UNIVERSITI PUTRA MALAYSIA

FACTORS ASSOCIATED WITH THE RISK OF DEVELOPING TYPE 2 DIABETES MELLITUS AMONG MALAYSIAN STUDENTS IN A PUBLIC UNIVERSITY

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2021/2022

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BY

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A project submitted as a partial fulfilment of the requirement for the degree of Bachelor of Science in Dietetics with Honours from the Faculty of Medicine and Health Sciences, Universiti Putra Malaysia

This project entitled “Factors associated with the risk of developing type 2 diabetes mellitus among Malaysian students in a public university.” was prepared by Nur Fatiah Abdul Khalid and submitted to the Faculty of Medicine and Health Sciences as partial fulfilment of the requirement for the degree of Bachelor of Science (Dietetics) from the Faculty of Medicine and Health Sciences, Universiti Putra Malaysia.

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Date: 12 September 2022

ACKNOWLEDGEMENT

First and foremost, I would like to convey my deepest gratitude to my bachelor dissertation's supervisor, Assoc. Prof. Dr. Barakatun Nisak and my co-supervisor, Chiang Wan Ling for giving me the opportunity to do research and providing guidance throughout the whole research process. Dr Nisak and Chiang Wan Ling spent their precious time to guide me to conduct the research and thesis writing. In addition, I want to express my gratitude to Dr. Syafiqah Binti Rahmat, our course coordinator for DTK 4959A and DTK 4959B, for all her work in organizing and directing us during this project.

I am very thankful to all my friends who volunteer to help me to spread the questionnaire through the online platform for my data collection and for the participants who voluntarily participated in this study. Without them, my research project would not have been possible.

I also like to express my gratitude to family, and friends and not to forget my cats for always giving me the infinite amount of support, encouragement, and patience that I needed throughout my final year project.

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ABSTRACT

FACTORS ASSOCIATED WITH THE RISK OF DEVELOPING TYPE 2 DIABETES MELLITUS AMONG MALAYSIAN STUDENTS IN A PUBLIC UNIVERSITY

NUR FATIAH BINTI ABDUL KHALID

Diabetes has become a serious public health concern worldwide, and it is now increasingly frequent in medical settings. However, despite multiple studies done on the topic of type 2 diabetes (T2DM), some of the factors associated with it were contradictory. Thus, this cross-sectional study aimed to determine the prevalence of risk of developing T2DM among university students from a selected public university. Participants were recruited using a convenience sampling method from the Faculty of Medicine and Health Sciences, Faculty of Engineering, Faculty of Science, Faculty of Food Science and Technology, Faculty of Educational Studies, Faculty of Veterinary Medicine, Faculty of Agriculture, and Faculty of Modern Language and Communication, University Putra Malaysia. A self-administered questionnaire was collected from the participants using an online platform (Google Form). The Modified Finnish Diabetes Risk Score (FINDRISC) questionnaire was used to assess the risk of developing T2DM, and the International Physical Activity Questionnaire (IPAQ) was used to classify the physical activity level of the participants. The eating behaviour was assessed using the Dutch Eating Behaviour Questionnaire (DEBQ). There was a significant association of the Body Mass Index (BMI) category (x^2= 50.057,p<0.001), and waist circumference (x^2= 44.572,p<0.001) with the risk of developing T2DM. There was no significant difference between age (t = -0.876, p=0.168) according to the risk of developing T2DM. There were no significant association between sex (x^2= 0.330,p= 0.566), ethnic (x^2= 0.020,p= 0.887), faculty (x^2= 2.127,p= 0.145), income (x^2= 0.271,p= 0.602), family history (x^2= 3.341,p= 0.068), and physical activity level (x^2= 1.588,p= 0.452) and eating behaviour with the risk of developing T2DM. Thus, more research with larger sample size is needed to properly determine the factors associated with the risk of developing T2DM.

ABSTRAK

FAKTOR - FAKTOR YANG BERKAITAN DENGAN RISIKO PEMBANGUNAN DIABETES MELLITUS JENIS 2 DALAM KALANGAN PELAJAR MALAYSIA DI UNIVERSITI AWAM

NUR FATIAH BINTI ABDUL KHALID

Diabetes telah menjadi kebimbangan kesihatan awam yang serius di seluruh dunia, dan kini semakin kerap berlaku dalam dunia perubatan. Walau bagaimanapun, beberapa kajian telah dibuat mengenai topik diabetes jenis 2 (T2DM), beberapa faktor yang berkaitan dengannya adalah bercanggah. Justeru, kajian keratan rentas ini bertujuan untuk menentukan kelaziman risiko menghidapi T2DM dalam kalangan pelajar universiti di university awam. Peserta menyertai kajian ini menggunakan kaedah persampelan mudah daripada Fakulti Perubatan dan Sains Kesihatan, Fakulti Kejuruteraan, Fakulti Sains, Fakulti Sains dan Teknologi Makanan, Fakulti Pengajian Pendidikan, Fakulti Perubatan Veterinar, Fakulti Pertanian, dan Fakulti Moden. Bahasa dan Komunikasi, Universiti Putra Malaysia. Soal selidik yang dijawab sendiri telah dikumpulkan daripada peserta menggunakan platform dalam talian (*Google Form*). Soal selidik *The Modified Finnish Diabetes Risk Score (FINDRISC)* digunakan untuk menilai risiko menghidapi T2DM dan *International Physical Activity Questionnaire (IPAQ)* digunakan untuk mengklasifikasikan tahap aktiviti fizikal peserta. Tingkah laku makan dinilai dengan *Dutch Eating Behaviour Questionnaire* (DEBQ*)*. Terdapat perkaitan yang signifikan antara kategori Indeks Jisim Badan (BMI) (x^2= 50.057, p<0.001), lilitan pinggang (x^2= 44.572, p<0.001) dengan risiko menghadapi T2DM. Tiada perbezaan yang signifikan antara umur (t = -0.876, p=0.168). Tiada perkaitan yang signifikan antara jantina (x^2= 0.330, p= 0.566), etnik (x^2= 0.020, p= 0.887), fakulti (x^2= 2.127, p= 0.145), pendapatan (x^2= 0.271, p= 0.602), sejarah keluarga (x^2= 3.341, p= 0.068), dan tahap aktiviti fizikal (x^2= 1.588, p= 0.452) dan tingkah laku makan dengan risiko menghidapi T2DM. Oleh itu, lebih banyak penyelidikan dengan saiz sampel yang lebih besar diperlukan untuk menentukan dengan betul faktor-faktor yang berkaitan dengan risiko menghidapiT2DM.

CHAPTER 1

INTRODUCTION

1.1 Background

For the past few years, diabetes has become a major health threat around the world and it has become very common in a medical setting (Oo et al., 2020). A study showed that diabetes has become one of the pandemics around the world. According to International Diabetes Federation (IDF), In 2019, around 463 million adults aged 20 to 79 had diabetes, with estimates that this figure will climb to 700 million by 2045 (IDF, 2019). Diabetes mellitus is a metabolic condition caused by insufficient or inadequate insulin secretion, as well as insulin action on both sides (World Health Organization [WHO], 2016). Insulin is a hormone generated by the pancreas that allows glucose to move from the bloodstream to the cells, allowing them to make energy (IDF, 2020).

There are several types of diabetes, which are Type 1 diabetes (T1DM), Type 2 diabetes (T2DM), Gestational diabetes (GDM), and others. But the most common diabetes is T2DM. A study by The International Diabetes Federation (IDF) showed that T2DM is more frequent in adults, accounting for almost 90% of all diabetes cases (IDF, 2020). The incidence of T2DM has rapidly increased around the world over the past 20-30 years due to changes in lifestyle poor eating habits and a lack of physical exercise (Gazzaz, 2020). The development of T2DM is associated with a sedentary lifestyle, overweight, central obesity, hypertension, unhealthy diet, Age, and family history (Lima et al., 2014). Most of these factors can be modified to reduce the incidence of T2DM (IDF, 2017).

Young adults are vulnerable and susceptible to developing T2DM as they have the freedom to make their own decision regarding their food intake and lifestyle (Amankwah-Poku, 2019). A study showed that most university students went through a lifestyle phase, specifically, eating behaviour that raises the risk of T2DM and other chronic disorders (Lima et al., 2014). The study also revealed that the most common risk factor for T2DM in university students is sedentariness which is higher among women (university students) with a percentage of 77.6% and in students with the age range of 20 to 24 years with a percentage of 71.3% (Lima et al., 2014). Thus, it is important to evaluate the T2DM risk in young adults, to detect pre-diabetes and stop the progression of T2DM.

Studies about the risk of T2DM and its associated factors among Malaysian young adults, particularly university students are warranted to screen for early detection of undiagnosed diabetes and pre-diabetes, which then prevent the rapid rise in the prevalence of T2DM among Malaysians.

1.2 Problem Statement

National Health and Morbidity Survey 2019 showed that diabetes cases among Malaysian adults increased from 11.2% in 2011 to 13.4% in 2015 (Health,2019). Diabetes mellitus is one of Malaysia's top 10 causes of mortality with 2,197 deaths. In Malaysia, the risk of developing diabetes and its associated risk factors among young adults were not well-established. A study in Ghana showed that the risk of developing diabetes in university students is high due to changes in their lifestyle as they have the freedom to make choices for their food intake and lifestyle (Amankwah-Poku, 2019). Sedentariness, overweight, central obesity, high fasting plasma glucose, and arterial hypertension are all common risk factors for T2DM among university students in Brazil (Lima et al., 2014). Moreover, a study conducted at a university in Jeddah, Saudi Arabia found that half of the study participants had poor knowledge scores regarding the basic knowledge of the Diabetes (Gazzaz, 2020). Therefore, the risk of T2DM and its related risk factors among university students must be determined.

1.3 Significance of the study

The study aims to determine the risk of T2DM among university students in Universiti Putra Malaysia (UPM). The findings of this study would fill a gap in existing research in terms of variables linked with the risk of T2DM among university students in UPM, specifically socio-demographic characteristics, socio-medical factors, physical activity, and eating behaviour. This study would become a reference for other risks of developing T2DM research in the future as it will contribute to the body of knowledge regarding the socio-demographic, socio-medical, physical activity, eating behaviour, and risk of developing T2DM among university students in UPM. This study may provide further knowledge for policymakers and health care professionals in developing interventions to lower the chances of getting T2DM among university students.

1.4 Research question

1. What is the risk of type 2 diabetes among university students at UPM?
2. Is there any differences in socio-demographic factors, socio-medical factors, physical activity level, and eating behaviour according to the risk of developing type 2 diabetes mellitus among university students in UPM?

1.5 Objectives

1.5.1 General Objective

To assess the factors associated with the risk of developing type 2 diabetes mellitus among Malaysian students in a selected public university

1.5.2 Specific Objective

- To assess the socio-demographic factors, socio-medical factors, physical activity level, and eating behaviour among university students at UPM.
- To determine the diabetes risk among university students in UPM.
- To determine the differences in socio-demographic factors, nutritional status, physical activity level, and eating behaviour according to diabetes risk among university students in UPM.

1.6 Hypothesis

There are significant associations between socio-demographic factors, socio-medical factors, physical activity level, and eating behaviour with the risk of developing type 2 diabetes mellitus among university students in UPM.

