Adherence of Patients with Type 2 Diabetes Mellitus with the SEMDSA Lifestyle Guidelines

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DECLARATION WITH REGARD TO INDEPENDENT WORK

I, Amy Birkinshaw, identity number 8411130182083 and student number 2013183351, do hereby declare that this research project submitted to the University of the Free State for the degree MAGISTER SCIENTIAE: **Adherence of patients with Type 2 Diabetes Mellitus with the SEMDSA lifestyle guidelines**, is my own independent work, and has not been submitted before to any institution by myself or any other person in fulfilment of the requirements for the attainment of any qualification. I further cede copyright of this research in favour of the University of the Free State.

A. Birkinshaw *30 January 2017*

SIGNATURE OF STUDENT **DATE**

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To Dad, Mom and Marc – This one's for you! Thanks for always believing in me and being such a strong, unwavering support system. I love you always

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LIST OF ABBREVIATIONS

ADA	American Diabetes Association
AHA	American Heart Association
ALA	Alpha-linolenic acid
ATP	Adenosine triphosphate
BMI	Body Mass Index
BP	Blood pressure
CDC	Centers for Disease Control and Prevention
CHD	Coronary heart disease
CKD	Chronic kidney disease
CVD	Cardio-vascular disease
DASH	Dietary Approaches to Stop Hypertension
DHA	Docosahexaenoic acid
DPPRG	Diabetes Prevention Programme Research Group
DM	Diabetes mellitus
DRI	Daily Recommended Intake
EASD	European Association for the Study of Diabetes
EPA	Eicosapentaenoic acid
EPIC	European Investigation into Cancer and Nutrition Study
FF3	Food Finder 3
FFQ	Food frequency questionnaire
FPG	Fasting plasma glucose
GI	Glycaemic index
GP	General practitioner
GPAQ	Global Physical Activity Questionnaire
HFCS	High fructose corn syrup
HDL	High density lipoprotein
HSFSA	Heart and Stroke Foundation of South Africa
IDF	International Diabetes Federation

LEADER	Liraglutide Effect and Action in Diabetes: Evaluation of Cardiovascular Outcome Results Trial
LDL	Low density lipoprotein
mmol/L	millimoles per litre
MNT	Medical nutrition therapy
MRC	Medical Research Council
MUFA	Monounsaturated fatty acids
NCD-RisC	Non-communicable Diseases Risk Factor Collaboration
NICUS	Nutrition Information Centre, University of Stellenbosch
NHANES	National Health and Nutrition Examination Survey
OGTT	Oral glucose tolerance test
PG	Plasma glucose
PGC-1	Peroxisome proliferator-activated receptor gamma coactivator-1
PUFA	Polyunsaturated fatty acids
PREFREC	Panama population-based survey of risk factors associated with cardiovascular disease in adults ≥ 18 years
PVD	Peripheral vascular disease
RBG	Random blood glucose
SANDF	South African National Defence Force
SANHANES	South African National Health and Nutrition Examination Survey
SEMDSA	Society for Endocrinology, Metabolism and Diabetes in South Africa
SFA	Saturated fatty acids
SHIELD	Study to Help Improve Early Evaluation and Management of Risk Factors Leading to Diabetes
STEPS	STEPwise approach to Surveillance
T2DM	Type 2 diabetes mellitus
TE	Total energy
TG	Triglycerides
THUSA	Transition, Health & Urbanisation in South Africa

v-LDL	Very low density lipoprotein
WHO	World Health Organisation

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SUMMARY

Over the last decade, the global burden of disease and mortality has shifted from infectious diseases to chronic diseases. Type 2 diabetes mellitus (T2DM) is considered to be the fastest growing chronic disease in the world.

T2DM is a progressive disease that is associated with a high degree of morbidity and premature mortality in many countries, including South Africa. The global rise in overweight and obesity is considered to be the main reason that the prevalence of T2DM is increasing at such an alarming rate.

T2DM is largely preventable. Multi-sectoral, population-based strategies and approaches are, however, needed to address the modifiable risk factors involved in the development of T2DM. Evidence-based nutrition principals and recommendations are continuously summarised by the Society for Endocrinology, Metabolism and Diabetes in South Africa (SEMDSA) into guidelines for the management of T2DM.

In the present study, a cross-sectional study design was applied in a convenient sample (n=50) to determine the adherence of patients with T2DM with the SEMDSA lifestyle guidelines. Participants were over 18 years old and being treated for T2DM at a private physician's practice in Bloemfontein. The study was approved by the Health Sciences Research Ethics Committee of the University of the Free State and all participants signed written informed consent.

Three questionnaires were completed by the researcher in a structured interview with each participant. A Food Frequency Questionnaire (FFQ) was used to obtain information about dietary intake to determine both macronutrient and micronutrient intake. Physical activity intensity and duration was calculated using the Global Physical Activity Questionnaire (GPAQ), developed by the WHO. Information related to travel to and from work/ other places, activity at work and recreational activities as well as sedentary behaviour was obtained. Information related to socio-demographics (age, gender, language, marital status and level of education) and smoking and alcohol intake were collected using a questionnaire developed by the researcher (based on the SEMDSA guidelines). Anthropometric measurements were taken by the

researcher according to standardised techniques, to determine BMI, waist circumference and waist-height ratio.

The median age of participants was 57.9 years and the median time since T2DM diagnosis was seven years. The majority of participants were married (74%). About half spoke Afrikaans at home (52%) and worked full-time (54%). Gender was fairly equally distributed.

The majority of participants were overweight (22%) or obese (66%). Most (90%) had a waist circumference above the high-risk cut point, while 92% had a high risk waist-height ratio above 0.5.

The SEMDSA guidelines recommend that carbohydrates should make up 45-60% of total energy intake, total fat should be restricted to < 35% of total energy and of this, < 7% should come from saturated fat. It is recommended that sodium should be restricted to < 2 300 mg daily and that two portions of oily fish should be consumed each week to meet the recommended omega 3 fatty acid intake.

Information related to dietary intake indicated that the SEMDSA lifestyle guidelines were poorly adhered to. Most participants followed a diet that was low in carbohydrates, high in fat (especially saturated fat) and low in omega 3 fatty acids. Sodium intake was high. Sedentary behaviour and lack of physical activity were common in the majority of participants, with 84% not meeting the guideline for aerobic exercise and 92% not meeting the guideline for resistance training. Ten percent of the participants were current smokers and of the men that regularly consumed alcohol, two thirds (66.67%) fell into the 'high' consumption (> 2 units daily) category.

In conclusion, the adherence of participants to the SEMDSA guidelines was poor, thus increasing their risk of long term complications and poor glycaemic control. Complying with the SEMDSA guidelines can assist in maintaining a healthy weight, consuming a healthy diet and performing regular exercise. Further research related to the barriers that prevent patients from following the guidelines is warranted, in order to motivate practical, cost-effective and relevant interventions.

OPSOMMING

Oor die afgelope dekade, het die wêreldwye siekteprofiel en mortaliteit verander van infektiewe siektes na chroniese siektes. Tipe 2 diabetes mellitus (T2DM) word beskou as die chroniese siekte wat die vinnigste toeneem.

T2DM is ‘n progressiewe siekte wat in baie lande, insluitend Suid-Afrika, met ‘n hoë vlak van morbiditeit en premature mortaliteit, verband hou. The wêreldwye toename in oormassa en vetsug word beskou as die hoofrede waarom T2DM so toeneem.

T2DM is grootliks voorkombaar. Multi-sektorale, populasie-gebaseerde strategieë word egter benodig om die modifiseerbare risikofaktore wat met T2DM verband hou, aan te spreek. Wetenskaplik bewysde voedingbeginsels en aanbevelings word voortdurend deur die Society for Endocrinology, Metabolism and Diabetes in South Africa (SEMDSA) in riglyne vir die hantering van T2DM opgesom.

In die huidige studie is ‘n dwarssnit studieontwerp op ‘n geriefssteekproef (n=50) toegepas, om die deelnemers met T2DM se nakoming van die SEMDSA-leefstylriglyne te bepaal. Deelnemers was ouer as 18 jaar en was almal pasiënte by die praktyk van ‘n privaatinternis in Bloemfontein. Die studie is goedgekeur deur die Gesondheidwetenskappe Etiekkomitee van die Universiteit van die Vrystaat, en alle deelnemers het ingeligte toestemming geteken.

Drie vraelyste is deur die navorser in ‘n gestruktureerde onderhoud met elke deelnemer voltooi. ‘n Voedselfrekwensievraelys is gebruik om inligting oor dieetinname in terme van makro- en mikrovoedingstofinname in te samel. Die intensiteit en duur van fisiese aktiwiteit is bepaal deur van die Global Physical Activity Questionnaire (GPAQ), wat deur die Wêreldgesundorganisasie ontwikkel is, gebruik te maak. Inligting oor vervoer, aktiwiteite by die werk, ontspanning, sowel as sittende aktiwiteite is ingesamel. Inligting oor sosiodemografiese faktore (ouderdom, geslag, taal, huwelikstatus en vlak van onderwys), en rook- en drankgebruik is deur middel van ‘n vraelys wat self deur die navorser, gebaseer op die SEMDSA-riglyne, ontwikkel is, ingesamel. Antropometriese metings is deur die navorser volgens gestandardiseerde tegnieke geneem om liggaamsmassaindeks (LMI), middelomtrek en middel-lengte-verhouding te bepaal.

Die mediaanouderdom van deelnemers was 57.9 jaar en die mediaan tydperk vandat T2DM gediagnoseer is, was sewe jaar. Die meerderheid van deelnemers was getroud (74%). Ongeveer helfte het Afrikaans as huistaal gepraat (52%) en het voltyds gewerk (54%). Gelyke getalle mans en vrouens is ingesluit.

Die meerderheid deelnemers was oormassa (22%) of vetsugtig (66%). Die meeste (90%) het ‘n middelomtrek bo die hoë-risiko afsnypunt gehad, terwyl 92% ‘n middel-lengte verhouding bo 0.5 gehad het.

Die SEMDSA riglyne beveel aan dat koolhidrate 45-60% van totale energieinname behoort uit te maak, en dat totale vet tot < 35% van totale energie inname beperk behoort te word, waarvan < 7% versadigde vette behoort in te sluit. Daar word aanbeveel dat daaglikse natrium tot < 2 300 mg per dag beperk word, en dat twee porsies vetterige vis elke week ingeneem word om aan omega-3-vetsuurbehoeftes te voldoen.

Inligting oor dieetinname het gewys dat die SEMDSA leefstylriglyne baie swak nagekom is. Die meeste deelnemers het ‘n dieet laag in koolhidrate, hoog in vet (veral versadigde vet) en laag in omega-3-vetsure gevolg. Natriuminname was hoog. In die meerderheid deelnemers was sittende gedrag en ‘n gebrek aan fisiese aktiwiteit algemeen, met 84% wat nie die riglyn vir aerobiese oefening, en 92% vir weerstandsoefening, nagekom het nie. Tien persent van die deelnemers het huidiglik gerook en van die mans wat gereeld alkohol ingeneem het, het twee derdes (66.67%) in die ‘hoë” inname kategorie (> 2 eenhede per dag) geval.

In samevatting, was die deelnemers se nakoming van die SEMDSA-riglyne swak, wat hul risiko vir langtermykomplikasies en swak glikemiese beheer verhoog. Nakoming van die SEMDSA riglyne kan help om ‘n gesonde massa te handhaaf, om ‘n gesonde dieet in te neem en gereelde oefening te doen. Verdere navorsing om die hindernisse wat voorkom dat pasiënte die riglyne volg te identifiseer, met die doel om meer praktiese, koste-effektiewe en relevante intervensies te motiveer, word aanbeveel.

CHAPTER 1
Overview of the study

1.1. Introduction and Motivation

Type 2 diabetes (T2DM) is not a new disease. The earliest reference dates back to 1550 BC, where Ebers Papyrus recommended a diet bountiful in carbohydrates, grains, wheat, berries, grapes and honey to manage the condition (Wheeler, 2000:116).

T2DM is a progressive disease that is associated with a high degree of morbidity and premature mortality in many countries, including South Africa (Lumb, 2014:673). This condition places a significant financial burden on those with T2DM and their families, as well as on health care systems and national and global economies, by affecting both the direct cost of care, as well as loss of work and wages (World Health Organisation (WHO), 2016:6).

T2DM is largely preventable. Multi-sectoral, population-based strategies and approaches are needed to address the modifiable risk factors involved in the development of T2DM. These include overweight and obesity, most often the result of unhealthy diet and lifestyle practices and physical inactivity (WHO, 2016:35; McNaughton, 2013:274).

1.1.1. Epidemiology of Diabetes

The prevalence of insulin resistance and T2DM are increasing globally (Imamura *et al*., 2016:3), with T2DM being classified as the fastest growing chronic disease in the world (WHO, 2016:5; International Diabetes Federation (IDF), 2013:32; Amod *et al*., 2012:S4).

The prevalence of diabetes has almost doubled in the last two decades – rising from 4.7% in 1980 to 8.5% in 2014 (WHO, 2016:6). Last year (2016), 422 million adults were living with diabetes (WHO, 2016:6) and a significant percentage (30–85%)

remain undiagnosed (IDF, 2015:55; Amod *et al*., 2012:S4). The latest estimations forecast that in 2040, 642 million (more than 10% of the global population) will have the condition (IDF, 2015:13). More than 90% of patients diagnosed with diabetes have T2DM (IDF, 2015:14; Amod *et al.*, 2012:S4).

The global burden of disease and mortality has clearly shifted from infectious diseases to chronic diseases. 'Metabolic diseases' and 'diseases of lifestyle' have reached epidemic proportions over the last half century (Bird & Hawley, 2012:311) and are having a major impact on the health of Africans and South Africans, urban and rural alike (Mattei *et al*., 2012:1325).

Eighty percent of persons with diabetes live in low and middle income countries (IDF, 2013:31), and over the last decade diabetes prevalence has risen faster in these areas than it has in higher income countries (WHO, 2016:6). The World Bank has classified South Africa as a middle income country for the 2016 fiscal year (World Bank, 2016: online).

Africa, as a whole, has the lowest proportion of people diagnosed with T2DM – 5.7% or 19.8 million people, but Africa is also home to the highest percentage of persons with undiagnosed T2DM in the world. An estimated 62% of T2DM cases remain undiagnosed on the African continent (IDF, 2013:56).

In 2013, 8.6% of all deaths in sub-Saharan Africa were caused by diabetes-related complications (IDF, 2013:56) and 76% of these deaths occurred in people under 60 years of age (IDF, 2013:53). During 2015, 2.286 million cases of diabetes were identified in South Africa (7% of the population) and 57 318 people died from the disease (IDF, 2015: online).The graph below illustrates the prevalence of diabetes in adults, by age, in South Africa compared to Africa and the rest of the world (IDF, 2015: online).

