



VALIDATION OF SUGAR CRAVING ASSESSMENT
TOOL (MySCAT) AMONG NEWLY DIAGNOSED TYPE
II DIABETES PATIENTS IN KUANTAN AND
TERENGGANU

BY

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ABSTRACT

Type II Diabetes Mellitus (T2DM) is increasing dramatically among the Asian population. Many patients with T2DM are struggling to control their blood glucose levels. There is a persistent need to spread awareness regarding the current state of diabetes patients' sugar intake especially in Malaysia, which is one of the highest consumers of sugar across the Asian region. The purpose of this study is to validate the Sugar Craving Assessment Tool (MySCAT) among T2DM respondents. A total of 168 respondents were recruited to participate in this cross-sectional study. It was conducted in out-patient health clinics in Kuala Terengganu and Kuantan. Respondents sugar craving and dietary behaviour were measured using structured questionnaires which were MySCAT, 3-day dietary recall and demographic data. The interview sessions were conducted by a dietitian. MySCAT internal consistency test had a Cronbach's alpha value of 0.75 and showed a significant correlation ($r=0.56$, $p < 0.001$) with actual sugar intake collected via 3 days diet recall. Receiver operating characteristic (ROC) analysis reported a cut-off point for MySCAT scores as 16.5; the sensitivity = 0.83 and specificity = 0.38. From analysis, 62% of respondents were categorized as cravers and 38% as non-cravers. Males and females had no significant differences in craving status. Body mass index (BMI) had no association with craving scores. The mean carbohydrate (CHO) intake was 195g/day (SD=33.4) of which, mean intake of CHO for cravers was 203 g/day while the mean for non-cravers was 169 g/day. Mean value of calorie consumed over three days was 1620 kcal (SD=260.2). BMI correlated significantly with calorie intake ($r = 0.43$, $p < 0.001$), while CHO intake was significantly associated with energy intake ($r=0.85$, $p < 0.001$) as well as with BMI ($r=0.43$, $p < 0.001$). Moreover, significant correlation was found between sugar intake and carbohydrate intake ($r=0.567$, $p < 0.001$). Analysis of eating behaviour using the Dutch Eating Behaviour Questionnaire (DEBQ) showed that, sugar craving scores were similar regardless of respondents eating behaviour (restraint, emotional or external). Most of our respondents were cravers regardless of the eating behaviour. This study found that MySCAT provides an easy and efficient tool which was sensitive enough to identify those with sugar craving problem. It also provides an overview of respondent's dietary intake and points out their problem with dietary intake compliance. We conclude that MySCAT is an important tool that can aid dietitians in their consultation session.