1.7 Conceptual Framework

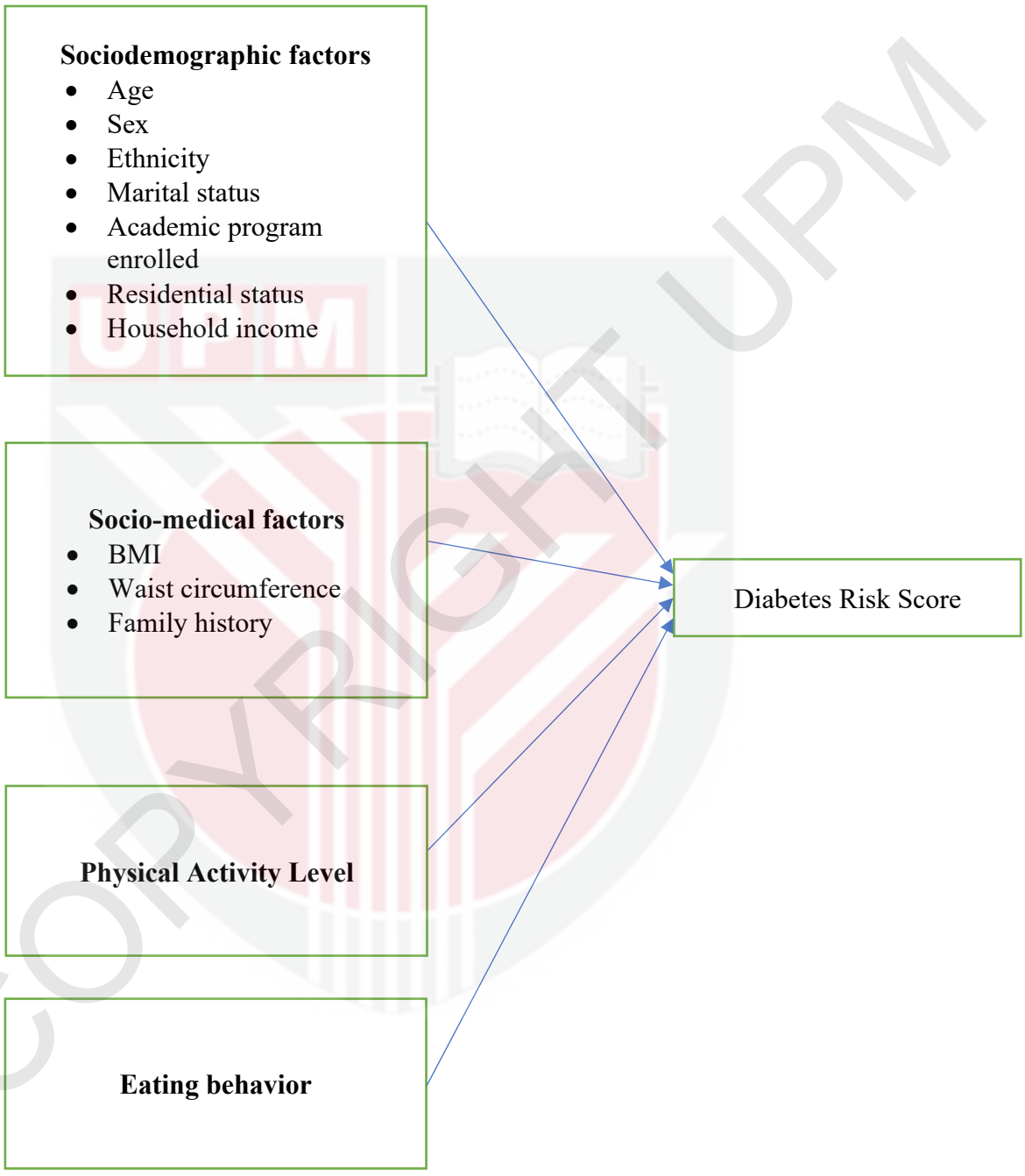

Figure 1.1: Conceptual Framework

CHAPTER 2

LITERATURE REVIEW

2.1 Overview of Type 2 diabetes mellitus

Diabetes is one of the progressive, chronic diseases that is characterized by hyperglycemia, which is a high blood glucose level, and over time leads to serious damage to a blood vessel, heart, eyes, nerves, and kidneys (Fowler, MJ, 2008). Insulin-dependent diabetes or Type 1 diabetes (T1DM) is a type of diabetes in which the pancreas produces little or no insulin. Type 2 diabetes (T2DM) is the most common type of diabetes where insulin resistance occurs, and the pancreas could not produce sufficient insulin (WHO,2021).

According to studies, T2DM is on the rise all around the world for the past 20-30 years due to the changes in lifestyle such as unhealthy diets and lack of physical activity (Gazzaz, 2020). Meanwhile, in Malaysia, about 3.9 million population aged 18 years and above are diabetic (Health, 2019). The increasing trend of both diagnosed and undiagnosed diabetes in Malaysia showed an alarming sign. The study showed that the prevalence of undiagnosed diabetes in Malaysia keeps increasing from 4% (2011) to 8.9%(2019) (Health, 2019), as shown in Figure 2.1. Moreover, the prevalence of undiagnosed diabetes (5.3%) is higher compared to the prevalence of diagnosed diabetes (0.6%) among the age group of 18-29 in Figure 2.2 (Health, 2019). Hence, it is important to explore the diabetes risk among Malaysian adults of this age group.

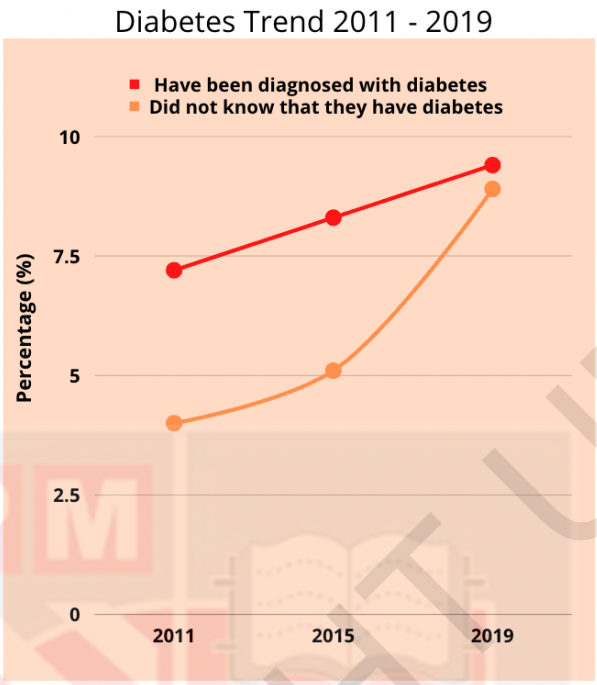

Figure 2.1: Diabetes Trend 2011 – 2019 (Source: NHMS 2019)

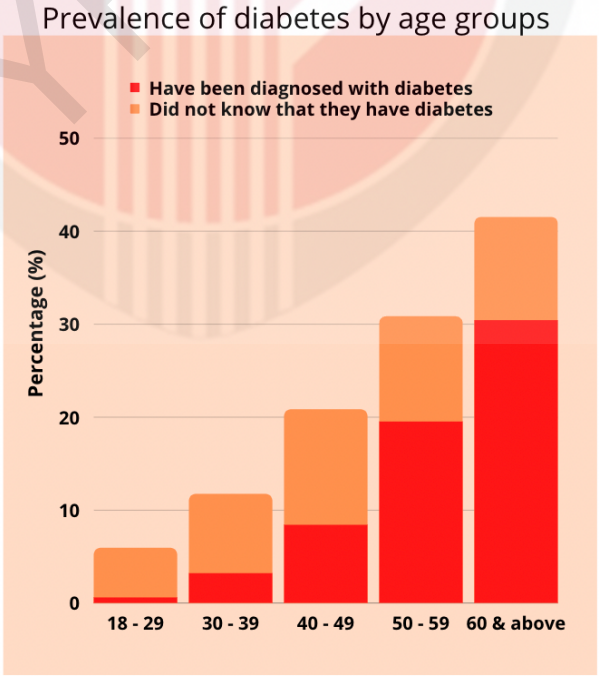

Figure 2.2: Prevalence of Diabetes by Age Groups (Source: NHMS 2019)

A rapid increase in the prevalence of undiagnosed diabetes among Malaysian adults suggested that many Malaysian individuals were unaware of their risk of T2DM throughout the pre-diabetic stage (Health, 2019). Early detection of individuals with pre-diabetes is essential to prevent the development of diabetes. The young generation is the target population as they might go through lifestyle changes, especially eating behaviour that increase their risk of developing T2DM.

2.2 Risk of T2DM

Few studies have been conducted (Table 2.1) to determine the risk of developing T2DM among university students in China, Brazil, Jordan, and Denmark (Al-Shudifat et al., 2017;Hao, Zhang, Chen, & Shi, 2014; Lima et al., 2014; Skøt et al., 2018). Based on the studies, we can conclude that sedentariness, obesity, central obesity, and family history are factors for the risk of developing T2DM.

2.2.1 T2DM risk assessment tool

The Modified Finnish Type 2 Diabetes Risk Assessment Tool (FINDRISC) is commonly used to screen T2DM due to its high sensitivity and specificity in detecting the risk of developing T2DM in the following 10 years. FINDRISC consists of 12 questions and it has been validated by the statistician and biochemist (Oo et al., 2020).

Table 2.1: Summary of studies that determine the risk of developing T2DM.

	Author, Year of Publication, method of assessments (online/physical)	Outcome Measured	Target population, sample size, Age	Study Duration	Exposure and assessment method	Results and Findings
1.	Lima et al., 2014) Physical assessment	• Sociodemographic • Anthropometric • Physical activity • Blood pressure • fasting plasma glucose levels	• Brazilian college students (n=702) • 16-58 years old	• September – November 2010 • February – June 2011	• Self-answer questionnaire • Biochemical data by specialized laboratory	• The most prevalent risk factor for diabetes was sedentary behaviour, followed by obesity, central obesity, high fasting plasma glucose, and arterial hypertension. • Sedentariness (65.1 percent) was the most prevalent risk factor for diabetes among students with only one risk factor ($p< 0.0001$).
2.	(Hao, Zhang, Chen, & Shi, 2014)	• Fasting blood glucose • Alanine transaminase (ALT) • Height • Weight	• Chinese university students (n=6716) • 17-20 years old	• Not mentioned (the study used secondary data)	• Not stated (Secondary data using nameless information.)	• Boys from high socioeconomic position were more likely to have diabetes or impaired fasting glucose. • Both sexes had a significantly higher risk of diabetes and

	Physical assessment	• Blood pressure measured				impaired fasting glucose when their ALT levels were elevated. • Girls who were overweight and had pre-hypertension had a higher chance of developing diabetes and having impaired fasting glucose.
3.	(Al-Shudifat et al., 2017) Physical assessment	• Diabetes risk questionnaire (FINDRISC) • Anthropometric Measurements • Blood Test	• Students from Jordan (n=1821) • 8-25 years old	• January – February 2014 (2 months) (convenience sampling)	• The Finnish Diabetes Risk Score (FINDRISC).	• T2DM was discovered in 5.2 % of moderate-risk adolescents and 1.8% students. • Undiagnosed T2DM was found in 66 % and 70 % of the students with a moderate or high FINDRISC score, respectively.
4.	(Skøt et al., 2018) Online assessment	• Sociodemographic • Physical activity • Sweet consumption • FFM personality traits	• Danish university students (n=1205)	Not mentioned	• Online Questionnaire	• A Higher perceived susceptibility scores was associated with history of diabetes, overweight/obese, diagnosed with diabetes, and consuming sweets once a day or more.

		• 40 years old and below	• A Lower perceived susceptibility scores was associated with at least one parent with tertiary education level, achieved recommended physical activity level, and the personality traits of openness, conscientiousness, extraversion, and emotional stability. All the correlations were significant at the 1% level.

2.3 Risk factors of T2DM risk

2.3.1. Socio-demographic factors

2.3.1.1 Sex

According to a prior study, there was a sex difference in the prevalence of diabetes and impaired fasting glucose, with 0.09 % and 3.67 % in boys and 0.18 % and 1.09 % in girls. (Hao, Zhang, Chen, & Shi, 2014). Another study showed that the chances of having diabetes or impaired fasting glucose were considerably greater in individuals with increased ALT (odds ratio 1.76 (1.03–3.01) in males and 6.29 (2.21–17.87) in girls (Article, 2014). As a result, it has been established that sex is linked to the chance of having T2DM.

2.3.1.2 Income

Furthermore, it has been demonstrated that boys with a high socio-economic position have a higher chance of acquiring diabetes or impaired fasting glucose than boys with a low socio-economic status; this link is also seen in females (Hao, Zhang, Chen,& Shi, 2014). A a Moreover, increased T2DM incidence is linked to low SES in high, middle, and low-income nations, according to systematic review and meta-analysis data. (Kyrou et al., 2020). Other than that, a study shows that socioeconomic status plays important role in the increasing number of non-communicable diseases (NCD) as low socioeconomic groups consume less nutritious foods meanwhile the high

socioeconomic groups were found to lack physical activity and consume lots of unhealthy diets.