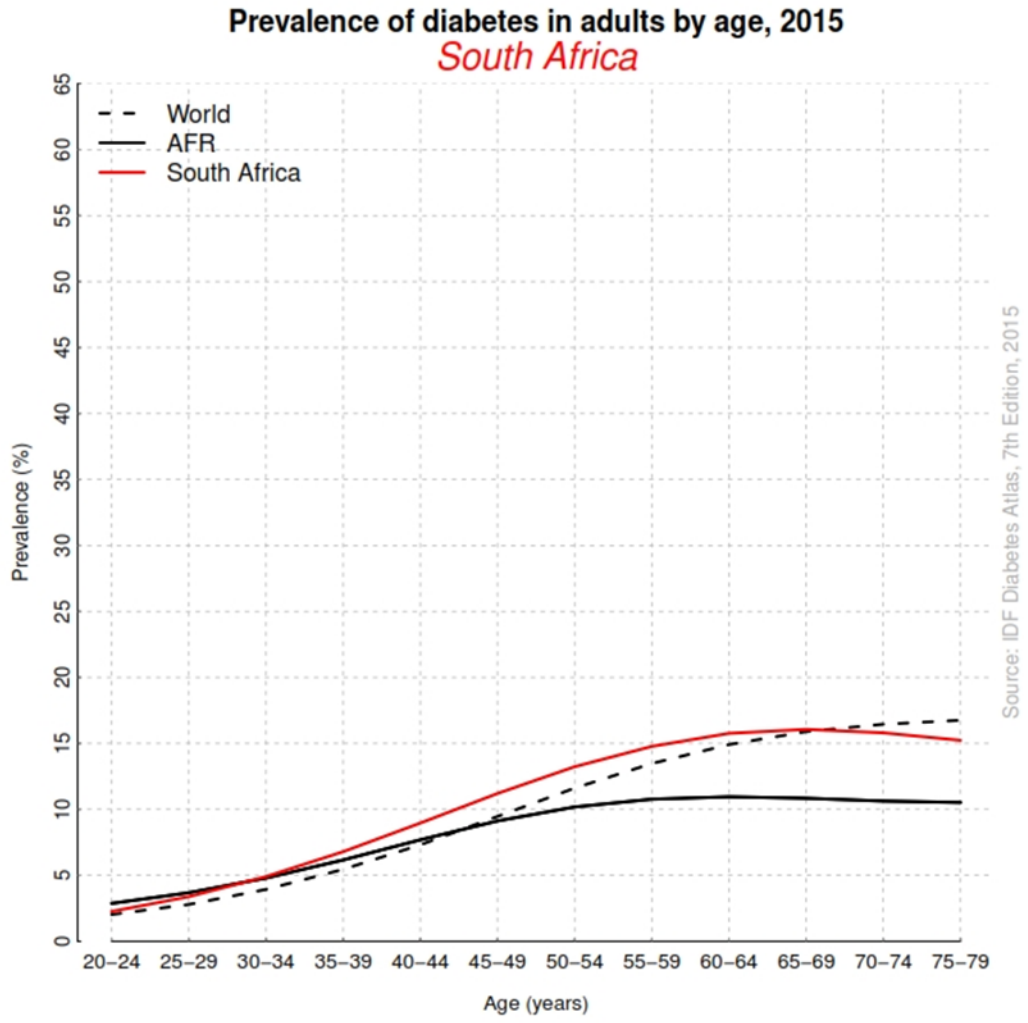

Figure 1.1: Prevalence of diabetes in South African adults by age, 2015 (IDF, 2015; online)

1.1.2. Epidemiology of Overweight and Obesity

The global rise in overweight and obesity is the main reason that the prevalence of T2DM has increased at such an alarming rate (Eckel *et al*., 2011:1424).

According to a study from 188 countries determining trends in overweight and obesity over 33 years (1980–2013), almost one third (2.1 billion people) of the global population are either overweight or obese (Ng *et a*l.,2014:766). Over the duration of the study, overweight and obesity rates increased by 8% in both men and women.

The NCD Risk Factor Collaboration (NCD-RisC) investigated trends in adult body mass index (BMI) in 200 countries from 1975 to 2014. A large number (1698) of population-based data sources were consulted, including 19.2 million participants (9.9

million men and 9.3 million women). It was found that mean BMI increased from 21.7 kg/m^2 to 24.2 kg/m^2 in men, and from 22.1 kg/m^2 to 24.4 kg/m^2 in women over the last 39 years. Obesity increased from 3.2% (1975) to 10.8% (2014) in men and from 6.4% (1975) to 14% (2014) in women. Severe obesity (BMI ≥ 35 kg/m^2) was present in 2.3% of the male population and 5.07% of females. Morbid obesity (BMI ≥ 40 kg/m^2) affected 0.64% of men and 1.6% of women (NCD-RisC *et al*., 2016:1377).

Adiposity is placing an increasing burden on the health and resources of global populations (Kontis *et al*., 2014:427), resulting in the fight against obesity being included in the global non-communicable disease targets of 2025 (WHO, 2013–2020:31). The goal is to halt the prevalence of overweight and obesity at the 2010 level.

If overweight and obesity continue to increase at the current rate, it is estimated that rates of obesity will reach 18% in men and 21% in women, while severe obesity will be present in 6% of men and 9% of women by the year 2025 (NCD-RisC *et al*., 2016:1377).

According to the Heart and Stroke Foundation of South Africa (2015: online), a staggering 70% of South African women and 30% of South African men are overweight or obese – the highest in Sub-Saharan Africa and higher than the global statistics (Ng *et al*., 2014:766).

The Lancet's 2014 publication on the global, regional and national prevalence of overweight and obesity, showed that South African women had the highest rates of obesity in Sub-Saharan Africa with 40.1% and a combined rate of overweight and obesity of 59.7%. According to the South African National Health and Nutrition Examination Survey (SANHANES) more than one in 10 (11.6%) South African men were obese, with a combined rate of 25% for overweight and obesity (Shisana *et al*., 2013:9).

1.1.3. Policies and guidelines to address T2DM

Living well with T2DM is possible. Diabetes management can be strengthened and improved through the use of evidence-based guidelines, standards and protocols (WHO, 2016:7). Applying these guidelines can improve outcomes and contribute to

optimal blood-glucose control. The strategies included in guidelines are most often related to a combination of diet and exercise advice. If necessary, medication for the control of blood glucose, blood pressure and hypercholesterolaemia is recommended to help prevent complications. Regular screening for long term complications (such as nerve damage in the eyes, kidneys and feet) is also recommended (WHO, 2016:7).

Most countries have national diabetes policies that address unhealthy diets and physical inactivity as well as national guidelines or standards for T2DM care (WHO, 2016:67). According to the International Diabetes Federation (2015:100), policies that limit the intake of fat, sugar and salt, as well as taxation on sugar-rich foods are integral to preventing the increase of T2DM. In addition to policies, national scientific-based guidelines are very important for improving T2DM care and preventing complications (WHO, 2016:69). However, less than half (47%) of the 126 countries that report having a national guideline for T2DM report fully implementing it (WHO, 2016:70).

The newest South African guidelines for the management of T2DM were released by the Society for Endocrinology, Metabolism and Diabetes of South Africa (SEMDSA) in 2012 (Amod *et al*., 2012:S1-S95). These guidelines are intended to reduce the burden of T2DM complications by managing each confounder (modifiable risk factors, comorbitities, symptoms and complications) of the disease effectively.

1.2. Problem Statement

As outlined in the introduction to this study, T2DM is rapidly becoming a global epidemic. Mortality and complications related to T2DM can, however, be prevented by applying evidence-based guidelines that aim to address the modifiable risk factors involved in the development of the condition.

In view of the high cost (both on an individual and health care system level) involved in controlling T2DM with oral agents and insulin, guidelines related to diet and lifestyle are justified. Comparing the diets, alcohol consumption, smoking habits and physical activity patterns of South Africans with T2DM with the guidelines suggested by SEMDSA, can provide information about the degree to which these guidelines are applied. Identifying these gaps can further contribute to the empowerment of

dietitians, diabetes educators and medical practitioners to target areas that need attention in patient education with the aim of optimising patient care and enhancing patient understanding.

To our knowledge no studies have compared the diet and lifestyles of patients with T2DM with the SEMDSA 2012 T2DM guidelines.

1.3. Aim and Objectives

1.3.1. Main Aim

The main aim of this study was to determine the diet and lifestyles of patients with T2DM treated in a private practice in Bloemfontein, and to compare these with the latest SEMDSA guidelines (2012) for the management of T2DM.

1.3.2. Objectives

In order to achieve the main aim, the following were determined in a sample of patients diagnosed with T2DM:

- Socio-demographic factors - Age, gender, marital status, home language, highest level of education and current employment status.
- Anthropometry - BMI (height and weight), waist circumference and waist-height ratio.
- Lifestyle factors, including diet, alcohol consumption, smoking habits and physical activity and how these compare with the SEMSDA guidelines.
- Associations between variables:
    - BMI and amount of minutes spent in sedentary behaviour (time spent sitting per day)
    - BMI categories and categories of saturated fat
    - BMI categories and categories of education
    - BMI categories and categories of physical activity
    - BMI categories and categories of sodium intake
    - Physical activity and categories of sodium intake

- Sodium intake and median minutes spent sitting
- Median minutes of physical activity per week and categories of waist circumference
- Categories of waist circumference and categories of physical activity

1.4. Outline of the Dissertation

This dissertation is divided into six chapters. Figure 1.2. provides an overview of the report:

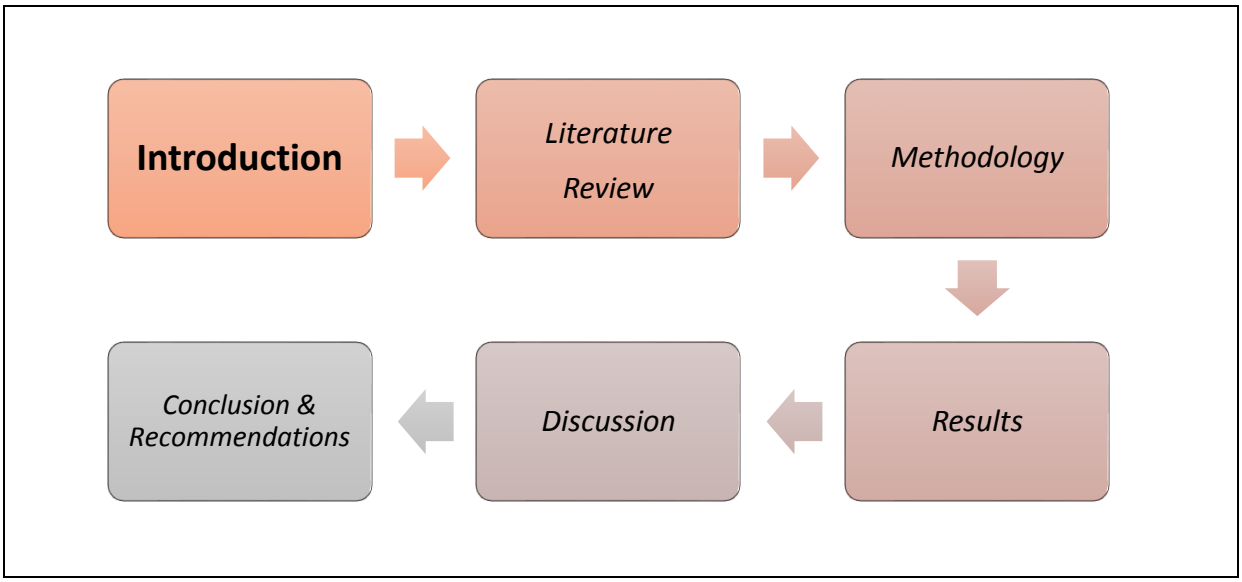

Figure 1.2: Outline of the dissertation: Introduction

In Chapter 1 the motivation for the study as well as the aim and objectives have been discussed. Chapter 2 comprises the literature review where an overview of T2DM, including the aetiology and pathophysiology, signs and symptoms, diagnosis, complications, co-morbidities and modifiable risk factors are laid out. In addition, diet and lifestyle interventions or modifications that are recommended in the management of T2DM are discussed. In Chapter 3 the methodology is explained, including study design, sampling, study procedures and ethical considerations. Chapter 4 includes the results of the study. Firstly the patient profile is described, followed by diet and lifestyle behaviours and how these compare with the SEMDSA guidelines.

In Chapter 5 the limitations in regard to this study are given and the findings are discussed, possible reasons for these findings are stated and results are compared with relevant studies in similar fields. Chapter 6 allows for conclusions and recommendations related to practice as well as future research.

CHAPTER 2
Literature review

2.1. Introduction

T2DM is one of the major health care crises of the 21st century (IDF, 2015:12). Although there may be a genetic predisposition associated with T2DM, there are many modifiable risk factors involved in the development of the condition. These include overweight and obesity, unhealthy diet, alcohol consumption, smoking and physical inactivity (McNaughton, 2013:274). If these risk factors are controlled in persons at risk for T2DM, advancement of the disease and costly complications (time, health and monetary) arising from uncontrolled blood glucose, can be avoided (IDF, 2015:16).

T2DM can be prevented, or efficiently managed, by maintaining a healthy weight, consuming a healthy diet and performing regular exercise. If lifestyle modification alone does not control blood glucose, oral hypoglycaemic agents and/or insulin therapy are usually recommended (Asif 2014:1).

In this literature review, an overview of T2DM, including the aetiology and pathophysiology, signs and symptoms, diagnosis, complications, co-morbidities and modifiable risk factors is given. In addition, diet and lifestyle interventions or modifications recommended in the management of T2DM, will be discussed.

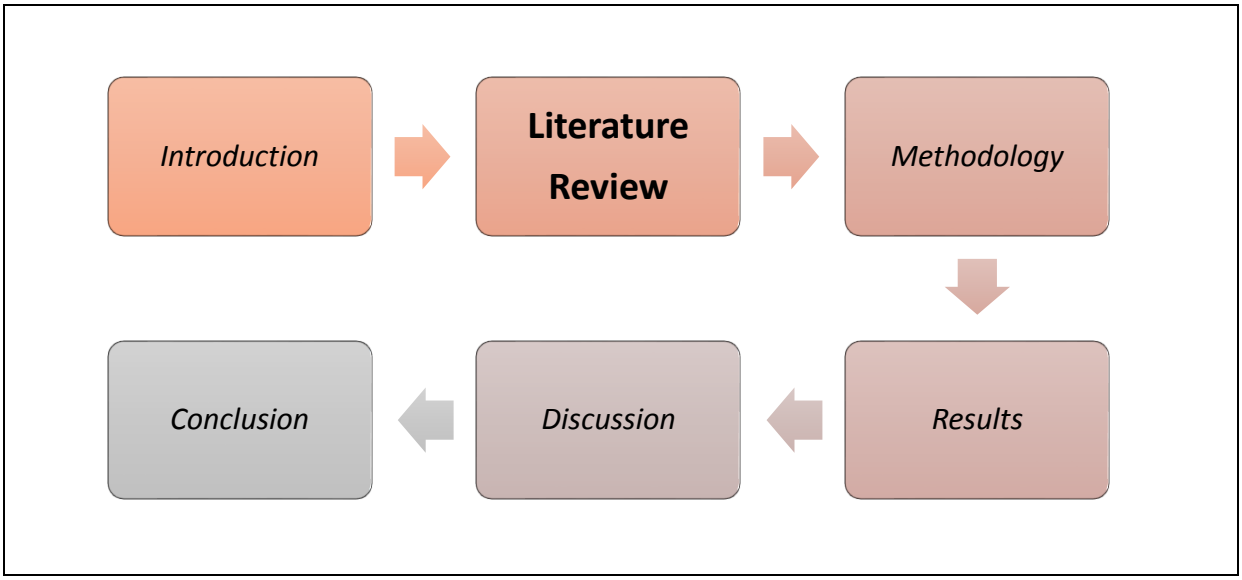

Figure 2.1. Progression of the study: Literature Review

2.2. Aetiology and Pathophysiology of Type 2 Diabetes

Once referred to as “adult onset diabetes” or “non-insulin dependent diabetes”, T2DM is a chronic condition that affects the way the body metabolises glucose (Asif, 2014:1). There are several pathogenic processes involved in the development of T2DM. These include processes that impair or destroy the beta cells of the pancreas, resulting in insufficient insulin being produced, and others that result in insulin resistance and impaired glucose metabolism (IDF, 2015:132; Amod *et al*., 2012: S5).

Due to the fact that T2DM is a progressive disease (Turner *et al.*, 1999:2005), the exact cause is difficult to pinpoint and may only be established retrospectively (Amod *et al*., 2012:S7). Often there is not one specific factor, but a number of contributing factors involved in the development of the disease (Laaksonen *et al*., 2002:1070).

2.2.1. Aetiology

The aetiology of T2DM includes the complex involvement of genetic and environmental factors. A family history of T2DM is clearly associated with the development of the disease (Kaku, 2010:41), and the significantly higher chance of

developing the condition among monozygotic twins, as opposed to dizygotic twins, strongly suggests gene involvement in the development of T2DM (Pyke, 1979:333).

According to Wheeler and Barroso (2011:52), 44 independent loci show genome-wide significant associations with T2DM (Wheeler & Barroso, 2011:52). The following genes seem to have the strongest associations:

- **TCF7L2:** Decreased beta-cell responsiveness, leading to impaired insulin processing and decreased insulin secretion
- **MTNR1B, FADS1, DGKB, GCK:** Lowered early glucose-stimulated insulin release
- **FSADS1**: Altered metabolism of unsaturated fatty acids
- **PPARG:** Dysregulation of fat metabolism
- **KCNJ11:** Inhibition of serum glucose release
- **FTO & IGF2BP2:** Increased adiposity and insulin resistance
- **HHEX:** Control of the development of pancreatic structures, including beta-islet cells
- **SLC30A8:** Transport of zinc into the beta-islet cells, which influences the production and secretion of insulin
- **WFS1:** Survival and function of beta-islet cells (Billings & Florez, 2010:59-77).