مُلخَص البَحْث

بات مَرَضُ السُّكْرِي مِنَ النُّوعِ الثَّانِي يَتَزَايِدُ بِشَكْلِ كَبِيرٍ بَيْنَ سُكَّانِ آسِيَا. العَدِيدُ مِنَ مَرَضَى السُّكْرِي مِنَ النَّمَطِ الثَّانِي يُكَافِحُونَ لِلسَّيْطَرَةِ عَلَى مُسْتَوَى جُلُوكُوزِ الدَّمِ. هُنَالِكَ حَاجَةٌ مَاسَةً لِنَشْرِ الوَعْيِ حَوْلِ الوَضْعِ الرَّاهِنِ لِمَرَضِ السُّكْرِي، خَاصَّةً فِي مَالِيْزِيَا وَالَّتِي صُنِفَتْ كَوَاحِدَةٍ مِنَ أَعْلَى الدُّوَلِ المُسْتَهْلِكَةِ لِلسُّكْرِ فِي آسِيَا. وَبِالتَّالِي، فَإِنَّ العَرَضَ مِنَ هَذِهِ الدِّرَاسَةِ هُوَ التَّحَقُّقُ مِنَ دِقَّةِ عَمَلِ أَدَاةِ اسْتِيبَانِ الإفْرَاطِ فِي تَنَاوُلِ السُّكْرِ (MySCAT) لِلْمَرَضَى اللَّذِينَ يَعاْنُونَ مِنْ مُشْكَلَةِ الإفْرَاطِ فِي تَنَاوُلِ السُّكْرِ، وَلِذَلِكَ تَمَّ تَحْدِيدُ مَجْمُوعَةٍ مُكوَّنَةٍ مِنَ 168 مِنَ مَرَضَى السُّكْرِي مِنَ النَّمَطِ الثَّانِي لِلْمِشَارَكَةِ فِي هَذِهِ الدِّرَاسَةِ. تَمَّ إِجْرَاءُ الدِّرَاسَةِ فِي عِيَادَاتٍ صَحِيَّةٍ فِي مَدِينَتِي كَوَالَا تَرَنْجَانُو وَكُوَانْتَانِ فِي مَالِيْزِيَا. إِعْتَمَدْنَا عَلَى أَدَاةِ اسْتِيبَانِ الإفْرَاطِ فِي تَنَاوُلِ السُّكْرِ (MySCAT) وَاسْتِيبَانِ النِّظَامِ الغِذَائِيِّ لِمُدَّةِ ثَلَاثَةِ أَيَّامٍ وَالبَيَانَاتِ الدِّيمُوغْرَافِيَّةِ لِقِيَاسِ الإفْرَاطِ فِي تَنَاوُلِ السُّكْرِ وَالسُّلُوكِ الغِذَائِيِّ. تَمَّ إِجْرَاءُ المَقَابَلَاتِ مَعَ مَرَضَى السُّكْرِي مِنْ قَبْلِ أَحْصَائِي التَّغْذِيَّةِ، وَقَدْ أَظْهَرَتْ نَتَائِجُ الاتِّسَاقِ الدَّاخِلِيِّ لِأَدَاةِ اسْتِيبَانِ السُّكْرِ لَدَى المَرَضَى قِيَمَةَ كَرُونَبَاحِ الفَا ($\alpha=0.75$) وَكَانَتْ هُنَاكَ عِلَاقَةٌ اِيجَابِيَّةٌ قَوِيَّةٌ بَيْنَ أَدَاةِ الاسْتِيبَانِ عَنِ الإفْرَاطِ فِي تَنَاوُلِ السُّكْرِ وَالكَمِيَّةِ الفَعْلِيَّةِ الَّتِي قِيَسَتْ خِلَالَ ثَلَاثَةِ أَيَّامٍ ($r = 0.56$ ، $p > 0.001$). أَفَادَ تَحْلِيلُ ROC لِأَدَاةِ اسْتِيبَانِ السُّكْرِ عَنِ حَسَاسِيَّةِ قِيَمَتِهَا 0.83 وَخُصُوصِيَّةِ قِيَمَتِهَا 0.38. أَمَا قِيَمَةُ الحُدِّ الأَعْلَى لِأَدَاةِ الاسْتِيبَانِ القَابِلِ لِلتَّطْبِيقِ (Cut-Off) فَكَانَ 16.5. تَمَّ تَصْنِيفُ 62% مِنَ المِشَارَكِينَ مِنْ مَرَضَى السُّكْرِي عَلَى أَنَّهُمْ مَفْرُطِينَ فِي تَنَاوُلِ السُّكْرِ وَ 38% عَلَى أَنَّهُمْ غَيْرُ مُفْرُطِينَ فِي تَنَاوُلِ السُّكْرِ. لَمْ يَسْجَلِ الذُّكُورُ وَالإِنَاثُ اخْتِلَافَاتٍ كَبِيرَةً