THE ASSOCIATION BETWEEN FOOD LITERACY WITH CARBOHYDRATE AND SUCROSE INTAKE AMONG TYPE II DIABETES PATIENTS IN HOSPITAL PAKAR UNIVERSITI SAINS MALAYSIA (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 duly acknowledged. I also declare that it has not been previously or concurrently submitted as a whole for any other degrees at Universiti Sains Malaysia or other institutions. I grant Universiti Sains Malaysia the right to use the dissertation for teaching, research and promotional purposes.

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Mandy Yee Hui Teng

Date: 01/07/2025

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ABSTRAK

Pengurusan pemakanan merupakan aspek penting dalam penjagaan pesakit (T2DM). Secara khusus, pengambilan karbohidrat dan sukrosa perlu dipantau dengan teliti bagi mengekalkan kawalan glisemik dan mencegah komplikasi diabetes. Kajian ini dijalankan untuk mengkaji hubungan antara literasi pemakanan dengan pengambilan karbohidrat dan sukrosa dalam kalangan pesakit T2DM di Hospital Pakar Universiti Sains Malaysia (HPUSM). Satu kajian keratan rentas telah dijalankan melibatkan 110 pesakit T2DM berumur antara 18 hingga 60 tahun. Data dikumpulkan dengan soal selidik piawai bagi menilai literasi pemakanan (EFLBQ-D), dan pengambilan karbohidrat dan sukrosa (kaedah rekod pemakanan 24 jam selama tiga hari). Daripada 110 responden, 15 orang (13.6%) mempunyai pengambilan karbohidrat yang tidak mencukupi; 26 orang (23.6%) mempunyai pengambilan yang mencukupi; manakala 69 orang (62.7%) mengambil karbohidrat secara berlebihan. Bagi pengambilan sukrosa, 106 orang (96.4%) mempunyai pengambilan yang mencukupi, manakala 4 orang (3.6%) mengambil secara berlebihan. Skor median literasi pemakanan ialah 56 dengan julat antara kuartil sebanyak 17, menunjukkan tahap literasi pemakanan yang agak rendah dalam populasi kajian. Terdapat hubungan yang ketara antara literasi pemakanan dengan pengambilan karbohidrat ($p < 0.001$), dan antara literasi pemakanan dengan pengambilan sukrosa ($p < 0.001$). Kajian lanjut disarankan bagi memberikan pemahaman yang lebih jelas tentang pengaruh literasi

pemakanan kepada kualiti pemakanan dalam usaha penambahbaikan status pemakanan pesakit T2DM.

THE ASSOCIATION BETWEEN FOOD LITERACY WITH CARBOHYDRATE AND SUCROSE INTAKE AMONG TYPE II DIABETES PATIENTS IN HOSPITAL PAKAR UNIVERSITI SAINS MALAYSIA (HPUSM)

ABSTRACT

Dietary management is a crucial part of T2DM care. In particular, carbohydrate and sucrose intake must be carefully monitored to maintain glycaemic control and prevent complications from diabetes. This study investigates the association between food literacy with carbohydrate and sucrose intake among T2DM patients in Hospital Pakar Universiti Sains Malaysia (HPUSM). A cross-sectional study was conducted among 110 T2DM patients aged 18 to 60 years old. Data was collected using standardized questionnaires: the Eating and Food Literacy Questionnaire for Diabetics (EFLBQ-D) to assess food literacy and 3-day 24-hour diet recall to assess carbohydrate and sucrose intake. Out of 110 subjects, 15 subjects (13.6%) had inadequate carbohydrate intake; 26 subjects (23.6%) had adequate carbohydrate intake and 69 subjects (62.7%) had excess carbohydrate intake. As for sucrose intake, 106 subjects (96.4%) had adequate intake; while 4 subjects (3.6%) had excess intake. The median score for food literacy is 56 with interquartile range of 17, showing moderately low food literacy level among target population. There is significant association between food literacy with carbohydrate intake ($p < 0.001$), and between food literacy with sucrose intake ($p < 0.001$). It is suggested that more studies should be carried out to provide clearer understanding on how food literacy affects dietary behaviour to improve nutritional status among T2DM patients. Future research should focus on longitudinal studies to establish causal relationships between variables.

CHAPTER 1: INTRODUCTION

1.1 BACKGROUND OF STUDY

Diabetes is a chronic metabolic disease that involves higher blood glucose levels in the body compared to normal, which is the result of either insufficient insulin production or the body's resistance to insulin (Sapra et. al., 2023). The risk factors contributing to diabetes include overweight or obesity, sedentary lifestyle, unhealthy diet, old age, ethnicity and family history. Other risk factors include a combination of socioeconomic, environmental and healthcare-related factors (Sapra et al., 2013).

