercise with more than sixty minutes to maintain and control their body weight when compared to women among Indian Medical and Nursing undergraduates. Another similar finding of Zou et al. (2020) also showed that participants who has the engagement in higher physical activity level may had a lower body fat percentage between both gender among middle-aged population.

On the other hand, normal BMI may also show high body fat percentages. This can be seen in the present study that female has normal BMI and a high body fat percentage. This finding also showed the similar result from another study that the researchers also found that there is a large discrepancy between body fat percentages and BMI in Singapore adults with a high percentage of body fat but lower BMI (Chen et al., 2021). Therefore, this can be concluded that BMI is not a good indicator to predict the obesity of an individual. This is supported by CDC (n.d.) as BMI could not measure the body fat clearly and BMI can only act as the initial screening of overweight and obesity for adults also claimed that health care staff may also recognize that high body fat may also depending by genetics, fat distribution, and lifestyle factors. (CDC, n.d.) Another study also stated that BMI is a poor indicator of body fat percentage and could not measure accurately and exactly about the fat distribution in body (Nuttall, 2015). In brief, female have a higher body fat percentages may be attributed to essential fat, body fat distribution and lifestyle factors.

5.6 The comparison of fasting blood glucose between male and female UTAR students

In comparing the FBG between male and female respondents, the Mann-Whitney test was used. There was a significant difference (p=0.006) between male and female students whereby the FBG of male was significantly higher than female students. This present study was in line with the previous study of Mauvais-Jarvis. (2019) that women may have a lower fasting plasma glucose than men. The current finding also supported by another study of Kautzky-Willer et al. (2015) which it indicated that the there is a higher prevalence of severe hypoglycaemia and severe nocturnal hypoglycaemia experienced by women when compared to men. In addition, an earlier study from Diamond et al. (1993) also reported that female had a decreased counterregulatory hormonal responses to hypoglycemia when compared to male. Furthermore, findings from also showed that normal women had a lower fasting blood glucose level than men and may have glucose levels as low as 2.8 mmol/L without symptoms (Brutsaert, 2022). Besides that, another similar study also suggested that women are more prone to serious or severe hypoglycemia that impact their wellbeing or diabetes management with 3.0 mmol/L (McDermid, 2022).

Female had a low FBG level than male may be attributed to hormonal differences, body composition and lifestyle factors. For instance, an earlier study from Godsland (2005), female had more oestrogen and progesterone which can lead to increased insulin sensitivity and improve glucose uptake. Besides that, increased body weight or obesity would cause an accelerated

insulin resistance and higher fasting blood glucose levels. Study of Al-Goblan, Al-Alfi and Khan (2014) showed that obesity is associated with higher amount of nonesterified fatty acids, glycerol, hormones, cytokines, proinflammatory markers and other substance and this eventually causes insulin resistance with higher blood glucose levels. As evidenced, UTAR male students had a high BMI and WC from the current findings showed that UTAR male students tend to have a higher fasting blood glucose levels when compared to female UTAR students. Next, regarding the lifestyle factors female tend to be more health-conscious by eating a healthy diet with low sugar content such as low SSB intake in order to improve insulin sensitivity and lower fasting blood glucose levels (Lopez-Portillo et al., 2022). As evidenced, UTAR female students had a low intake of SSB when compared to UTAR male students and this lead to a low fasting blood glucose level in female and higher fasting blood glucose level in male.

5.7 The relationship between sugary-sweetened beverages intake, anthropometric indices with fasting blood glucose among UTAR students

5.7.1 The relationship between sweetened beverages intake and fasting blood glucose among UTAR students

In the present study, Spearman correlation test had produced a weak positive correlation between SSB and FBG (r=0.189, p=0.007). It is an increasing trend in the study in which the more the intake of SSB, the higher the level of FBG level. According to the CDC (n.d.), the higher SSB intake may lead to higher blood glucose levels and eventually results in type 2 diabetes mellitus. This is supported by the previous study of McKeown et al. (2017), there is a positive

correlation between SSB intake and FBG (p=0.0015) with each additional serving of SSB intake was associated with higher fasting blood glucose. Besides that, another study of James et al. (2016) revealed that greater sweetened beverages consumption was also correlated with increased fasting glucose concentration (p=0.01). There is also a few studies claimed that high SSB consumption had a higher insulin resistance and this eventually lead to a high risk of diabetes (Deshpande, Mapanga, and Essop, 2017; Dhingra et al., 2007; Lana, Rodriguez-Artalejo, Lopez-Garcia; 2014; Ma et al., 2016).

