THE ASSOCIATION BETWEEN DIETARY INTAKE AND BLOATING SYMPTOMS IN TYPE 2 DIABETES PATIENTS AT HPUSM

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by

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DECLARATION

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

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NURUL NATASHA BINTI MOHD BUSTAMAM

Date:……

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ABBREVIATIONS

[a]	Percentage of energy intake from total calories
BMI	Body Mass Index
BSQ	Bloating Severity Questionnaire
CHO	Carbohydrate
CI	Confidence Interval
FODMAP	Fermentable Oligosaccharides, Disaccharides, Monosaccharides and Polyols
GI	Gastrointestinal
kcal	Kilocalorie
MD	Mean Difference
MNT	Medical Nutrition Therapy
NCD	Non-Communicable Disease
SD	Standard Deviation
Sev24	Severity in the Past 24 Hours (from BSQ)
SevGen	Severity General Score (from BSQ)
SPSS	Statistical Package for the Social Sciences
T2DM	Type 2 Diabetes Mellitus

ABSTRAK

Simptom gastrointestinal (GI) seperti kembung perut sering dilaporkan dalam kalangan pesakit diabetes mellitus jenis 2 (T2DM). Simptom ini boleh menjejaskan kualiti kehidupan dan tabiat pemakanan, namun data tempatan mengenai kaitan antara pemakanan dan simptom kembung masih terhad. Kajian ini dijalankan untuk mengenal pasti tahap keterukan simptom kembung perut dan menentukan hubungan antara pengambilan diet dan tahap keterukan kembung perut dalam kalangan pesakit T2DM. Kajian keratan rentas ini melibatkan 100 pesakit T2DM. Data dikumpul menggunakan ingatan diet 24 jam, soal selidik sosiodemografi dan soal selidik keterukan kembung (*BSQ*). Purata umur peserta adalah 63(11) purata pengambilan tenaga ialah 1491.83 ± 615.2 kcal, dengan karbohidrat menyumbang 52.5%, protein 17.4% dan lemak 30.1% daripada jumlah tenaga. Skor purata SevGen ialah 14.4 ± 6.2 dan Sev24 ialah 9.66 ± 4.7, menunjukkan tahap sederhana simptom kembung. Tiada perbezaan yang signifikan dalam pengambilan diet antara individu yang mengalami dan tidak mengalami kembung ($p > 0.05$). Hasil korelasi Pearson juga menunjukkan tiada hubungan signifikan antara pengambilan tenaga atau makronutrien dengan simptom kembung, walaupun terdapat kecenderungan simptom yang lemah antara pengambilan lemak dan skor Sev24 ($r = -0.190$, $p = 0.058$). Kesimpulannya, kajian ini mendapati tiada hubungan yang signifikan antara pengambilan diet dan simptom kembung perut dalam kalangan pesakit T2DM. Walau bagaimanapun, trend yang diperhatikan menunjukkan keperluan kajian lanjut yang memberi tumpuan kepada pengambilan lemak, serat, dan tabiat pemakanan. Penemuan ini menyumbang kepada pemahaman awal mengenai kaitan antara diet dan simptom kembung perut dalam kalangan pesakit diabetes di Malaysia.

ABSTRACT

GI symptoms, particularly bloating, are frequently reported among individuals with T2DM. Such symptoms may negatively affect quality of life and dietary habits. However, limited local data exists on how dietary intake relates to bloating symptoms in this population. This study aimed to assess the dietary intake of T2DM patients with mean age of at HPUSM, determine the severity of bloating, and to explore the association between dietary intake and bloating severity. A cross-sectional study was conducted involving 100 T2DM patients at Hospital USM. Data collection included a 24-hour dietary recall, sociodemographic questionnaire, and the Bloating Severity Questionnaire (*BSQ*) consisting of SevGen and Sev24 components. Results of this study indicated that there is no association between dietary intake and bloating symptom among T2DM. The overall mean energy intake was 1491.83 ± 615.2 kcal, with carbohydrates contributing 52.5%, protein 17.4%, and fat 30.1% of total energy. The average SevGen and Sev24 scores were 14.4 (6.2) and 9.66 (4.7), respectively, indicating moderate bloating symptoms. No statistically significant differences in dietary intake were found between participants with and without bloating symptoms ($p > 0.05$). Additionally, Pearson correlation results showed no significant association between energy or macronutrient intake and bloating scores, though fat intake showed a weak negative trend with bloating symptoms (Sev24: $r = -0.190$, $p = 0.058$). In conclusion, this study found no significant association between dietary intake and bloating among T2DM patients. However, observed trends suggest further research is warranted, especially focusing on fat intake, fiber content, and eating behaviour. These findings contribute preliminary evidence on the dietary patterns and bloating experiences of Malaysian diabetic patients.