2.3.1.3 Marital Status

Moreover, marital status is significantly associated with being overweight, which is one of the factors in developing the T2DM (Lima et al., 2014). Based on a study that has been conducted in Brazil, T2DM affected 13% of divorced people, 6% of married people, and 6% of single people (De Oliveira et al., 2020). Furthermore, being married was associated with a 0.39 probability of having diabetes, but being single was connected to a 0.33 likelihood of developing diabetes, according to the same study by (De Oliveira et al., 2020). Only a few studies have looked at the link between marital status and the likelihood of acquiring T2DM. Thus, more research is needed to determine the link between marital status and the risk of acquiring T2DM.

2.3.1.4 Ethnicity

Another non-modifiable T2DM risk factor is ethnicity, with some ethnic groups having a significantly higher risk of T2DM regardless of where they live (Kyrou et al., 2020). Some studies in Europe have compared the prevalence of T2DM in minority and ethnic minority groups to the prevalence of T2DM in European host populations, with the pooled data consistently indicating that the former groups had a greater prevalence of T2DM (Ericson et al., 2018). Based on systemic review and meta-analysis, T2DM risk is higher among European ethnic minority groups than among European host populations, and it varies based on their geographical location (Kyrou et al., 2020). A study in Malaysia finds out that a subgroup analysis showed a

significant correlation between the major ethnic groups and the combined prevalence of diabetes. The Indian subpopulation had the highest rate of diabetes prevalence (25.10%), followed by the Malays (15.25%), Chinese (12.87%), Bumiputera (8.62%), and others (6.91%)(Akhtar et al., 2022).

2.3.1.5 Age

Numerous European cross-sectional and longitudinal studies have consistently demonstrated that Age is a key T2DM predictor, with considerably increased T2DM prevalence with increasing Age, confirming this relationship between ageing and T2DM in both men and women (IDF, 2019). Next, research found that Age is associated with both prediabetes and diabetes among women and diabetes among males, with a $p<0.01$ significance. (Hilawe et al., 2016). Research done in Palau found that Age and a large waist circumference were both significantly associated with pre-diabetes and diabetes among individuals in Palau. (Rahim et al., 2020). Moreover, Both diabetes duration (Pearson correlation coefficient r = 0.38 $p<0.001$) and age at diabetes diagnosis (Pearson correlation coefficient r = 0.71 $p<0.001$) were positively related. (Nanayakkara et al., 2018). Thus, it is shown that most of the studies conducted to determine the association between Age and T2DM risk. Therefore, this study will fill this research gap and investigate the hypothesis stated.

2.3.1.6 Educational Program Enrolled

Next, for the educational program enrolled, a study conducted by Lima and colleagues (2014) stated that due to a lack of literature, the statistically significant link between T2DM risk factors and knowledge area cannot be examined, and the relationship

remains uncertain. Finally, despite an increase in the number of research on the risk of developing T2DM, no study has looked at the link between the educational program enrolled and the risk of getting T2DM among university students. Therefore, this study will fill this research gap and investigate the hypothesis stated.

2.3.2 Socio-medical Factors

2.3.2.1 Body Mass Index (BMI)

BMI was significantly associated with prediabetes and diabetes in both sexes (men & women) with $p<0.01$, as shown in research conducted among adults in Palau (Hilawe et al., 2016). This statement is supported by the finding of multiple studies in Europe that mention BMI is associated with a higher risk of T2DM (Kyrou et al., 2020). Moreover, in another study that is conducted in Jordan, overweight was frequent in this young group, with 23.2 percent being either overweight (BMI 25.0–29.9 kg/m^2) or obese (BMI ≥ 30 kg/m^2) (Al-Shudifat et al., 2017). Additionally, it has been shown that BMI can independently predict the onset of T2DM, with incidence rates being about three and ten times greater in people with BMIs between 25 and 30 kg/m^2 and over 30 kg/m^2, respectively (Bonora et al., 2004). Thus, based on our reading, BMI is one of the factors that influence the risk of developing T2DM.

2.3.2.2 Waist Circumference

By measuring waist circumference, Malaysians have a prevalence of abdominal obesity of between 55.6% and 57.4% (Mohamud et al., 2011). The previous study shows that Malaysia has the highest prevalence of abdominal obesity compared to other countries such as China which has the same ethnic population (Gu et al., 2005).

With a frequency of 57.4%, abdominal obesity is the most common form of metabolic syndrome. (Mohamud et al., 2011). Moreover, a study conducted by Malaysia Diabcare showed that 72% of patients with T2DM were obese and with a BMI of 27.8 kg/m². The prevalence of impaired fasting glucose, impaired glucose tolerance, and previously undiagnosed T2DM was also correlated with waist circumference and BMI (p<0.001) (Li et al., 2017). The same study also mentions that compared to BMI, waist circumference demonstrated a larger connection with glucose impairment and diabetes, and even after controlling for BMI, waist circumference was still significant for all glucose impairment scores and diabetes. This is because waist circumference, a measure of central obesity, is more closely correlated to visceral fat than BMI, a measure of overall obesity, which cannot distinguish between fat mass with fat-free mass. Increased levels of circulating inflammatory cytokines and adhesion molecules are linked to visceral obesity, which encourages the onset of insulin resistance and T2DM (Despres and Lemieux, 2006; Hamdy et al., 2006; Kahn et al., 2006; Montoy et al., 2009).

2.3.2.3 Family History

Family history is one of the most powerful risk factors for the development of T2DM. Even after controlling for the most common causes of diabetes, such as physical activity (PA), BMI, waist circumference, and a genetic risk score based on many SMPs, a research found that family history was still highly linked to the chance of acquiring T2DM in the future. (Scott et al., 2014). Meanwhile, another study shows that students who were has family history of T2DM, were overweight, or were obese, and had a higher score for the risk of developing T2DM (Skøt et al., 2018). According to data from the EPIC-InterAct project, various studies with European participants

found that T2DM family history was highly related to T2DM risk, with the majority of this risk remaining unexplained even after reporting for important anthropometric, lifestyle, and genetic T2DM risk variables (Kyrou et al., 2020). A local study find out that young adults with a family history of T2DM had a significantly higher score for T2DM risks (Hasbullah et al., 2021). This finding is verified by the Korea National Health and Nutrition Survey, which found that T2DM prevalence was considerably greater in persons aged 25 to 44 with a first-degree family history of diabetes than in those without a history of the disease. Another study finds out that the likelihood of having T2DM increased by 1.4 to 6.1 times in families with a history of diabetes (Harrison et al., 2003). Furthermore, there is a significant association between family history and risk of developing T2DM was found (Hasbullah et al., 2021; Kyrou et al., 2020). Study by Hasbullah et al. (2021) find that young adults with a family history of T2DM had a significantly higher score for T2DM risks. This finding is verified by the Korea National Health and Nutrition Survey, which found that T2DM prevalence was considerably greater in persons aged 25 to 44 with a first-degree family history of diabetes than in those without a history of the disease. Another study finds out that the likelihood of having T2DM increased by 1.4 to 6.1 times in families with a history of diabetes (Harrison et al., 2003).

2.3.3 Physical Activity

The worldwide prevalence of physical inactivity was 96% and 27.5% of adults were physically inactive in 2016 (Guthold et al., 2020). In Malaysia, 25.1% of adults were physically inactive. There was a significant reduction in the trend of insufficient physical activity as compared to 2011 (35.7%) and 2015 (33.5%) (IKU, 2020). The low prevalence of physical activity might be due to the long working hours and the modernization of technology that impacts our physical activity level.

Obesity and other metabolic syndrome components are all associated to a higher risk of T2DM, both directly and indirectly, through increasing unhealthy eating habits, a sedentary lifestyle, and a lack of physical activity (Kyrou et al., 2020). Study showed that the risk of developing diabetes and cardiovascular outcome could be reduced by increasing the Physical activity level (Wahid et al., 2016). According to Meta-analysis, result from the cubic spline model, those who accrue 11.25 MET h/week have a 26% (95% CI 20%, 31%) lower chance of acquiring T2DM than those who are fully inactive, regardless of their body weight (Smith et al., 2016)(Wahid et al., 2016).

Physical activity has three main advantages for slowing the progression of T2DM. First, as skeletal muscle cells contract, more blood flows into the muscle, which improves the uptake of glucose from plasma. Second, exercise lowers excessive intra-abdominal fat, a proven risk factor that encourages IR. Lastly, it has been demonstrated that moderate exercise increases glucose absorption by 40%. Exercise increases glucose uptake and insulin sensitivity, but it can also reduce or even eliminate oxidative stress and inflammation, two factors that increase the risk of T2DM (Galicia-Garcia et al., 2020). Furthermore, another study indicated that

physical activity clinics can reduce T2DM risk by 47% when compared to control clinics, but no significant differences were detected among the different randomization groups. (Uusitupa et al., 2019). Another study mention that physical activity is associated with the risk of T2DM, risk T2DM was reduced in the general public by 26% when compared to inactive adults who did not meet the current public health recommendations of 150 minutes of moderate to vigorous physical activity per week (Smith et al., 2016). Moreover, another study find out that with a sedentary lifestyle and no PA at all, glucose metabolism was associated (Brugnara et al., 2016). As a result, it was discovered that physical activity is linked to the development of T2DM.

2.3.4 Eating Behavior

Eating behavior is a habit that will affect the food choice and the craving to eat (Subramaniam et al., 2017). Emotional, external, and restrained eating behaviors are three types of common eating behavior that are usually described in research. External eating is produced by food-related signals, such as sight and the palatability of food, whereas emotional eating is driven by emotional arousal. Furthermore, dietary restriction eating is a type of dietary management that is influenced by cognitive signals (Subramaniam et al., 2017).

Obesity is one of the outcomes from the uncontrol eating behavior that will lead to the development of T2DM as a study showed that obesity might play an important role in the initiation of the metabolic syndrome by interacting with genetic variations at candidate genes for dyslipidemia, hypertension, and diabetes (Hainer et al., 2006).

Moreover, obesity, as a genetically driven condition, by interacting with genetic variants at candidate genes for dyslipidemia, hypertension, and diabetes, it may play a major role in the start of the metabolic syndrome (Hainer et al., 2006). Thus, eating behavior will influence the BMI and then the BMI will influence the risk of developing T2DM.

Lastly, even though there is a surge in the number of studies regarding eating behavior, but there is no study investigate the relationship between eating behavior and the risk of developing diabetes type 2 among university students. Thus, more studies are warranted to study the relationship between eating behavior with the risk of developing T2DM among university students.

2.4 Online Surveys on Investigating the risk of developing T2DM

Malaysia has been profoundly affected by the global virus pandemic, where the Malaysia government has implemented the Movement Control Order to prevent the spread of the virus. Thus, the online survey is the most suitable alternative approach to conduct a study due to this restriction. The advantages of online survey are low cost, convenient as most people work or study from home nowadays, hence increased in the use electronic gadget. However, there will be a few challenges and limitations to conduct online survey such as low response rates and bias. The low response rates might happen due to a lack of interest to answer the survey by the potential respondents. Also, the response rate is influenced by the length of the questionnaire. The average response rate for the online survey is around 30% (SurveyAnyplace, 2021). Thus, to ensure enough response rates the structure and content, as well as the

suitability of the survey for the targeted population should be carefully considered when developing the online survey.

CHAPTER 3

METHODOLOGY

3.1 Study Design

This was a cross-sectional study which utilized an online survey. It aimed to determine the factors associated with the risk of developing T2DM among Malaysian students in a selected public university that was conducted from March to June 2022.

3.2 Study Location

This study was conducted via an online form (Google form) that was distributed among university students in UPM. Universiti Putra Malaysia (UPM), Serdang, Selangor located approximately 30 km south of the capital city of Kuala Lumpur. UPM is a university that provides courses in a variety of topics and disciplines. UPM Serdang has 16 faculties and 10 institutes, with a total of 11981 undergraduate students (Official Portal of Universiti Putra Malaysia, 2017).

3.3 Study Population and Subject Criteria

Students at UPM who fulfil the inclusion and exclusion criteria were welcomed to participate in the study as subjects. The inclusion and exclusion criteria were as below:

Table 3.1: Inclusion and Exclusion Criteria for Population Study

Inclusion criteria	Exclusion criteria
• Age between 18-45 • Male and female • Malaysian • Malay or English-literate	• Diagnosed with T1DM and T2DM • Pregnant or breastfeeding • Presence of disabilities (blindness) • Not certain of family history of diabetes.