Overall, there is a few reason to support the present findings with that higher SSB intake had an elevated fasting blood glucose levels in the body. The regular consumption of high sugar added beverages can lead to increased blood glucose over time, especially when it is consumed in excessive amounts. According to Fletcher, (2021), the high sugar added sweetened beverages contained it's simple carbohydrates content. In this case, the simple carbohydrates can be broken down and this may cause a rapid spike in blood glucose levels, leading to increased insulin production by the pancreas to help regulate blood glucose. Over time, the increased demand for insulin can lead to insulin resistance, which it is a condition that body become less responsive to insulin, resulting in higher fasting blood glucose levels (Tseng et al., 2021; Wang et al., 2015).

5.7.2 The relationship between body mass index and fasting blood glucose among UTAR students

Based on the current result, there was no significant correlation between BMI and FBG by using the Spearman correlation test. (r=0.125, p=0.077). The present study was similar to the finding of Howlader et al. (2018) that there is no significant correlation (p=0.65) between BMI and fasting blood glucose between male and female teenagers in Bangladesh. Besides that, Arjun et al. (2022) also stated that there is no significant correlation between BMI and FBG (p=0.212) among undergraduate nursing student in a selected nursing college, Mangaluru. Besides that, a study of Vargese, Joseph and Matthew, (2019) also claimed that there is no statistically significant correlation (p=0.08) found in between BMI and FBG among medical students in Kerala. Another study from also showed consistent finding in which it claimed that it showed no significant correlation between BMI and FBG (p=0.087) among Nepalese population (Thapa, and Rana, 2016).

On the other hand, there is a contradictory findings showed that there is a positive correlation between BMI and the FBG among university student in the study from Oktariza, Kelanjati and Tirthaningsih, (2020). Besides that, there is also a positive correlation which indicated that BMI and FBG was having a positive correlation (p<0.0001) among Jharkhand population with the age of 20 to 70 years old. This is due to as BMI increases, the insulin resistance may also be increases and further results in increased blood glucose in the body. However, there is still a limited studies to prove the statement of increased BMI is correlated with FBG among the study group of university students.

The reason why BMI had no significant correlation with FBG was probably due to the age factor and lifestyle habits. Firstly, relationship between BMI and FBG was influenced by age with the support from study of Ko, Wai and Tang, (2006) showed that every decade-increase in age is associated with 0.154 mmol/L increase in FBG. Another study also proved that high BMI is associated with high FBG (Lee et al., 2011). The article of Doustjalali et al. (2020) also showed that there is a positive correlation between BMI and FBG among Malaysian adults that aged between 40 to 60 years old. As evidenced, UTAR students aged between 18 to 25 years old has lower FBG. Besides that, the lifestyle habits with a good dietary pattern may not be associated between BMI and FBG levels among university students and it was supported by few articles from university of Cameroon, Belgrade, Serbia, and North-western Turkey (Dabou, Bruno and Sama., 2018; Gazibara et al., 2013; Topbas et al., 2022). As evidenced, UTAR students had good intake of dietary pattern with low SSB intake and physically active in daily activities. Hence this lead to a low BMI in this study population.

Apart from that, It can also be concluded that the present finding may be due to a small sample size and a further research is therefore needed for group of study population with a larger sample size.