Type 1, type 2, gestational diabetes, neonatal diabetes and maturity-onset diabetes of the young (MODY) are some of the types of diabetes mellitus. Type 1 diabetes mellitus (T1DM) and Type 2 diabetes mellitus (T2DM) are two main subtypes of diabetes mellitus. While T1DM typically affects children or teenagers, T2DM is believed to impact middle-aged and older adults who have chronic hyperglycaemia as a result of unhealthy eating and lifestyle choices (Sapra et al., 2013).

According to the International Diabetes Federation (IDF), around 463 million which is 9.3% of people globally have diabetes. The prevalence of diabetes is expected to increase to 10.2% or 578 million by 2030 and further increase to 10.9% or 700 million by 2045 if no effective intervention is done. It was also found that the number of diabetic patients is higher in urban areas, which is 10.8% compared to rural areas, which is 7.2%. The study suggested that one in two people with diabetes unaware that they have this chronic disease (Saeedi et. al., 2019).

A study published in 2022 reported that in Malaysia, diabetes has a prevalence of 14.39% while prediabetes has a prevalence of 11.62%. This is higher than the prevalence of diabetes and prediabetes in neighbouring countries such as Indonesia and Singapore.

It was also found that there is significant difference in prevalence of diabetes among different ethnicities (Akhtar, 2022).

The latest National Diabetes Registry Report (2023) reported on the characteristics of enrolled patients as shown in the table below:

Table 1: Characteristics of Patients Enrolled in National Diabetes Registry, 2023

Variable	Percentage (%)
Sex	
Male	42.92
Female	57.08
Ethnicity	
Malay	60.13
Chinese	19.27
Indian	12.58
Others	8.02
Type of Diabetes	
Type 2	99.48
Type 1	0.47
Others/Unknown	0.05
Age at Diagnosis	
Mean	65
Median	65
Inter-quartile Range	16

Hence, it was shown that in Malaysia, the prevalence of diabetes is higher among females compared to males. Malays have the higher prevalence, followed by Chinese, Indians and other ethnicities. It was also shown that a majority of diabetes is Type 2 diabetes (T2DM). Most of the registered patients were diagnosed between the age of 65 to 69 years old, followed by 60 to 64 years old and 70 to 74 years age group, showing that older adults have higher prevalence of diabetes (Ministry of Health Malaysia, 2023).

In the same report, the characteristics of enrolled patients by state were also shown in table below:

Table 2: Characteristics of Patients Enrolled in National Diabetes Registry, 2023, by State

State	Percentage (%)
Johor	14.43
Kedah	8.97
Kelantan	3.68
Melaka	5.41
Negeri Sembilan	6.79
Pahang	5.32
Perak	9.81
Perlis	1.85
Pulau Pinang	5.44
Sabah	3.25
Sarawak	9.56
Selangor	16.17
Terengganu	4.14
WP Kuala Lumpur	4.38
WP Labuan	0.18
WP Putrajaya	0.63

Hence, it was shown that the prevalence of diabetes is highest in Selangor and Johor (Ministry of Health Malaysia, 2023).

The prevalence of diabetes is expected to increase due to aging populations, sedentary lifestyles and increasing prevalence of obesity. This disease may bring negative health impacts and lead to other chronic diseases such as cardiovascular diseases and kidney diseases. Hence, the aim of this study is to explore how food literacy may affect the carbohydrate and sucrose intake among T2DM patients.

1.2 PROBLEM STATEMENT

The International Diabetes Federation (IDF) Diabetes Atlas (2021) reported that 10.5% of the adult population, aged 20 to 79 years old, has diabetes. Additionally, it was reported that over 90% of people with diabetes have type 2 diabetes. Urbanization, aging populations, declining physical activity, and rising obesity rates are some of the reasons contributing to this high incidence (IDF., 2021).

To gain a deeper insight to T2DM, we must understand its pathophysiology. The two main causes that contribute to the development of (T2DM) are defective insulin production by pancreatic β-cells and the incapacity of insulin-sensitive tissues to respond to insulin (Galicia-Garcia et. al., 2020). For glucose homeostasis, insulin release and activity are important mechanisms. As the illness worsens, insulin secretion is not enough to keep glucose levels stable, which results in hyperglycaemia. The main characteristic of patients with T2DM is obesity or a higher percentage of body fat, primarily in the abdomen, also known as adipose tissue. Adipose tissue increases the release of free fatty acids (FFAs) and dysregulation of adipokines, among other inflammatory processes, which contribute to insulin resistance (Galicia-Garcia et. al., 2020). The main factors of the T2DM epidemic include obesity, sedentary lifestyles and diets high in calories.

Effective dietary management is essential for glycaemic control, especially on limiting carbohydrate and sucrose intake to prevent further complications brought by T2DM. Dietary carbohydrates are believed to have a crucial effect on managing T2DM since they primarily influence blood glucose levels. T2DM patients with increased intake of carbohydrates with high glycaemic index (GI) have poor glycaemic control (Bonsembiante et. al., 2021). As for sucrose intake, although studies show that moderate sucrose consumption may not negatively affect health, excessive intake of sucrose,

especially in high-calorie diets, can worsen blood glucose regulation and contribute to obesity, which is a key risk factor for T2DM (Brunner et. al., 2012).