3.4 Sample Size Determination

To determine the sample size, a correlation study formula was being used.

(Lwanga & Lemeshow (1991))

$$N = [(Z\alpha + Z\beta) / C]^2 + 3$$

$$C = 0.5 \text{ X } \ln [(1+r) / (1-r)]$$

Where

N = number of respondents needed

Standard deviation for $\alpha = 1.96$

Standard deviation for $\beta = 0.84$ (80%)

r = the expected correlation coefficient

Table 3.2: Sample Size Based of Correlation Study

Correlation studies	Correlation coefficient, r	Sample size, N
Physical Activity, Sedentary Behaviour, and Quality of Life among University Students (Nowak et al., 2019)	0.346	$C = 0.5 \times \ln [(1+r)/(1-r)]$ C= 0.36 $N = [(Z\alpha+Z\beta)/C]^2 + 3$ N= 63.49 *64
Who perceives a higher personal risk of developing type 2 diabetes? A cross- sectional study on associations between personality traits, health-related behaviours and perceptions of susceptibility among university students in Denmark (Skøt et al., 2018)	0.230	$C = 0.5 \times \ln [(1+r)/(1-r)]$ C= 0.23 $N = [(Z\alpha+Z\beta)/C]^2 + 3$ N= 151.20 *152
Psychometric Properties of the Malay Version of the Dutch Eating Behaviour Questionnaire (DEBQ) in a Sample of Malaysian Adults Attending a Health Care Facility (Subramaniam et al., 2017)	0.390	$C = 0.5 \times \ln [(1+r)/(1-r)]$ C = 0.41 $N = [(Z\alpha+Z\beta)/C]^2 + 3$ N = 49.63 *50

To consider the possibility of missing data and non-response rate, an additional 20% was included

Table 3.3: Adjusted Respond Rate

Adjust for The Respond Rate		
Correlation studies	Correlation coefficient, r	Sample size, N
Physical Activity, Sedentary Behaviour, and Quality of Life among University Students	64/0.8	80
Who perceives a higher personal risk of developing type 2 diabetes? A cross- sectional study on associations between personality traits, health-related behaviours, and perceptions of susceptibility among university students in Denmark	152/0.8	190
Psychometric Properties of the Malay Version of the Dutch Eating Behaviour Questionnaire (DEBQ) in a Sample of Malaysian Adults Attending a Health Care Facility	50/0.8	63

To fulfill the requirements for variables, the highest sample size was chosen (190 participants). Thus, a minimum sample of 190 participants was needed for this study.

3.5 Sampling Design

Simple random sampling and convenience sampling were used in this study, as shown in Figure 3.1. The study aimed to approach students in UPM who met the inclusion and exclusion criteria via online platforms (emails, WhatsApp or Facebook).

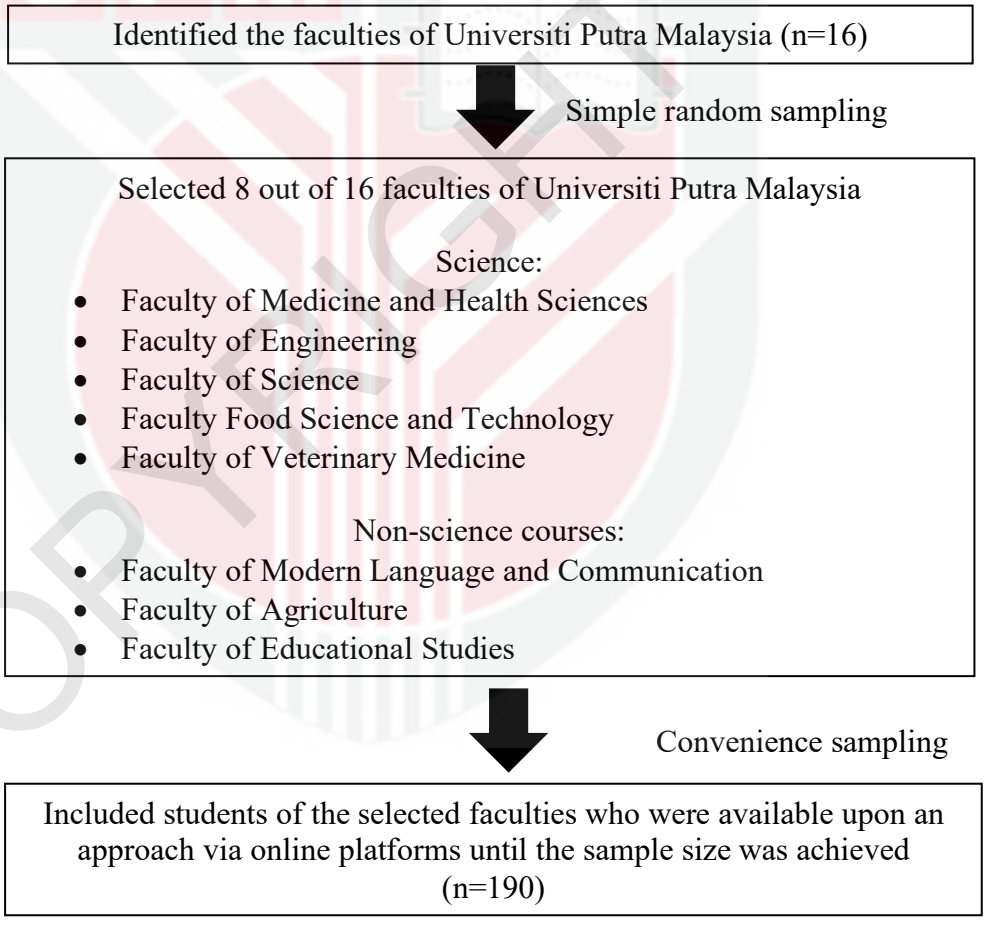

Figure 3.1: Flow chart of the sampling method

3.6 Study Measurements

The instrument used for data collection was a self-administered questionnaire administered electronically using the internet which consisted of 4 sections (socio-demographic and nutritional status, physical activity, T2DM risk and eating behaviour) built based on the objectives of the study. The self-administered questionnaire was sent to the respondents via a link of Google Forms on virtual platforms. The languages used in the questionnaire were both English and Malay. The information sheet and informed consent form was also included in the Google Forms. Participants had to provide their informed consent before answering the questionnaire.

3.6.1 - Socio-demographic and Nutritional status

Several questions that were included in this section were gender, race, Age, academic program enrolled, household income, self-reported anthropometric measurement (weight, height, waist circumference) and family history. Respondents required to measure their weights if they own a weighing scale at home. In cases of not owning the equipment, they required to recall their latest body weight. The respondents also required to recall their latest height measurement. Body mass index (BMI) was calculated by dividing the weight (kg) by the square of height (m^2). The data was classified into WHO BMI Classification. Waist circumference measurements were obtained by providing the subjects with pants sizes (S, M, L, XL, XXL, XXXL) in centimetres, according to Uniqlo size chart.

Table 3.4: WHO BMI Classification

Classification	BMI (kg/m^2)	Risk of co-morbidities
Underweight	< 18.5	Low
Normal Range	18.5 – 24.9	Average
Overweight	25 – 24.9	Increased
Obese Class I	30.0 – 34.9	Moderate
Obese Class II	35.0 – 39.9	Severe
Obese Class III	≥ 40.0	Very severe

Table 3.5: Men and women pants size (inch/cm) for proxy measurement of waist circumference

Pant sizes	Inches / cm (men)	Inches / cm (women)
XS	26 – 28 / 66 - 72	22 – 24 / 57 - 63
S	27 – 30 / 68 - 76	23 – 26 / 60 - 66
M	30 – 33 / 76 - 84	24 – 27 / 63 - 69
L	33 -- 36 / 84 - 92	27 – 29 / 69 - 75
XL	36 – 39 / 92 – 100	29 – 31 / 75 – 81
XXL	39 – 42 / 100 – 108	31 – 34 / 81 - 87
XXXL	42 – 45 / 108 – 116	

3.6.2 - Physical Activity

The physical activity level of the participants was obtained using International Physical Activity Questionnaire (IPAQ). IPAQ was designed primarily to determine the physical level of adults ranging from the Age of 15-69 years old. IPAQ was used to assess the physical activity level with multiple domains such as gardening activities and work-related activities. The physical activity level of the participants was calculated by weighing the type of activity with the Multiple of the resting metabolic rate (METS) to determine the MET-minutes score. The MET-minutes is the MET score multiplied by the minute's activity performed. The value of MET can be used to analyze the physical activity level and thus, analyze the IPAQ data (Table 3.6).

Table 3.6: Activity Intensity with MET Scores

Activity Intensity	MET scores (minute/week)
Walking	3.3 METs
Moderate PA	4.0 METs
Vigorous PA	8.0 METs

Source: (2018 Physical Activity Guidelines Advisory Committee, 2018)

There are 3 proposed levels which are inactive, minimally active and Health enhancing physical activity (HEPA) active. (Table 3.6)

Table 3.7: Categorical score of physical activity

Category	Description
Inactive	No activity is reported **OR** • Some activity is reported but does not meet the Categories 2 or 3.
Minimally Active	Any of the following criteria • 3 or more days of vigorous activity of at least 20 minutes per day **OR** • 5 or more days of moderate-intensity activity or walking of at least 30 minutes per day **OR** • 5 or more days of any combination of walking, moderate-intensity or vigorous intensity activities achieving a minimum of at least 600 MET-min/week.
HEPA Active	Any of the following criteria • Vigorous-intensity activity on at least 3 days and accumulating at least 1500 MET minutes/week **OR** • 7 or more days of any combination of walking, moderate-intensity or vigorous intensity activities achieving a

	minimum of at least 3000 MET-minutes/week

(Craig et al., 2003)

3.6.3 - Type 2 Diabetes Risk

The Finnish Diabetes Risk Score (FINDRISC) questionnaire was used to assess the T2DM risk of the participants. The modified FINDRISC consist of 12 questions and has been validated by the clinician, statistician and a biochemist (Oo et al., 2020). The questionnaire includes questions related to age, family history of diabetes mellitus, hypertension, antihypertensive drug treatment, consumption of soft drinks, physical activity, BMI and waist circumference. The final FINDRISC score was calculated by adding up the scores received by the respondents**.** The risk of developing T2DM was classified based on the final score range of the participants. In the following ten years, it was classified as low risk (<4), moderate risk (4-6), or high risk (≥7), of developing T2DM.

3.6.4 - Eating Behaviour

The eating behaviour of the participants was determined using Dutch Eating Behaviour Questionnaire (DEBQ). The DEBQ consists of 33 items (questions) that measure emotional eating (13 items), external eating (10 items), and restrained eating (10 items) and is evaluated based on a Likert scale with a scoring system identified as: 1 = never, 2 = seldom, 3 = sometimes, 4 = often, and 5 = very often (Subramaniam 2017). The average score is calculated for each subscale, by adding scores obtained from individual items and dividing them by the number of the items included in a subscale. The average score was classified into three categories which are Low (1.00-2.99), Moderate (3.00-3.99) and High (4.00-5.00). Higher scores suggest that the participants have higher level of restrained, emotional, and external eating, respectively.

3.7 Pre-testing

A pilot test was conducted among 10 undergraduate UPM students from faculty of Medicine and Health Sciences who met the criteria to assess the usability, procedures of the study instruments and data collection process. The self-administered questionnaire and feedback form was sent to them via online platforms. The duration to answer the questionnaire was recorded. The study instruments were revised based on the feedback given during the pre-testing. The respondents in the pre-test were not included in the actual study.

3.8 Procedure

Data collection was conducted from March until June 2022**.** The approval to conduct this research was obtained from UPM's Ethics Committee for Research Involving Human Subjects (JKEUPM). After finalizing the study instruments, the pre-testing was conducted among 10 undergraduate UPM students. The questionnaire was amended based on the feedback from the pre-testing.

The potential subjects were approached through online platforms (social media or emails). The self-administered questionnaire was attached as a link to Google Forms and distributed to them. The first part of the questionnaire was the screening questions, to assess the eligibility of the potential subjects. The second part was the information sheet and informed consent form, where information about the study was given, and the subjects needed to provide their informed consent upon agreeing to take part in the survey. The participants who agreed to participate in the survey answered the four sections questionnaire.