مِنْ نَاحِيَةِ الإفْرَاطِ فِي تَنَاوُلِ السُّكْرِ. تَشِيرُ النَتَائِجُ إِلَى عَدَمِ وَجُودِ أَيِّ فَرْقٍ بَيْنَ مُؤَشِّرِ كُتْلَةِ الجِسْمِ وَالإِفْرَاطِ فِي تَنَاوُلِ السُّكْرِ. مُتَوَسِّطُ تَنَاوُلِ الكَرْبُوهِيدْرَاتِ كَانَ 195 جِرامًا/بِاليَوْمِ ($SD=33.4$)، أَمَا مُتَوَسِّطُ الكَرْبُوهِيدْرَاتِ لِلْمَفْرُطِينَ فِي تَنَاوُلِ السُّكْرِ فَكَانَ 203 جِرامًا/بِاليَوْمِ بَيْنَمَا كَانَ المُتَوَسِّطُ لِعَلاَمَةِ المَفْرُطِينَ فِي تَنَاوُلِ السُّكْرِ 169 جِرامًا/بِاليَوْمِ. كَانَتْ قِيَمَةُ مُتَوَسِّطِ الشُّعْرَاتِ الحَرَارِيَّةِ المُسْتَهْلِكَةِ عَلَى مَدَى ثَلَاثَةِ أَيَّامٍ 1620 سُعْرَةً بِاليَوْمِ ($SD=260.2$). وَأكَّدتِ النَتَائِجُ عَلَى وَجُودِ عِلَاقَةٍ قَوِيَّةٍ تَرْتِيبُ بَيْنَ مُؤَشِّرِ كُتْلَةِ الجِسْمِ وَمُتَوَسِّطِ الشُّعْرَاتِ الحَرَارِيَّةِ ($r = 0.43$ ، $p > 0.001$)، وَبَيْنَ تَنَاوُلِ الكَرْبُوهِيدْرَاتِ وَمُتَوَسِّطِ الشُّعْرَاتِ الحَرَارِيَّةِ ($r = 0.85$ ، $p > 0.001$). وَكَانَتْ العِلَاقَةُ اِيجَابِيَّةً ($r = 0.43$ ، $p > 0.001$) بَيْنَ مُؤَشِّرِ كُتْلَةِ الجِسْمِ وَتَنَاوُلِ الكَرْبُوهِيدْرَاتِ. عِلَاوَةً عَلَى ذَلِكَ، تَشِيرُ النَتَائِجُ إِلَى وَجُودِ عِلَاقَةٍ اِيجَابِيَّةٍ بَيْنَ تَنَاوُلِ الكَرْبُوهِيدْرَاتِ وَ تَنَاوُلِ السُّكْرِ ($r = 0.567$ ، $p > 0.001$). تَمَّ قِيَاسُ سُلُوكِ المَرَضَى فِي تَنَاوُلِ الطَّعَامِ بِاسْتِيبَانِ سُلُوكِيَّاتِ الطَّعَامِ الهُولَنْدِيِّ (DEBQ)، وَأَظْهَرَتْ النَتَائِجُ بِأَنَّ مَعْدَلَاتِ الإفْرَاطِ فِي تَنَاوُلِ السُّكْرِ كَانَتْ مَتَمَاثِلَةً بِغَضِّ النِّظَرِ عَنِ سُلُوكِ المَرِيضِ (كَبِجْحِ النِّفْسِ أَوْ عَاطْفِي أَوْ خَارِجِي)، بِمَعْنَى أَنَّ مُعْظَمَ المُنْتَسِبِينَ لِهَذِهِ الدِّرَاسَةِ كَانُوا مُفْرُطِينَ فِي تَنَاوُلِ السُّكْرِ بِغَضِّ النِّظَرِ عَنِ سُلُوكِيَّاتِهِمْ. وَجَدَ البَحْثُ بِأَنَّ أَدَاةَ اسْتِيبَانِ السُّكْرِ (MySCAT) تُعْتَبَرُ أَدَاةً سَهْلَةً وَ فَعَالَةً فِي قِيَاسِ أَوَّلَمَكِ الذَّيْنَ يَعاْنُونَ مِنْ مُشْكَلَةِ الإفْرَاطِ فِي تَنَاوُلِ السُّكْرِ، كَمَا تُوفِّرُ نَبْذَةً عَامَةً عَنِ المَدْخُولِ الغِذَائِيِّ لِمَرَضَى السُّكْرِي مِنَ النَّمَطِ الثَّانِي. وَ أُخِيرًا تَقْتَرِحُ عَلَى أَحْصَائِي التَّغْذِيَّةِ فِي مَقَابَلَاتِهِمْ مَعَ مَرَضَى السُّكْرِي بِاسْتِيبَانِ أَدَاةِ اسْتِيبَانِ الإفْرَاطِ فِي تَنَاوُلِ السُّكْرِ (MySCAT).