CHAPTER 1: INTRODUCTION

1.1 Background of Study

Diabetes is a chronic condition that occurs when the pancreas can no longer make insulin, or the body cannot effectively use insulin. There are three types of diabetes, type 1, type 2 and gestational diabetes (International Diabetes Federation, 2024). The prevalence of DM has increased significantly, mainly as a result of continuous rise in the incidence of T2DM. According to World Health Organization (WHO) statistics, more than 422 million adults globally were suffering from diabetes mellitus in 2014 and a continuous rise in DM prevalence is expected (Lovic et al., 2019). Meanwhile based on the Malaysian National Health and Morbidity Survey in 2019, the prevalence of diabetes in adults aged ≥18 years has increased from 11.2% in 2011 to 18.3% (NHMS, 2019). In order to attenuate the problems of diabetes, management strategies usually include lifestyle changes such as increased physical activities and dietary interventions. A study consistently reported that dietary factors contributed significantly to the diabetes where include high simple CHO, fat and cholesterol (Song et al., 2019). In Malaysia, studies have shown that individuals with T2DM frequently consume diets high in carbohydrates and fats, with many patients exceeding the recommended intake for fat while only moderately adhering to guidelines for carbohydrates and protein (Md Isa et al., 2023). And thus, dietary management approaches that are tailored to meet the needs of people with T2DM reflect these elements that are aimed at reducing the risk of acute and chronic complications (Ojo, 2019).

GI symptoms are highly prevalent, but many people who have them will have no organic explanation for their symptoms. Most of these people will be labelled as having a functional GI disorder, such as irritable bowel syndrome, functional dyspepsia, or functional constipation. These conditions affect up to 40% of people at any one point in time, and two-thirds of these people will have chronic, fluctuating symptoms (Black et al.,

2020). Although, GI symptoms are not life threatening, it reduces quality of life (Sundas et al., 2022). In diabetes patients, GI complications are very common and greatly affect the quality of life. Diabetes can affect almost every part of GI tract from the oesophagus to the rectum, and causes a variety of symptoms, such as delayed gastric emptying or diabetic gastroparesis. Abnormally increased retention of gastric contents may be associated with symptoms, including nausea, bloating, vomiting, postprandial fullness, and early satiety, which may be debilitating (Marathe et al., 2024). Up to 75 percent of people with diabetes have some type of GI issue (Stephani W., 2020).

Dietary modification is associated with a reprogramming of nutrient intake, which are proven to be effective for the management of diabetes and associated complications (Oza et al., 2021). Malaysian Ministry of Health (MOH) provides suggestion of macronutrients intake among T2DM patients as follows; 45–60% carbohydrate, 15–20% protein, and 25–35% fat Lifestyle choices and dietary habits play a crucial role in maintaining and disrupting GI health (Gastro F., 2024). Numerous studies have been conducted on the influence that different types of nutrition may have on the onset of chronic diseases at the level of the GI system (Corsello et al., 2020). Hence, it is vital to understand the association between dietary intake and bloating symptoms among diabetic patients.

1.7 **Problem Statement**

GI symptom such as bloating is a distressing symptom that can negatively impact dietary intake and leads to poor adherence to diabetes management and may leads to complications. While dietary management is essential for controlling blood glucose levels and preventing complications, many patients with T2DM continue to experience gastrointestinal symptoms, particularly bloating, which negatively affect their quality of life and adherence to treatment. Despite the known impact of diet on both metabolic control and gastrointestinal function, there is limited research specifically examining the association between dietary intake and the occurrence of bloating among Malaysian adults with T2DM. This gap in knowledge hinders the ability of healthcare providers to offer targeted nutritional guidance that could alleviate gastrointestinal discomfort and improve overall diabetes management. Therefore, this study aims to address this evidence gap by exploring the association between dietary intake and bloating symptoms in Malaysian T2DM patients, with the goal of informing culturally appropriate dietary strategies to improve gastrointestinal comfort and overall management outcomes.