3.9 Statistical Analysis

IBM SPSS Statistic Version 26 (IBM, United States) was used to conduct the statistical data analysis. The significance level for all statistical tests was set to $p<0.05$. The information that was taken from SPSS was separated into two categories, which were numerical and categorical data. Numerical data such as Age, weight, and height was extracted by using mean, mode, median and standard deviation. While categorical data such as gender, waist circumference, ethnicity, marital status, academic program, residential status, household income, family history, physical activity level, eating

behaviour and risk of developing T2DM was extracted using frequency and percentage. For bivariate analysis, the associations of independent variables (Socio-demographic factors, socio-medical factors, physical activity level) and the risk of developing T2DM were tested using the independent t-test and Mann-Whitney test for continuous variables, and the Chi-Square test of Independent and Fisher Exact test for categorical variables.

CHAPTER 4

RESULTS AND DISCUSSION

4.1 Recruitment and Response Rate

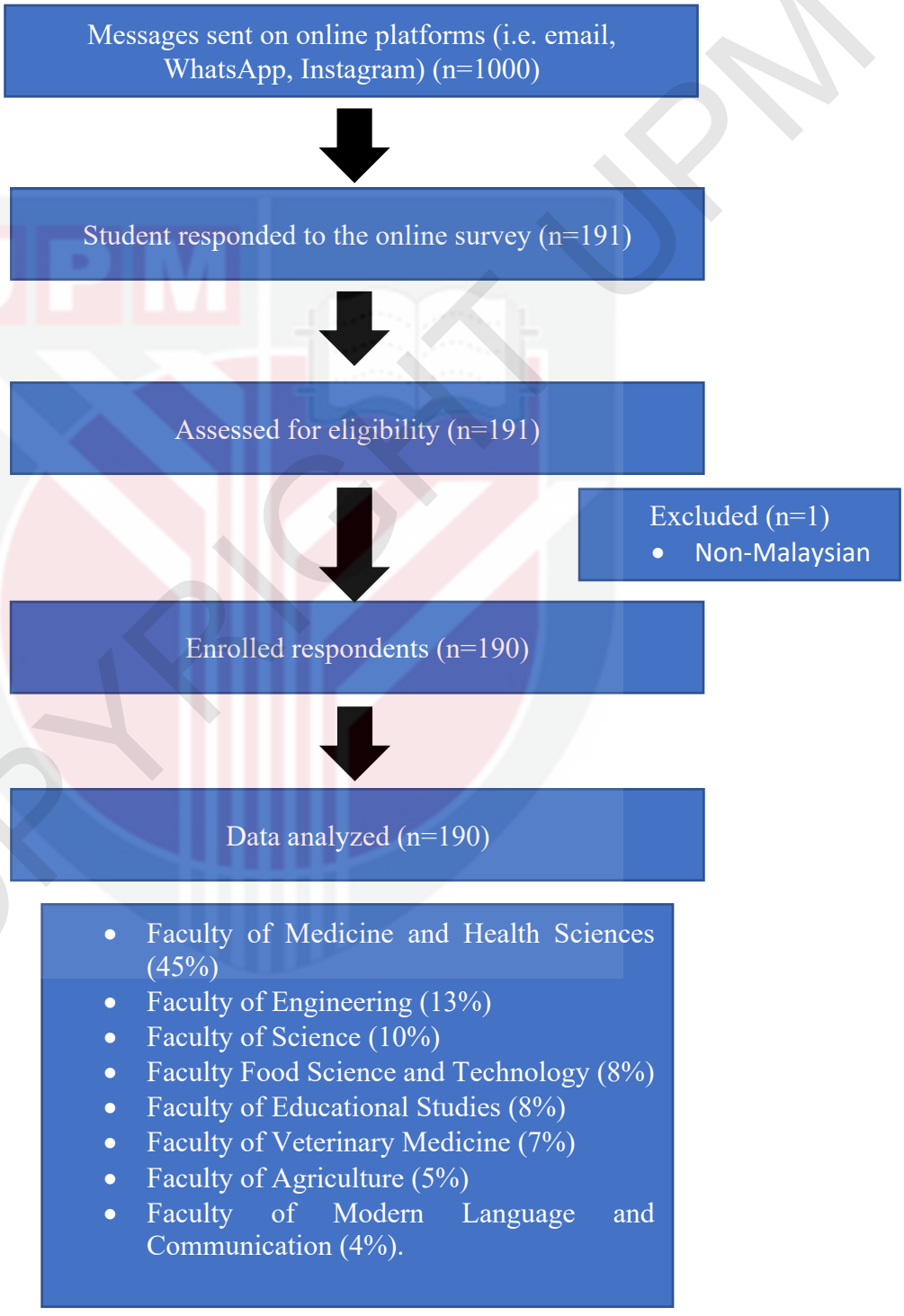

Figure 4.1: Screening and recruitment of respondents

Approximately 1000 messages containing information about this study were sent via email, WhatsApp and Instagram during the data collection phase of this study. A total of 191 UPM students responded to the online survey. One of them was excluded as she was non-Malaysian. An overall 190 respondents were eligible and recruited in this study upon their given consent. 190 responses were analysed. The majority of the respondents were from the Faculty of Medicine and Health Sciences (45%), followed by the Faculty of Engineering (13%), Faculty of Science (10%), Faculty Food Science and technology (8%), Faculty of Educational studies (8%), Faculty of Veterinary Medicine (7%), faculty of Agriculture (5%) and lastly Faculty of Modern Language and Communication (4%). Hence the response rate for this study was 19%. Moreover, 100% of the minimum sample size needed in this study was achieved.

4.2 Socio-demographic Characteristic

Table 4.1 shows the distribution of socio-demographic characteristics among the participants. A total of 190 participants whose data were accepted as they passed the inclusion and exclusion criteria of the study. This indicates that 100% of the sample size was achieved. Based on the results, it was found that the majority of the participants (71%) were female, and the mean age was 22.22 ± 0.98 years old, ranging from 20 -27 years old. The gender gap in the enrolment of Malaysian male university students explains the discrepancies in participant numbers between the sexes (Tienxhi, 2017). Most of the participants (83%) were Malay, followed by Chinese (10%), Indian (4%) and Others (3%). This proportion was consistent with the proportion of Malaysian population by ethnicity in a local study (Hasbullah et al., 2021). 28% of

participants were from the high household income category (>RM 10 000), while 27% of the participants came from the low household income category (>RM 2500). Meanwhile, 22% and 23% of the participants came from middle household income of RM 2500 - RM 5000, and RM 5001 - RM 10 000, respectively.

Table 4.1: Distribution of participants according to socio-demographic characteristics (*n*=190)

Variables	**n(%)**	**Mean ± SD**	**Range**
Age		22.22 ± 0.98	20-27
Sex			
• Male	55 (29)		
• Female	135 (71)		
Ethnicity			
• Malay	157(83)		
• Indian	8 (4)		
• Chinese	20 (10)		
• Others	5 (3)		
Academic program enrolled			
• Faculty of Engineering	25(13)		
• Faculty of Food Science and Technology	16(8)		
	19(10)		

• Faculty of Science	8(4)
• Faculty of Modern Language and Communication	13(7)
• Faculty of Veterinary Medicine	9(5)
• Faculty of Agriculture	86(45)
• Faculty of Medicine and Health Sciences	14(8)
• Faculty of Educational Studies	
Household Income	
• Less than RM2500 per month	51(27)
• RM 2500 - RM 5000 per month	42(22)
• RM 5001 - RM 10 000 per month	44(23)
• More than RM 10 000 per month	53(28)

4.3 Nutritional Status

Table 4.2 shows the distribution of Nutritional Status among the participants. The majority of the participants (48%) were found to have a normal BMI (18.5 – 22.9 kg/m^2), followed by underweight (<18.5 kg/m^2) (22%), overweight (23.0 – 27.4 kg/m^2) (18%), and obese (>27.5 kg/m^2) (1%). This finding contradicts the to finding by Al-Shudifat et al. (2017) that found majority of the university students were overweight. Next, most of our participants were wearing Medium size (34%) for their pants, followed by Small (23%), Large (19%), Extra Small (9%), Extra Large (9%), two Extra Large (5%), and three Extra Large (1%). This finding is a new outcome as there are limited studies that uses pants size to determine the estimated waist circumference of the participants. Moreover, we also found out that more than half of the participants (62%) have no family history of diabetes. This finding is similar to what Hasbullah et al. (2021) found, where the number of participants who had no family history of diabetes were higher than the number of participants who had family history of diabetes.

Table 4.2: Distribution of participants according to nutritional status (*n*=190)

Variables	**n(%)**	**Mean ± SD**	**Range**
Weight (kg)		57.87 ±13.32	32-93
Height (m)		1.62 ± 0.08	1.3-.1.9
BMI (kg/m^2)		21.99 ± 4.27	14.4-37.5
BMI Category (kg/m^2)			
• < 18.5	41(22)		
• 18.5 - 22.9	92(48)		
• 23 - 27.4	35(18)		
• >27.5	22(2)		
Waist circumference			
• XS /S	61(32)		
• M	64(34)		
• L	37(19)		
• XL / XXL / 3 XL	28(15)		
Family History			
• Yes	73 (38)		
• No	117 (62)		

4.4 Physical Activity Level

Table 4.3 depicts the physical activity levels of the participants. The results showed that the majority of the participants were minimally active (43%), followed by inactive (34%), and HEPA active (22%). This finding was similar to the finding from the National Health and Morbidity Survey (2019) where up to 25.1% of Malaysian adults were physically inactive (IKU, 2020). This might be due to busy schedule and the modernization of technology that affect the physical activity level of Malaysian adults.

Table 4.3: Distribution of participants according to physical activity level (*n*=190)

Variables	**n(%)**
• Inactive	64(34)
• Minimally active	82(43)
• HEPA active	42(22)
• Missing	2(1)

4.5 Eating Behaviour

The eating behaviour was divided into three different categories which were emotional eating, external eating and restrained eating. The results showed that the majority of the participants had a moderate level of emotional (54.2%), followed by the low level of emotional eating (37.4%) and a high level of emotional eating (8.4%).

Moreover, for the external eating category, the results showed that the majority of the participants had a moderate level of external eating (54.2%), followed by the low level of external eating (37.4%) and a high level of external eating (8.4%).

Next, for the restrained eating category, the results showed that the majority of the participants had a low level of restrained eating (58.4%), followed by a moderate level of restrained eating (32.6%) and a high level of restrained eating (8.9%). The finding contradicts the study by Subramaniam et al. (2017) where it did not classify eating behaviour into 3 different categories (Low, Moderate, and High). The result of current study is a new outcome where no previous studies observe the association of eating behaviour with the risk of developing T2DM.

Table 4.4: Distribution of participants according to eating behaviour category (*n*=190)

Variables	**n(%)**
Emotional eating	
• Low	71(37.4)
• Moderate	103 (54.2)
• High	16 (8.4)
External Eating	
• Low	71(37.4)
• Moderate	103 (54.2)
• High	16 (8.4)
Restrained Eating	
• Low	111 (58.4)
• Moderate	62 (32.6)
• High	17 (8.9)

4.6 Risk of developing T2DM

Table 4.5 depicts the risk of developing T2DM in the participants. The results showed that the majority of the participants had a low risk of developing diabetes (76%), followed by moderate risk (21%), and high risk (22%). This finding was similar to study by Al-Shudifat et al. (2017) that found out the majority of university students had a low risk of developing T2DM (Al-Shudifat et al., 2017). The fact that most of the participants in this study were from the Faculty of Medical and Health Sciences may be the reason for this finding.

Table 4.5: Distribution of participants according to risk of developing T2DM (*n*=190)

Variables	**n(%)**
• Low risk (<4 points)	145 (76)
• Moderate risk (4-6 points)	39 (21)
• High risk (7 and above)	6 (3)

4.7 Associations between Socio-demographic factors with the risk of developing type 2 diabetes (*n*=190).

Table 4.6 shows the associations between socio-demographic factors with the risk of developing T2DM. There was no mean difference between Age and risk of developing T2DM. This finding contradicts with other studies, where Age was mean difference with the risk of developing T2DM (Hilawe et al., 2016; Rahim et al., 2020). The seven-year difference in age range of the participants compared to previous studies might be the main explanation for the insignificant difference in mean Age.