ABSTRAK

Penyakit kencing manis atau Diabetes Mellitus Jenis II (“*Type 2 Diabetes Mellitus*”; T2DM) meningkat secara mendadak di kalangan penduduk di rantau Asia. Ramai pesakit diabetes yang sedang berusaha untuk mengawal tahap glukosa di dalam darah mereka. Terdapat keperluan berterusan untuk menyebarkan kesedaran yang lebih mengenai pengambilan gula pesakit-pesakit diabetes terutama di Malaysia, yang merupakan salah satu negara pengguna gula yang tertinggi di rantau Asia. Tujuan kajian ini adalah untuk mengesahkan Alat Penilaian Keinginan Gula (MySCAT) di kalangan pesakit-pesakit diabetes T2DM. Seramai 168 responden telah mengambil bahagian dalam kajian rentas yang dijalankan di klinik-klinik kesihatan pesakit luar di Kuala Terengganu dan Kuantan. Keinginan gula dan tingkah-laku pemakanan pesakit diukur dengan menggunakan soal selidik berstruktur yang terdiri daripada MySCAT, peringatan kembali pemakanan tiga hari diet (“*Three-day dietary recall*”) dan juga data demografi. Sesi wawancara dilakukan oleh ahli dietitian (“*dietitian*”). Ujian konsistensi dalaman MySCAT mempunyai nilai alpha Cronbach sebesar 0.75 dan menunjukkan korelasi yang signifikan ($r = 0.56$, $p < 0.001$) manakala nilai pengambilan gula sebenar adalah dikumpulkan melalui peringatan kembali pemakanan 3-hari yang lalu. Analisis ROC melaporkan titik pemotongan untuk skor MySCAT sebagai 16.5; dengan sensitiviti = 0.83 dan kekhususan = 0.38. Dari analisis yang dijalankan, 62% daripada responden dikategorikan sebagai pengidam gula (“*cravers*”) manakala 38% adalah bukan pengidam. Tiada perbezaan yang signifikan dalam status keinginan gula di antara pesakit lelaki dan perempuan. BMI juga tiada berkaitan dengan skor keinginan gula. Purata pengambilan karbohidrat adalah 195g / hari (SD = 33.4) di mana bagi pengidam gula adalah 203 g / hari manakala purata bagi bukan pengidam gula adalah 169 g / hari. Nilai purata pengambilan kalori selama tiga hari ialah 1620 kcal (SD = 260.2). BMI berkorelasi dengan pengambilan kalori ($r = 0.43$, $p < 0.001$), manakala pengambilan karbohidrat adalah dikaitkan secara signifikan dengan pengambilan tenaga ($r = 0.85$, $p < 0.001$) serta BMI ($r = 0.43$, $p < 0.001$). Selain daripada itu, korelasi yang signifikan didapati antara pengambilan gula dan pengambilan karbohidrat ($r = 0.567$, $p < 0.001$). Analisis tingkah laku pemakanan menggunakan Soal-jawab Tabiat Pemakanan Negara Belanda “*Dutch Eating Behaviour Questionnaire*” (DEBQ) menunjukkan bahawa skor keinginan gula adalah sama tanpa mengira tingkah laku pesakit (pengekangan, emosi atau faktor luaran). Kebanyakan responden adalah pengidam gula tanpa mengira tingkah laku pemakanan mereka. Kajian ini mendapati bahawa MySCAT menyediakan suatu peralatan mudah yang senang untuk difahami dan yang cukup sensitif untuk mengenalpasti pesakit diabetes yang mengalami masalah mengidam gula. Ia juga memberikan gambaran keseluruhan pengambilan makanan pesakit-pesakit ini dan mengenal-pasti masalah-masalah pematuhan pengambilan makanan mereka. Kami menyimpulkan bahawa MySCAT adalah peralatan penting yang boleh membantu dietitian dalam sesi diet dengan pesakit diabetes.