1.3 Study Objective

General Objective

To identify the association of dietary intake and GI symptom of bloating among T2DM patients in HPUSM.

Specific Objective

1. To assess the dietary intake among T2DM patients in HPUSM.
2. To determine the severity of bloating symptoms among T2DM patients in HPUSM.
3. To examine dietary differences with bloating status.
4. To determine the association between dietary intake and bloating in T2DM patients in HPUSM.

1.4 **Research Questions**

1. What is the dietary intake among T2DM patients in HPUSM?
2. What is the level of severity of bloating symptoms among T2DM patients in HPUSM?
3. Is there a significant difference in dietary intake between individual with and without bloating symptoms among patients with type 2 diabetes?
4. Is there any association between dietary intake with bloating symptoms among T2DM patients in HPUSM?

1.5 Research Hypotheses

Hypothesis 1:

Ho: There is no association between dietary intake and bloating symptoms in T2DM patients at HPUSM.

HA: There is an association between dietary intake and bloating symptoms in T2DM patients at HPUSM.

Hypothesis 2:

Ho: There is no significant difference in dietary intake between individuals with and without bloating symptoms.

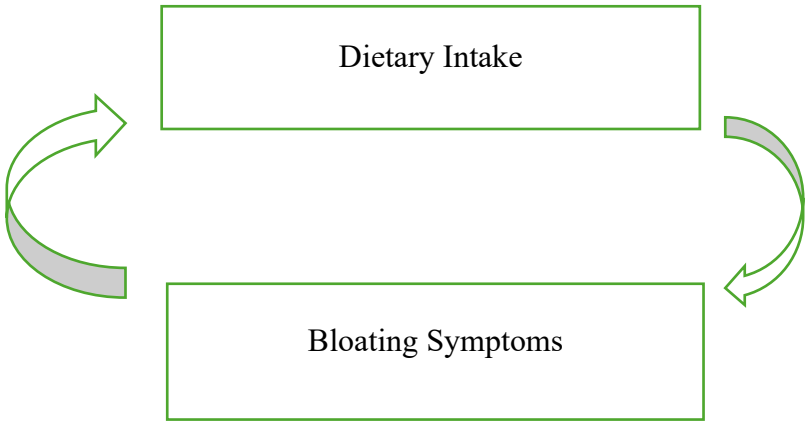
HA: There is significant difference in dietary intake between individuals with and without bloating symptoms.

1.6 **Significance of Study**

This study is significant as it addresses a critical gap in understanding the relationship between dietary intake and gastrointestinal symptoms, specifically bloating, among individuals with T2DM in Malaysia. Although the management of T2DM typically emphasizes glycaemic control and the prevention of complications, GI symptoms such as bloating can significantly affect patients' dietary intake, quality of life, and compliance with medical nutrition therapy (MNT). Understanding the association between dietary intake and bloating is important because diet plays a dual role in both diabetes management and the modulation of gastrointestinal health. Identifying dietary patterns or specific food groups that contribute to or alleviate bloating symptoms may lead to more personalized and effective nutrition interventions for T2DM patients. This is especially crucial in Malaysia, where the local diet and eating habits may differ significantly from those in Western countries, where most existing studies are conducted. The findings have the potential to guide healthcare professionals in providing personalized dietary counselling, improve symptom management, and ultimately enhance the overall well-being and metabolic health of T2DM patients. Furthermore, the results may contribute to the refinement of clinical guidelines and public health strategies for diabetes management in Malaysia, ensuring they reflect the latest scientific evidence on the interplay between diet, gut health, and metabolic outcomes