Next, no association was found between gender and the risk of developing T2DM. This result also contradicts with other studies that found a higher risk of developing T2DM among female compared to male (Hao, Zhang, Chen, & Shi, 2014). This could be due to difference in the increased insulin resistance at different stages of life between genders where female had higher insulin resistance in early childhood until mid-puberty (Huebschmann et al., 2019; Jeffery et al., 2018; Sattar, 2013).

There was also no significant association between ethnicity and the risk of developing T2DM. This finding is inconsistent with studies from European countries (Ericson et al., 2018; Kyrou et al., 2020). Kyrou et al. (2020) found that the risk of developing diabetes is higher among minority group compared to majority group which is varied by their geographical location. A local study by Akhtar et al. (2020) revealed a significant correlation between the ethnic groups and the prevalence of diabetes. The Indian subpopulation had the highest rate of diabetes prevalence (25.10%), followed by the Malays (15.25%), Chinese (12.87%), Bumiputera (8.62%), and others (6.91%).

Furthermore, there was no association between educational programs enrolled with the risk of developing diabetes. According to Lima et al. (2014), the statistically significant link between T2DM risk factors and knowledge area cannot be examined, and the relationship remains uncertain (Lima et al. 2014). This result is another new finding that will fill the research gap due to the limited studies on the relationship between academic program enrolment and the risk of developing diabetes.

For household income, no significant association was found with the risk of developing diabetes. This finding is inconsistent with other studies study where there is a significant association between household income with the risk of developing diabetes (Hao, Zhang, Chen, & Shi, 2014: Kyrou et al., 2020). Hao et al., (2014) mentioned that the risk of developing diabetes increases with the socio-economy position of the individual (Hao et al. 2014).

Table 4.6: Socio-demographic factors according to diabetes risk in Malaysian students in UPM (*n*=190)

Variables	**Risk of Developing T2DM**		x^2	***t*-value**	***p- value***
	Low risk (n= 145)	Moderate to High risk (n = 45)			
Age	22.19 ± 0.90	22.33±1.22		0.876[a]	0.168
Sex					0.566
• Male	44 (23.2%)	11 (5.8%)	0.330[b]		
• Female	101 (53.2%)	34(17.9%)			
Ethnic					0.887
• Malay	119 (62.6%)	38 (20%)	0.020[b]		
• Non-malay	26 (13.7%)	7 (3.7%)			
Faculty					
• Science courses (Faculty of Engineering) (Faculty of Food Science and Technology) (Faculty of Science) (Faculty of Veterinary Medicine) (Faculty of Medicine and Health Sciences)	125 (65.8%)	34 (17.9%)	2.127[b]		0.145

• Non-science courses (Faculty of Modern Language and Communication) (Faculty of Agriculture) (Faculty of Educational Studies	20 (10.5%)	11 (5.8%)		
Income				
• ≤ RM5000 per month	73 (38.4%)	20(10.5%)	0.271[b]	0.602
• > RM5001	72 (37.9%)	25(13.2%)		

[a]Independent T test
[b]Chi-square test
*Significant at p<0.05
** Significant at p<0.00

4.8: Associations between nutritional status and the risk of developing T2DM (*n*=190)

Table 4.7 showed the associations between the distribution of nutritional status and anthropometry of the participants with the risk of developing T2DM. There was a significant association between BMI and the risk of developing T2DM ($p<0.001$), whereby an individual with a BMI of 23kg/m^2 and above has a higher risk of developing T2DM compared to those with a BMI less than 23. This finding is consistent with several studies (Hilawe et al., 2016; Kyrou et al., 2020). Moreover, it has been shown that BMI can independently predict the onset of T2DM, with incidence rates being about three and ten times greater in people with BMIs between 25 and 30 kg/m^2 and over 30 kg/m^2, respectively (Bonora et al., 2004).

Furthermore, based on the result, we found a significant association between waist circumference and the risk of developing T2DM ($p<0.001$). Li et al. (2017) also found that impaired fasting glucose, impaired glucose tolerance, and previously undiagnosed T2DM were also correlated with waist circumference and BMI ($p<0.001$) (Li et al. 2017). The same study also mentioned that; compared to BMI, waist circumference demonstrated a larger connection with glucose impairment and diabetes, and even after controlling for BMI, waist circumference was still significant for all glucose impairment scores and diabetes (Li et al. 2017). This is because waist circumference, a measure of central obesity, is more closely correlated to visceral fat than BMI, a measure of overall obesity, which cannot distinguish between fat mass with fat-free mass. Increased levels of circulating inflammatory cytokines and adhesion molecules are linked to visceral obesity, which encourages the onset of insulin resistance and

T2DM (Despres & Lemieux, 2006; Hamdy et al., 2006; Kahn et al., 2006; Montoy et al., 2009).

In the current study, no significant association between family history and risk of developing T2DM was found (p=0.068), which contradicts the findings of previous studies (Hasbullah et al., 2021; Kyrou et al., 2020). A study by Hasbullah et al. (2021) found that young adults with a family history of T2DM had a significantly higher score for T2DM risks (Hasbullah et al., 2021). This finding is verified by the Korea National Health and Nutrition Survey, which found that T2DM prevalence was considerably greater in persons aged 25 to 44 with a first-degree family history of diabetes than in those without a history of the disease (Moon et al., 2017). Another study found that the likelihood of having T2DM increased by 1.4 to 6.1 times in families with a history of diabetes (Harrison et al., 2003). There was a possibility of different misclassifying types of diabetes as the participants might have a family history of T1DM or another type of diabetes (Scott et al., 2014).

Table 4.7: Associations between nutritional status and the risk of developing T2DM (*n*=190)

Variables	**Risk of Developing T2DM**		***x²***	***p- value***
	Low risk (n= 145)	Moderate to High risk (n = 45)		
BMI (kg/m^2)				
• < 23	121 (63.7%)	12 (6.3%)	50.057[b]	0.001**
• ≥ 23	24 (12.6%)	33 (17.4%)		
Waist Circumference (cm)				
• Normal waist circumference (Male <90; Female <80)	138 (72.6%)	24 (12.6%)	44.572[b]	0.001**
• Abdominal obesity (Male ≥90; Female ≥80)	7 (3.7%)	21(11.1%)		
Family History				
• Yes	50 (26.3%)	23 (12.1%)	3.341[b]	0.068
• No	95 (50 %)	22 (11.6%)		

[a]Independent T test
[b]Chi-square test
*Significant at p<0.05
** Significant at p<0.001

4.9 Associations between physical activity level and the risk of developing T2DM (*n*=190)

Table 4.8 illustrates the associations between physical activity level with the risk of developing T2DM. There was no significant association found between physical activity (PA) level and the risk of developing T2DM (p=0.452). The result contradicts a previous study that found an association between physical activity with the risk of T2DM (Smith et al., 2016). The risk of T2DM was reduced in the general public by 26% when compared to inactive adults who did not meet the current public health recommendations of 150 minutes of moderate to vigorous physical activity per week (Smith et al., 2016). Furthermore, another study found that with a sedentary lifestyle and no PA at all, glucose metabolism was associated (Brugnara et al., 2016). This is because physical activity has a few main advantages for slowing the progression of T2DM. A study mentioned that physical activity such as exercise can increase glucose uptake and insulin sensitivity, moreover it also reduces or even eliminates the oxidative stress and inflammation which are two factors that could increase the risk of T2DM (Galicia-Garcia et al., 2020).

Table 4.8: Associations between physical activity level and the risk of developing T2DM (*n*=190)

Variables	**Risk of Developing T2DM**		x^2	*p- value*
	Low risk (n= 145)	Moderate to High risk (n = 45)		
MET Category			1.588[b]	0.452
• Inactive	47 (25%)	17 (9%)		
• Minimally active	61 (32.4%)	21 (11.2%)		
• HEPA Active	35 (18.6%)	7 (3.7%)		

[b]Chi-square test

4.10 Associations between eating behaviour category and the risk of developing T2DM (*n*=190)

Table 4.9 illustrates the association between eating behaviour and the risk of developing T2DM. No significant association was found between the eating behaviour category (emotional eating, external eating, restrained eating) and the risk of developing T2DM. The result is a new outcome as there was no study conducted before that explore the association between eating behaviour and the risk of developing T2DM. Most studies only focused on the association between eating behaviour category and the Body Mass Index (BMI) (Hainer et al., 2006). Based on previous studies, obesity is one of the outcomes of uncontrolled eating behaviour which will lead to the development of T2DM it might play an important role in the

initiation of the metabolic syndrome by interacting with genetic variations at candidate genes for dyslipidemia, hypertension, and diabetes (Hainer et al., 2006). This outcome will fill in the research gap of the study. Thus, eating behaviour influences the BMI, but it does not affects the risk of developing T2DM.

Table 4.9 Associations between Eating behaviour category and the risk of developing T2DM (*n*=190)

Variables	**Risk of Developing T2DM**		***x²***	***p- value***
	Low risk (n= 145)	Moderate / High risk (n = 45)		
Emotional eating				
• Low	58 (30.5%)	13 (6.8%)		
• Moderate	77 (40.5%)	26 (13.7%)	2.963[b]	0.227
• High	10 (5.3%)	6 (3.2%)		
External Eating				
• Low	58 (30.5%)	13 (6.8%)		
• Moderate	77 (40.5%)	26 (13.7%)	2.963[b]	0.227
• High	10 (5.3%)	6 (3.2%)		
Restrained Eating				
• Low	90 (47.4%)	21 (11.1%)		
• Moderate	43 (22.6%)	19 (10.0%)	3.365[b]	0.186
• HigH	12 (6.3%)	5 (2.6%)		

[b]Chi-square test

*Significant at $p<0.05$

CHAPTER 5

CONCLUSION

5.1 Conclusion

In conclusion, there was a low prevalence of risk of developing T2DM among students in Universiti Putra Malaysia. Besides, most of the participants had low physical activity levels. Although a significant association between physical activity level and risk of developing T2DM was not found, further research may be needed as multiple studies have found that those with low physical activity levels had significantly higher risk of developing T2DM. Hence, it will be beneficial to study further how the type, duration and intensity of physical activity may affect the risk of developing T2DM in the future. Moreover, this study also showed that there was no significant association between eating behaviour level with the risk of developing T2DM. The result was a new finding as there was no available study that observe the relation between eating behaviour with the risk of developing T2DM conducted in Malaysia. All in all, this study found significant associations between BMI and waist circumference with the risk of developing T2DM. Meanwhile, there was no significant association between socio-demographic factors, physical activity level and eating behaviour with the risk of developing T2DM among university students in Universiti Putra Malaysia.

5.2 Limitations and Recommendations

Several limitations were identified when conducting this study. The use of a self-administered questionnaire increases the chance of bias in the self-reported data of the participants. Under-report or overreport may occur when the participants answer the questionnaire. Moreover, due to the limitation caused by the pandemic of COVID-19, the sampling and data collection method chosen were less effective in obtaining the right sample size and representatives. The convenience sampling method that was used was not representative of the whole community and causes bias.

The recommendation for future studies is to use a random sampling method that represents the whole community from various sociodemographic categories. It is important to achieve a targeted sample size that will provide more accurate findings. Moreover, It is recommended to include diet history or Food Frequency Questionnaire (FFQ) into the list of questionnaires to determine the relationship between dietary intake and the risk of developing T2DM better.

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Appendix B: Participation Information Sheet and Informed Consent Form (English)

JAWATANKUASA ETIKA UNIVERSITI UNTUK PENYELIDIKAN MELIBATKAN MANUSIA (JKEUPM)
UNIVERSITI PUTRA MALAYSIA, 43400 UPM SERDANG, SELANGOR, MALAYSIA

FORM 2.4: RESPONDENT'S INFORMATION SHEET AND INFORMED CONSENT FORM

Please read the following information carefully and do not hesitate to discuss any questions you may have with the researcher.

1. STUDY TITLE :

ASSESSMENT OF THE RISK OF DEVELOPING TYPE 2 DIABETES MELLITUS WITH ITS ASSOCIATED FACTORS AMONG UNIVERSITY STUDENTS IN UNIVERSITI PUTRA MALAYSIA.