Variations of the TCF7L2 gene increase susceptibility to the development of T2DM (Gloyn *et al*., 2009:800), with an 80% increase in susceptibility in those who inherit two copies of the variants (Grant *et al*., 2009:1107).

Some populations are at a greater risk of developing T2DM than others, even at lower BMI levels (Bhowmik *et al*., 2015:460; Ganz *et al*., 2015:50). Asian populations are more susceptible to developing T2DM at lower levels of overweight than persons of European ancestry (WHO, 2004:157). T2DM is more prevalent in African Americans, Hispanics and Indians with the highest rate found in the Pima Indians and natives of the South Pacific Islands such as the Nauru (WHO, 2016; Wild *et al*., 2004:1048). Hypertension and prehypertension have been found to increase the risk of developing T2DM in Caucasians compared to African Americans (Wei *et al.*, 2011:873) and conditions such as pre-eclampsia and gestational diabetes further increase susceptibility to T2DM (IDF, 2015:12).

Although genetics play an obvious role in the development of T2DM, it is becoming more and more evident that lifestyle factors and behaviours associated with urbanisation may play a major contributing role (IDF, 2015:104). The combination of increased energy intake, decreased energy expenditure and the resultant obesity, smoking and excessive alcohol consumption increase one's chances of developing T2DM (Kaku, 2010:42). Western lifestyles are characterised by diets high in saturated fats, sugar sweetened beverages and processed foods, as well as long periods of sedentary behaviour, with very little physical activity. This type of lifestyle is very conducive to developing overweight and obesity (IDF, 2015:104).

Obesity has been identified by the WHO as a global epidemic (Mc Donald *et al*., 2015:1075) and it is a major risk factor in the development of T2DM (Bhowmik *et al*., 2015:460; Ganz *et al*., 2014:50). According to Eckel *et al.* (2011:1424), most patients with T2DM are obese. Ganz *et al*. (2014:58) have confirmed that overweight and obesity are significantly associated with T2DM, even if no other risk factors are present. The higher the BMI, the more likely a T2DM diagnosis. Wang *et al*. (2008:2120) have, however, shown that persons with a normal weight that consume an energy dense diet, are also at risk of developing T2DM.

An unfavourable environment during pregnancy and infancy can also increase the risk of low birthweight and T2DM in adulthood (Li *et al*., 2012:2479). Furthermore, Hectors *et al.* (2011:1273) have suggested that environmental pollution may also play a role in the development and progression of T2DM.

2.2.2 Pathophysiology

T2DM is characterised by both insulin resistance and inadequate insulin secretion by the pancreatic beta cells. Although most overweight and obese patients have insulin resistance, T2DM will only develop in patients who are unable to produce the amount of insulin required to control their glycaemia (Pillippe *et al*., 2011:359; Kahn *et al*., 2006:840). As a result, hyperglycaemia and disturbances in carbohydrate, fat and protein metabolism will occur (Amod *et al*., 2012:S5).

2.2.2.1. Insulin Resistance

Insulin resistance occurs when the body stops processing insulin effectively, and the pancreas is no longer able to produce the amounts of insulin required to adequately control blood glucose levels (Reaven, 1995:473). Modifiable risk factors that contribute to the development of insulin resistance include overweight, obesity and a sedentary lifestyle (Diabetes Prevention Programme Research Group (DPPRG), 2002:393).

Reasons for the development of insulin resistance may include an insulin signalling deficiency, glucose transporter defect or lipotoxicity (Taylor, 2013:1047). Insulin resistance has been linked to increased levels of free fatty acids and pro-inflammatory cytokines in plasma, resulting in less glucose being transported into skeletal muscle cells, hepatic glucose production increasing and increased breakdown of fat (Kaku, 2010:43).

Glucose tolerance progresses from normoglycaemia to intermediate hyperglycaemia (impaired fasting glucose and impaired glucose tolerance) and then to DM (Amod *et al.*, 2012:S5).

2.2.2.2. Beta Cell Dysfunction

Impairment of the beta cells can lead to inadequate insulin production or abnormal patterns of insulin release and high circulating blood glucose levels, resulting in glucose toxicity that can lead to further beta cell damage (Cerf, 2013:2).

Beta cell dysfunction is thought to be caused by amyloid deposition in the Islets of Langerhans, oxidative stress and excess circulating fatty acids (Taylor, 2013:1047).

2.2.2.3. Amino Acid Metabolism

Wang *et al*. (2011:448) propose that amino acid metabolism may play an important role in the development of T2DM. These authors followed 2 422 normoglycaemic individuals for 12 years, during which time 201 developed T2DM. In this longitudinal study, high fasting plasma concentrations of isoleucine, tyrosine and phenylalanine were found to be reliable predictors of future T2DM.

2.3. Signs and Symptoms

T2DM is a progressive disease that often goes undiagnosed for years. As long as 12 years before diagnosis there may be a progressive decline in beta cell function (Fonesca, 2009:S151–S156). Some of the earliest signs and symptoms of T2DM are often mild and therefore go unnoticed or are attributed to a general lack of well- being (Buamert *et a*l, 2014:87).

The IDF (2013:22) and the American Diabetes Association (ADA) (2015: online) have compiled a list of the most common signs and symptoms:

- Polyuria
- Nocturia
- Polydipsia
- Polyphagia
- Weight-loss
- Fatigue
- Decreased concentration
- Neuropathy
- Blurred vision
- Frequent infections
- Slow wound healing
- Vomiting and stomach pain

Ketoacidosis or a non-ketoic hyperosmolar state are the most severe clinical manifestations and can lead to severe confusion, coma and even death if not treated promptly (Amod *et al*., 2012:S5).

2.4. Diagnosis

Any one of four abnormalities listed in Table 2.1 below constitute a T2DM diagnosis:

Table 2.1: Diagnosis of diabetes mellitus (Amod *et al*., 2012:S7; ADA, 2010:S62; Genuth *et al.*, 2003:3160; ADA, 1997:1183)

Fasting Plasma Glucose (FPG)	≥ 7 mmol/L; or
Oral Glucose Tolerance Test (OGTT) Two Hour Plasma Glucose (2-h PG)	≥ 11.1 mmol/L; or
Glycated Haemoglobin A1c (HbA1c)	≥ 6.5 %; or
Random Plasma Glucose (RPG)	≥ 11.1 mmol/L if classic symptoms of diabetes or hyperglycaemia crisis is present.

The test should be repeated on a different day to confirm diagnosis unless there is marked hyperglycaemia with acute metabolic decompensation or obvious symptoms of diabetes mellitus including polyuria, polydipsia and weight loss (Amod *et al*., 2012:S7).

2.5. Complications and Comorbidities

Complications due to T2DM can include short term (immediate) or long term complications. In the short term complications are usually due to hypoglycaemia, whereas long term complications are most often associated with prolonged hyperglycaemia.

2.5.1. Complications

2.5.1.1. Short Term Complications

A blood glucose level below 3.9 mmol/L is classified as hypoglycaemia (Seaquist *et al.*, 2013:1385). Hypoglycaemia may occur due to skipped meals, exercising without eating, excess alcohol intake and overuse of certain medications including aspirin, insulin and sulfonylureas. The symptoms of hypoglycaemia are relatively easy to recognise and may include rapid heartbeat, sweating, pallor, anxiety, sleepiness,

confusion, numbness in lips, fingers and toes, headache and slurred speech (Seaquist *et al*., 2013:1386).

Functionally the brain requires a steady flow of glucose from the blood, therefore hypoglycaemia causes brain fuel deprivation that if left untreated can lead to coma and in prolonged, severe cases brain death (Cryer, 2007:868).

2.5.1.2. Long Term Complications

One of the main goals in the management of T2DM is to prevent long-term micro- and macrovascular complications associated with the disease (Laakso & Cederberg, 2012:1).

i. Microvascular

Chronic hyperglycaemia results in low-grade chronic inflammation (Andersson *et al*., 2008:595), which may cause tissue damage to the retina (capillary endothelial cells), renal glomerulus (mesangial cells), neurons and peripheral nerves (Schwann cells) (Brownlee, 2005:1615). This leads to:

- Retinopathy
- Nephropathy
- Neuropathy
- Small – artery peripheral arterial disease

(Sharma *et al.*, 2015:667; Küçükler *et al*., 2014:127; Munilakshmi *et al*., 2014:114)

ii. Macrovascular

Atherosclerosis is the main cause of macrovascular complications in T2DM (Fowler, 2008:79) and is associated with a worsening prognosis, more rapid progression and earlier onset than general atherosclerosis (Wu *et al*., 2010:5). Atherosclerosis is caused by chronic inflammation due to chronic hyperglycaemia, smoking, high levels of low density lipoprotein (LDL), low levels of high density lipoprotein (HDL) and high blood pressure (Insull, 2009:S4). Atherosclerosis causes narrowing of arterial walls and acute vascular infarction (Fowler, 2008:79) which may lead to:

- **Cardiovascular disease (CVD)**
  - Myocardial infarction
  - Atrial fibrillation
  - Heart failure
- **Cerebrovascular disease**
  - Stroke
  - Transient ischemic attack
- **Peripheral vascular disease**
  - Gangrene
  - Ulcers of lower limbs
  - Sexual dysfunction

(Hsieh *et al*., 2016:53; MedlinePlus, 2016: online; Noordzij *et al*., 2012:1558).

2.5.2. Comorbidities

Patients with T2DM are characterised by a higher incidence of chronic comorbidities than the general population (Pantalone *et al*., 2015:1). In a cross-sectional study by Lin *et al*. (2015:e23), 161 174 patients with T2DM were assessed for diagnosed chronic comorbidities. This study reported that the combination of hypertension, dyslipidaemia and obesity occurred most commonly (19% of the study population).

2.5.2.1. Hypertension

Hypertension itself is a risk factor for T2DM in both men and women, regardless of BMI (Meisinger *et al*., 2008:1809). Controlling blood pressure in patients with T2DM is highly important in the prevention of cardiovascular and renal complications (Petrie *et al*., 2016:1140). Most people with T2DM die of cardiovascular conditions and up to 75% of cardiovascular diseases have been attributed to hypertension (Campbell *et al*., 2011:998).

Blood pressure is measured in millimetres of mercury (mm Hg) and hypertension or high blood pressure is classified in 3 stages, according to severity:

Table 2.2: Classification of hypertension (National Heart, Lung and Blood Institute, 2015: online)

	Pre - Hypertension	**Stage 1 Hypertension**	**Stage 2 Hypertension**
Systolic	120-139	140-159	160-179
Diastolic	80-89	90-99	100-109

Hypertension is divided into primary and secondary hypertension. Primary hypertension tends to develop over many years, as a person ages, whereas secondary hypertension is caused by another medical condition or the use of certain medications (Carretero & Oparil, 2000:329).

Hypertension has been dubbed “The Silent Killer” as often people with hypertension experience no symptoms and therefore it may go undiagnosed for years. According to the Southern African Hypertension Society (2014: online), about 40% of adults over the age of 25 have hypertension but only about 50% of sufferers are aware of their condition and of those that are aware only half of them take any action (lifestyle modification and/or antihypertensive medication) to control the disease.

According to Campbell *et al*. (2011:997), over time, hypertension, in combination with uncontrolled blood glucose, leads to negative effects on the human body, including:

- **Heart and artery damage**
  - Hypertension can cause microscopic tears in the walls of veins and arteries, leading to scar tissue forming. This rough surface causes platelets, cholesterol, fats and plaque to stick to it leading to narrowing and hardening of the arteries (atherosclerosis).
  - Damaged and hardened arteries can impair blood flow to vital organs.
  - Tiny pieces of scar tissue or plaque can break off the wall of the arteries and stick in narrowed veins and arteries impeding blood flow and oxygen to the heart and brain resulting in myocardial infarction or stroke.

- The heart needs to pump harder to direct blood through damaged veins and arteries, causing the heart to become enlarged and the walls to thicken, making the cardiac muscle less effective.
- Angina develops when the heart doesn't receive enough blood and oxygen.
- Narrowing of peripheral arteries (legs, arms, head, and stomach) causes peripheral vascular disease (PVD).

- **Stroke**
  - If a blood vessel in the brain becomes blocked or bursts, the brain tissue will not be supplied with the blood and oxygen that it requires and it will start to perish.
- **Kidney damage**
  - Renal artery stenosis leads to kidney impairment, the kidneys become less efficient at filtering toxins from the body.
  - This can lead to kidney failure and chronic kidney disease (CKD).
- **Vision loss**

  - Delicate blood vessels in the eye become strained and the optic nerve swells leading to vision impairment, without treatment (anti-hypertensives and strict blood glucose control) this can lead to complete vision loss.
  (Campbell *et al*., 2011:997; Foex & Sear, 2004:73)

The pathogenesis of T2DM and hypertension includes the complex involvement of genetic and environmental factors including family history of hypertension, overweight or obesity and an unhealthy, high sodium containing diet with little physical activity (Campbell et al., 2011:999).

Adeniyi *et a*l. (2016:1) studied 265 participants in the rural areas of Mthatha, Eastern Cape, South Africa with concurrent T2DM and hypertension. A staggering 75.5% of these participants were found to have uncontrolled hypertension (BP ≥ 140/90 mmHg). In the Mthatha study the main risk factors for hypertension were being male, ≥ 65 years old, unemployed, consuming excessive amounts of alcohol and consumption of

a western type diet, these factors were independently and significantly associated with uncontrolled hypertension.

Data from the ongoing Liraglutide and cardiovascular outcomes in type 2 diabetes (LEADER) trial confirmed these trends in the rest of the world. About half (51%) of the 9340 participants from 32 countries with T2DM and hypertension were treated to a 'target' blood pressure of < 140/85 mmHg, and only 26% to the recommended baseline blood pressure target (< 130/80 mmHg) despite the prescription of multiple antihypertensive drugs at baseline (Petrie et al., 2016:1140).

2.5.2.2. Dyslipidaemia

The risk for developing CVD is 2 to 3 times higher in men and 3 to 5 times higher in women with T2DM than in the general population (Amod *et al.*, 2012:S57). Dyslipidaemia is a known risk factor for cardiovascular disease in patients with T2DM (Chehade *et al*., 2013:327). Dyslipidaemia is a major accelerator in those with T2DM to macrovascular complications and atherosclerosis. Outcomes after CVD events such as myocardial infarctions, strokes and revascularisation are poorer when compared to those without T2DM (Amod *et al*., 2012:S57).

Prognostic characteristics of dyslipidaemia (Table: 2.3.) in patients with T2DM include increased plasma triglyceride levels and decreased high-density lipoprotein (HDL). Total cholesterol and low-density lipoprotein (LDL) may also be elevated (Fodor, 2011:1). This is due to increased free fatty acid flux secondary to insulin resistance, compounded by increased inflammatory adipokines (Chehade *et al*., 2013:327).

Table 2.3: Dyslipidaemia derangements (National Cholesterol Education Programme, 2002: II-5)

Triglycerides	> 1.69 mmol/L
Total Cholesterol	> 5.20 mmol/L
LDL	> 3.10 mmol/L
HDL	< 1.04 mmol/L

However, a total cholesterol level > 5 mmol/L or a LDL level > 3 mmol/L may be considered acceptable cut off points for diagnosing dyslipidaemia (van Schoor, 2010:47).

Causes of dyslipidaemia can be primary (genetic) or secondary. Secondary causes include (Rosenson, 2016: online):

- T2DM
- Excessive alcohol consumption
- Cholestatic liver diseases
- Nephrotic syndrome

A number of studies have confirmed the link between dyslipidaemia and cardiovascular disease in patients with T2DM (Chew *et al*., 2012:339). Most commonly elevated triglyceride (TG) levels and low levels of HDL cholesterol are commonly seen in patients with T2DM, while LDL levels are usually only marginally elevated, however qualitative changes in LDL are often found. These patients seem to have a higher proportion of smaller, denser LDL particles (v-LDL). This type of LDL is more easily oxidised, therefore contributing to cardiovascular events (ADA, 2004:S68).

The hyperglycaemia that is typical of insulin resistance results in suppression of lipoprotein lipase activity and leads to a reduction of v-LDL catabolism (Chew et al., 20012:340). This, combined with increased hepatic production of very low-density lipoprotein triglycerides (due to insulin resistance) contributes to hypertriglyceridemia. Increased TG levels cause lower HDL, and due to hyperglycaemia, HDL is less able to prevent the oxidation of LDL. LDL becomes oxidised and contributes to the progression of atherosclerosis by promoting vascular smooth muscle cell proliferation and migration (Taquchi *et al*., 2007:132).