1.7 Conceptual Framework

Figure 1.0: Conceptual framework of the study



The figure above shows the conceptual framework outlining the association between dietary intake and bloating symptoms among T2DM. Generally, the dietary intake can influence bloating symptoms as consumption of gas forming food may lead to bloating. Foods that can cause or worsen gas and bloating include carbonated drinks, lentils, and cruciferous vegetables (Fletcher, 2018). Bloating is commonly associated with a sensation of abdominal fullness, pressure, or distension, which can negatively affect appetite and eating behaviour. Individuals experiencing bloating often report early satiety, meaning they feel full after consuming only a small amount of food. This can lead to a reduction in total energy and nutrient intake because patients may unconsciously or intentionally limit portion sizes to avoid worsening their discomfort. According to visceral hypersensitivity and impaired gastric accommodation, these sensations can alter normal hunger and satiety cues, causing decreased motivation to eat (Melchior et al., 2025). This present study is interested to determine the association between dietary intake and bloating symptoms among T2DM.

CHAPTER 2.0: LITERATURE REVIEW

2.1 Bloating Symptoms in Type 2 Diabetes Mellitus

According to Rome Foundation, bloating is one of the GI symptoms that be define as a sensation of gassiness, trapped gas, or a feeling of the abdomen being distended or swollen although there may be no obvious visible distension or swelling of the abdomen, some patients also describe a sense of fullness or pressure in the upper abdomen (DuBreuil, 2021). Unlike other GI symptoms, such as diarrhea or constipation, bloating is subjective but often provides a clear indication of discomfort and potential underlying gastrointestinal issues as it is one of the most common gastrointestinal symptoms, which is a frequent complaint in the patients of all ages (Oshima, 2021).

Moreover, diabetes can damage the nerves in the stomach and slow or stop digestion. This condition is called gastroparesis, a condition when the stomach doesn't empty properly (CDC, 2024). Diabetic gastroparesis is a potential complication that occurs in the setting of poorly controlled diabetes, resulting from dysfunction in the coordination and function of the autonomic nervous system, neurons, and specialized pacemaker cells (interstitial cells of Cajal, ICC) of the stomach and intestine, and the smooth muscle cells of the GI tract (Aswath et al., 2023). Additionally, gastroparesis can cause bloating soon after eating or even long after meals, contributing to discomfort and poor appetite (CDC,2024). However, it is suspected that diabetic gastroparesis in Malaysia is underdiagnosed due to its similar presentation to other conditions such as gastroesophageal reflux disease (Petri et al., 2021). A study by Oshima et al (2021) reported that, gastroparesis can be challenging to diagnose due to the lack of instrument, standardized method, and paucity of research data on normative value, risk factors, and treatment studies in Asian patients. A systematic review by Li et al (2023) show that the meta-analysis revealed that the overall global prevalence of DM-DGP was 9.3%.

In addition to gastroparesis, patients with diabetes often report functional GI disorders, such as irritable bowel syndrome (IBS). A study by Vanuytsel et al. (2021) reported that IBS-like symptoms, including abdominal pain and altered bowel movements, were more prevalent in individuals with diabetes than in the general population, a particularly in those with a history of high blood glucose levels. Furthermore, diabetes-related autonomic neuropathy is thought to play a key role in the development of GI symptoms. The autonomic nervous system, which regulates the gastrointestinal tract, is often impaired in individuals with diabetes, leading to GI motility disorders such as gastroparesis and constipation (Davis et al., 2024).

The underlying mechanisms of GI symptoms in diabetes are multifactorial. One of the primary contributors is diabetic autonomic neuropathy, a condition that affects the nerves controlling the gastrointestinal system. Autonomic neuropathy can lead to delayed gastric emptying, abnormal peristalsis, and other motility disorders, which contribute to symptoms like bloating, nausea, and constipation (Zhao et al., 2020). Additionally, hyperglycaemia is believed to exacerbate gastrointestinal dysfunction. High blood glucose levels can impair the function of the enteric nervous system, disrupt gut motility and contribute to gastrointestinal discomfort (El-Salhy et al., 2015). Chronic inflammation and alterations in the gut microbiome in diabetes patients have also been implicated in the development of gastrointestinal symptoms.