However, high food literacy is required to manage good carbohydrate and sucrose intake. Vidgen et. al. (2014) stated that food literacy refers to the knowledge, skills, and behaviours needed to make informed dietary decisions, including understanding food labels, planning meals, and selecting nutritionally appropriate foods. Despite knowing the importance of diet in T2DM management, many patients struggle to maintain healthy eating patterns due to limited food literacy.

Hence, this research aims to assess the level of food literacy among T2DM patients in Hospital Pakar Universiti Sains Malaysia (HPUSM). The research findings will also provide information on the carbohydrate and sucrose intake among T2DM patients in Hospital Pakar Universiti Sains Malaysia (HPUSM). In this study, the researcher will examine how food literacy and intake of carbohydrates and sucrose by patients with T2DM at Hospital Pakar Universiti Sains Malaysia (HPUSM) are related. Understanding this relationship is crucial for planning, implementing and monitoring as well as evaluating dietary habits and behaviours of individuals with T2DM. Additionally, it can address the fundamental knowledge deficits that underlie these behaviours. Healthcare providers can create more successful health interventions to enhance the long-term health outcomes of people with T2DM by addressing this research gap.

1.3 RESEARCH QUESTIONS

The following questions are sought to be answered at the end of the study:

i. What is the food literacy score among T2DM patients in Hospital Pakar Universiti Sains Malaysia (HPUSM)?
ii. How much carbohydrate is consumed among T2DM patients in Hospital Pakar Universiti Sains Malaysia (HPUSM)?
iii. How much sucrose is consumed among T2DM patients in Hospital Pakar Universiti Sains Malaysia (HPUSM)?
iv. Is there a significant association between food literacy and carbohydrate intake among T2DM patients in Hospital Pakar Universiti Sains Malaysia (HPUSM)?
v. Is there a significant association between food literacy and sucrose intake among T2DM patients in Hospital Pakar Universiti Sains Malaysia (HPUSM)?

1.4 RESEARCH OBJECTIVES

1.4.1 GENERAL OBJECTIVE

To investigate the association between food literacy and carbohydrate and sucrose intake among T2DM patients in Hospital Pakar Universiti Sains Malaysia (HPUSM).

1.4.2 SPECIFIC OBJECTIVES

i. To determine food literacy among T2DM patients in Hospital Pakar Universiti Sains Malaysia (HPUSM).
ii. To assess carbohydrate intake among T2DM patients in Hospital Pakar Universiti Sains Malaysia (HPUSM).

iii. To assess sucrose intake among T2DM patients in Hospital Pakar Universiti Sains Malaysia (HPUSM).

iv. To determine the association between food literacy and carbohydrate intake among T2DM patients in Hospital Pakar Universiti Sains Malaysia (HPUSM).

v. To determine the association between food literacy and sucrose intake among T2DM patients in Hospital Pakar Universiti Sains Malaysia (HPUSM).

1.5 RESEARCH HYPOTHESIS

Null Hypothesis (H_0)

i. There is no association between food literacy and carbohydrate intake among T2DM patients in Hospital Pakar Universiti Sains Malaysia (HPUSM).

ii. There is no association between food literacy and sucrose intake among T2DM patients in Hospital Pakar Universiti Sains Malaysia (HPUSM).

Alternative Hypothesis (H_A)

i. There is an association between food literacy and carbohydrate intake among T2DM patients in Hospital Pakar Universiti Sains Malaysia (HPUSM).

ii. There is an association between food literacy and sucrose intake among T2DM patients in Hospital Pakar Universiti Sains Malaysia (HPUSM).