APPROVAL PAGE

I certify that I have supervised and read this study and that in my opinion; it conforms to acceptable standards of scholarly presentation and is fully adequate, in scope and quality, as a thesis for the degree of Master of Health Sciences

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DECLARATION

I hereby declare that this thesis is the result of my own investigations, except where otherwise stated. I also declare that it has not been previously or concurrently submitted as a whole for any other degrees at IIUM or other institutions.

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LIST OF ABBREVIATIONS

T2DM	Type II Diabetes mellitus
T1DM	Type I Diabetes mellitus
NCDs	Non-communicable diseases
WHO	World Health Organization
BMI	Body Mass Index
HbA _{1c}	Glycated haemoglobin
FBS	Fasting plasma glucose
OGTT	Oral glucose tolerance test
RPG	Random plasma glucose
ADA	American dietetic association
CVD	Cardiovascular diseases
ADA	American diabetic association
CAD	Coronary artery disease
OHA	Oral hypoglycaemic agents
UK	United Kingdom
MANS	Malaysian Adult Nutrition Survey
MOH	Ministry of health Malaysia
CDC	Centre for Disease Control and Prevention
GDM	Gestational diabetes mellitus
NHMS	National health and morbidity survey
CPG	Malaysian clinical practice guideline
FHS	Framingham Heart study
AHA	American heart association
MNT	Medical Nutrition therapy
FAO	Food and agriculture organization
CI	Confidence level
EASD	European association for the study of diabetes
ACCORD	Action to Control Cardiovascular Risk in Diabetes trial
ADVANCE	Action in Diabetes and Vascular Disease
VADT	Veterans Administration Diabetes Trail
SPSS	Statistical Package for Social Sciences programme software
ROC	Receiver operating characteristic
AUC	Area Under Curve
Se	Sensitivity
Sp	Specificity
BMI	Body Mass Index
RDs	Registered dieticians
HSNZ	Hospital Sultanah Nur Zahirah
DEBQ	Dutch Eating Behaviour Questionnaire
FCI	Food Craving Inventory
FCQ	Food Craving Questionnaire
FFQ	Food Frequency Questionnaire
NMRR	National Medical Research Register
IREC	IIUM Research Ethics Committee
CHO	Carbohydrate

DM	Diabetes mellitus
HPT	Hypertension
HPL	Hyperlipidaemia
SD	Standard deviation
No	Number
MySCAT	Malaysian Sugar Craving Assessment Tool
SSB	Sugar-sweetened beverages
USFDA	United State Food and Drug Administration
WHO	World Health Organization

CHAPTER ONE

INTRODUCTION

1.1 BACKGROUND OF THE STUDY

Type 2 Diabetes (T2DM) is non-communicable disease, however cases had been increasing since past decade where it may seem that it is. The prevalence of diabetes had been on upward trend. It was reported by the third National Health Morbidity Survey (NHMS III) in 2006 that diabetes is the second most common chronic disease in Malaysia. It was estimated by Letchuman *et al.*, (2010) that there is 80% increase in the prevalence of diabetes during the past decade. This increasing rate of diabetes had been linked to the increase of sugar consumption globally as it reported by the US Department of Agriculture. In 2012 that there is an escalating rise in sugar industry to overcome the demand of the market. Malaysia had been ranked as one of the highest sugar importer country in the world (USDA, 2012). It could be debatable whether sugar is addictive food item; however, we cannot deny the statistics and the projected hazards of excessive sugar intake by diabetes patients (Amal *et al.*,2011).