5.7.3 The relationship between waist circumference and fasting blood glucose among UTAR students

From the research finding, Spearman correlation test had produced a weak positive correlation between WC and FBG (r=0.151, p=0.033). This result

showed an increasing trend whereby the larger WC may lead to a higher level of FBG. This is supported by the previous study of Veghari et al. (2014) which was indicated that there is a positive correlation between WC and FBG among northern adults in Iran. Besides that, few studies also revealed the similar results in which insulin resistant can be clearly observed among the central obese individual among European adolescents and in adults population (Kondaki et al., 2011; Stepien et al., 2011). In addition, another study which showed a consistent findings with present findings that there is a positive correlation between WC and FBG among adults in China (Zhang et al., 2018).

Overall, there is a few reasons to support the present findings with that the higher waist circumference had a higher fasting blood glucose levels in the body. For instance, an individual with larger waist circumference would have a greater visceral fat or abdominal fat built up deep in the abdomen. This further results in high insulin resistance. In fact, insulin resistance is defined as when the body produces insulin, but the body's cells become less responsive to insulin and it is hard to control blood glucose. Eventually, the glucose would build up in the blood and causing higher fasting blood glucose (Al-Shudifat et al., 2018; Hajian-Tilaki and Heidari, 2015; Hsieh, Wang and Chen, 2014).

5.7.4 The relationship between body fat percentages and fasting blood glucose among UTAR students

The spearman correlation was used to test the relationships between body fat percentage and FBG. The finding of this study revealed that there was no significant correlation between body fat percentage with FBG (r=-0.077,

p=0.280). This was inconsistent with the previous studies as many of the past findings have proven that higher FBG level was associated with higher body fat percentages among university students. For instance, the study of Majili and Kinabo (2015) showed that the blood glucose concentration was increasing with the increased body fat content among the adult population in Ilala Municipality, Dar es Salaam, Tanzania. When there is a lot of fat amount in the body, the liver will then produce more glucose due to insulin resistance. This further lead to a raise in glucose production in the body. Besides that, Mehdad et al. (2012) claimed that high level of FBG was associated and positive correlate with higher body fat percentages. In addition, a study of Stolk et al. (2005) showed that adiposity with higher body fat percentage (higher fat distribution throughout the body) among adults in Thailand ($p<0.0001$). In addition, the study of Chen et al. (2020) revealed that the individual with higher body fat percentage which above the reference value may had a higher risk of type 2 diabetes mellitus with high FBG levels among Chinese adults.

The discrepancy of the present study with previous study was probably due to insulin sensitivity whereby by nature, body fat percentage alone may not be a sufficient predictor of insulin sensitivity to regulate and control blood glucose levels. In fact, there was a case with low fat body fat percentages individual have an elevated FBG (Johanson et al., 2003). Furthermore, the dietary habits or food choices may also affect FBG levels among university students regardless of body fat percentage. As evidenced, UTAR students had low SSB intake and this good dietary habits would lead to a stable and normal FBG level. Besides that, physical activity may also help to improve insulin sensitivity and

lower the FBG levels. Both aerobic and resistance exercise were able to regulate the glycaemic level in the body (Shah et al., 2021; Wake, 2020).

5.8 The comparison in fasting blood glucose between different body mass index status among UTAR students

Considering the FBG between different BMI categories, a Kruskal Wallis Test was used to determine the significant level. There was a significant difference (p=0.014) between FBG with different BMI categories. Furthermore, in the post hoc analysis, there was only a pair which is normal vs obesity class 1 showed a significant value (p=0.008).

In addition, another study of Sepp et al. (2014) showed that there was a significant difference between BMI and blood glucose level. The finding from this particular study revealed that higher blood glucose level was associated with FBG among higher BMI population. Besides that, another study of Park et al. (2019) also reported that the increases of BMI were positively associated with increased FBG among Korean adolescents. While for those who were overweight or obese at the baseline may had a higher fasting blood glucose when compared to the normal weight individual. The study of Oktariza, Kalanjati and Tirthaningsih (2021) also proved that there is higher FBG level was well observed and associated with higher BMI among university students.