2.2 Dietary Intake

Dietary intake refers to the measurement and evaluation of the quantity and quality of nutrients consumed by an individual on a daily basis, including calories, macronutrients, vitamins, and minerals (Thomas & Foster, 2016). Dietary intake plays a critical role in managing GI symptoms, as certain foods can exacerbate or alleviate bloating (Barhum, 2018). The dietary intake patterns among patients with type 2 diabetes mellitus (T2DM) have garnered increasing attention due to the rapidly rising prevalence

of diabetes in Malaysia. According to a recent study by Cheong et al. (2023), the incidence of T2DM in the country has increased significantly, prompting greater emphasis on the role of dietary modifications in both prevention and management. Their findings revealed that while most patients met the recommended carbohydrate and protein intakes, fat consumption consistently exceeded national guidelines, suggesting a dietary imbalance that may contribute to poor glycaemic control and other metabolic complications. Recent large-scale studies have provided comprehensive insights into the macronutrient consumption trends among Malaysian T2DM patients, highlighting both adherence and deviations from recommended dietary guidelines (Md Isa et al., 2023).

The Malaysian Ministry of Health recommends that adults, including those with T2DM, consume 45–60% of their total energy intake (TEI) from carbohydrates, 15–20% from protein, and 25–35% from fat (Ministry of Health Malaysia, 2017). However, actual intake patterns among T2DM patients often diverge from these guidelines, particularly concerning fat consumption. The association between dietary intake and GI symptom such as bloating is well-established, with macronutrient composition playing a vital role in symptom development and management (Agah et al., 2022).

CHO, particularly fermentable oligosaccharides, disaccharides, monosaccharides, and polyols (FODMAPs), are major contributors to bloating (Veloso, 2023). These compounds are poorly absorbed in the small intestine and undergo fermentation by gut microbiota, leading to gas production and bloating. High FODMAP foods include certain fruits (apples, pears), vegetables (onions, garlic), dairy products, and artificial sweeteners. Studies such as those by Gearry et al., (2016) have demonstrated the efficacy of low-FODMAP diets in reducing bloating and other GI symptoms. The author also states that up to 86% of patients with IBS find improvement in overall GI symptoms as well as individual symptoms such as abdominal pain, bloating, constipation, diarrhea, abdominal distention, and flatulence following the diet. FODMAP restriction reduces the osmotic load and gas production in the distal small bowel and the

proximal colon, providing symptomatic relief in patients. For individuals with T2DM, who may already experience altered gut motility and dysbiosis, the reduction of FODMAP intake can significantly alleviate symptoms.

Fat consumption also plays a critical role in bloating as the presence of fat in the small intestine slows gastric emptying, stimulates the release of many GI hormones, and suppresses appetite and energy intake as a result of the digestion of fats into free fatty acids (Watson, 2017). The effects of free fatty acids are, in turn, dependent on their chain length. High-fat diets are known to delay gastric emptying, a phenomenon that is particularly relevant in T2DM patients who may have gastroparesis. Gastroparesis is a condition in which the stomach empties into the small intestine more slowly than it should (Cafasso, 2023). This is called delayed gastric emptying. Gastroparesis can be triggered by a viral infection, a chronic disease such as diabetes. Delayed gastric emptying can lead to prolonged sensations of fullness and bloating. Laboratory studies have shown that the addition of fat to a meal resulted in more symptoms of fullness, bloating, and nausea in dyspeptic patients (Azadbakht & Khodarahm, 2016). Moreover, evidence showed that perception of gastric distension increased by lipids but not by glucose (Hajishafiee et al., 2019).

Proteins, while less frequently implicated in bloating, can still contribute under certain conditions. Excessive protein intake, particularly from sources like red meat, can result in putrefaction in the colon due to incomplete digestion, producing gas and bloating (Wu et al., 2022). Additionally, some protein-rich foods, such as legumes, are high in oligosaccharides and may exacerbate symptoms. The role of gut microbiota in the interaction between macronutrients and bloating is increasingly recognized as recent research provide strong evidence that gut microbiota plays essential role in human health (Hill & Round, 2021). T2DM is often associated with dysbiosis, characterized by an imbalance in microbial composition (Slouha et al., 2023). Diet-induced changes in gut microbiota can influence gas production and bloating. Probiotic supplementation and

prebiotic intake have shown potential in modulating gut microbiota, though their efficacy may vary based on individual microbial profiles (Zhao et al., 2018).