1.6 CONCEPTUAL FRAMEWORK

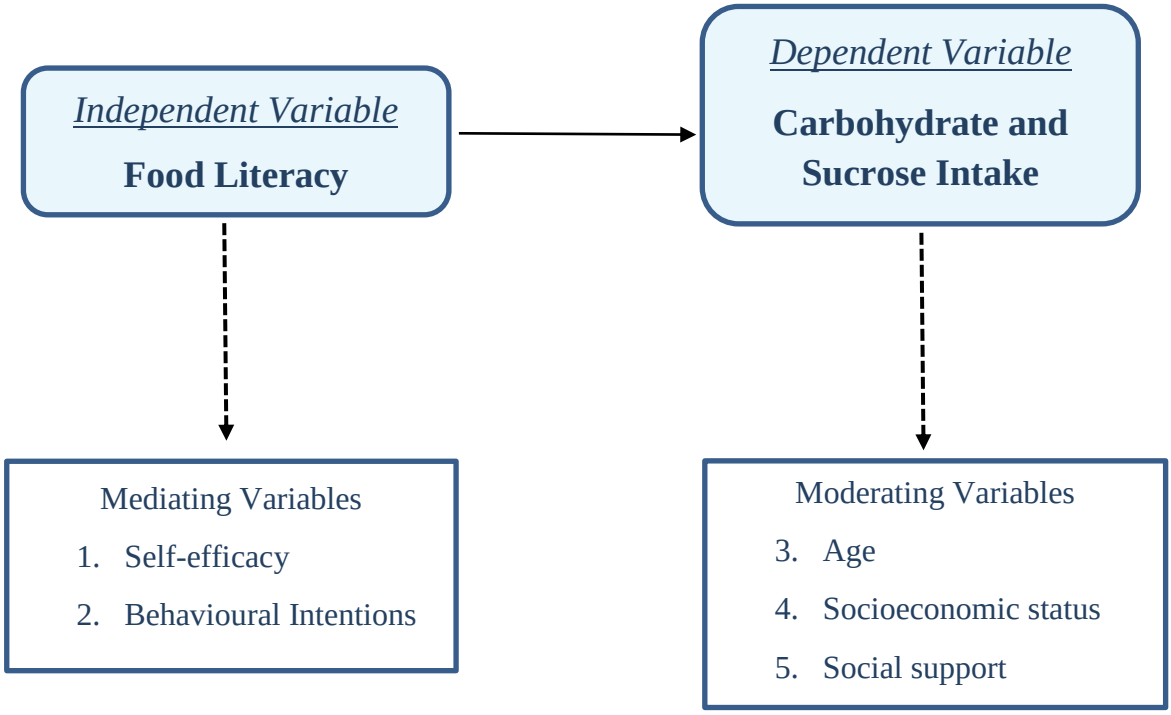

Figure 1: Conceptual Framework of Cause and Effect related to Food Literacy and Carbohydrate and Sucrose Intake.

This conceptual framework illustrates the relationship between food literacy with carbohydrate and sucrose intake which are influenced by several mediating and moderating variables. It is important to understand the role of food literacy among T2DM patients for better health improvement.

Studies have shown that there is a positive association between food literacy and dietary intake (Vaitkeviciute et. al., 2015). This means that individuals who prepare food more frequently and possess a higher understanding of food have healthier eating habits. On the other hand, individuals who seldom participate in food preparation and possess a lower level of nutritional knowledge may have undesirable eating habits. Therefore, food literacy influences dietary choices, including carbohydrate and sucrose intake, which impacts blood glucose control and diabetes outcomes.

In addition, there are mediating and moderating variables that may influence the study's outcome. In this study, mediating variables, such as self-efficacy and behavioural intentions, explain how food literacy influences carbohydrate and sucrose intake. Self-efficacy refers to an individual's belief in their ability to perform specific actions, such as managing carbohydrate and sucrose intake effectively while behavioural intentions refer to the motivational factors that drive individuals toward action.

Moderating variables include sociodemographic factors such as age and socioeconomic status (SES) and social support. For example, individuals with lower income, also known as low socioeconomic status, may find it challenging to act on food literacy due to limited access to healthy food options, despite understanding their importance. A study done in 2021 has shown that there is an association between SES and dietary intake. It was found that while consumption of fruits, vegetables, whole grains, and fibre increased with SES, those with lower SES reported consuming less dairy and nuts and seeds. It was also found that overweight and abdominal obesity were more common among women in low SES than women in middle and high SES (Gómez, 2021).

CHAPTER 2: LITERATURE REVIEW

2.1 PREVALENCE OF TYPE II DIABETES MELLITUS

Type 2 diabetes mellitus, T2DM, with its rising prevalence rates that pose significant challenges to healthcare systems, is a major public health concern. International Diabetes Federation stated that approximately 537 million adults aged 20–79 years are living with diabetes worldwide, and this number is expected to rise to 783 million by 2045 (IDF, 2023). Over 90% of these cases are T2DM, which is closely linked to modifiable lifestyle factors such as diet, physical activity, and obesity (IDF, 2023).

In Malaysia, the prevalence of diabetes has increased dramatically over the past few decades. The National Health and Morbidity Survey (NHMS) reported that there were 18.3% of adults aged 18 years and above, which is around 3.9 million, living with diabetes in 2019, compared to 11.6% in 2006. Additionally, a significant proportion of these individuals remain undiagnosed.

A study published in 2022 reported that in Malaysia, diabetes has a prevalence of 14.39% while prediabetes has a prevalence of 11.62%. This is higher than the prevalence of diabetes and prediabetes in neighbouring countries such as Indonesia and Singapore. By ethnicity, it was found that Indians have the highest prevalence of diabetes at 25.10%, followed by Malays at 15.25%, Chinese at 12.87%, Bumiputeras at 8.62% and lastly others at 6.91% (Akhtar, 2022). In a study done to investigate the diabetes control trends among T2DM in Kelantan, it was found that the prevalence of diabetes had increased from 11.3% in 2015 to 19.5% in 2019 (Nazmi et. al., 2023)

World Health Organization (WHO) had estimated that Malaysia's overall number of diabetes would rise from 0.94 million in 2000 to 2.48 million in 2030, which is a 164% increase (Mafauzy, 2006). This rising prevalence shows the importance of understanding

the factors influencing dietary behaviours, particularly carbohydrate and sucrose intake, among T2DM patients.