On the other hand, in comparing to the previous study, even though the study showed the higher FBG level was observed in higher BMI or obese individual. However, this current result with higher FBG level seen in overweight

individual is not parallel with the standard finding in which higher BMI led to high FBG as obese individual has higher amount of non-esterified fatty acids, glycerol, hormones, cytokines, proinflammatory markers and other substances which involved in the increased of insulin resistance and eventually raising the blood glucose level (Al-Goblan, Al-Alfi and Khan, 2014; Martyn, Kaneki, Yasuhara, 2008). Nonetheless, the present study had shown that there was a higher fasting blood glucose level among those who were overweight. This finding was supported by the study of Vargese, Joseph and Matthew, (2019) which also revealed their result that there is a high prevalence or FBG among those who were overweight.

These discrepancy may be due to the limited sample size and inequal number of participants between BMI categories. Further research with equal sample size for participant between BMI categories is therefore required to validate the link between the FBG levels on different BMI categories.

5.9 Strength and Limitation

The present study has several strengths and limitations. First and foremost, the present study determined the prevalence of SSB consumption with their preference of the SSB among UTAR students. This findings can contribute to the current limited literatures on SSB consumption of university students in Malaysia. Besides, the present study could provide insight into the relationship between anthropometrics and FBG associated with the risk of diabetes mellitus among university students. This study was one of the few studies conducted to investigate the relationship between anthropometric indices and FBG of

university students. In brief, the present study could provide evidence for further research. Furthermore, the use of quota sampling, which is a non-probability sampling that relies on the non-random selection of a predetermined number or proportion of units among the sample population. Hence, this can access the gender indifference which ease in SSB consumption, anthropometrics indices and FBG levels. Moreover, the FBG of the respondents was accessed by using finger prick blood test. This can measure the blood glucose of each individual more accurately when compared to a random blood glucose testing as this FBG test required fasting for several hours particularly 8 hours prior to the blood test (CDC, nd.).

Apart from that, there are several limitations in this study. First and foremost, the present study was conducted in UTAR Kampar Campus. This leads to the lacking access to university students from other ethnicities as majority of the UTAR students were from Chinese ethnicity. Therefore, this current finding might not be able to be the representative to university students from other ethnicities in Malaysia, such as Malays and Indians. Besides that, despite of the location of UTAR Kampar Campus located, there was a limited access to the university which located in urban area. It is noted that different geographical region may lead to a different lifestyle factors among university students. Hence, the representativeness of the sample could not be guaranteed and more respondents are required to validate the accuracy and reliability of the data. Next, the use of self-administrated questionnaire (BEVQ-15) might show a limitation whereby the participants might have difficulties in memory relapsing and recalling bias on the SSB consumption in a month. The memory lapse

would result in overreporting or underreporting of data during the report of frequency and amount of SSB intake. Lastly, the amount of sugar consumed for each SSB intakes might not be assessed accurately due to the nature of the questionnaire. Therefore, other dietary intake assessment such as 24-hour dietary recall or food diary are recommended to be conducted in order to understand better on the amount of sugar from the sugary drinks consumed in the future (Tan et al., 2020).

5.10 Future Study

For future studies, it would be reliable to conduct a prospective cohort study on SSB consumption pattern of university students as well as to warrant the correlation between SSB intake, anthropometrics indices and FBG of university students. This is because it can collect all the information with higher accuracy with more details information. A large population size with the involvement of all ethnicities and geographical region from all university in Malaysia can be focussed on in order to validate the accuracy and reliability of the findings among university students. A real-time assessment of dietary intake such as food diary or 24 hour dietary recall can also be adopted in the future to avoid the limitation like memory bias. Last but not least, other factors such as peer influence, price, availability of SSB in university or at home that may be probably associated with SSB consumption of university students. This potential determinants which would results in the SSB intake could be investigated in future studies in which this would be beneficial in developing an effective health program to lower the risk of prediabetes and diabetes among university students.