The 10 year risk of patients with T2DM to develop coronary heart disease (CHD) is calculated using the Framingham Risk Score. This tool takes into account age, gender, cholesterol levels and blood pressure and determines a percentage of CHD likelihood within the next 10 years. Although this is useful to create a more accurate numeric score of CHD in patients with T2DM, it is not required to start lipid lowering

therapy. As T2DM is considered to be a coronary risk, equivalent lipid lowering therapy is indicated in almost all cases (Amod *et al*., 2012:S57).

Table 2.4: Lipid lowering therapy targets (Amod *et al*., 2012:S58)

Total Cholesterol	< 4.5 mmol/L
LDL	< 1.8 mmol/L
HDL	> 1.2 mmol/L (women) > 1.0 mmol/L (men)
TG	< 1.7 mmol/L

In both patients on pharmacological therapy and not on therapy, diet modification remains the cornerstone of the management of dyslipidaemia.

2.6. Modifiable Risk Factors

2.6.1. Overweight and Obesity

As previously mentioned, overweight and obesity significantly increase one's risk of developing T2DM (Lin *et al.*, 2015:e23; Gillett *et al*., 2012:15; Eckel *et al*., 2011:1424).The Global Health Observatory states that the prevalence of T2DM and other metabolic diseases increases steadily with an increasing BMI (WHO, 2014: online). Furthermore, the WHO reports that mortality rates increase with a BMI over 24.9 kg/m^2 (WHO, 2014).

Two large studies have confirmed the link between overweight and obesity and T2DM. The first was the National Health and Nutrition Examination Surveys (NHANES) which studied 4 257 American participants over four years (1999-2002). They reported that 82% of participants with T2DM had a BMI > 25 kg/m^2. Secondly, the Study to Help Improve Early Evaluation and Management of Risk Factors Leading to Diabetes (SHIELD) was undertaken in more than 200 000 participants from Greenwich, North America. They reported that 87% of those with T2DM had a BMI > 25 kg/m^2. In both

of these studies the prevalence of T2DM increased in a linear fashion as BMI increased, with T2DM being most common amongst morbidly obese individuals (BMI > 40kg/m²).

There are several biological mechanisms that link obesity and T2DM (Sung *et al*., 2012:717), these include a family history of T2DM and/or obesity, abdominal obesity, high LDL levels and/or low HDL levels (Mc Donald *et al*., 2015:1078). Insulin resistance and hyper secretion of insulin are common in overweight and obese persons. This results in increased blood glucose levels and an increased risk of developing T2DM. Obesity induced insulin resistance develops as a result of three distinct mechanisms (Eckel *et al*., 2011:1425):

- Increased production of adipokines and/or cytokines from adipose tissue. These include tumour necrosis factor, resistin and retinol-binding protein 4, and decreased levels of adiponectin.
- Ectopic fat deposition in the liver and skeletal muscle cells as well as dyslipidaemia.
- Mitochondrial dysfunction that compromises beta cell function.

Fat distribution is also an important factor to consider, since android or visceral fat distribution (fat stored in the upper body) has a closer correlation with insulin resistance and the development of T2DM than fat stored in the lower body (gynoid fat distribution) (Kaku, 2010:42; van Dam, 2003:1115). Measurement of waist circumference is a good indicator of fat distribution (Klein *et al*., 2007: 1197).

Weight loss can lead to improved glycaemic control and insulin sensitivity and is recognised as one of the most important therapeutic interventions in overweight and obese individuals with T2DM (Amod *et al*., 2012:S15).

2.6.2. Diet

Depending on the quality of the diet, it can both cause and prevent T2DM. Suboptimal nutrition *in vitro* can have permanent effects on the structure and function of tissues. Low birth-weight infants are at risk of developing insulin resistance in skeletal muscle

and adipose tissue and often display age-related decreased glucose tolerance that can increase the risk for T2DM later in life (Ferland-Mc Collough *et al*., 2012:1003).

Diets high in refined carbohydrates and saturated fats and low in fibre have been linked to the development of T2DM. Inversely, healthy diets high in unrefined carbohydrates (that have a lower glycaemic index and are more nutritionally dense) and low in added sugar and saturated fats, are associated with a lower risk of developing T2DM (Castetbon *et al*., 2013:3).

In the Dutch part of the European Investigation into Cancer and Nutrition Study (EPIC–NL) conducted in 2012, 20 835 overweight and obese participants were studied to determine the effect of diet on the development of T2DM. It was found that a diet higher in sugar and refined carbohydrates such as sugary drinks, chips and snacks, and lower in fibre, fruit and vegetables, was strongly correlated with an increased risk of developing T2DM (Bauer *et al.,* 2013:1128).

Jenkins *et al.* (2003) have also reported that individuals that followed vegetarian diets had a much lower risk of developing T2DM than those that did not follow a vegetarian diet. It was noted that legumes, traditionally processed cereals and low glycaemic index whole-grains, were more likely to keep blood glucose levels stable and thus reduced the risk of developing T2DM.

In a nationally representative survey done in France between 2006 – 2007 amongst 1 476 middle aged (45–74 years old) subjects that included 101 participants with T2DM, Castetbon *et al.* (2013) found that patients diagnosed with diabetes that received nutrition education, were more likely to consume a healthier diet than those without diabetes. Their diets were found to be lower in refined sugars, alcohol and energy, and higher in protein, unrefined carbohydrates, fruit and vegetables.

Medical nutrition therapy (MNT) plays a major role in controlling weight and blood glucose levels and preventing micro and macro vascular complications and diabetes induced mortality (Castetbon *et al*., 2013:2 ; Khazrai *et al*., 2013:25). Evert *et al*. (2014:S120) have defined the goals of MNT in T2DM as “promoting and supporting healthy eating patterns and emphasising a variety of nutrient dense foods in appropriate portion sizes”. This is to improve overall health and specifically to attain individualised glycaemic, blood pressure and lipid goals and to delay or prevent the

complications related to T2DM. Healthy diets for patients with T2DM should be individualised and focus on energy balance to achieve or maintain a healthy weight. These diets should include an optimal distribution of macronutrients and encourage patients to eat according to their specific needs to control for T2DM associated complications and comorbidities including hypertension and dyslipidaemia (Evert *et al*., 2014:S124).

The SEMDSA dietary guidelines recommend that all food groups should be included in the diabetic diet to ensure optimal glycaemic control, palatability, improved compliance (Amod *et al*., 2012;16; Mellor, 2012:234) and weight loss if necessary (Amod *et al*., 2012: S18). A healthy, balanced eating plan is emphasised, with specific guidelines for carbohydrate, protein, fat and sodium intake and alcohol consumption (Amod *et al*., 2012: S19).

2.6.2.1. Carbohydrates

Carbohydrates are one of the main macronutrients in the diet, and a key form of energy for most organisms (van Dam & Seidell, 2007: S24). Within the human body, carbohydrates are the preferred energy source. They spare the use of protein for energy, so that protein can be used to repair and replete muscle cells (protein can also be used as an energy source if carbohydrates are not available). Carbohydrates also add flavour and sweetness to foods, provide dietary fibre and function as prebiotics to stimulate the growth of probiotics for digestive health (Mortensen, 2015: online).

The total amount of carbohydrates consumed in any given meal, is the primary predictor of glycaemic response in patients with T2DM and should be regulated (Deakin *et al*., 2011:15). This can be done by the use of exchanges, controlled portion sizes and experienced estimation. The glycaemic index (GI) measures how carbohydrate containing food raise the blood glucose in comparison to a reference food, either glucose or white bread (Jenkins *et al*., 2002:266S). Foods with a high GI increase the blood glucose more than foods with an intermediate or low GI.

Carbohydrates should come from whole food sources such as fruits, vegetables, legumes, whole-grains and dairy products rather than processed or refined carbohydrates that lack fibre, vitamins and minerals and are often high in fat, refined sugar and sodium (Evert *et al*., 2014:S121).

Although an “ideal” amount of dietary carbohydrates for patients with T2DM has not been established (Evert *et al.*, 2014:S121; Deakin *et al.,* 2011:16), consistent carbohydrate intake and regular meals help control blood glucose in T2DM (Amod *et al*., 2012:S15). SEMDSA (2012:S16) recommend that 45–60% of TE should be consumed from carbohydrates.

2.6.2.2. Fructose, Glucose and Sucrose

Fructose and glucose are the most common simple sugars in the human diet and combining these monosaccharides in equal amounts forms the disaccharide sucrose. All carbohydrates contain glucose and some, namely fruits and vegetables, contain fructose too. Fructose is sweeter than glucose (Bray *et al*., 2004:537) and is therefore often used as a sweetener in processed foods.

Industrialisation and food processing have led to more refined and added sugars being present in the usual diet. According to Cordain *et al*. (2005:343), the amount of refined sucrose consumed per capita, in England, rose from 6.8 kg in 1815 to 54.5 kg in 1970 and in the United States the amount of refined sucrose consumed per capita in 1970 was 55.5 kg and by the year 2000 it had risen to 69.1 kg. In South Africa, Bourne *et al*. (1993: 241) assessed added sugar intake of the urban African population, and found it to be on par with the rest of the world (about 17.8 kg per capita of added sugar). This is a global phenomenon with the Nordic countries and the Netherlands reporting the same trends (Cordain *et al*., 2005:343).

Studies have shown that excessive intake of added sugars are implicated in the development of T2DM and metabolic abnormalities, also contributing to cardiovascular disease (DiNicolantonio *et al*., 2015:372). Davis *et a*l. (2007:1331) determined that total sugar intake, rather than GI or glycaemic load, contributed to higher fat stores and lower insulin sensitivity (Davis *et al.,* 2007:1331).

A Finnish cohort study of 4 304 men and women (aged 40-60 years old and followed up for 12 years) that did not have T2DM at baseline, found that the participants that consumed a diet with a higher intake of fructose and glucose were more likely to develop T2DM, than those that ate less fructose and glucose (Montonen *et al*., 2007:1447).

Consumption of added fructose significantly increases one's risk of developing T2DM (DiNicolantonio *et al*., 2015:372), whereas whole foods that contain fructose such as fruits and vegetables are protective against T2DM (Amuta *et al*., 2016:397), most probably due to a dose dependent response. The amount of fructose in a peach makes up about 1% of the fruit's weight (Food Intolerance Diagnostics, 2014: online), while the amount of fructose present in sweetener such as High Fructose Corn Syrup (HFCS) makes up 50–65% of the sweetener's weight (Bray *et al*., 2004:537).

Fructose and glucose have the same chemical formula (C6 H12 O6) but they are metabolised very differently. Glucose is absorbed by the gut and released into the blood stream where it is metabolised to produce energy in the form of ATP (Giugliano *et al*., 2008:217S). Fructose is metabolised almost completely in the liver to glucose, glycogen, lactate and fatty acids (Tappy & Lě, 2010:23). Large intakes of dietary fructose increase hepatic *de novo* lipogenesis and reduce hepatic fatty acid oxidation, contributing to inflammation, dyslipidaemia, decreased insulin sensitivity and increased visceral adiposity (Stanhope *et al*., 2009:1322), thus increasing the risk of developing T2DM.

2.6.2.3. Fibre

Both insoluble and soluble fibre have health benefits. Insoluble fibres (wholegrains, fruits and vegetables) add bulk to the stool and decrease the transit time of food through the digestive tract (Eswaran *et al*., 2013:719). Soluble fibres (oat bran, barley, nuts, seeds, legumes and some fruit and vegetables) absorb water and form a gel-like substance during digestion (Eswaran *et al*., 2013:719), thus slowing digestion and helping to maintain stable blood glucose levels. Chen *et al.* (2016:1232) found that by supplementing 10 to 20 g of soluble fibre daily (for one month) in patients with T2DM, fasting blood glucose levels, central adiposity, insulin resistance and levels of LDL and TG all improved significantly. Soluble fibre interferes with lipid and or bile acid metabolism (Kristensen & Bugel, 2011:1057).

Fibre recommendations are fairly standard across the world, ranging from 21 to 38 g/day (Table 2.5):

Table 2.5: Fibre intake recommendations (g/day) (Nordic Council of Ministers, 2012; Institute of Medicine Food and Nutrition Board, 2005; Australian National Health and Medical Research Council, 2006; New Zealand Ministry of Health, 2006; European Food Safety Authority, 2010; WHO, 2003)

Nordic Countries	United States of America and Canada	Australia and New Zealand	Europe	World Health Organisation
25 – 35 g/day	19 – 50 years 38 g/day (Males) 25 g/day (Females) > 50 years 30 g/day (Males) 21 g/day (Females)	30 g/day (Males) 25 g/day (Females)	25 g/day	25 g/day

2.6.2.4. Types and amounts of fats

Saturated and unsaturated fats have vastly different effects on human health. Saturated fats are found mostly in animal products, while unsaturated fats are found mostly in plants and seeds (de Souza *et al*., 2015:1).

Both the amount and type of fat in the diet may influence one's risk of developing T2DM, independent of obesity (Buijsse *et al*., 2015:455).

i. Saturated Fats

Short term studies have shown that the intake of saturated fats by overweight or obese participants can induce insulin resistance (Xiao *et al.*, 2006:1371). Recently, the focus has shifted from saturated fats *per se* to the different fatty acids present in food containing saturated fats. Although most saturated fats are thought to have a detrimental effect on health (increasing the risk of coronary heart disease and T2DM) (Forouhi *et al*., 2014:810), evidence now shows that the intake of dairy (typically high in saturated fat), is inversely associated with the development of T2DM (O'Connor *et al*., 2014:909; Sluijs *et al*., 2012:382).

Results from the EPIC-InterAct case-cohort study (a study including 12 403 participants with incident T2DM), showed that certain saturated fatty acids (SFAs) were positively correlated with the development of T2DM (even chain SFA 14.0, 16.0 & 18.0), while others were not (odd chain SFA 15.0 & 17.0 and longer SFA 20.0, 22.0, 23.0 & 24.0). The odd chain SFAs (15.0 & 17.0) are present in dairy products, while the even chain SFAs (14.0, 16.0 & 18.0) are derived from *de-novo* lipogenesis, in which carbohydrates and alcohol are converted to fatty acids in the liver or adipose tissue (Forouhi *et al*., 2014:815).

The consumption of trans fats has adverse effects on serum cholesterol (increased LDL and decreased HDL) and contributes to inflammation and endothelial cell dysfunction. Trans fats can also decrease insulin sensitivity, particularly in those predisposed to insulin resistance and T2DM (Mozaffarian *et al*., 2009:S5).

ii. Unsaturated fats

Unsaturated fats are either monounsaturated (MUFA) or polyunsaturated (PUFA). Most often foods will contain more than one type of fat. Foods high in MUFAs include olive oil, canola oil and peanut oil, while walnuts, sunflower seeds and fatty fish, like salmon and trout, are high in PUFAs (AHA, 2016: online).

A meta-analysis of 102 studies (involving 4 220 participants) showed that by substituting just 5% of total energy from saturated fats or carbohydrates with unsaturated fat (specifically PUFAs), the risk of developing T2DM decreased by 22% and coronary heart disease by 7% (Imamura *et al*., 2016:2). Although MUFAs also have health benefits, their effect on cardiovascular health was not as significant as that of PUFAs (Imamura *et al*., 2016:11).

PUFAs are hypothesised to suppress oxidative stress, hepatic lipogenesis and steatosis, pancreatic lipotoxicity and insulin resistance (Imamura *et al*, 2016:12). In addition, increased intake of PUFAs enhances cell membrane fluidity, increasing insulin sensitivity and thus lowering the risk for T2DM (Kröger *et al*., 2015:282).

The three main omega 3 PUFAs include alpha-linolenic acid (ALA), eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA). ALA is an essential FA found in canola oil and walnuts and can be converted, in small amounts, to EPA and DHA in the body

(Swanson *et al*., 2012:1). Due to a low conversion efficiency, it is recommended that most EPA and DHA should be obtained from their primary food sources such as cold water fatty fish e.g. salmon and pilchards (Swanson *et al*., 2012:1).

T2DM is characterised by low grade chronic inflammation (Andersson *et al*., 2008:595) and omega 3 PUFAs have anti-inflammatory properties (Jouris *et al*., 2011:432). Although the benefits of omega 3 PUFAs on cardiovascular health are well established (Kromhout *et al.,* 2012:436; Lopez & Ortega, 2003:S22; Kris-Etherton *et al.,* 2002:2747), the evidence for T2DM is not as clear (Kabir *et al*., 2007:1670).