2.2 FOOD LITERACY

The term “food literacy” is first derived from health literacy. According to Nutbeam (2008), health literacy is the "cognitive and social skills that determine the ability to access, understand, and use information to promote and maintain individual health." Food literacy refers to the knowledge, skills, and behaviours needed to make informed dietary decisions, including understanding food labels, planning meals, and selecting nutritionally appropriate foods (Vidgen & Gallegos, 2014). It was mentioned that food security, social connectedness, nutrition behaviours, and diet quality are all thought to be enhanced by food literacy. The most often mentioned framework is the definition and conceptualization by Vidgen and Gallegos (2014), which consists of 11 theoretical components within the 4 domains of planning and organizing, selecting, preparing, and eating (Thompson et. al., 2022).

In recent years, studies are done to develop and validate as well as evaluate validity and reliability for food literacy instruments to comprehensively assess level of food literacy. Thus, food literacy is increasingly recognized as a fundamental determinant of dietary behaviours and, by extension, health outcomes, particularly in managing chronic diseases such as T2DM.

In a study, Downs et. al. (2008) stated that in the context of modern food environment, food literacy played a crucial role in shaping an individual’s dietary habits and patterns as well as defining food environment as the relationship between consumers and the food system, which included food availability, cost, convenience, and desirability. Modern food environment can be characterized by processed foods, marketing of high-

calorie, nutrient-poor products, and complex labelling systems that can confuse consumers. An adequate level of food literacy can assist an individual in resisting unhealthy food marketing and identify and select healthier alternatives. For example, many processed foods contain hidden sugars or misleading health claims, which can lead to the overconsumption of sucrose and other refined carbohydrates (Morenga et al., 2013).

Despite the importance of food literacy, many individuals, especially those in low socioeconomic status, face challenges in achieving higher levels of food literacy. These challenges including limited education and limited access to healthy food choices. For example, those in higher socioeconomic status has higher consumption of fruits, vegetables, whole grains, and fibre while those in lower socioeconomic status consume less dairy and nuts and seeds (Gómez, 2021). Hence, educational programmes that promotes nutritional knowledge should be widely spread to increase nutritional awareness.

2.3 CARBOHYDRATE INTAKE AMONG T2DM PATIENTS

Diet plays a crucial role in chronic diseases such as T2DM. For decades, T2DM patients have been advised to limit their carbohydrate (CHO) intake and spread the total dietary carbohydrate throughout the day to manage both glucose and insulin levels in the body to avoid further health complications. This is because dietary carbohydrate is an important macronutrient that can influence blood glucose and insulin levels (Meyer et. al., 2000).

The term “Glycaemic Index (GI)” was introduced for the purpose of classifying foods according to their physiological effect on blood glucose levels (Wolever, 2008). It is a useful parameter to aid in understanding the metabolic effect of CHO-containing

foods. GI compares the blood glucose response to 50g of CHO present in food. Food with lower glycaemic index is absorbed more slowly and causes less elevation in blood glucose and insulin levels (Evert, 2014). Thus, T2DM patients are advised to consume food with low glycaemic index.

There were several attempts to identify the optimal macronutrient distribution for diabetic patients. In 2012, a study stated that the energy distribution from a diabetic diet should be 45% CHO, <30% fat and 10-20% protein. In 2019, the American Diabetes Association states that diabetic patients should consume 45-60% CHO, 20-35% fat and 15-20% protein of total energy intake per day (ADA, 2019).

In this research study, the Medical Nutrition Therapy Guidelines for Type 2 Diabetes Mellitus will be used to assess the carbohydrate intake among T2DM patients. It is recommended that individuals with diabetes should consume CHO between 45-60% of total energy intake per day (Malaysian Dietitians' Association, 2013). Thus, an intake of 45% to 60% of carbohydrate of total energy intake per day is considered adequate. On the other hand, carbohydrate intake of less than 45% of total daily energy intake is considered inadequate while carbohydrate intake of more than 60% of total daily energy intake is considered excess.

2.4 SUCROSE INTAKE AMONG T2DM PATIENTS

Throughout the years, T2DM patients are advised to limit sugar intake to reduce sucrose consumption which can worsen complications of T2DM. A number of studies have reported the associations between sugar intake and diabetes. For example, a systematic review and meta-analysis reported that higher habitual consumption of sugar sweetened beverages was associated with a greater incidence of T2DM (Imamura et. al., 2015).

Although some studies state that moderate amount of sucrose taken daily at mealtimes is acceptable for diabetic patients following a diabetic diet, T2DM patients should still avoid consuming sucrose in excess to avoid excess energy intake since positive energy balance is one of the major risk factors of T2DM (Veit et. al., 2022).