2.3 Association Between Diet and Bloating Symptoms

GI symptoms such as bloating, nausea, early satiety, and abdominal discomfort are frequently reported by individuals with T2DM. Dietary factors play a key role in the development and exacerbation of these symptoms, particularly in patients with diabetic gastroparesis. Meals that are high in fat and fiber, as well as large portion sizes, have been shown to delay gastric emptying and worsen bloating (Horowitz et al., 2020). While fiber is essential for glycaemic control, excessive intake, especially of insoluble fiber may increase fermentation and gas production, leading to bloating and discomfort (Wang et al., 2020). Fat, on the other hand, slows gastric motility and, when consumed in large amounts, can contribute to postprandial fullness and distension. These dietary factors, combined with impaired gastric regulation in diabetes, contribute significantly to bloating and other GI symptoms. Therefore, assessing and modifying dietary patterns is crucial in managing these symptoms and improving the quality of life for T2DM patients.

Another key contributor to GI symptoms is poor glycaemic control, which itself may impair gut motility. Hyperglycaemia has been associated with autonomic dysfunction that disrupts gastric emptying and alters peristalsis, thereby worsening symptoms like bloating, constipation, and fullness (Parkman et al., 2020). Thus, dietary strategies aimed at glycaemic stability can also improve GI function. Recommendations for T2DM patients with bloating or gastroparesis often include consuming small, frequent meals that are low in fat and fiber to reduce the gastric load and facilitate smoother digestion (Camilleri & Chedid, 2019). These meal patterns have been found to be effective in minimizing bloating and promoting better blood glucose control. Additionally, avoiding carbonated beverages and slowly digestible carbohydrates has been advised to further reduce abdominal distension. The dual impact of dietary modification on both glycaemic and

gastrointestinal symptoms makes it a central strategy in the comprehensive dietary management of T2DM.

Beyond physiological and nutritional factors, social determinants such as food insecurity also influence dietary intake and GI health. Food insecurity, defined as the lack of consistent access to nutritious and adequate food, has been linked to poor dietary diversity, excessive consumption of high-fat or low-nutrient foods, and poor glycaemic control, all of which can contribute to bloating and other GI symptoms (Seligman et al., 2021). In the Malaysian context, a study by Md Isa et al. (2023) found that while carbohydrate and protein intake among T2DM patients were generally within recommended limits, fat intake was frequently higher than advised, possibly reflecting economic limitations and food access barriers. These patterns may predispose individuals to GI symptoms, particularly when combined with irregular meal timings and poor dietary quality. Thus, addressing food insecurity should be considered an essential component in managing bloating and other GI complaints in T2DM patients, alongside clinical and dietary strategies.

CHAPTER 3: METHODOLOGY

3.1 Research Design

This study is designed as a cross-sectional study which involved the use of questionnaires. The questionnaires are used to determine dietary intake and bloating symptoms among T2DM patients in HPUSM. Cross - sectional study is chosen because it enables us to investigate the real time of dietary intake and bloating symptoms in T2DM in the present.

3.2 Sampling Method

This research was using a purposive sampling method. This method was chosen due to lack of manpower and insufficient number of eligible subjects in clinic. All the T2DM patients in HPUSM who met the inclusion are welcome to voluntarily participate in this study. An inform consent have been obtained from the eligible participants who are willing to participate in this study. Although the initial sample size calculation indicated that 143 respondents were required to achieve sufficient statistical power, only 100 respondents were successfully recruited for this study. This shortfall was primarily due to time constraints and limited accessibility to eligible participants within the study period. Despite extensive efforts to reach the target sample, factors such as low participant availability, non-responsiveness and time limitations impacted recruitment. Nevertheless, the collected sample still provides valuable insights and maintains reasonable representation of the target population.