2. INTRODUCTION:

In this study, the researcher would like to determine the association between associated factors and the risk of developing T2DM among university students in Universiti Putra Malaysia. This is because, for the past few years, diabetes has become one of the major health threats around the world. According to International Diabetes Federation (IDF), approximately 463 million adults in-between the age of 20 to 79 were living with diabetes. In Malaysia, there have been relatively limited studies conducted to study the association of associated factors with the risk of developing T2DM among university students in Universiti Putra Malaysia. Thus, this study can help to provide more information regarding the association between university students with the risk of developing T2DM.

3. WHAT WILL YOU HAVE TO DO?

The study requires the participants' cooperation to answer the questions asked in the questionnaire. The questionnaire consists of 4 parts related to sociodemographic characteristics, physical activity level, T2DM diabetes risk, and Eating behavior. Participation in this study is voluntary. Participants who are not interested in this study are free to decline their participation in this study. Participation in this study would not be given an award or reward.

4. WHO SHOULD NOT PARTICIPATE IN THE STUDY?

The participants should not participate in this study if they are diagnosed with T1DM and T2DM, pregnant or breastfeeding, presence of disabilities and they are not certain of their family history of diabetes.

5. WHAT WILL BE THE BENEFITS OF THE STUDY:

(a) TO YOU AS THE SUBJECT?

This study will allow the participant to find out their risk of developing T2DM in few years.

(b) TO THE INVESTIGATOR?

The investigator can further their understanding of the association between associated factors with the risk of developing T2DM among university students in Universiti Putra Malaysia. This research will help to add knowledge on the relationship of associated factors with the risk of developing T2DM in university students in Universiti Putra Malaysia.

6. WHAT ARE THE POSSIBLE RISKS?

There are no risks in this study

7. WILL THE INFORMATION THAT YOU PROVIDE AND YOUR IDENTITY REMAIN CONFIDENTIAL?

All information provided is confidential and the results obtained will be used for academic purpose only. Researches will not disclose your personal participant personal information to any outsider party. No description of any individuals to be made on any part of the study or publication.

8. WHO SHOULD YOU CONTACT IF YOU HAVE ADDITIONAL QUESTIONS DURING THE COURSE OF THE RESEARCH?

If you have additional questions, please contact:

Researcher:

Nur Fatiah Binti Abdul Khalid

Tel: 0164809792

Email: 2000377@student.upm.edu.my

*Please initial here if you have read and understood the contents of this page*_____

9. CONSENT

I ..... Identity Card No. .....
address.....
.....hereby voluntarily agree to take part in the research stated above *(clinical /drug trial/video recording/ focus group/interview-based/ questionnaire-based).

I have been informed about the nature of the research in terms of methodology, possible adverse effects and complications (as written in the Respondent's Information Sheet). I understand that I have the right to withdraw from this research at any time without giving any reason whatsoever. I also understand that this study is confidential and all information provided with regard to my identity will remain private and confidential.

I* wish / do not wish to know the results related to my participation in the research

I agree/do not agree that the images/photos/video recordings/voice recordings related to me be used in any form of publication or presentation (if applicable)

* delete where necessary

Signature ..... (Respondent)

Date :.....

Signature ..... (Witness)

Name :.....

I/C No. :.....

I confirm that I have explained to the respondent the nature and purpose of the above-mentioned research.

Date .....

Signature ..... (Researcher)

Appendix C: Participation Information Sheet and Informed Consent Form (Malay)

JAWATANKUASA ETIKA UNIVERSITI UNTUK PENYELIDIKAN MELIBATKAN MANUSIA (JKEUPM)
UNIVERSITI PUTRA MALAYSIA, 43400 UPM SERDANG, SELANGOR, MALAYSIA

BORANG 2.4: PENERANGAN DAN PERSETUJUAN RESPONDEN

Sila baca maklumat berikut dengan teliti. Sekiranya anda mempunyai sebarang pertanyaan, sila kemukakan kepada penyelidik.

1.TAJUK KAJIAN

PENILAIAN TERHADAP RISIKO PEMBAGUNAN DIABETES MELLITUS JENIS 2 DENGAN FAKTOR-FAKTOR YANG BERKAITAN DI KALANGAN PELAJAR UNIVERSITI DI UNIVERSITI PUTRA MALAYSIA.

2. PENGENALAN

Dalam kajian ini, penyelidik ingin menentukan perkaitan antara faktor yang berkaitan dengan risiko perkembangan Diabetes Mellitus Jenis 2 dalam kalangan pelajar universiti di Universiti Putra Malaysia. Sejak beberapa tahun kebelakangan ini, diabetes telah menjadi salah satu penyakit serius yang menjadi ancaman utama kesihatan di seluruh dunia. Menurut Internasional Diabetes Federation (IDF), kira-kira 463 juta orang dewasa di antara umur 20 hingga 79 tahun menghidap penyakit diabetes. Di Malaysia, kajian terhadap faktor yang menyebab penyakit diabetes di kalangan pelajar universiti adalah sangat terhad. Justeru, kajian yang akan dijalankan ini akan dapat membantu memberikan lebih banyak info berkaitan perkaitan antara pelajar universiti dan risiko menghadapi Diabetes Mellitus Jenis 2.

3. APAKAH YANG PERLU ANDA LAKUKAN?

Kajian ini memerlukan kerjasama dari pihak peserta untuk menjawab soalan yang dikemukakan dalam borang soal selidik. Borang soal selidik terbahagi kepada 4 bahagian, iaitu sosiodemografi, tahap aktiviti fizikal, risiko diabetes dan tingkah laku makan. Penyertaan dalam kajian ini adalah secara sukarela. Peserta yang tidak berminat dengan kajian ini bebas untuk menolak penyertaan mereka dalam kajian ini. Penyertaan dalam kajian ini tidak akan diberikan anugerah atau ganjaran.

4. SIAPA YANG TIDAK BOLEH MENYERTAI KAJIAN INI?

Para peserta tidak boleh mengambil bahagian dalam kajian ini jika mereka didiagnosis dengan T1DM dan T2DM, mengandung atau menyusu, kehadiran orang kurang upaya yang tidak boleh membaca dan mereka yang tidak pasti tentang sejarah keluarga mereka yang pernah menghidap diabetes.

5. APAKAH FAEDAH MENYERTAI KAJIAN INI?

a)KEPADA ANDA SEBAGAI PESERTA?

Kajian ini membolehkan peserta mengetahui risiko mereka mendapat T2DM dalam beberapa tahun yang akan datang.

b) KEPADA PENYELIDIK?

Penyelidik boleh melanjutkan pemahaman mereka tentang perkaitan antara faktor- faktor yang berkaitan dengan risiko T2DM dalam kalangan pelajar universiti di Universiti Putra Malaysia.

6. ADAKAH IA BERISIKO?

Tiada risiko dalam kajian ini

7. ADAKAH MAKLUMAT DAN IDENTITI SAYA KEKAL RAHSIA?

Segala maklumat yang diberikan adalah sulit dan keputusan yang diperolehi akan digunakan untuk tujuan akademik sahaja. Penyelidik tidak akan mendedahkan maklumat peribadi peserta peribadi anda kepada mana-mana pihak luar. Tiada penerangan tentang mana-mana individu yang akan dilakukan pada mana-mana bahagian kajian atau penerbitan.

8. SIAPA YANG SAYA PERLU HUBUNGI SEKIRANYA SAYA MEMPUNYAI SOALAN TAMBAHAN SEMASA MENGIKUTI PENYELIDIKAN INI?

Jika anda mempunyai soalan tambahan, sila hubungi:

Penyelidik:

Nur Fatiah Binti Abdul Khalid

Tel: 0164809792

Email: 2000377@student.upm.edu.my

Sila tandatangan di sini sekiranya anda telah membaca dan memahami kandungan halaman ini _____

9. PERSETUJUAN

Saya…… No Kad Pengenalan. …….. beralamat…… ……..dengan ini bersetuju untuk mengambil bahagian secara sukarela dalam penyelidikan yang tersebut di atas *(kajian klinikal/percubaan ubat-ubatan/rakaman video/kumpulan sasaran/temuduga/ soal selidik).

Saya telah diberi penjelasan secara menyeluruh mengenai penyelidikan ini dari segi metodologi, risiko dan komplikasi (seperti tertulis pada Helaian Penerangan Responden). Saya memahami bahawa saya berhak menarik diri dari penyelidikan ini pada bila-bila masa tanpa memberi sebarang alasan.Saya juga memahami bahawa sebarang maklumat yang berkaitan identiti saya akan dirahsiakan.

Saya* berminat / tidak berminat untuk mengetahui keputusan kajian yang melibatkan saya.

I setuju/tidak bersetuju untuk imei/gambar/rakaman video/ rakaman suara digunakan dalam apa jua bentuk penerbitan atau pembentangan. (sekiranya berkaitan).

*potong yang tidak berkenaan

Tandatangan ……..…… Tandatangan ……..……..
(*Responden*) (*Saksi*)

Tarikh :…… Nama :……..…..

No. K/P: ……..…..

Saya mengesahkan bahawa saya telah menerangkan kepada responden ini sifat dan tujuan penyelidikan yang tersebut di atas.

Tarikh …….…… Tandatangan ……..……..
(*Penyelidik*)

Appendix D: Questionnaire

Lembaran Maklumat. Information Sheets

Salam dari Fakulti Perubatan dan Sains Kesihatan, Universiti Putra Malaysia. Saya Nur Fatiah Abdul Khalid, pelajar sarjana muda. Saya sedang menjalankan kajian untuk menentukan risiko menghidap diabetes mellitus jenis 2 dengan faktor-faktor yang berkaitan di kalangan pelajar universiti di Universiti Putra Malaysia. Seramai 190 pelajar akan terlibat dalam kajian ini. Pelajar di UPM yang memenuhi kriteria penyertaan adalah dialu-alukan untuk menyertai kajian sebagai subjek. Kriteria penyertaan dan pengecualian adalah seperti di bawah. Penyertaan anda dalam kajian ini adalah melalui tinjauan dalam talian yang mengambil masa kira-kira 15 minit.

Greeting from Faculty of Medicine and Health Sciences, Universiti Putra Malaysia. I'm Nur Fatiah Abdul Khalid, a undergraduate student. I'm currently doing study to determine the risk of developing type 2 diabetes mellitus with its associated factors among university students in Universiti Putra Malaysia. A total 190 students will be involved in the study. Students at UPM who fulfil the inclusion criteria are welcomed to participate in the study as subjects. The inclusion and exclusion criteria are as below. Your participation in this study will be through an online survey which takes about 15 minutes.

Kriteria penyertaan / Inclusion criteria:

- Berumur antara 18 – 45 /Age between 18-45
- Lelaki dan Perempuan / Male and female
- Warganegara Malaysia / Malaysian
- Boleh membaca dalam Bahasa Melayu atau Inggeris / Malay or English-literate

Kriteria pengecualian

- Didiagnos dengan T1DM atau T2DM / Diagnosed with T1DM and T2DM
- Mengandung atau menyusu / Pregnant or breastfeeding
- Tidak boleh melihat / Presence of disabilities (blindness)
- Tidak pasti sejarah keluarga yang menghidap diabetes / Not certain of family history of diabetes.

Sekiranya anda mempunyai sebarang pertanyaan tentang kajian ini, sila hubungi penyelidik kajian ini. If you have any inquiry about the study, please contact the researcher of this study.