World Health Organisation (WHO) strongly recommends reducing intake of free sugars to less than 10% of total energy intake. It should be noted that there are free sugars added to foods and beverages by the manufacturers (WHO, 2015). Additionally, Dietary Guidelines for Chinese Residents (2022) recommended that diabetic patients should control their daily added sugar intake to no more than 50g, and preferably less than 25g (Liu, 2023).

In this research study, the Medical Nutrition Therapy Guidelines for Type 2 Diabetes Mellitus will be used to assess the sucrose intake among T2DM patients. It is recommended that individuals with diabetes may consume sucrose between 10-20% of total energy intake per day as part of the total CHO allowance (Malaysian Dietitians' Association, 2013). Thus, an intake of 10% to 20% of sucrose of total energy intake per day is considered adequate. On the other hand, sucrose intake of more than 20% of total daily energy intake is considered excess.

2.5 ASSOCIATION BETWEEN FOOD LITERACY WITH CARBOHYDRATE AND SUCROSE INTAKE

Due to the rise in poor eating habits, the prevalence of chronic diseases such as T2DM is also steadily increasing over the years. As such, dietary practices, habits and patterns have a significant effect on an individual’s health (Schulze, 2018). In recent years, people have gained more interest in making good nutritional and dietary choices for better health (Perignon, 2017). Since the types of diet for an individual vary according

to their environment, culture and religious beliefs, socioeconomic factors and personal preferences, the ability to identify and make informed choices on food for better health is important. In order to make nutritionally informed choices on diet, people need the knowledge, skills, and behaviours needed to make informed dietary decisions (Truman, 2017). Hence, "food literacy" has been actively discussed.

According to Vidgen and Gallegos (2014), food literacy is the knowledge, skills, and behaviours needed to make informed dietary decisions, which involves planning and organizing, selecting, preparing, and eating. For T2DM patients, food literacy is important to regulate and control daily dietary carbohydrate and sucrose intake to maintain normal blood sugar and insulin level (Riccardi, 2021). Although research specifically exploring the association between food literacy and carbohydrate or sucrose intake among T2DM patients remains limited, several studies provide relevant insights on this topic.

A study done in 2020 showed a positive and significant relationship between nutrition literacy and food habits among adolescents (Koca et. al., 2020). In this study, the study participants were found to be at a good level of nutrition literacy, which means they had sufficient nutritional knowledge and are able to obtain, process, analyse and use enough information to make good food decisions (Beşparmak et. al., 2023). Other studies, however, stated that adolescents have moderate nutrition literacy, which was below expected level (Ayer et. al., 2021). Both studies agreed that food literacy should be promoted and increased through education for development of healthy dietary behaviours.

In 2021, a food survey was done to evaluate food literacy among adults who are 18 years old and above. This study concluded that higher food literacy level was

associated with better dietary choices, including better carbohydrate consumption among adults (Lee, 2023). Another study was conducted to assess food literacy among adults. This study focused on nutrition knowledge, food preparation skills and eating behaviours. This study showed that higher level of food literacy may contribute to better dietary choices, which indirectly influence carbohydrate consumption by encouraging selection of minimally processed foods instead of sugary carbohydrates (Murakami et. al., 2023).

Additionally, a scoping review of food literacy interventions has found that higher food literacy can reduce sugar consumption, and consequently sucrose intake, among adults (O'Brien et. al., 2024). Other studies also concluded that health literacy, which includes food literacy, had a positive impact on glycaemic control and improved self-management behaviours among T2DM patients (Butayeva et. al., 2023).

Furthermore, studies have shown that food literacy is a fundamental concept in management of chronic diseases such as T2DM (Cullen et. al., 2015). It is important that T2DM patients has the ability to develop knowledge and skills in food management to maintain blood sugar levels at an optimum level. Hence, educational interventions for promoting food literacy among T2DM patients were done to prevent complications of this chronic disease (Savarese et. al., 2021).

2.6 FOOD LITERACY ASSESSMENT METHOD

A valid and reliable food literacy assessment method is needed to assess and monitor food literacy among individuals, communities and populations, to increase understanding of the relationship between food literacy and dietary intake and to plan and evaluate interventions done to improve food literacy (Fingland et. al., 2021). However, studies have highlighted the complexity of developing a food literacy survey due to inconsistent understanding of the term “food literacy” (Fingland et. al., 2021). Thus,

many research were done to develop and validate food literacy instruments specific for certain groups of individuals, communities and populations.

In 2018, the first validated questionnaire that assesses food literacy among the adult population, which is the Swiss Short Food Literacy Questionnaire (SFLQ) was developed based on a nutrition-specific health literacy framework (Gréa Krause et. al., 2018). The questionnaire consists of 12 items. In the research, it was found that there is a positive association between food literacy and knowledge of recommended salt intake among adults. In 2022, a research study was conducted to revisit the definition of food literacy and to develop a food literacy measurement tool for adults. In the end of this research study, a food literacy measurement tool consisting of 14 questions in the nutrition and safety domain, 8 questions in the cultural and relational domain, and 11 questions in the socio-ecological domain was developed (Yoo et. al., 2022). Furthermore, a 25-item food literacy measurement tool was also developed to identify vulnerable groups based on the scores for each factor of this measurement tool. This study proposed a food literacy that reflects the food system as well as concepts in previous literatures (Park et. al., 2020).