Diabetes had been field of interest to vast number of studies. Most of these studies had been focused on investigating risk factors and causation of the diseases. Other studies provided a profound understanding regarding diabetes and eating behaviour. However, fewer studies had been investigating specific food items that have direct effect on diabetes patients. Though, T2DM is curable disease if managed well, the statistics of mortality had been increased since past decade. Based on the *Action to Control Cardiovascular Risk in Diabetes* (ACCORD) study, they reported that the hazard of mortality ratio hazardously increased, they also found out that intensive

therapy group reported an increase in mortality in association to weight gain (ACCORD, 2008). These finding ignited the need to apprehend eating pattern of diabetes patients. Thus, Van Strien *et al.*, (2008) suggested treatment for patients with overeating tendency. However, still few studies had discussed specific food item and it's association with diabetes patients, espacially sugar as an addictive food item that can accelerate diabetes prognosis (Swarna, 2014).

1.2 RESEARCH OBJECTIVES

This research is aimed to validate Malaysian Sugar Craving Assessment Tool (MySCAT) and to investigate craving, food intake and eating behaviour among diabetes patients of T2DM as listed below:

1.2.1 General objectives

To validate Sugar Craving Assessment Tool (MySCAT) among diabetes patients (T2DM).

1.2.2 Specific Objectives

- 1- To assess the internal consistency of Sugar Craving Assessment Tool (MySCAT) among diabetes patients (T2DM).
- 2- To assess the sensitivity and specificity of Sugar Craving Assessment Tool (MySCAT) among diabetes patients (T2DM).
- 3- To assess the level of cravings for sugar among diabetes patients.
- 4- To determine the correlation of sugar craving and glycaemic control among (T2DM).

- 5- To determine the correlation between Socio economic status, family history, gender, BMI and multi-chronic disease and sugar craving.
- 6- To determine their craving level in association to their glycaemic control and eating behaviour
- 7- To identify diabetes patients' eating behaviour and its association with craving.

1.3 RESEARCH QUESTIONS

This research is trying to answer the following questions:

- 1- Does the Sugar Craving Assessment Tool (MySCAT) have an internal consistency to assess sugar craving among diabetes patients?
- 2- Is Sugar Craving Assessment tool (MySCAT) sensitive and specified to measure sugar craving?
- 3- What is the status of sugar cravings among diabetes patients?
- 4- Is there association between sugar cravings and glycaemic control among (T2DM)?
- 5- Is there an association between socio economic status, family history, gender, BMI and multi-chronic disease and sugar craving?
- 6- What are T2DM eating behaviour scales?
- 7- Is there association between sugar cravings and eating behaviour among T2DM?

1.4 THEORETICAL FRAMEWORK

The goal of this study is to provide easy useful tool for dietician during their consultation as most dietitian reported that time is one of the main problems in consultation (Lemon *et al.*, 2004). This study focusses precisely on measuring patient's sugar intake since, sugar had been one of the major issues for diabetes patients. Diabetes patient usually under report their food intake when asked to report their 24-diet recall. Therefore, an efficient tool is needed to measure their food intake over a period of time. In Malaysia there are few studies conducted to investigate sugar intake, though Malaysia had been reported as one the highest sugar consumer countries. The nature of this study is concentrated on diabetes patients' sugar craving and sugar intake with it association to eating behaviour and investigating other variables that can influence sugar craving either positively or negatively. Study variables are illustrated in the conceptual framework below (Figure 3.1).