CHAPTER 6

CONCLUSION

The participants in this study had a lower SSB intake which is indicated a healthy eating habit. In terms of anthropometric indices and blood glucose parameter, the participants also have normal BMI, WC, body fat percentage and FBG. There was a significant difference between male and female students whereby the SSB intake of male (60.1%) was significantly higher than female students (39.9%). There was a significant difference of BMI, WC, body fat percentage and FBG between male and female respondents. The present study also reported that the BMI status, WC and FBG of male are higher than female students in UTAR whereas only the body fat percentage was significantly higher in female students. Correlation test was performed and it showed there was no significant correlation between BMI and body fat percentage with FBG. There is a weak positive correlation between SSB and WC with FBG. Furthermore, Kruskal-Wallis test was used to compared the FBG between different BMI categories. Lastly, a significant difference of FBG between different BMI categories. To conclude, even though majority of the UTAR students had normal FBG, however, there is still few students having the risk of prediabetes especially among those who were overweight. The need to identify the high-risk group in the community is important since the young age. The intervention studies should be implemented to prevent or delay the onset of diabetes.

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APPENDIX A

QUESTIONNAIRE

1. Name

_____

2. Gender

Mark only one oval.

- ◯ Male
- ◯ Female

3. Age

_____

4. Contact Number

_____

5. Nationality

Mark only one oval.

- ◯ Malaysian
- ◯ Other: _____

6. Ethnicity

Mark only one oval.

- ◯ Chinese
- ◯ Malay
- ◯ Indian
- ◯ Other: _____

7. Faculty

Mark only one oval.

- ◯ CFS
- ◯ FSc
- ◯ FEGT
- ◯ FBF
- ◯ FICT
- ◯ FAS
- ◯ ICS
- ◯ Other: _____

8. Course of study (Eg: Dietetics) *

_____

9. Year of study (Eg: Y1T1)

_____

10. Smoker status

Mark only one oval.

- ◯ Active smoker
- ◯ Ex-smoker
- ◯ Non-smoker

11. Have you taken any medication now?

Mark only one oval.

- ◯ Yes
- ◯ No

12. If yes, can you state the name of your medication?

_____

13. Have you done your fasting 1 day before? (> 8hrs fasting)

Mark only one oval.

- ◯ Yes
- ◯ No

APPENDIX B

BEVQ QUESTIONNAIRE

Beverage Questionnaire

Subject ID _____

Date _____

Instructions:
In the past month, please indicate your response for each beverage type by marking an "X" in the bubble for "how often" and "how much each time"
1) Indicate how often you drank the following beverages, for example, you drank 5 glasses of water per week, therefore mark 4-6 times per week
2) Indicate the approximate amount of beverage you drank each time, for example, you drank 1 cup of water 2 times per day, therefore mark 1 cup under "how much each time"

	HOW OFTEN (MARK ONE)							HOW MUCH EACH TIME (MARK ONE)				
Type of Beverage	Never or less than 1 time per week (go to next beverage)	1 time per week	2-3 times per week	4-6 times per week	1 time per day	2+ times per day	3+ times per day	Less than 6 fl oz (3/4 cup)	8 fl oz (1 cup)	12 fl oz (1 1/2 cups)	16 fl oz (2 cups)	More than 20 fl oz (2 1/2 cups)
Water	o	o	o	o	o	o	o	o	o	o	o	o
100% Fruit Juice	o	o	o	o	o	o	o	o	o	o	o	o
Sweetened Juice Beverage/Drink (fruit ades, lemonade, punch, Sunny Delight)	o	o	o	o	o	o	o	o	o	o	o	o
100% Vegetable Juice (V8, etc.)	o	o	o	o	o	o	o	o	o	o	o	o
Whole Milk	o	o	o	o	o	o	o	o	o	o	o	o
Reduced Fat Milk (2%)	o	o	o	o	o	o	o	o	o	o	o	o
Low Fat/Fat Free Milk (Skim, 1%, Buttermilk, Soymilk)	o	o	o	o	o	o	o	o	o	o	o	o
Soft Drinks, Regular	o	o	o	o	o	o	o	o	o	o	o	o
Diet Soft Drinks/Artificially Sweetened Drinks (Crystal Light)	o	o	o	o	o	o	o	o	o	o	o	o
Sweetened Tea	o	o	o	o	o	o	o	o	o	o	o	o
Coffee, with cream and/or sugar (includes non-dairy creamer)	o	o	o	o	o	o	o	o	o	o	o	o
Tea or Coffee, black, with/ without artificial sweetener (no cream or sugar)	o	o	o	o	o	o	o	o	o	o	o	o
Non-alcoholic or Light Beer	o	o	o	o	o	o	o	o	o	o	o	o
Beer, Ales, Wine Coolers	o	o	o	o	o	o	o	o	o	o	o	o
Hard Liquor (shots, rum, tequila, etc.)	o	o	o	o	o	o	o	o	o	o	o	o
Mixed Alcoholic Drinks (daiquiris, margaritas, etc.)	o	o	o	o	o	o	o	o	o	o	o	o
Wine (red or white)	o	o	o	o	o	o	o	o	o	o	o	o
Meal Replacement Shakes/Protein Drinks (Slimfast, shakes, etc.)	o	o	o	o	o	o	o	o	o	o	o	o
Energy Drinks (Red Bull, Rockstar, Full Throttle, etc.)	o	o	o	o	o	o	o	o	o	o	o	o
Other (list):	o	o	o	o	o	o	o	o	o	o	o	o
Other (list):	o	o	o	o	o	o	o	o	o	o	o	o