Omega 3 fatty acids have been found to significantly lower triglyceride levels in patients with T2DM (Rudkowska, 2009:26; Connor, 1995:950-962). In the Nurses' Health Study, 5 103 female patients with T2DM completed self-reported food frequency questionnaires every 2 years. Higher intakes of fish and omega 3 fatty acids were inversely associated with coronary heart disease and total mortality (Hu *et al*., 2003:1852-1857). Intake of fish was also positively associated with intake of fibre from fruits and vegetables and negatively associated with the intake of processed foods (Hu *et al*., 2003:1852-1857).

Since T2DM is a risk factor for cardiovascular disease (Chehade *et al*., 2013:327) and omega 3 FAs have shown a positive effect on atherosclerosis (Lopez & Ortega, 2003:S22), the Heart and Stroke Foundation of South Africa recommends an intake of 2-5g of omega 3 FAs daily (1-2% of total energy). The SEMDSA guideline recommends eating two or more portions of oily fish per week to meet omega 3 recommendations (Amod *et al*., 2012:S16).

2.6.2.5. Sodium

It is estimated that 20-60% of patients with T2DM have concurrent hypertension (Salanitro & Roumie, 2010:107). Excessive sodium intake contributes to hypertension by increasing vascular volume and studies have shown that sodium itself inhibits the effectiveness of some anti-hypertensive drugs (Ekinci *et al*., 2010:1295).

Since patients with T2DM are already at an increased risk of developing cardiovascular disease (Fowler, 2008:79), excess sodium intake can further hasten

the progression to cardiovascular disease and chronic kidney disease (Provenzano *et al*., 2014:106).

It is a well-known fact that decreasing sodium intake (and increasing potassium intake) has a positive effect on blood pressure in most individuals (Vollmer *et al*., 2001:1019). For this reason, the Dietary Approaches to Stop Hypertension (DASH) diet is recommended as first line treatment to control hypertension, an intervention that is particularly important in patients with T2DM (Provenzano *et al*., 2014:106).

The Heart and Stroke Foundation of South Africa and the WHO recommend a sodium intake guideline for adults of < 2 000 mg daily (HSFSA, 2014:7; WHO, 2012:18). The American Heart Association (AHA) has stricter guidelines for those at risk of heart disease, including patients with T2DM, of < 1 500 mg sodium daily (AHA, 2016: online), while the SEMDSA 2012 guideline is set at < 2 300 mg sodium daily.

2.6.3. Lifestyle

2.6.3.1. Sedentary Behaviour and Physical Activity

Physical activity is defined as any bodily movements produced by skeletal muscle that requires energy expenditure (WHO, 2016: online). Long periods of sedentary behaviour and lack of physical activity are proven to contribute to the development of T2DM (IDF, 2015:104; Amod *et al*., 2012: S4; Arshad *et al*., 2016:234) and it is widely accepted that regular physical activity significantly reduces the risk of developing T2DM (Lavie *et al*., 2013:95; Shi *et al*., 2013:1).

Exercise improves glycaemic control by increasing insulin sensitivity and lowering blood glucose concentrations and by the important role that it plays in weight control (Macleod *et al.*, 2013). In a review of 11 studies conducted by Macleod *et al.* (2013:593-603), daily physical activity significantly decreased time spent in hyperglycaemia and controlled average blood glucose concentrations, though no significant results were seen in fasting glucose or time spent in hypoglycaemia.

Shi *et al*. (2013) found that it did not matter whether the exercise was performed during leisure time, at gym, or as structured sport - the same positive results were noted in

daily active living. Moderately fit obese individuals were found to be at a far lower mortality risk than those who were unfit with a normal BMI (Lavie *et al*. 2013:95).

Recommendations from the Francophone Diabetes Society in France conclude that the combination of endurance training and resistance training had the greatest effect on decreasing risk for the development of T2DM. Endurance training proved to increase insulin sensitivity in all individuals – those diagnosed with T2DM and those with normal blood glucose levels. Muscle mass is increased during resistance training, resulting in a larger body surface area and capacity for glucose metabolism (Duclos *et al*., 2013:205).

Regular physical activity is a clinically proven, low cost, primary intervention in T2DM (Bird & Hawley, 2012:311; Amod *et al*., 2012:S18).The benefits of regular physical activity in T2DM include (Lumb 2014:673; Yang *et al*., 2014:487; Amod *et al*., 2012:S18):

- Improved glycaemic control
- Decreased insulin resistance
- Improved blood pressure
- Improved lipid profile
- Decreased adiposity
- Weight loss and maintenance thereof
- Increased cardiorespiratory fitness
- Sense of well-being
- Decreased stress and anxiety

Moderate to high levels of physical activity are directly associated with cardiorespiratory fitness (Amod *et al*., 2012:S18) and regular physical activity lowers HbA1c levels by an average of 0.6 – 0.8% (Lanhers *et al*., 2015:2). This is significant, as lower HbA1c levels are associated with improved morbidity and mortality outcomes (Nicholas *et al*., 2013:1). Long term exercise programmes offer similar decreases in HbA1C levels as long term drug or insulin therapy (Snowling & Hopkins, 2006:2518).

Although daily exercise is an important part of T2DM prevention, management and control, only a small percentage of diabetic patients actually engage in enough regular

physical activity (Boudreau & Godin, 2014:918; Duclos *et al*. 2013:205; Lavie *et al.*, 2013:95). This may be due to the fact that 80% of people with T2DM are overweight or obese (Yang *et al*., 2014:487). They often have mobility issues, peripheral neuropathy, visual impairment and cardiovascular disease making physical activity a difficult and daunting task. Bird and Hawley (2012:311) reported that "lack of time to exercise" was the most common excuse given by adults regardless of age, gender and ethnicity.

i. Aerobic Exercise

Aerobic exercise engages large groups of muscles and includes exercises like brisk walking, jogging, cycling, spinning and swimming. It has traditionally been the main focus area of exercise in T2DM management (Armstrong *et al*., 2015:14).

A meta-analysis done by Yang *et al*. (2014:497), including 12 trials and 626 participants, found that aerobic exercise had a better effect on HbA1c levels than resistance training. Yokoyama *et al*. (2008:400) reported that whole body glucose utilization was increased in patients with T2DM that performed aerobic activity 3-5 times per week. In another study by the same authors (Yokoyama *et al*., 2004:85), a marked decrease in arterial stiffness of the common carotid and femoral arteries was noted after a 3 week exercise protocol including ergometer and walking. However there were no anthropometric changes in the subjects. The reduction of stiffness in these arteries was associated with improved insulin resistance in T2DM.

ii. Resistance Training

Although the benefits of aerobic exercise are well established, increasing and preserving muscular strength, flexibility, mobility and balance are just as important. Exercises that improve muscular strength, such as resistance training, have been shown to decrease age-related sarcopenia, improve mobility and enhance functionality in people with T2DM (Armstrong *et al*., 2015:14).

Resistance training is two-fold, it increases muscular strength (the force exerted by a muscle) and muscular endurance (the ability of the muscle to continue to perform without fatigue). Resistance training is performed using weights, resistance bands or body weight exercises such as push-ups and squats.

Low muscular strength is associated with an increase in morbidity and mortality (Artero *et al*., 2012:352) and T2DM itself is an independent risk factor for low muscular strength (Nishitani *et al*., 2011:175). It is therefore important to promote and preserve muscle strength in these patients. Over time resistance exercise is able to increase and maintain lean muscle mass (Ryan *et al*., 2001:247) helping to improve insulin sensitivity. By increasing skeletal muscle mass, body weight and blood glucose levels are easier to control (Williams *et al*., 2007:574).

A systematic review by Gordon *et al*. (2009:159) found that resistance training improved markers of glycaemic control and insulin sensitivity in patients with T2DM. Of the ten randomised control trials included in the analysis, all but three were published in the last ten years. Major findings were that resistance exercise performed over time had the same benefits as aerobic training, but that short bouts of resistance training with intermittent rest periods may be better tolerated than aerobic training, therefore making this type of exercise more sustainable in the long term (Gordon *et al.,* 2009:172).

2.6.3.2. Alcohol Consumption

In a recent meta-analysis investigating alcohol consumption and risk of T2DM, Knott *et al.* (2015:1804) reviewed 38 studies, including almost two million participants (125 926 with T2DM). Compared with current non-drinkers or never drinkers, there was a decreased risk of developing T2DM at alcohol consumption levels < 63 g a day. The peak reduction range (risk reduced by 18%) was found at 10-14 g of alcohol a day (Knott *et al*., 2015:1807). These reductions were the largest in women, with a reduced risk of T2DM being found in women that consumed < 71 g alcohol a day (peak reduction rate was 31-37 g a day, 34% risk reduction compared to total abstainers) (Knott *et al*., 2015:1807). Risks for developing T2DM increased above the 63 g/day threshold for all participants and an intake above 71 g of alcohol a day increased the risk of developing T2DM in women (Knott *et al*., 2015:1807).

Metcalf *et al*. (2014:4) found that low to moderate alcohol intake over the past 3 months significantly reduced the risk of T2DM in both normal weight and overweight participants. The same association was not, however, found in obese participants.

i. Benefits

As previously mentioned, moderate consumption of alcohol decreases one's risks of developing T2DM (Rhem *et al*., 2010:826; Shai *et al*. (2007:3011). One of the mechanisms that may be responsible for this reduced risk, is the 'anti-inflammatory hypothesis' which proposes that the expression of inflammatory proteins may be beneficially altered by the consumption of alcohol (Knott *et al*., 2015:1804). Fibrinogen is an inflammatory marker that has been associated as a predictor for T2DM (Dankner & Roth, 2012:93). Moderate alcohol consumption has beneficial effects on fibrinogen levels (Brein *et al*., 2011:636).

Moderate alcohol consumption may also increase insulin sensitivity (Hendriks 2007:S40), and adiponectin levels are significantly increased with moderate alcohol consumption (Brein *et al*., 2011:636). Adiponectin is an anti-inflammatory protein hormone that is secreted from fat cells and modulates fatty acid catabolism and glucose regulation (Danker & Roth, 2012:92). Adiponectin levels are inversely related to weight and body fat in adults and higher levels of adiponectin have been shown to decrease the risk of developing T2DM (Dankner & Roth, 2012:92).

Low HDL levels are associated with an increased risk of T2DM (Haase *et al.,* 2015:3328). Another mechanism associated with moderate alcohol intake and decreased T2DM risk, may be the possible stimulatory effect on HDL (Knott *et al*., 2015:1804). A meta-analysis by Brein *et al*. (2011:636) included 63 studies and 1 686 participants. They found that moderate alcohol consumption (up to one drink a day or 15 g of alcohol for women and up to two drinks per day or 30 g of alcohol for men) significantly increased levels of HDL.

ii. Detrimental effects

A dose-dependent relationship has been established between the amount and duration of alcohol consumption and the development and progression of T2DM (Molina *et al*., 2014:203). While moderate alcohol consumption seems to have a protective effect on T2DM (Rhem *et al*., 2010:826), alcohol abuse (binge drinking: > 4-5 drinks on a single occasion or chronic heavy alcohol consumption: > 7 drinks a week for women, > 14 drinks a week for men) is a contributing factor to T2DM (Molina

et al., 2014:203). High alcohol consumption increases the risk of abnormal glucose regulation and thus increases the risk for T2DM (Cullmann *et al.,* 2011:441).

Alcohol is very high in energy, and can contribute to obesity (specifically visceral obesity) (Kaku, 2010:42), which in turn increases one's risk for T2DM.

Ahmed *et al*. (2006:795) found an inverse relationship between diabetes self-care practices and alcohol consumption in a large sample of 65 996 diabetic adults. Adherence to self-monitoring of blood glucose, HbA1c testing and correct administration of diabetic medications was assessed. Results showed a gradient of compliance, with those that drank more being less likely to comply with correct self-management practises than participants who drank less. Participants who drank just one drink a day were less likely to adhere fully to self-management care than those that abstained from taking alcohol (Ahmed *et al.,* 2006:800).

2.6.3.3. Smoking

Smoking is significantly associated with insulin resistance and T2DM (Akter *et al*., 2015:2). A meta-analysis of 25 cohort studies confirmed an association between active smoking and developing T2DM compared to individuals that had quit smoking or never smoked at all (Willi *et al*., 2007:2654).

Akter *et al*. followed up 53 930 Japanese employees (aged 15-83 years), for 3.9 years. None of the participants had T2DM at baseline but 2 441 (4.5%) had developed T2DM at follow up, the largest proportion from the active smokers group. It was also noted that the risk for current smokers to develop T2DM was significantly increased as the number of cigarettes smoked per day increased (Akter *et al*., 2015: 8).

Smoking cessation seems to increase the short term risk of developing diabetes (Oba *et al*., 2012:1), but this risk decreases as time goes by, and by 10 years after cessation of smoking the risk of developing T2DM is equal to that of someone who has never smoked (Akter *et al*., 2015:13).

The exact mechanism of how smoking contributes to T2DM is not completely understood, though insulin resistance seems to be the main contributor. Chronic inflammation, oxidative stress, endothelial cell dysfunction (Yanbaeva *et al*.,

2007:1559) and central adiposity (Chiolero *et al*., 2008:801) caused by smoking, all seem to contribute to the development of insulin resistance and T2DM.

T2DM is an emerging health crisis caused by insulin resistance that can potentially be prevented. Although genetics does play a role in the development of the disease, incorporating healthy lifestyle practices into daily life can help prevent and manage T2DM, even for those genetically at risk. Preventative measures include maintaining a normal body weight, consuming a diet that is high in fibre and low in saturated fat and sodium and incorporating regular exercise into daily routines.

CHAPTER 3
Methodology

3.1. Introduction

In this chapter the study design, population and sampling, methodology and procedures will be discussed. A description of validity and reliability of the tools, statistical analysis and ethical considerations will also be included.

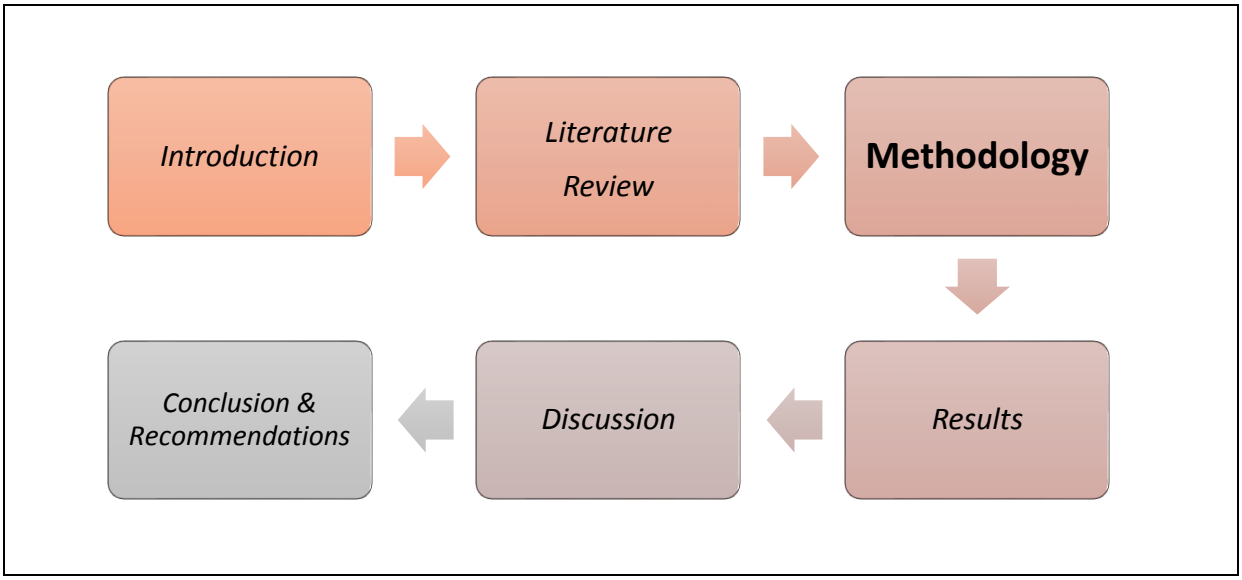

Figure 3.1. Progression of the study: Methodology

3.1.2. Study Design

A cross-sectional study design was applied. Data were collected once at a specific point in time (four months) and from multiple participants. In this study, data were collected from males and females of different ages and backgrounds (education level, socioeconomic status etc.).