As for age-specific populations, food literacy measurement tools were also developed and adapted for children. A study was conducted to develop and validate the Food and Nutrition Literacy Questionnaire for Chinese School-age Children (FNLQ-SC). This questionnaire consists of 19 core components, including food and nutrition knowledge and understanding, ability of access, selection, preparing food and healthy eating (Liu et. al., 2021).

Food literacy assessment is crucial among patients with chronic diseases to ensure they have adequate dietary knowledge and skills to maintain health. Recently, in 2024, a

study was conducted to develop and validate a food literacy instrument specific to individuals with T2DM. Six statements remaining after exploratory factor analysis testing were added to an existing food literacy questionnaire called the Eating and Food Literacy Behaviours Questionnaire (EFLBQ) to develop The Eating and Food Literacy Questionnaire for Diabetics (EFLBQ-D). The new questionnaire consists of two new factors each with three statements, which are carbohydrate counting and nutrition label reading and healthy food preparation methods. It was concluded that the EFLBQ-D is a valid and reliable measurement tool to assess food behaviours and food literacy skills of T2DM patients (Ludwig et. al., 2024).

The development and validation of these food literacy assessment tools is crucial for interventions in promoting nutritional knowledge, management of chronic diseases and supporting research.

2.7 DIETARY ASSESSMENT METHOD

In nutrition assessment, dietary assessment is done to evaluate an individual's dietary intake. It is a difficult and challenging process as it may subject to random and systematic measurement errors. Food records, food frequency questionnaires, 24-hour recalls, and screening tools are examples of traditional dietary assessment methods (Bailey et. al., 2021). Nowadays, digital versions of these dietary assessment methods are also available. Accurate dietary assessments are very important in order to plan, implement and monitor dietary interventions (Natarajan et. al., 2004). Thus, many research studies are done to compare and evaluate the strengths and limitations of each dietary assessment method.

Weighed food record, often referred to as the "gold standard" of individual quantitative dietary assessment methods, has the highest accuracy and reliability

compared to other dietary assessment methods (Carlsen et. al., 2010). This is because weighed food records do not rely on the respondent's memory or ability to estimate portion sizes (Ishii et. al., 2017). Hence, weighed food record is often used in studies to compare with other dietary assessment methods. A study on dietary assessment methods was done to compare weighed food record with 24-hour diet recall, food frequency questionnaire (FFQ) and estimated diet record. This study had concluded that FFQ may not be able to accurately portray the individual's normal diet due to inaccuracy in the estimation of frequency of food consumption. It was also found that 24-hour diet recall, which is an open-ended questionnaire, produced results that are closely associated with the values obtained from the weighed food record (Arsenault et. al., 2020).

Dietary assessment methods are useful in assessing and evaluating dietary intakes among T2DM patients for monitoring and maintaining optimum blood sugar levels. A systematic scoping review has revealed that the most common dietary assessment method used for dietary assessment among T2DM patients is the 24-hour dietary recall (Uzokwe et. al., 2022). The most commonly used dietary assessment methods in large-scale population-based studies, such as national nutrition surveys, are FFQ and 24-hour diet recall (Karavasiloglou et. al., 2022). 24-hour diet recall is beneficial in dietary assessment due to its low respondent burden, ability to compile detailed dietary information and flexibility. In a study that aims to determine the number of 24-hour diet recall needed to estimate energy intake, it was found that three 24-hour diet recalls are the optimal choice for higher accuracy (Ma et. al., 2009).

CHAPTER 3: METHODOLOGY

3.1 STUDY DESIGN

A cross-sectional study design was used to investigate the association between food literacy and carbohydrate and sucrose intake among T2DM patients in Hospital Pakar Universiti Sains Malaysia (HPUSM), Kubang Kerian, Kelantan. This study design allowed the researcher to gather, summarize, present, and interpret information appropriately. A survey in the form of questionnaires with standardized questions was used to determine the patients' food literacy and to evaluate their carbohydrate and sucrose intake. Cross-sectional study design was chosen due to its ability to provide a snapshot of population characteristics at a specific point in time, allowing for efficient assessment of associations between multiple variables, which can lead to further research or intervention development. Additionally, cross-sectional studies are relatively time-effective, cost-effective and simple in execution.

3.2 STUDY AREA

This study was carried out in Hospital Pakar Universiti Sains Malaysia (Hospital USM), Kubang Kerian, Kelantan. This location was chosen because it was the ideal place to conduct clinical research and the most suitable location for data collection among T2DM patients. The specific locations chosen were Klinik Rawatan Keluarga (KRK), Klinik Pakar Perubatan (KPP), and Dietetics Outpatient Clinic in Hospital Pakar Universiti Sains Malaysia (HPUSM).