Virginia Polytechnic Institute and State University, 2008

Figure 1.
The Beverage Intake Questionnaire: Evaluation of Initial Validity and Reliability*
*Scoring instructions are available from the corresponding author upon request.c

APPENDIX C

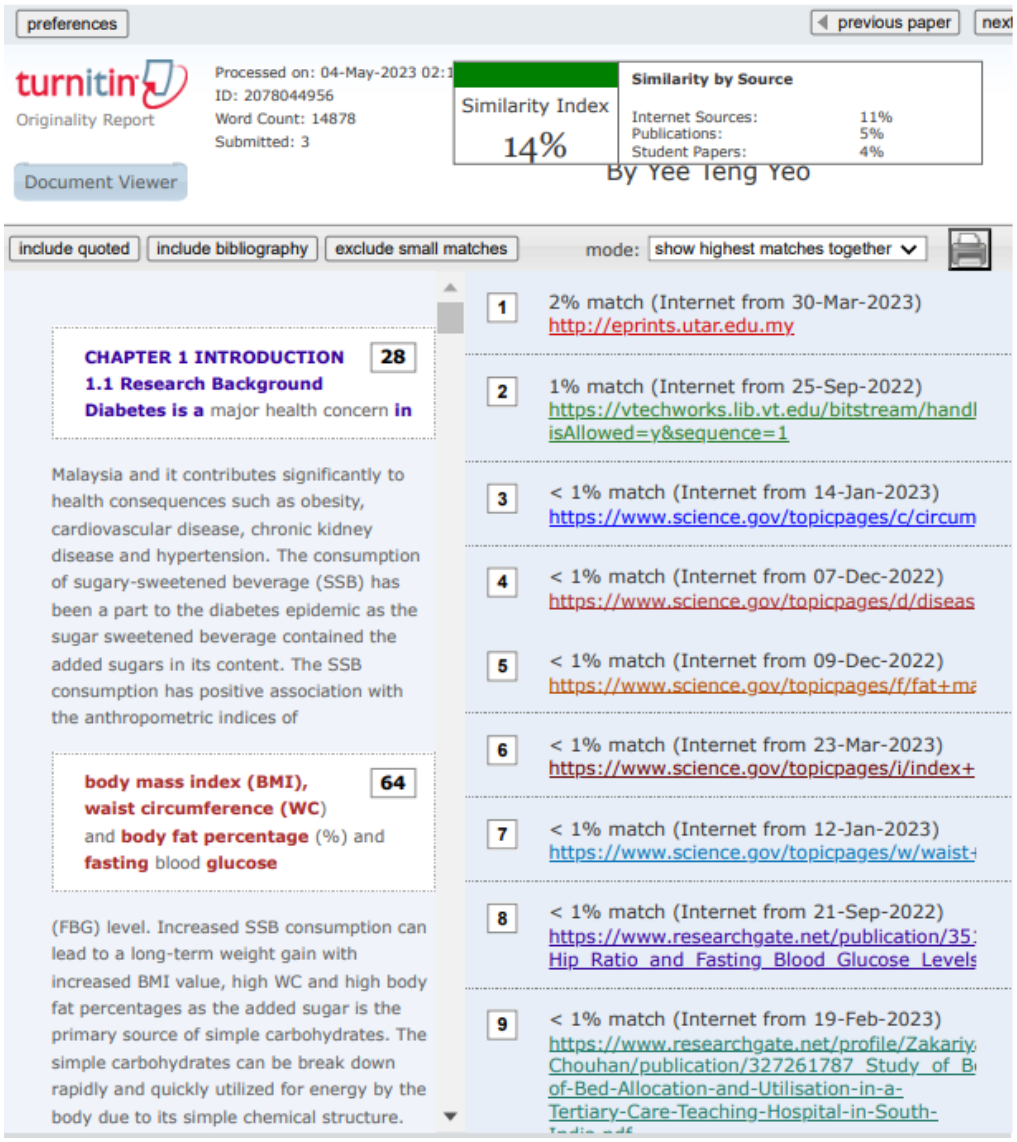
NORMALITY TEST

Table A.1: Tests of Normality

	Kolmogorov-Smirnov[a]	Shapiro-Wilk
	Sig.	Sig.
Sugary-sweetened beverage (SSB) consumption	0.000	0.000
Body mass index (BMI)	0.000	0.000
Waist circumference (WC)	0.000	0.000
Body fat percentage (%)	0.065*	0.023
Fasting blood glucose	0.000	0.000

[a] Lilliefors Significance Correction, * $p > 0.05$

APPENDIX D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CHAPTER 1 INTRODUCTION 28
1.1 Research Background
Diabetes is a major health concern in
Malaysia and it contributes significantly to health consequences such as obesity, cardiovascular disease, chronic kidney disease and hypertension. The consumption of sugary-sweetened beverage (SSB) has been a part to the diabetes epidemic as the sugar sweetened beverage contained the added sugars in its content. The SSB consumption has positive association with the anthropometric indices of
body mass index (BMI), 64
waist circumference (WC)
and body fat percentage (%) and
fasting blood glucose
(FBG) level. Increased SSB consumption can lead to a long-term weight gain with increased BMI value, high WC and high body fat percentages as the added sugar is the primary source of simple carbohydrates. The simple carbohydrates can be break down rapidly and quickly utilized for energy by the body due to its simple chemical structure.