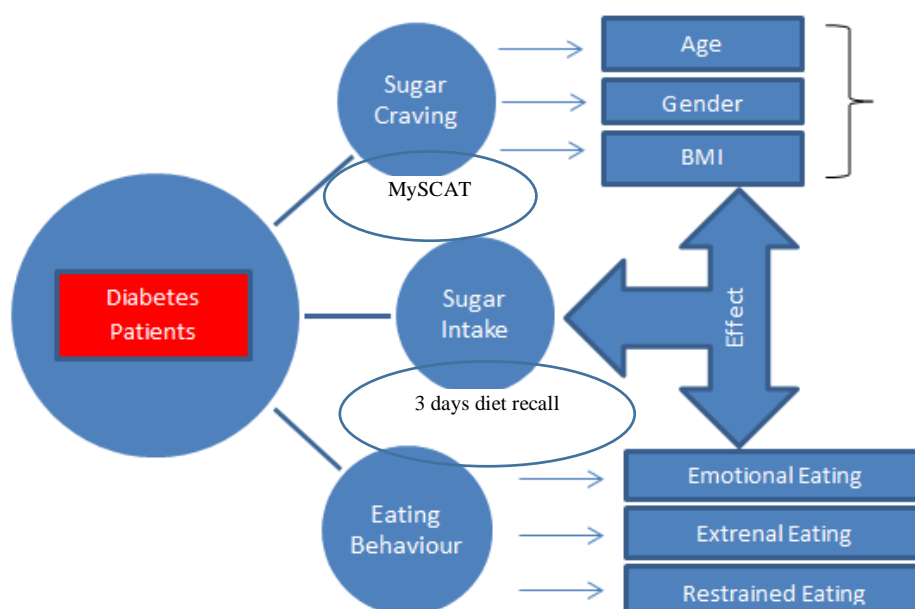


Figure 1.1 conceptual framework of MySCAT and sugar intake and its effect on study variables

1.5 HYPOTHESES

Based on postulating relationship of diabetes patients with their craving for sugar, actual sugar intake, eating behaviour, gender, BMI and the efficiency of using MySCAT to measure sugar craving among Malaysian diabetes patients; the following hypotheses were generated:

- Sugar Craving Assessment Tool is valid tool to measure sugar craving among Malaysian diabetes patients.
- Sugar Craving Assessment Tool is an efficient tool to measure sugar craving among Malaysian diabetic patients.
- The sugar craving status is high among Malaysian diabetes patients.
- There is no association between sugar cravings and glyceamic control among (T2DM).
- There is an association between socio economic status, family history, gender, BMI and multi-chronic disease and sugar craving
- Diabetes patients have emotional eaters.
- There is no association between sugar cravings and eating behaviour among diabetic patients.

CHAPTER TWO

LITERATURE REVIEW

2.1 TYPE 2 DIABETES MELLITUS

2.1.1 Etiology of Diabetes

Diabetes mellitus is one of the main non-communicable diseases (NCDs) that many individuals had developed due to many risk factors such as genetic; obesity; inactivity and life style (Wildman *et al.*, 2008; Needland *et al.*, 2012). Diabetes mellitus is a disease of endocrine system that can be divided in these major categories which are type 1 (T1DM) and type 2 (T2DM) and gestational diabetes mellitus (GDM). The T1DM is caused by auto immune destruction of beta cells in the pancreas, which results in absolute deficiency of insulin in the body, therefore, those with T1DM need insulin injection due to the absence of insulin in their body, which explains why they are called insulin dependent diabetes or juvenile onset diabetes (Escott, 2005). T1DM was reported to account 5-10% of those with diabetes. The complications of T1DM are severe hyperglycaemia with or without ketoacidosis. Mainly the auto immune destruction can be related to genetic predisposition of the disease as well as its related to environmental factors (ADA, 2014).

T2DM results from relative deficiency or insulin resistance. Patients with T2DM relatively have insulin at least in the beginning, however, they later develop insulin dependence similar to those with T1DM as result to diabetes deterioration or prognosis of diabetes, therefore, they are called non-insulin dependent. Specific aetiology to diabetes T2DM is still not clear, since they later develop autoimmune destruction of beta-cells in the pancreas (Malani *et al.*, 2012).

T2DM accounts nearly 90-95% of diabetes patients (Mahan *et al.*, 2012). It was mentioned by many researchers that T2DM usually go undiagnosed for many years which due to the hyperglycemia developing gradually, where, most patients will be oblivious to the existence of their disease; those patients mostly will suffer from the complications of T2DM such as macro-vascular and micro-vascular complications. Long term uncontrolled blood glucose level is associated with risk of heart diseases, stroke, peripheral neuropathy, renal disease, blindness and amputation which result in reduce life expectancy (Smushkin *et al.*, 2010).