3.3 STUDY POPULATION

- Reference population

Type 2 diabetes mellitus patients in Hospital Pakar Universiti Sains Malaysia (HPUSM), Kubang Kerian, Kelantan were chosen from outpatient clinics.

- Target population

Type 2 diabetes mellitus patients in the outpatient clinic setting in Hospital Pakar Universiti Sains Malaysia (HPUSM).

- Source population

Type 2 diabetes mellitus patients who visited outpatient clinic in Hospital Pakar Universiti Sains Malaysia (HPUSM).

- Sampling frame

Registration list for T2DM patients in outpatient clinic and in Hospital Pakar Universiti Sains Malaysia (HPUSM), Kubang Kerian, Kelantan.

3.4 SUBJECT CRITERIA

3.4.1 INCLUSION CRITERIA

i. Male and female adults aged 18 to 60 years old diagnosed with T2DM.
ii. T2DM patients in outpatient setting in HUSM.
iii. Able to understand and speak Bahasa Melayu and/or English.

3.4.2 EXCLUSION CRITERIA

i. Individuals diagnosed with other types of diabetes.
ii. Patients with severe gastrointestinal diseases.
iii. Patients with cognitive disorders or mental health issues.
iv. Pregnant or lactating women.
v. Patients with serious hearing or vision problems.

3.5 SAMPLE SIZE ESTIMATION

Sample size is calculated based on three specific objectives.

One proportion sample size formula was used to determine the required sample size of the population. In this study, a confidence interval of 95% will be set with a Z-score value of 1.96 and the precision rate will be set at 10%.:

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

n = sample size

Z= value representing desired confidence level

Δ = precision

p = anticipated population proportion

3.5.1 SAMPLE SIZE FOR FIRST SPECIFIC OBJECTIVE

The first objective was to determine food literacy among T2DM patients in Hospital Pakar Universiti Sains Malaysia (HPUSM). According to Abdullah et. al. (2020), 279 out of 427 T2DM patients in Perak, Malaysia was found to have limited health literacy which is equivalent to 65.3%. This means that 34.7% of the patients has adequate health literacy. Thus, the anticipated population proportion was 0.347.

$$n = \left[\frac{1.96}{0.1}\right]^2 0.347(1-0.347)$$

= 87 participants

To account for potential dropouts, extra participants were required to join in the study. Hence, a 20% dropout rate is applied to the sample size.

n = 87 + (87 x 20%)

= 87 + 17

= 104 participants

3.5.2 SAMPLE SIZE FOR SECOND SPECIFIC OBJECTIVE

The second objective was to assess carbohydrate intake among T2DM patients in Hospital Pakar Universiti Sains Malaysia (HPUSM). According to Md Isa et. al. (2023), 60.7% of T2DM Malaysian patients have appropriate dietary carbohydrate intake. Thus, the anticipated population proportion was 0.607.

$$n = \left[\frac{1.96}{0.1}\right]^2 0.607(1 - 0.607)$$

= 92 participants

To account for potential dropouts, extra participants were required to join in the study. Hence, a 20% dropout rate was applied to the sample size.

n = 92 + (92 x 20%)

= 92 + 18

= 110 participants

3.5.3 SAMPLE SIZE FOR THIRD SPECIFIC OBJECTIVE

The third objective was to assess sucrose intake among T2DM patients in Hospital Pakar Universiti Sains Malaysia (HPUSM). According to Tseng et. al. (2021), 16% of adults with diabetes consume sugar-sweetened beverages at least once a day. This meant that 84% of the population has more appropriate sugar intake. Thus, the anticipated population proportion was 0.84.

$$n = \left[\frac{1.96}{0.1}\right]^2 0.840(1 - 0.840)$$

= 52 participants

To account for potential dropouts, extra participants were required to join in the study. Hence, a 20% dropout rate was applied to the sample size.

$$n = 52 + (52 \times 20\%)$$

$$= 60 + 10$$

$$= 70 \text{ participants}$$

The sample size of this study was calculated according to three specific objectives. This adjustment was done to ensure that the sample adequately represents the target population. The calculated sample size was104 participants for specific objective 1, 110 participants for specific objective 2 and 70 participants for specific objective 3. Thus, the highest value, which is **110 participants**, was chosen for this study.

3.6 SAMPLING METHOD

The sampling method used in this research was convenience sampling. Participants who met the inclusion criteria were chosen for this study. However, all subjects were recruited voluntarily, and an informed consent was obtained from all participants prior to their recruitment to the study. The researcher determined the eligibility of the subjects with their sociodemographic data. Convenience sampling was cost effective and allowed for easier access to participants who met the inclusion criteria. It also reduced logistical challenges and ensures a more practical data collection process. Although convenience sampling method had some limitations, such as potential bias or limited generalizability, it was still a valuable approach for exploratory studies especially due to time and resources constraint.