- Cik Nur Fatiah Abdul Khalid – (016-4809792) / (e-mel: 200377@student.upm.edu.my)
- Prof. Madya Dr Barakatun Nisak Mohd Yusuf – (03-97692524) / (emel: bnisak@upm.edu.my)

BAHAGIAN A / SECTION A

BAHAGIAN A - FAKTOR SOSIODEMOGRAFI DAN STATUS NUTRISI / SECTION A – SOCIODEMOGRAPHIC FACTORS AND NUTRITIONAL STATUS

1.	Apakah umur anda? What is your age?	
2.	Apakah jantina anda? What is your gender?	☐ Lelaki /Male ☐ Perempuan / Female
3.	Apakah etnik anda? What is your ethnic?	☐ Melayu / Malay ☐ India / Indian ☐ Cina / Chinese ☐ lain - lain / Others
4.	Fakulti mana yang anda belajar? What faculty do you study at?	☐ Fakulti Kejuruteraan / Faculty of Engineering ☐ Fakulti Sains dan Teknologi Makanan / Faculty of Food Science and Technology ☐ Fakulti Sains / Faculty of science ☐ Fakulti Bahasa Moden dan Komunikasi / Faculty of Modern Language and Communication ☐ Fakulti Perubatan Veterinar / Faculty of Veterinary Medicine ☐ Fakulti Pertanian / Faculty of Agriculture ☐ Fakulti Perubatan dan Sains Kesihatan / Faculty of Medicine and Health Sciences ☐ Fakulti Pengajian Pendidikan / Faculty of Educational Studies
5.	Apakah pendapatan bulanan isi rumah (RM) anda? What is your household income (RM)?	☐ Kurang daripada RM 2500 sebulan / Less than RM2500 per month ☐ RM 2500 – RM 5000 sebulan / RM 2500 – RM 5000 per month

		☐ RM 5001 – RM 7500 sebulan / RM 5001 – RM 7500 per month ☐ Lebih daripada RM 10 000 sebulan / More than RM10 000 per month
6.	Apakah berat badan (Kg) anda? What is your weight (Kg)?	
7.	Apakah tinggi (m) anda? What is your height (m)?	
8.	Apakah ukur lilit pinggang (cm) anda? What is your waist circumference (cm)?	☐ XS (Women : 57 - 63 cm / 22. 4 - 24.8 inch) (Man : 66-72 cm / 26 - 28 inch) ☐ S (Women : 60-66 cm / 23.63 - 26 inch) (Man : 68-76 cm / 27 - 30 inch) ☐ M (Women : 63-69 cm / 24.8 - 27.17 inch) (Man : 76-84 cm / 30 - 33 inch) ☐ L (Women : 69-75 cm / 27.17 - 29.5 inch) (Man : 84 - 92 cm / 33 - 36 inch) ☐ XL (Women : 75-81 cm / 29.5 - 31.9 inch) (Man : 92-100 cm / 36 - 39 inch) ☐ XXL (Women : 81-87 cm / 31.9 - 34.25 inch) (Man : 100-108 cm / 39 - 42 inch) ☐ 3XL (Women : 87-93 cm / 34.25 - 36.6 inch) (Man : 108-116 cm / 42 - 45 inch)
9.	Sejarah keluarga yang menghidapi T2DM (Ahli keluarga terdekat dan lanjutan) . Family history of T2DM (Immediate and extended family members)	☐ Ada / Yes ☐ Tiada / No

BAHAGIAN B / SECTION B

BAHAGIAN B- AKTIVITI FIZIKAL / SECTION B – PHYSICAL ACTIVITY (International Physical Activity Questionnaire- IPAQ)

1.	Sepanjang 7 hari yang lalu, berapa hari anda melakukan aktiviti fizikal yang cergas seperti mengangkat berat, menggali, aerobik atau berbasikal laju?. During the last 7 days, on how many days did you do vigorous physical activities like heavy lifting, digging, aerobics, or fast bicycling? [Jika tiada aktiviti fizikal yang cergas, langkau ke soalan 3. If there is no vigorous physical activities, skip to questions 3]	
2.	Berapa banyak masa yang biasa anda gunakan untuk melakukan aktiviti fizikal yang cergas pada satu daripada hari tersebut? (jawab dalam jam/minit sehari)/. How much time did you usually spend doing vigorous physical activities on one of those days? (answer in hours/minutes per day)	
3.	Dalam tempoh 7 hari yang lalu, berapa hari anda melakukan aktiviti fizikal sederhana seperti membawa beban ringan, berbasikal pada kadar biasa atau tenis beregu? Tidak termasuk berjalan kaki. (jawab dalam hari/ minggu). During the last 7 days, on how many days did you do moderate physical activities like carrying light loads, bicycling at a regular pace, or doubles tennis? Do not include walking. (answer in days/week). [Jika tiada aktiviti fizikal sederhana, langkau ke soalan 5. If there is no moderate physical activities, skip to question 5]	
4.	Berapa banyak masa yang biasanya anda gunakan untuk melakukan aktiviti fizikal sederhana pada satu daripada hari tersebut? (jawab dalam jam/minit sehari). How much time did you usually spend doing moderate physical activities on one of those days? (answer in hours/minutes per day)	

5.	Dalam tempoh 7 hari yang lalu, berapa hari anda berjalan selama sekurang- kurangnya 10 minit pada satu masa? (jawab dalam hari/minggu). During the last 7 days, on how many days did you walk for at least 10 minutes at a time? (answer in days/week)	
6.	Berapa banyak masa yang biasa anda luangkan untuk berjalan pada satu daripada hari tersebut? (jawab dalam jam/minit sehari). How much time did you usually spend walking on one of those days? (answer in hours/minutes per day).	
7.	Dalam tempoh 7 hari lepas, berapa banyak masa yang anda habiskan untuk duduk pada hari bekerja? (jawab dalam jam/minit sehari). During the last 7 days,how much time did you spend sitting on a weekday? (answer in hours/minutes per day).	

BAHAGIAN C / SECTION C

BAHAGIAN C / SECTION C- Modified the Finnish Type 2 Diabetes Risk Assessment Tool (FINDRISC)

1.	Umur / Age	☐ <40 ☐ 40-60 ☐ >60
2.	Adakah mempunya ibubapa, adik-beradik atau saudara yang menghidapi diabetes? / Do you have diabetic parents or siblings or relative?	☐ Ya / Yes ☐ Tidak / No
3.	Adakah anda pernah menerima rawatan darah tinggi? / Being treated for hypertension?	☐ Ya / Yes ☐ Tidak / No
4.	Adakah anda minum minuman ringan?/ Do you drink canned soft drink?	☐ Tidak / Non ☐ 3-5 tin setiap minggu / 3-5 cans weekly ☐ 1 tin dan lebih/hari / 1 can & more/day
5.	Adakah anda melakukan senaman? / Do you do exercise?	☐ ≥30 minit sehari / ≥30 minutes per day ☐ <30 minit setiap hari / <30 minutes per day ☐ Tidak sama sekali / Not at all
6.	Ukur lilit pinggang / Waist circumference	☐ Lelaki / Male (<36 inches/<90cm) , Perempuan / Female (<32 inches/<80cm) ☐ Lelaki / Male (36-40 inches / 90cm-102cm), Perempuan / Female (32-35 inches / 80cm-88cm) ☐ Lelaki / Male (>40 inches / >102cm), Perempuan / Female (>35 inches / >88cm)

BAHAGIAN D / SECTION D

BAHAGIAN D / SECTION D- Dutch Eating Behaviour Questionnaire (DBEQ)

		Tidak pernah / Never	Jarang / Seldom	Kadang - kala / Sometimes	Biasa / Often	Selalu / Very Often
1.	Adakah anda merasai keinginan untuk makan apabila anda berasa terganggu? / Do you have the desire to eat when you are irritated?					
2.	Jika makanan itu sedap, apakah anda akan makan lebih dari biasa? / If food tastes good to you, do you eat more than usual?					
3.	Adakah anda merasai keinginan untuk makan apabila anda tiada kerja lain untuk dilakukan? / Do you have a desire to eat when you have nothing to do?					
4.	Jika berat badan anda bertambah, apakah anda akan makan kurang dari biasa? / If you have put on weight, do you eat less than you usually do?					
5.	Adakah anda merasai keinginan untuk makan apabila anda murung atau rasa tidak semangat? / Do you have a desire to eat when you are depressed or discouraged?					
6.	Jika makanan itu mempunyai bau dan kelihatan sedap, adakah anda akan makan lebih dari biasa ? / If food smells and looks good, do you eat more than usual?					
7.	Berapa kerapkah anda menolak makanan dan minuman yang ditawarkan kerana bimbang tentang berat badan anda? / How often do you refuse food or drink offered because you are concerned about your weight?					

8.	Adakah anda merasai keinginan untuk makan apabila anda berasa sepi? / Do you have a desire to eat when you are feeling lonely?					
9.	Jika anda ternampak atau bau sesuatu yang lazat, adakah anda merasai keinginan untuk memakannya? / If you see or smell something delicious, do you have a desire to eat it?					
10.	Adakah anda merasai keinginan untuk makan apabila seseorang telah mengecewakan anda? / Do you have a desire to eat when somebody lets you down?					
11.	Semasa waktu makan, adakah jumlah makanan anda kurang daripada jumlah yang diingini? / Do you try to eat less at mealtimes than you would like to eat?					
12.	Jika anda terus mempunyai makanan lazat, adakah anda akan terus memakannya? / If you have something delicious to eat, do you eat it straight away?					
13.	Adakah anda rasa keiginan untuk makan apabila anda berasa marah? / Do you have a desire to eat when you are cross?					
14.	Adakah anda jaga pemakanan anda? /Do you watch what you eat					
15.	Jika anda lalu di kedai roti, adakah anda merasai keinginan untuk membeli sesuatu yang lazat? / If you walk past the baker do you have the desire to buy something delicious?					
16.	Adakah anda merasai keinginan untuk makan apabila rasa seperti sesuatu yang buruk bakal berlaku? / Do you have a desire to eat when you are approaching something unpleasant to happen?					
17.	Adakah anda sengaja memakan makanan yang melangsingkan ? /Do you deliberately eat foods that are slimming?					
18.	Jika anda ternampak orang lain makan,					

	adakah anda juga merasai keinginan untuk makan? /If you see others eating, do you also have the desire to eat?					
19.	Sekiranya anda terlebih makan, adakah anda akan kurangkan makanan anda pada hari-hari berikutnya? / When you have eaten too much, do you eat less than usual the following days?					
20.	Adakah anda merasai keinginan untuk makan apabila anda berasa cemas atau bimbang?/Do you get the desire to eat when you are anxious, worried or tense?					
21.	Bolehkah anda mengawal diri daripada memakan makanan lazat? / Can you resist delicious food*					
22.	Adakah anda sengaja makan sedikit supaya berat badan anda tidak naik? / Do you deliberately eat less in order not to become heavier?					
23.	Adakah anda merasai keinginan untuk makan apabila sesuatu perkara yang bertentangan dengan keinginan anda berlaku? / Do you have a desire to eat when things are going against you or when things have gone wrong?					
24.	Jika anda lalu di sebuah kedai snek atau kafe, adakah anda merasai keinginan untuk membeli sesuatu yang lazat? / If you walk past a snack bar or a café, do you have the desire to buy something delicious?					
25.	Adakah anda merasai keinginan untuk makan apabila emosi anda terganggu? / Do you have the desire to eat when you are emotionally upset?					
26.	Berapa kerapkah anda cuba mengelak daripada makan di antara waktu makan kerana sedang menjaga berat badan anda? / How often do you try not to eat between meals because you are watching your weight?					
27.	Adakah anda akan makan lebih dari biasa apabila melihat orang lain makan? / Do you					

	eat more than usual when see others eating					
28.	Adakah anda merasai keinginan untuk makan apabila anda berasa bosan? / Do you have a desire to eat when you are bored or restless?					
29.	Berapa kerapkah anda cuba mengelak daripada makan petang kerana sedang menjaga berat badan anda? / How often in the evening do you try not to eat because you are watching your weight?					
30.	Adakah anda merasai keinginan untuk makan apabila anda berasa takut? / Do you have a desire to eat when you are frightened?					
31.	Adakah anda mengambil kira berat badan anda semasa makan? / Do you take into account your weight with what you eat?					
32.	Adakah anda merasai keinginan untuk makan apabila anda berasa kecewa? /Do you have a desire to eat when you are disappointed?					
33.	Apabila anda sedang menyediakan makanan, adakah anda cenderung untuk makan sesuatu? / When you are preparing a meal are you inclined to eat?					

Appendix E: Similarity Report

FYP THESIS WRITING

ORIGINALITY REPORT

7%	8%	10%	5%
SIMILARITY INDEX	INTERNET SOURCES	PUBLICATIONS	STUDENT PAPERS

PRIMARY SOURCES

1	www.chp.gov.hk Internet Source	1%
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3	www.ncbi.nlm.nih.gov Internet Source	1%
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