1 2% match (Internet from 30-Mar-2023)
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Hip_Ratio_and_Fasting_Blood_Glucose_Levels
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Chouhan/publication/327261787_Study_of_B
of-Bed-Allocation-and-Utilisation-in-a-
Tertiary-Care-Teaching-Hospital-in-South-

APPENDIX E

Universiti Tunku Abdul Rahman			
Form Title : Supervisor's Comments on Originality Report Generated by Turnitin for Submission of Final Year Project Report (for Undergraduate Programmes)			
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FACULTY OF SCIENCE

Full Name(s) of Candidate(s)	Yeo Yee Teng
ID Number(s)	19ADB02734
Programme / Course	Bachelor of Science (HONS) Dietetics
Title of Final Year Project	The relationship between sugary-sweetened beverages (SSB) intake, anthropometric indices and fasting blood glucose level among male and female students from Universiti Tunku Abdul Rahman (UTAR) Kampar

Similarity	**Supervisor's Comments (Compulsory if parameters of originality exceeds the limits approved by UTAR)**
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Based on the above results, I hereby declare that I am satisfied with the originality of the Final Year Project Report submitted by my student(s) as named above.

Signature of Supervisor
Name: MUHAMMAD ZULHUSNI SUHAIMI

Date: 7/06/2023

Signature of Co-Supervisor
Name: _____

Date: _____