3.2. Population and Sample

Patients treated in a private practice for T2DM, were included.

3.2.1. Population

Data for this study were collected at a private physician's practice in Bloemfontein. Patients with T2DM seen in the medical practice constituted the population for this study. These patients are a small selection of a large population and therefore may not be representative of all private patients with T2DM in Bloemfontein.

On average about 6 000 patients with T2DM are seen at the practice annually, these include newly diagnosed patients and those coming for follow-up visits. This translates to around 500 patients a month.

3.2.2. Sample Selection

All adult patients with T2DM seen at the physicians' private practice during May to August 2016 that met the inclusion criteria for the study, were eligible to participate. Patients seen at the practice during this period were informed by the physician of the research study. If patients were willing to participate in the study, the researcher interviewed them directly after their consultation with the physician. If the time was not convenient, arrangements were made for an appointment at a more convenient time.

Due to the fact that the researcher completed the study on a part-time basis, an average of about 3 participants were interviewed per week over the 4 month period, until a total of 50 patients had been included. Initially 100 participants were planned to be included in the study but due to time constraints (of the participants themselves) many were reluctant to participate. In the time span set out to interview 100 participants, only 50 agreed to be included.

3.2.2.1. Inclusion Criteria

- Patients with T2DM, being treated in a private practice;

- Over the age of 18 years and
- Informed consent provided**.**

3.2.2.2. Exclusion Criteria

- Patients with T2DM with impaired cognition.

3.3. Measurements

3.3.1. Operational Definitions

In order to meet the objectives of the study, information related to socio-demographic status, anthropometry and lifestyle factors were required. The operational definitions for each of these will be discussed in the following section.

3.3.1.1. Socio-demographic Information

For the purpose of this study, socio-demographic factors referred to age, gender, marital status, home language, highest level of education and current employment status.

3.3.1.2. Anthropometric Information

i. Body Mass Index (BMI)

Weight and height were measured to determine BMI (weight divided by height squared) and categorised according to the cut-off points indicated in Table 3.1:

Table 3.1: BMI cut-off points (WHO, 2006: online)

Weight Status	BMI
Underweight	< 18.5 kg/m²
Normal Weight	18.5–24.9 kg/m²
Overweight	25–29.9 kg/m²
Obese	> 30 kg/m²

ii. Waist Circumference

The WHO Stepwise Approach to Surveillance (STEPS) protocol was used to measure waist circumference (WHO, 2008b). This technique requires subjects to stand with arms relaxed at sides, feet positioned close together and weight evenly distributed across the feet.

Population and country-specific cut-points were used. The Europid cut-points are used in sub-Saharan Africa (Amod *et al.,* 2012:S58).

Table 3.2: Waist circumference cut off points (IDF, 2006:11)

Waist Circumference	
Women	**Men**
< 80cm	< 94cm

3.3.1.3. Diet

Diet refers to usual daily intake of food and non-alcoholic drinks, energy, macro and micronutrients. A macronutrient intake less than the recommendations in the 2012 SEMDSA guidelines for the management of T2DM were considered inadequate, intakes within the suggested ranges were considered adequate and intakes higher were considered high.

2012 SEMDSA dietary guidelines (Amod *et al*., 2012:S16):

- Carbohydrates should make up 45-60% of total energy intake
- Fructose intake should be limited to < 60 g daily
- A sucrose intake of 10% of total energy is acceptable
- Soluble and insoluble fibre intake should be increased to 25-50 g daily
- Daily protein intake should be 15-20% of total energy
- Restrict fat intake to < 35% of total energy intake
- Saturated fat should be < 7% of TE
- Polyunsaturated fat < 10% TE
- Consume two or more portions of fish per week to provide the recommended omega 3 polyunsaturated fatty acids
- Reduce sodium intake to < 2 300 mg daily

3.3.1.4. Alcohol Consumption

Alcohol consumption was categorised as low, moderate and high according to the SEMDSA 2012 guidelines indicated in Table 3.3:

Table 3.3: Categories of alcohol consumption (Amod, *et al*., 2012:S16)

Alcohol Consumption	Low	Moderate	High
Men	< 2 units daily	2 units daily	> 2 units daily
Women	< 1 unit daily	1 unit daily	> 1 unit daily

One unit of alcohol is measured as 10g pure alcohol, also known as the “standard drink” (WHO, 2000:72). This equates to:

- 330 ml beer
- 100 ml wine
- 30 ml spirits

The lifestyle questionnaire addressed frequency and units of alcohol consumed while the THUSA FFQ addressed type and amount of alcohol consumed. Total units of alcohol consumed were calculated by the researcher.

3.3.1.5. Smoking

Smoking was categorised as indicated in Table 3.4:

Table 3.4: Classification of smoking habits (Amod *et al*., 2012:S13)

Current Smoking Habits		
Never Smoked	Current Smoker (Number of cigarettes smoked daily)	Quit Smoking (How long ago)

The SEMSDA 2012 guidelines recommend smoking cessation (Amod *et al.*, 2012:13).

3.3.1.6. Physical Activity

The latest T2DM physical activity guidelines from the WHO, Canadian and American Dietetics Associations have been revised and these are included in the SEMDSA 2012 physical activity guidelines for T2DM, including both aerobic and resistance exercise guidelines (Table 3.5 and 3.6).

Table 3.5: Aerobic exercise recommended for individuals with T2DM (Amod *et al*., 2012:S18-19).

Definition	Intensity	Frequency	Examples
Activities that consist of rhythmic, repetitive and continuous movement of the same large muscle groups for at least 10 minutes at a time	Moderate: 50-70% of maximum heart rate (**small increase in breathing or heart rate)**	Minimum 150 minutes per week	Cycling, brisk walking, continuous swimming, dancing, water aerobics, raking leaves
	OR		
	Vigorous: > 70% of maximum heart rate (**large increases in breathing or heart rate)**	Minimum 75 minutes per week	Brisk walking up an incline, jogging, aerobics, hockey, basketball, fast swimming, fast dancing
	OR		
Equivalent combination of moderate and vigorous aerobic exercise			

Aerobic exercise was determined by time and duration of daily physical activity. The Global Physical Activity Questionnaire (GPAQ) was used to measure duration in minutes per day/ days per week and intensity by self-reported increases in breathing and heart rate. Sedentary behaviour was measured by hours spent sitting per day.

Moderate aerobic exercise (GPAQ) = Work or moderate-intensity sports, fitness or recreational (leisure) activities and travel that cause a small increase in breathing or heart rate.

Vigorous aerobic exercise (GPAQ) = Work or vigorous-intensity sports, fitness or recreational (leisure) activities that cause large increases in breathing or heart rate.

These values were then analysed and compared with the SEMDSA guidelines for aerobic exercise.

Table 3.6: Resistance exercise recommended for individuals with T2DM (Amod *et al.*, 2012:S18-19).

Definition	Frequency	Examples
Activities that require muscular strength to move a weight or work against a resistance load	Two to three times per week: Start with one set of 10-15 repetitions at moderate weight Progress to two sets of 10-15 repetitions Progress to three sets at heavier weights	Exercise with weight machines, free weight lifting, Thera-Band® exercises

Frequency of resistance exercise was determined by the lifestyle questionnaire (Appendix A) (times per week), regardless of sets or reps.

3.3.2. Techniques

3.3.2.1. Socio-demographic Factors

Socio-demographic information was determined during a structured interview between the researcher and the participant using a questionnaire developed by the researcher (Appendix A).

3.3.2.2. Anthropometric measurements

Participants stood with arms resting at the sides, feet close together and weight evenly distributed over both legs.

The measurement was taken at the midpoint of the last palpable rib and the tip of the iliac crest. A non-stretch tape was used, the tape fitted snugly around the waist without causing constriction.

3.3.2.3. Diet

A structured interview was conducted by the researcher with each participant. To best capture habitual dietary intake (including types of foods consumed, frequency and amounts) a food frequency questionnaire (FFQ) was applied. Closed ended questionnaires demand an answer that can be placed into a category and participants could readily estimate portion sizes using standard household measures. Data was obtained using the Transition, Health & Urbanisation in South Africa (THUSA) FFQ, a quantitative, closed ended questionnaire. This FFQ was selected as it has been validated for the Tswana speaking population of South Africa and therefore includes both western and traditionally consumed foods (Appendix B).

The questionnaire was completed by the researcher after procedures for measuring dietary intake were explained to the participant before commencing with the interview.

Standard household measuring equipment was used to measure quantities of foods and beverages consumed:

- Measuring cup (250ml)
- Ladle for dishing up (125ml)
- Teaspoon (5ml)

Grams of foods and beverages consumed were determined from volume by using the Food Quantities Manual (Langenhoven *et al*., 1991). These amounts were then entered into the Medical Research Council's (MRC) Food Finder 3 (FF3) programme for analysis. Actual intake of sodium (grams per day) as well as percentages of protein, carbohydrates, fat, sucrose and fructose of total energy was determined.

3.3.2.4. Lifestyle

Alcohol consumption and smoking habits were determined using a questionnaire developed by the researcher and based on the SEMSDA 2012 guidelines. This was completed by the researcher in a structured interview with each participant (Appendix A).

Physical activity intensity and duration was calculated using the Global Physical Activity Questionnaire (GPAQ) developed by the WHO (Appendix C). It collects physical activity information in three settings – travel to and from work/ other places, activity at work and recreational activities, as well as sedentary behaviour.

Data were cleaned and analysed according to the GPAQ standards using the coding column in the questionnaire as an identifier.
Domains were cleaned as a combined set. While some of the calculations of results use all the domains and others use only one of the domains, it is necessary that each respondent has an overall "clean" response to all physical activity questions. To be included in the analyses, each participant had a valid response for at least one domain and had no invalid responses for any domains.

The following were checked for all the domains.

If…	**Then…**
Values in the hours column are 15, 30, 45, or 60	move them into the corresponding minutes variable, if the corresponding minutes variable is empty or zero (most likely a data recording error).
Maximum values: If for at least one "sub-domain" (vigorous work, moderate work, transport, vigorous recreation, or moderate recreation activity) the value of hours + minutes >16 hours	remove the case from all analyses.
If a respondent reports implausible values (eg., >7 days in any days column)	remove the case from all analyses.
If a respondent has inconsistent answers (eg., 0 days, but values >0 in the corresponding time variables)	remove the case from all analyses.

If one whole "sub-domain" (vigorous work, moderate work, transport, vigorous recreation, or moderate recreation activity) has missing values, but the other "sub-domains" are valid	include the case in the analysis, assuming no activity (0 days, 0 time) for this "sub-domain". That means that, as long as at least one "subdomain" has valid answers, and all others are missing, this person will be included in analyses.

GPAQ collects information on three domains. These domains are:

- Activity at work
- Travel to and from places
- Recreational activities.

For analysis purposes these domains can be further broken down into six different "sub-domains". These "sub-domains" are:

- Vigorous work (codes P1-P3)
- Moderate work (codes P4-P6)
- Travel (codes P7-P9)
- Vigorous recreation (codes P10-12)
- Moderate recreation (codes P13-15)
- Sitting (code P16)

A population's physical activity (or inactivity) can be described in different ways. The two most common ways are:

(1) to estimate a population's mean or median physical activity using a continuous indicator such as time spent in physical activity, and

(2) to classify a certain percentage of a population as 'inactive' or 'insufficiently active' by setting up a cut-point for a specific amount of physical activity.

The following guidelines describe both how to derive at continuous as well as categorical indicators when analysing GPAQ data.

For the calculation of a categorical indicator, the total time spent in physical activity during a typical week and the intensity of the physical activity were taken into account.

3.3.3. Validity and Reliability

Most variables in this study, namely diet, alcohol consumption, smoking and physical activity, were compared with the SEMSDA 2012 guidelines for T2DM. These guidelines are the latest guidelines for patients with T2DM in South Africa. They have been reviewed and developed from guidelines from other countries by a panel of experts and adapted for South Africans according to the latest research.

Validity refers to the accuracy and appropriateness of standards, guidelines, tests and inferons used (Rogelberg, 2002:62), while reliability refers to actual errors in measurement (Rogelberg, 2002:70).

3.3.3.1. Diet

It is of utmost importance that the research assessment tool and method being used provides the same, consistent results (Rogelberg, 2002:257). The FFQ tool used in this study has been validated for use in South Africa (MacIntyre *et al*., 2000:53-62). Only one trained researcher conducted structured interviews in individual interviews with each participant.

All communication took place in either English or Afrikaans, whichever the participant preferred.

3.3.3.2. Weight, Height and Waist Circumference

Validity was ensured as all participants were weighed and measured according to the same set of guidelines recommended by Lee and Nieman (2009).

Waist measurements were taken according to the WHO STEPS Protocol (WHO, 2008).

To ensure reliability the same researcher weighed and measured all participants and scales and stadiometers were calibrated each day before beginning.

All measurements were taken twice and rounded to the nearest 0.01 cm/ 0.1 kg.

3.3.3.3. Lifestyle

A lifestyle questionnaire was used to determine socio–demographic factors, alcohol consumption and smoking habits. The lifestyle questionnaire was developed by the researcher based on the SEMDSA 2012 guidelines.

The GPAQ was used to determine physical activity intensity and duration.

Self-reported information included dietary intake, alcohol consumption, smoking and exercise habits. The researcher asked the participants questions during the interview while filling in the responses on the questionnaire. These questionnaires were completed for each participant by the same researcher.

3.3.4. Pilot Study

A pilot study was conducted on five patients with T2DM that met the inclusion criteria before the main study commenced. The first five participants that agreed to participate in the research study were included in the pilot study. Data collection for the pilot study took place over three consecutive days.

The purpose of the pilot study was to determine whether questions were easy to understand. Any questions not easily understood by participants were reworded ("What is the time since T2DM diagnosis was made?" was changed to "How long have you had T2DM?"). The time taken to complete questionnaires and to take measurements were also determined during the pilot study.

Questionnaires completed in the pilot study were coded to ensure that the coding blocks were in order. The data from the pilot study were entered into an Excel document, on 2 spreadsheets and sent to the Department of Biostatistics at the University of the Free State to ensure that the procedure for data analysis was in order. As no major amendments to the questionnaires were necessary, the five participants that took part in the pilot study were included in the main study.

3.3.5. Data Collection Procedure

Before data collection could commence, the study was reviewed and approved by the Ethics Committee of the University of the Free State (ECUFS 89/2015) (Appendix D). The researcher also obtained written permission from the partners at the physicians' private practice to conduct the research study there (Appendix E).

Once the Ethics Committee approved the research study, the pilot study was conducted at the physicians' private practice.

Patients were informed of the research study by the physician consulting them at the private practice and if they agreed to participate in the study the researcher interviewed them directly after consultation with the physician. If this was not possible, an appointment was made for an alternate suitable time for the interview to be conducted. This process was repeated until 50 participants had been interviewed.

Participants were interviewed and measured by the researcher after the study had been explained to them and written informed consent had been given.

The pilot study and the actual study were conducted in the same manner.

Three questionnaires were completed in the interview, one related to socio-demographic factors and lifestyle, one on diet and the other on physical activity. Participants were weighed, measured and their waist circumference recorded in a private room. The structured interview took place in the same private area, after the measurements had been taken.

All interviews, information documents and consent forms were available in English or Afrikaans, whichever the participant was more comfortable with. Interviews lasted approximately one hour per participant.

Once all 50 participants had completed the structured interview and weight, height and waist circumference measurements had been obtained, data were coded by the researcher and entered into two Excel spreadsheets. Food frequencies (intake) were summarised to grams per day and entered into Food Finder 3. This information was then exported into Excel and sent to the biostatistician at the Department of Biostatistics, University of the Free State, to be verified. All statistical analyses were performed by the Department of Biostatistics.

3.4. Statistical Analysis

Statistical analysis was performed by the Department of Biostatistics at the University of the Free State. Descriptive statistics including percentages, frequencies, means, standard deviations, medians and percentiles were employed to describe categorical and continuous data.

Associations were calculated and described by means of 95% confidence intervals for relative risk and differences between percentages, medians or/and means.

The comparison with the SEMDSA 2012 guidelines entailed the percentage of participants that were doing what is stipulated by the guidelines in terms of diet, alcohol consumption, smoking habits and physical activity.