3.3 Study Period

Data collection began after ethical approval was obtained from the Human Research Ethics Committee USM (USM/JEPeM/KK/2501035) and the Director of Hospital USM. The data collection period ranged from April 2025 until May 2025, conducted on weekdays from 9.00 a.m. to 5.00 p.m. Data entry and analysis commenced in early April 2025.

3.4 Location of Study

This study was conducted in clinic at Hospital Pakar Universiti Sains Malaysia (HPUSM), Kubang Kerian, Kelantan. The clinic involved in the study were Klinik Rawatan Keluarga (KRK), Klinik Pakar Perubatan (KPP) and Klinik Dietetic.

3.5 Population of Study

Reference Population

T2DM patients in Kelantan

Target Population

T2DM patients at HPUSM

Source Population

T2DM patients aged 18 above, attending HPUSM during the study period

3.6 Sample Size Calculation

One proportion formula was used to determine the approximate sample size for this study:

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

n = sample size

z = value representing the desired confidence level

Δ = precision

p = anticipated population proportion

For this research, the values for Δ is 0.05 with the confidence interval 95%, therefore, the z-score will be 1.96. Based on study by Li et al, the percentage of Type 2 with gastrointestinal problem = 9.3 % (Li et al., 2023). Therefore, the proportion will be 0.093

$$n = (\left[\frac{1.96}{0.05}\right]^2 0.093(1 - 0.093)$$
$$n = 129.61$$

Therefore, from the calculation, the minimal sample size is 130 respondents. By considering drop-out rates of 10%, the final total number of respondents required for this study is:

130 + (130 x 0.1) = 143 respondents

3.7 Participant Criteria: Inclusion & Exclusion

The inclusion criteria:

The selection of the subject is based on:

- Participant must be aged 18 and above
- Type 2 Diabetes Mellitus Patients
- Diabetes patients who get a treatment / currently do check-up at HPUSM
- Hold nationality as Malaysian

The Exclusion criteria:

Subjects are excluded when:

- Pregnant or lactating women

- Critical ill diabetes patients
- Mental instability, based on an assessment by a mental health professional or existing medical records.
- Not willing to provide written informed consent to participate in this study

3.8 Research Tools

Sets of validated previous studies questionnaires was carried out for data collection in this study. Data were collected by using an interview- administered questionnaire by a principal investigator. The questionnaire includes demographic information such as age, ethnicity, educational level, occupational status, type of therapy and family history. 24 hour- diet recall was used to assess the dietary intake and Bloating Severity (BSQ) was used to assess the GI symptom of bloating among T2DM. The study was the translated and validated Malay version of BSQ as permitted by the respected (Nurzulaikha Mahd-Ab.lah et al.,2021). The time taken to complete the questionnaire was around 10 minutes.

Section A: 24 – hour Diet Recall

A 24-hour dietary recall (24HR) is a structured interview intended to capture detailed information about all foods and beverages consumed by the respondent in the past 24 hours, most commonly, from midnight to midnight the previous day. NutritionistPro™ (Axxya Systems, United States) was used to analyze data on calories and macronutrients (CHO, proteina and fat) intake.

Section B: Bloating Severity Questionnaire

Consist of two component, one component (SevGen) for severity general which consist of 6 questions, scores range from 6 to 30. The other component is severity 24-hour (Sev24), consist of 5 questions, scores range from 5 to 25. Sum of all questions for each part, the higher the score indicate high symptom (Nurzulaikha Mahd-Ab.lah,2021)

3.9 Statistical Analysis

All statistical analyses were performed using the Statistical Package for the Social Sciences (SPSS) Version 29. Frequency and percentage were used to describe categorical variables, while mean, median, and standard deviation were applied for continuous variables. Dietary intake data were analysed for macronutrient composition using dietary analysis software to ensure accurate quantification of dietary components.

Descriptive statistics were used to summarise the sociodemographic characteristics and dietary intake of the participants. To examine the relationship between dietary intake and gastrointestinal symptoms of bloating, it was assessed through the 24-hour dietary recall (24HR) and the Bloating Severity Questionnaire (BSQ). The Pearson's correlation coefficient (r) was used for continuous variables. For interpretation purposes, correlation coefficients (r) range from –1 to +1, with values closer to –1 or +1 indicating stronger negative or positive relationships, respectively. A correlation near 0 implies no meaningful association.