2.1.2 Diagnosis of Diabetes Mellitus Type 2

The diagnosis of T2DM can be identified by laboratory value of glycated haemoglobin HbA_{1c} which measures the average of one's blood glucose level over two to three months and those with 6.5% are considered diabetes. *Fasting Plasma Glucose* (FPG) is a test where patients should fast for 8 hours; diabetes is diagnosed at fasting blood glucose greater than or to 126 mg/dl (7 mmol/L). *Oral Glucose Tolerance Test* (OGTT) is another test to determine the body tolerance to glucose after drinking a special sweet drink containing glucose, diabetes is diagnosed at 2-hour blood glucose of greater than or equal to 200 mg/dl (11.1 mmol/L). Lastly is *Random Plasma Glucose* (RPG) which is can be taken any time of the day when patients have severed diabetes symptoms, diabetes diagnosed at blood glucose of greater than or equal to 200 mg/dl (11.1 mmol/L) (ADA, 2013; Mahan *et al.*, 2012).

2.1.2 Prevalence

2.1.2.1 Status of T2DM Worldwide

Diabetes mellitus had been increasingly doubled in numbers affecting more and more people around the globe. The World Health Organization (WHO) has been quantifying the prevalence of diabetes and estimating the number of those who have been affected and will be affected in the upcoming years. They estimated that more than 220 million people worldwide are having diabetes where T2DM comprised 90% of that count (WHO, 2010).

Wild *et al.*, (2004) reported that diabetes is projected to affect 366 million people by 2030. In 2011 Centre for Disease Control and Prevention (CDC) reported that diabetes affects 25.8 million people in the United States. Unfortunately, these numbers had been increasing. The International Diabetic Federation (IDF), in 2015 reported in their key messages that one in eleven adults had T2DM globally. These findings suggest that T2DM had reached its epidemic level especially in 75% of developing countries.

Moreover, it has been a challenge for most health professionals, researchers and those who suffer greatly from diabetes, to find ways to curb and manage dietary intake for those who have the disease and to find ways of prevention from developing the disease across all nations. The knowledge of prevalence can help to develop a calculation and allocation of resources to manage the disease. In 2015 the WHO issued a progress monitor book of non-communicable diseases, which reported that, percentage of premature mortality from NCDs was 14% in the US (WHO, 2015). They also reported that diabetes had contributed to cause 1.5 million deaths globally. Generally, high blood glucose contributed to cause 2.2 million deaths worldwide (WHO, 2016).

Diabetes is major cause of heart diseases and stroke and is the leading cause of kidney failure and non-traumatic lower limb amputations among American adults. In a review by Gross *et al.*, where, they reviewed the rise of sugar and food industry, they found out that the burden of T2DM had increased dramatically in the past decade. This is parallel to the change and rise of food industry and lifestyle based on recent data which suggested that high intake of refined sugar and carbohydrate food could increase risk of insulin resistance (Gross *et al.*, 2004).

In the 21st century, researchers estimated that diabetes will be a threat to human health globally as it was reported by Zimmet (2000).

2.1.2.2 Status of T2DM in Malaysia

In Asia, diabetes had affected many people. It was reported that Asian countries contributed to more than 60% of diabetic cases worldwide. This was related to the continuously increasing growth of urbanization in these countries which had contributed majorly to shift lifestyle to unhealthy one that had significant effect on growing cases of T2DM (Ramachandran *et al.*, 2012).

It was reported by the WHO that percentage of death from NCDs in Malaysia was 73% of total deaths which accounts to 107,000 deaths. This probability of mortality from NCDs was 20% higher in compares with other countries. They explained that mortality among different countries seems to vary. However, mortality by high blood glucose level among countries seems to be higher among low- and middle-income countries than in high income countries (WHO, 2016).

The Ministry of Health Malaysia had published a statistical report that showed T2DM accounts for 90% to 95% of all diagnosed diabetes where it could be present long before it is diagnosed. The survey estimated that for every person who is diagnosed