3.5. Ethical Aspects

3.5.1. Approval

Approval to conduct this study was obtained from the Health Research Ethics Committee of the Faculty of Health Sciences, UFS (Appendix D) and from the physician of the private practice in Bloemfontein (Appendix E).

3.5.2. Patient Treatment and Confidentiality

In this study it would not be ethical, as a registered dietitian, to interview someone with T2DM about their diet and lifestyle patterns and then avoid counselling if they required it. Therefore all patients with T2DM that took part in the study were counselled by the researcher on T2DM, blood glucose control, glycaemic index and diet and lifestyle modifications to help control T2DM and an eating plan was given after data collection had taken place. Participants participated voluntarily; care was taken to ensure that subjects understood the study and exactly what was expected of them. This was conveyed to participants before beginning the research process and all information was made available in the patient information document that was given to each

participant (Appendix F and G). All communication took place in English or Afrikaans, whichever the participant was more comfortable with. All participants were required to give written informed consent (Appendix F and G). Confidentiality was ensured by using only codes on questionnaires and no names. Participants could withdraw from the study at any time. Data is stored in a safe at the University of the Free State.

In summary 50 participants with T2DM that were treated at a private physicians' practice in Bloemfontein were included in this cross-sectional research study. Anthropometric measurements were taken to determine BMI, waist circumference and weight-height ratio. Two questionnaires were applied to collect data on the lifestyle habits (diet, alcohol consumption, smoking and physical activity) of participants.

CHAPTER 4
Results

4.1. Introduction

In the current chapter the results are presented. Firstly the patient profile is described, followed by diet and lifestyle behaviours and how these compare with the SEMDSA guidelines.

Figure 4.1 illustrates how the researcher had progressed in this report, here presenting the results of the study.

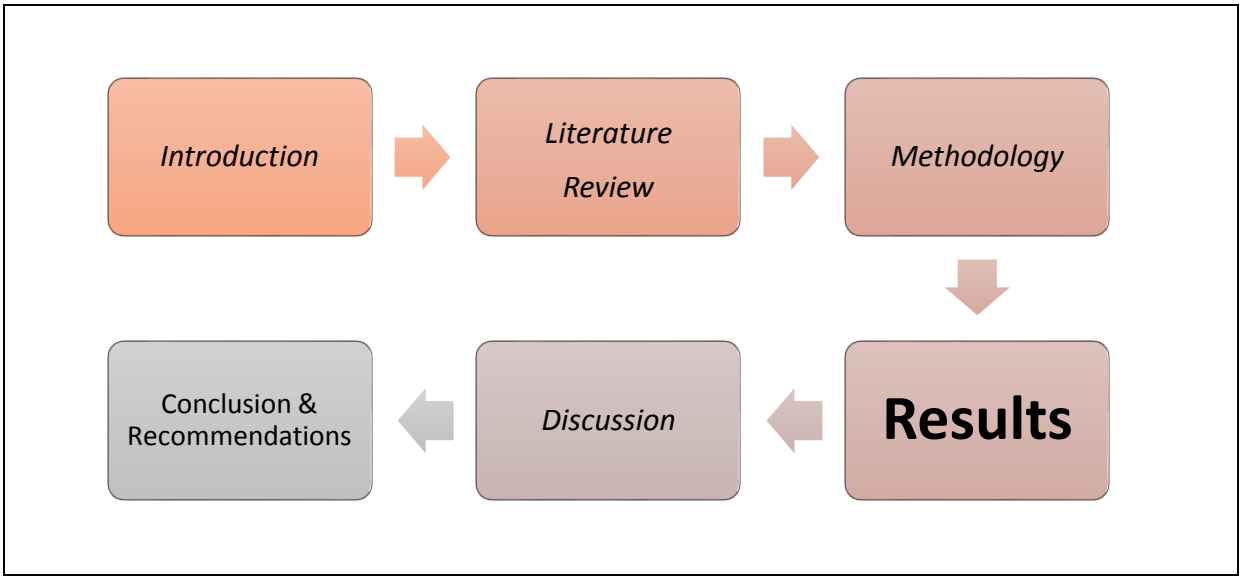

Figure 4.1. Progression of the study: Results

4.2. Participant Profile

Of the 50 participants that took part in this study, 48% were male and 52% female. Their ages ranged from 21.1 years to 82.6 years.

Almost three quarters (74%) of patients interviewed were married. Just more than half of participants listed Afrikaans as their home language (52%), while 28% of participants were Sotho speaking. Overall, 44% of participants had a tertiary qualification, while 54% had completed standard 9-10. Fifty four percent of participants were full time wage earners and 24% worked part time or had piece-jobs (Table 4.1).

Table 4.1: Participant profile

Variable	Frequency (n)	Percent (%)
Gender		
Male	24	48
Female	26	52
Marital Status		
Married	37	74.0
Divorced	4	8.0
Never Married	3	6.0
Widow /er	6	12.0
Home Language		
English	5	10.0
Afrikaans	26	52.0
Sotho	14	28.0
Tswana	3	6.0
Xhosa	2	4.0
Zulu	0	0.0
Other	0	0.0
Highest Level of Education		
None	0	0.0
Primary School	0	0.0
Std 6 – 8	1	2.0
Std 9 – 10	27	54.0
Tertiary Education	22	44.0
Employment Status		
Housewife by choice	2	4.0
Unemployed	5	10.0
Self-employed	4	8.0
Full time wage earner (Receives a salary)	27	54.0
Other (part-time, piece-job etc.)	12	24.0

The median age of participants was 57.9 years old, ranging from 21.1 to 82.6 years. The time since T2DM had been diagnosed ranged from 1 month to 30 years, with a median of seven years (Table 4.2).

Table 4.2: Median age distribution and years since diagnosis

Variable	Median	Range
Median age of participant (years)	57.9	21.1-82.6
Median years since diagnosis	7	0.1-30.0

4.3. Anthropometric Status of Participants

For the purpose of this study, anthropometric variables included BMI, waist circumference and waist–height ratio. Results pertaining to BMI are presented in Table 4.3.

Table 4.3: Body mass index (BMI)

Weight Status	BMI Cut-points (kg/m^2)	Frequency (n)	Percent (%)
Underweight	< 18.5	1	2.0
Normal Weight	18.5-24.9	5	10.0
Overweight	25-29.9	11	22.0
Obese	> 30	33	66.0

Overall 88% of participants were either overweight (22%) or obese (66%). Only 10% fell into the normal BMI category and only one person was classified as underweight.

Table 4.4: Waist circumference and waist-height ratio

Variable	Frequency (n)	Percent (%)
Waist Circumference • ***Male (cm)***		
< 94 cm	4	16.7
≥ 94 cm	20	83.3
• ***Female (cm)***		
< 80 cm	1	3.8

≥ 80 cm	25	96.2
Waist – Height Ratio		
≤ 0.5	4	8
> 0.5	46	92

Nearly all women (96.2%) and most men (83.3%) had a waist circumference above the high risk cut-points. Ninety two percent of participants had a waist-height ratio in the unhealthy category above 0.5 (Table 4.4).

Table 4.5: Median Anthropometric distributions

Variable	**Median**	**Range**
BMI (kg/m²)	33.46	16.76-48.34
Waist Circumference (cm) *Male*	106.5	80-143
Waist Circumference (cm) *Female*	107.5	67-128
Waist – Height Ratio	0.64	0.41-0.78

The median BMI for participants (33.46 kg/m²) was in the obese category. BMI ranged from 16.76 kg/m² to 48.34 kg/m². Median waist circumference was fairly similar for men (106.5 cm) and women (107.5 cm), with the median waist-height ratio being 0.64.

4.4. Lifestyle

4.4.1. Diet

Determining total energy consumption was not a primary objective of this study as it is not included in the SEMDSA guidelines, however to better understand and interpret the results (including percentage of macronutrient intake from TE) the mean, median and range are depicted in Table 4.6.

Table 4.6: Total energy intake of participants (kj/day)

Mean	Median	Range
14 304	13 272	3 912 – 28 849

The South African Daily Recommended Intake (DRI) for active individuals 19-70 years old is 10 093 kJ (Nutrition Information Centre, University of Stellenbosch (NICUS): DRIs). Participants in this study thus consumed 142% of the DRI.

The percentage of participants with dietary intakes below, within and above the SEMDSA guidelines, are presented in Tables 4.7–4.10.

The SEMDSA guideline for carbohydrate consumption is 45–60% of total energy (TE) intake. Most participants (56%) consumed less than 45% TE from carbohydrates. No one consumed more fructose than the guideline (< 60 g daily) and 92% met the guideline of less than 10% of TE from sucrose. Almost one quarter of participants (26%) consumed less fibre than recommended (25–50 g/day).

Table 4.7: Carbohydrate intake compared to the SEMDSA guidelines

Variable	Frequency (n)	Percent (%)
Carbohydrate % of TE		
< 45	28	56.0
45-60	22	44.0
Fructose (g)		
< 60	50	100.0
Sucrose % of TE		
≤ 10	46	92.0
> 10	4	8.0
Total Dietary Fibre (g)		
< 25	13	26.0
25-50	28	56.0
> 50	9	18.0

Table 4.8: Protein intake compared to the SEMDSA guideline

Protein % of TE	Frequency	Percent (%)
< 15	22	44.0
15-20	21	42.0
> 20	7	14.0

A large percentage of participants (44%) consumed less protein than recommended (15-20% of TE) (Table 4.7). In terms of fat intake, 50% of participants consumed less than 35% of TE from fat (recommended) and 50% consumed more than 35% of TE from fat (Table 4.9).

Almost all participants (92%) consumed more saturated fat than recommended and (90%) did not meet the omega 3 fatty acid intake recommendation.

Table 4.9: Fat intake compared to the SEMDSA guidelines

Variable	Frequency (n)	Percent (%)
Total fat % of TE		
< 35	25	50.0
> 35	25	50.0
Saturated Fat % of TE		
< 7	4	8.0
≥ 7	46	92.0
PUFA % TE		
< 10	38	76.0
≥ 10	12	24.0
Recommended Omega 3 fatty acid Intake		
≥ 2 portions/week	5	10
< 2 portions/week	45	90

As can be seen in Table 4.10, excess sodium was consumed by 74% of participants.

Table 4.10: Sodium categorised according to the SEMDSA guidelines

Sodium (mg)	Frequency	Percent
< 2 300	13	26.0
≥ 2 300	37	74.0

4.4.2. Alcohol Consumption and Smoking Habits

Results relating to alcohol consumption and smoking habits are presented in Table 4.11. A large percentage of participants reported that they never consumed alcohol (42%) and had never smoked (64%). Sixteen percent of participants reported drinking alcohol irregularly (over weekends) and 36% reported only drinking alcohol on special occasions.

Only three of the male participants drank alcohol regularly, while all of the women interviewed (26) said they never consumed alcohol or only consumed alcohol on special occasions.

Table 4.11: Alcohol consumption and smoking habits

Variable	Frequency (n)	Percent (%)
Alcohol Consumption Frequency		
Never	21	42.0
Every day	1	2.0
Most days	2	4.0
Only over weekends	8	16.0
Only on special occasions	18	36.0
Alcohol Consumption Categories (men)		
Low (< 2 units daily)	1	2.0
Moderate (2 units daily)	0	0.0
High (> 2 units daily	2	4.0
Current Smoking Habits		
Never smoked	32	64.0
Current smoker	5	10.0
Quit smoking	13	26.0

Five of the participants were current smokers and almost one quarter (26%) of participants had quit smoking, with the time since quitting ranging from very recently (< 1 month) to 46 years, with a median of 21 years ago.

Table 4.12: Median units of alcohol consumed and cigarettes smoked daily

Variable	Median	Range
Alcohol consumption (units)	5	1-10
Number of cigarettes	7	4-20

4.4.3. Exercise

4.4.3.1. SEMDSA Exercise Guidelines

The SEMDSA exercise guidelines for aerobic exercise are 150 minutes of moderate exercise or 75 minutes of vigorous exercise a week or a combination of both.

The resistance exercise guidelines are two to three times per week (for the purpose of this study sets and reps were negligible). The vast majority of participants (84% and 92% respectively) did not meet either guideline (Table 4.13).

Table 4.13: Aerobic and resistance exercise compared to the SEMDSA guidelines

Variable	Frequency (n)	Percent (%)
Aerobic Exercise		
Guideline attained	8	16
Guideline not attained	42	84
Resistance Exercise		
Guideline attained	4	8.0
Guideline not attained	46	92.0

4.4.3.2. Physical Activity and Sedentary Behaviour

For the purpose of this study, physical activity included moderate and vigorous aerobic exercise and travel, while sedentary behaviour included sitting but not sleeping.

Forty six percent of participants performed some type of physical activity, mostly moderate aerobic exercise (38%), while two participants either walked or cycled to work or shops. The results are presented in Table 4.14.

Table 4.14: Physical activity and sedentary behaviour

Variable	Frequency (n)	Percent (%)
Weekly Physical Activity		
Moderate	19	38.0
Vigorous	2	4.0
Travel	2	4.0
Daily Sedentary Behaviour	50	100.0

Sedentary behaviour ranged from 1 hour daily to 18 hours daily, with the median time spent sitting at 6 hours a day.

Table 4.15: Median physical activity and sedentary behaviour

Variable	Median (min)	Range (min)
Weekly Physical Activity		
Moderate	35.0	6.0-360.0
Vigorous	50.0	40.0-60.0
Travel	12.5	10.0-15.0
Daily Sedentary Behaviour	360.0	60.0-1080.0

4.4.3.3. Resistance Training

Most (92%) of the participants did not take part in resistance training at all and only four people met the SEMDSA guideline of resistance training two to three times per week (Table 4.16). Of those that did participate in resistance training, they did so for a median of 5.5 days per week (Table 4.17).

Table 4.16: Resistance training

Resistance Exercise	Frequency (n)	Percent (%)
≥ 2 times per week	4	8.0
< 2 times per week	46	92.0

Table 4.17: Median days and minutes spent on resistance training (n=4)

Variable	Median	Range
Days	5.5	2-7
Minutes	105	15-210

4.5. Associations between variables

Associations between variables (BMI, sedentary behaviour, physical activity, waist circumference, education and saturated fat and sodium intake) were determined and are indicated in the following tables.

4.5.1. Association between BMI and median minutes spent sitting daily (sedentary behaviour)

No significant difference in the median number of minutes spent sitting per day was found for the normal vs overweight groups (95% CI for the median difference [-120; 600]); the normal vs obese groups (95% CI [-60; 540]) or the overweight vs obese groups (95% CI -120; 180).

Table 4.18: Association between BMI and the number of minutes spent in sedentary behaviour (sitting per day)

BMI	n	Median number of minutes spent sitting per day	*Range (mins)*
Normal	6	570	240-1080
Overweight	11	360	120-900
Obese	33	360	60-1080

4.5.2. Association between BMI categories and categories of saturated fat intake

The association between BMI categories and the high saturated fat category were compared. No statistically significant differences were found between BMI and high saturated fat intake for the normal vs overweight groups (95% CI for the percentage differences -48.0%; 24.2%), the normal versus obese group (95% CI -50.5%;8.6%) or the overweight versus obese groups (95% CI -32.0%; 12.4%). The 95% CI interval does, however, indicate that there was a tendency for obese participants to have a higher saturated fat intake when compared to participants with a normal BMI (95% CI for the percentage difference [-50.5%; 8.6%].

Table 4.19: Association between BMI and categories of saturated fat intake

Variables	n	< 7% of TE	≥ 7 % of TE
Normal	6	1 (16.67%)	5 (83.33%)
Overweight	11	1 (9.09%)	10 (90.91%)
Obese	33	2 (6.06%)	31 (93.94%)

4.5.3. Association between categories of BMI and categories of education

The association between categories of BMI and the Std 9-10 category of education are indicated in Table 4.20. No statistically significant differences were found between levels of education of participants in the different BMI categories for normal BMI

compared to overweight (95% CI for the percentage differences -16.0%; 62.1%; the normal vs obese (95% CI -30.6%; 38.1%); the overweight vs obese (-47.3%; 11.6%).