To analyse the difference between sociodemographic characteristics and the outcome variables (24HR and BSQ), Independent t – test was used for comparisons. For all statistical analyses, a p-value < 0.05 was considered statistically significant. Additionally, 95% confidence intervals (CI) were reported to indicate the precision of the estimated effects.

CHAPTER 4: RESULT

4.1 Socio-demographic characteristics

A total of 100 patients with T2DM participated in this study. The mean age of participants was 63 (11) years, indicating that most respondents were older adults. In terms of gender distribution, the sample consisted of 49% males and 51% females, showing a fairly even representation. The majority of participants were Malay (96%), followed by Chinese (3%) and Indian (1%), reflecting the ethnic distribution of the local population.

Regarding educational level, 94% of the participants had attained secondary education, while only 6% had tertiary education. In terms of employment status, the majority were not working (90%), which may be attributed to the age profile of the sample, while 10% were still employed. With respect to diabetes treatment, 47% were on insulin therapy, 37% on oral medication, and 16% on a combination of both. All participants reported living with family, and none lived alone.

The mean fasting blood sugar level among participants was 8.6 ± 2.8 mmol/L, indicating poor glycaemic control in most respondents. In terms of anthropometric data, the mean weight was 67.0 (13) kg, mean height was 158 (7.3) cm, and the mean body mass index (BMI) was 27 (5.0) kg/m², classifying the group on average as overweight. Based on BMI categories, 4% of participants were underweight, 30% had normal weight, 43% were overweight, and 23% were classified as obese. The socio-demographic characteristics of the subjects are displayed in Table 4.1.

Table 4.1: Socio-demographic data of Respondents (n=100)

Characteristics	*n*(%)	Mean (SD)
Age		63 (11)
Gender		
Male	49 (49)	
Female	51 (51)	
Race		
Malay	96 (96)	
Chinese	3 (3)	
Indian	1 (1)	
Educational Level		
Secondary	94 (94)	
Tertiary	6 (6)	
Working Status		
Working	10 (10)	
Not Working	90 (10)	
Treatment		
Medication	37 (37)	
Insulin	47 (47)	
Both	16 (16)	
Living with		
Alone		
Family	100 (100)	
Fasting Blood Sugar		8.6 (2.8)

Anthropometric	
Weight	67 (13)
Height	158 (7.3)
BMI	27 (5)
BMI Category	
Underweight	4 (4)
Normal	30 (30)
Overweight	43 (43)
Obese	23 (23)

n: Total number of subjects

4.2 24-Hour Diet Recall among T2DM Patients at HPUSM (n=100)

The dietary intake of participants was assessed using the 24-hour dietary recall method, is presented in Table 4.2. The mean energy intake among the respondents was 1491.83 kcal with a standard deviation of 615.2, suggesting a wide variation in daily caloric consumption among individuals.

The mean carbohydrate intake was 194.4 ± 98.5 g contributing to 52.5 ± 12.0 % of the total energy intake. The mean protein intake was 69.8 ± 31.7 g, accounting for 17.4 ± 4.3 % of total daily energy intake. In terms of fat consumption, participants had a mean fat intake of 49.1 ± 32.9 g, which made up approximately 30.1 ± 10.0 % of the total daily energy intake.

Overall, the macronutrient distribution among participants generally adhered to standard recommendations for individuals with diabetes, although total energy intake varied widely, potentially reflecting differences in lifestyle, disease management, or nutritional awareness. The dietary intake among subject is displayed in Table 4.2.

Table 4.2: 24-Hour Diet Recall among T2DM Patients at HPUSM

Dietary Component	Mean (SD)
Energy (Kcal)	1491.83 (615.2)
Carbohydrate	
CHO (g)	194.4 (98.5)
CHO (%) [a]	52.5 (12.0)
Protein	
Protein (g)	69.8 (31.7)
Protein (%) [a]	17.4 (4.3)
Fat	
Fat (g)	49.1 (32.9)
Fat (%) [a]	30.1 (10.0)

n: Total number of subjects, SD: Standard deviation

[a]: Percentage of energy intake from total calories