Table 4.20: Associations between BMI categories and categories of education

Variables	n	Std 6-8	Std 9-10	Tertiary
Normal weight	6	0	4 (66.67%)	2 (33.33%)
Overweight	11	0	4 (36.36%)	7 (63.64%)
Obese	33	1 (3.03%)	19 (57.58%)	13 (39.39%)

4.5.4. Association between BMI categories and categories of physical activity

The association between BMI categories and low physical activity (< 150 minutes) were compared (Table 4.21). No statistically significant differences were found between BMI and physical activity for the normal vs overweight group (95% CI for the percentage differences -25.3%; 51.1%) or the normal versus obese group (95% CI –47.7%; 12.3%). There was, however, a statistically significant difference for the overweight versus obese group (95% CI -56.1%; -1.6%). The 95% CI interval indicates that there was a tendency for participants with a normal BMI to be less physically active than the overweight or obese groups (95% CI for the percentage difference [-25.3%; 51.1%] and [-47.7%; 12.3%].

Table 4.21: Association between BMI categories and categories of physical activity

Variables	n	< 150 min physical activity	≥ 150 min physical activity
Normal	6	5 (83.33%)	1 (16.67%)
Overweight	11	7 (63.64%)	4 (36.36%)
Obese	33	30 (90.91%)	3 (9.09%)

4.5.5. Association between BMI categories and categories of sodium intake

The association between BMI categories and the high sodium intake category were compared (Table 4.22). No statistically significant differences were found between BMI

and high sodium intake for the normal vs overweight groups (95% CI for the percentage differences -46.7%; 31.6%), the normal versus obese group (95% CI -47.5%; 19.9%) or the overweight versus obese groups (95% CI -34.5%; 21.2%).

Table 4.22: Association between BMI categories and categories of sodium intake

Variables	n	< 2 300 mg	≥ 2 300 mg
Normal	6	2 (33.33%)	4 (66.67%)
Overweight	11	3 (27.27%)	8 (72.73%)
Obese	33	8 (24.24%)	25 (75.76%)

4.5.6. Association between categories of physical activity and categories of sodium intake

The association between low physical activity and sodium intake were compared. The results indicate that physical activity was not associated with sodium intake (95% CI -27.4%; 19.4%).

Table 4.23: Association between categories of physical activity and categories of sodium intake

Variables	n	< 150 min physical activity	≥ 150 min physical activity
< 2 300 mg	13	11 (84.62%)	2 (15.38%)
≥ 2 300 mg	37	31 (83.78%)	6 (16.22%)

4.5.7. Association between categories of sodium intake and median minutes spent sitting

There was no statistically significant difference between the median minutes spent sitting per day and the intake of sodium in the low and high categories of sodium intake (95% CI for the median difference: [-60; 240]) (Table 4.24).

Table 4.24: Association between categories of sodium intake and median minutes spent sitting

Sodium Intake	n	Median minutes spent sitting per day	*Range (mins)*
< 2 300 mg	13	480	120-1080
≥ 2 300 mg	37	360	60-1080

4.5.8. Association between median minutes spent in physical activity per week and categories of waist circumference

Due to the fact that there were fewer than 6 participants in one group, the Kruskal-Wallis test was used (Table 4.25). The median number of minutes spent on physical activity did not differ significantly between the group with a normal waist circumference (90 minutes) and the group with a waist circumference in the above normal category who spent 0 minutes in physical activity (p-value: 0.31).

Table 4.25: Association between median minutes of physical activity per week and categories of waist circumference

Waist Circumference	n	Physical Activity *Median (mins)*	Physical Activity *Range (mins)*
Normal	5	90.0	0-420.0
Above Normal	45	0.0	0-2520.0

p = 0.31

4.5.9. Association between categories of waist circumference and categories of physical activity

When comparing the association between waist circumference and low physical activity (Table 4.26), there was a tendency for those with a larger waist circumference to do less aerobic exercise, however this was not statistically significant (95% CI -64.3%; 4.4%).

Table 4.26: Association between categories of waist circumference and categories of physical activity

Variables	n	< 150 min physical activity	≥ 150 min physical activity
Normal	5	3 (60%)	2 (40%)
Above normal	45	39 (86.67%)	6 (13.33%)

In summary male (48%) and female (52%) participants were almost equally distributed in this research study. Most participants were married (74%), Afrikaans (52%) and slightly older (median age = 57.9 years). Eighty-eight percent of participants were overweight (66%) or obese (22%). Diets consumed were high in TE, low in carbohydrates (% carbohydrates of TE - 56% of participants consumed ≤ 45% of TE from carbohydrates), high in saturated fat (92% of participants consumed ≥ 7% of TE from saturated fat), and high in sodium (74% of participants consumed ≥ 2 300 mg sodium daily). A large number of participants (42%) never consumed alcohol and 64% reported never smoking. Exercise was not commonplace, with 84% of participants not meeting the guideline for aerobic exercise and 92% not meeting the resistance exercise guideline.

CHAPTER 5

Discussion

5.1. Introduction

The main aim of this study was to assess the adherence of patients with T2DM to the SEMDSA lifestyle guidelines. In this chapter the researcher will discuss the findings, give possible reasons for these findings and compare the results with relevant studies in similar fields.

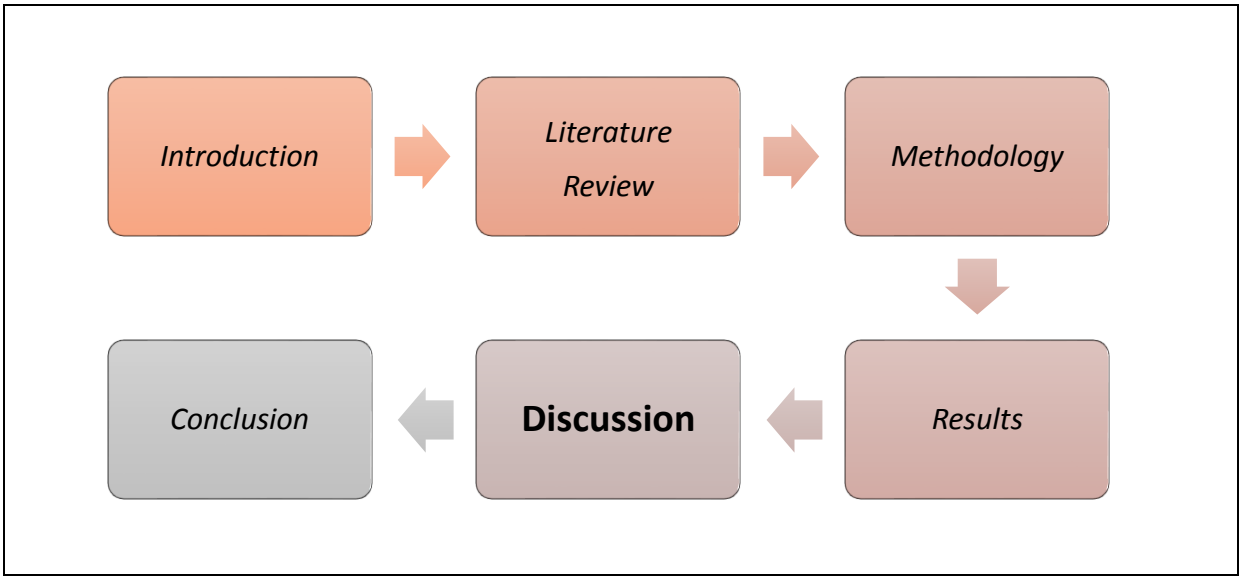

Figure 5.1: Progression of the study: Discussion

5.2. Limitations of the study

The primary limitation of this study was the relatively small number of participants that were included (n=50). Initially, the researcher planned to include patients from the South African National Defence Force (SANDF) where she was employed, as the study population. Logistically, this would have allowed access to a larger number of patients over a longer period of time. The SANDF did not, however, grant permission for the study to be conducted in their facilities, and for this reason an alternative study

population had to be identified. The private practice of a physician that treats diabetic patients in Bloemfontein was chosen. This introduced an element of possible bias and the sample may thus not be representative of the general T2DM population in Bloemfontein.

The characteristics of patients that are treated at a private practice are often different to those of patients that are treated at a public health facility such as the SANDF and this had an impact on the number of participants willing to take part in the study.

Generally, private patients are often employed full time and are less willing to spend time participating in a research project than patients attending a public health facility (where they are used to longer waiting times). Due to work and other commitments, private patients are less likely to have 'spare' time to spend participating in interviews. At the private practice, many patients visited the practice during their 'lunch hour' for follow-up appointments and to have their medication adjusted, and were thus in a hurry to get back to work. In addition to the mentioned barriers, many private patients travel to Bloemfontein from smaller, surrounding areas for specialised medical care. These patients have other appointments and commitments on the day that they are in the city, leaving little time for research interviews. To ask them to return on another day would have been costly and impractical.

Patient bias is a limiting factor in this type of study as patients with poorly controlled T2DM may have been unlikely to participate. The inclusion of newly diagnosed patients (≤ one month) may too be viewed as a limitation as it can be argued that these patients may not have had time to make the required changes to their diets. In this study, however, only four participants were newly diagnosed with T2DM.

The mentioned barriers resulted in a longer data collection period and a total sample that was smaller than the initially anticipated 100 participants. Regardless of these setbacks, the total number of participants was sufficient to make meaningful conclusions about the adherence of patients withT2DM to the SEMDSA guidelines.

As far as the research instruments are concerned, the quantitative food frequency questionnaire that was applied, did not include questions related to added salt intake and the use of non-nutritive sweeteners, which may have impacted on the intake of nutrients that are present in these foods (specifically sodium intake).

5.3. Participant Profile

In the present study, 52% of participants were female and 48% male (Table: 4.1.). This distribution is similar to gender distributions of the general population in the Free State as published in the latest (2011) census – 51.6% female, 48.4% male (Frith, 2011: online).

The median age of participants in the present study was 57.9 years (Table: 4.2). Peer *et al*. (2012:4) conducted a study on the rising prevalence of diabetes among urban-dwelling South Africans. They found that there was an increase in diabetes from 45 years old, that peaked (38.6% increase) in 65–74 year olds. Bradshaw *et al*. (2007: 702) have also reported that T2DM was more common in older (≥ 60 years) South Africans.

The most commonly spoken language in the Free State is Sesotho (64.2%) and the second is Afrikaans (12.7%) (Frith, 2011: online). In the present study, the majority of participants spoke Afrikaans (52%), while the second most commonly spoken language was Sesotho (28%) (Table: 4.1).

As the present study was conducted at a private medical practice, most patients were members of a medical aid and thus most probably from a higher socio-economic group, not representative of the general population. In the SANHANES survey, Shisana *et al.* (2013:26) reported that 25.3% of participants living in the Northern Cape, Western Cape and Free State were members of a medical aid, compared to 47.5% of participants that made use of government funded healthcare facilities.

The majority of participants in the present study were married (74%), while 8% reported that they were divorced. This is in contrast to figures reported for the general population in the Free State, where only 30.9% of adults are married or living together and 2.2% are divorced (Lehohla, 2012: 13) (Table:4.1).

Participants that took part in this study were generally employed and had a higher level of education than that reported for the general population in the province. In the present study, most participants had a level of education at Std 9-10 (54%), while 44% reported having a tertiary qualification (Table: 4.1). As far as figures for the Free State Province are concerned, 27.1% of inhabitants have passed matric, with only 9.4%

having a tertiary qualification (Lehohla, 2012:14 & 67).Thirty three percent of the Free State population are unemployed compared with only 10 percent in the present study (Lehohla, 2012:16).

5.4. Anthropometric Status

Overweight and obesity have been extensively documented in the literature as a major factor in the development of T2DM (WHO, 2016:12; Bhowmik *et al*., 2015:460; Eckel *et al*., 2011:1424; Hossain *et al*., 2007:213). In the present study, 88% of participants were overweight (22%) or obese (66%) according to the WHO BMI classification categories (Table: 4.3).

This occurrence of overweight and obesity is very similar to that reported in the Diet of Diabetic Patients in Spain study (Muñoz – Pareja, *et al*., 2012:4) that reported very similar results in participants with T2DM. In that study, 39.9% of participants were overweight and 47.1% were obese. A cross-sectional, epidemiological study spanning nine countries in Latin America reported similar results. The study was conducted by general practitioners in their respective private practices. Of the 3 592 participants with T2DM, interviewed by the 377 general practitioner's, 79% were overweight or obese (Stewart *et al*., 2007:12). Similar results have also been reported in the Kangbuk Samsung Hospital Study (South Korea) where 69% of 223 diabetic patients, were found to be overweight or obese (Sung *et al*., 2012:718). In Panama, the PREFREC (Risk Factors associated with Cardiovascular Disease) Trial, reported slightly lower levels of obesity in diabetic participants (39.4%) than that found in the present study (Mc Donald *et al.*, 2015:1083).

In 2014, levels of overweight and obesity in the general population were estimated at 1.9 billion globally, with 39% of adults being overweight and 13% obese (WHO, 2016). When looking at previous estimates, it is apparent that these numbers are constantly rising. Due to urbanisation, westernisation and economic development, developing countries are not excluded (Goryakin & Suhrcke, 2014:109). In South Africa, high rates of overweight and obesity have been reported for the general population, with 65% in women and 31% in men (Shisana *et al*., 2013:9; Joubert *et al*., 2007:683). The recent SANHANES report indicates that the level of overweight and obesity in the Free State

is 19.5% and 5.8% respectively (Shisana *et al*., 2013:137). However, these results are representative of the population as a whole, and include both younger and older participants. The rate of obesity was highest in the 'urban formal' category of the SANHANES, with 13.2% being obese (overweight 22.8%).

One of the strongest risk factors for T2DM is excess body fat (WHO, 2016:12). Abdominal obesity, most often expressed as an increased waist circumference, is an independent predictor of T2DM regardless of BMI, and is a stronger risk factor in women than in men (The InterAct Consortium, 2012:online).

National statistics for South Africa indicate that the mean waist circumference for males in the general population is 81.4 cm and for females, 89 cm. Ten percent of males had a waist circumference ≥ 102 cm and half of females (50.8%) ≥ 88 cm. The Free State had the second lowest mean waist circumference (78.3 cm) of the nine provinces, but again overweight and obesity were more prevalent in the 'urban formal' group, with the mean waist circumference increasing to 83.3 cm in males and 90.2 cm in females (Shisana *et al*., 2013:142).

One would expect higher rates of abdominal obesity in the diabetic population, and this was the case in the present study, where 90% of participants with T2DM (96.2% of women and 83.3% of men) had a waist circumference above the high risk cut points (Table: 4.4). Results from Spain were similar, though not quite as high as those found in the present study, with 71.4% of Spanish participants having abdominal obesity. In the Spanish study, higher cut-points were used (Male ≥ 102 cm; Female ≥ 88 cm) than in the present study, indicating that the percentage of participants with a high waist circumference may be even higher if lower cut-points were applied. The Helsinki Health Centre and Helsinki Heart District study assessed the prevalence of Metabolic Syndrome (including T2DM) in middle-aged men from 2001-2003. Findings revealed that of the 234 participants, a median waist circumference of 95 cm (range: 72-142 cm) was found (Siren *et al*., 2012:631). This is similar to that found in the present study, with a median of 106.5 cm (range: 80-143 cm) in males and a median waist circumference of 107.5 cm (range: 67-128) in the women included in the present study.

Compared to BMI, waist circumference and waist-hip ratio, Xu *et al*. (2013) have suggested that waist–height ratio (> 0.5) may be a better indicator to use to identify risk for T2DM. In a recent study by Wang *et al*. (2016), 95% confidence intervals were

used to demonstrate that waist–height ratio was indeed a better indicator of T2DM in men, but that BMI was a better indicator in women. Haijan and Tilaki (2015) confirmed this theory by concluding that waist circumference and waist-height ratio were slightly better predictors of T2DM than BMI in participants included in their study in Iran. Despite this, many studies including participants with T2DM have not included waist-height ratio in their analysis. In the present study 92% of participants had a waist-height ratio above 0.5 (Table: 4.4), with a median of 0.64 (range: 0.41-0.78) (Table: 4.5). In the present study, the percentage of participants presenting with higher than normal values was highest for the waist-height indicator at 92% (compared to waist circumference at 90% and BMI at 88%). Waist-height ratio may thus be a better predictor of T2DM than other anthropometric indicators.

5.5. Lifestyle

5.5.1. Diet

Studies from Europe (Italy and Spain) (Rivellese *et al*., 2007:660; Munoz-Pareja *et al*., 2012:1), America (Look Ahead Trial) (Vitolins *et al*., 2009:1367), the Far East (Japan) (Horikawa *et al*., 2014:176) and the Middle East (Saudi Arabia) (Mohamed *et al*., 2013:110) have assessed dietary intake of patients with T2DM. These studies have all determined dietary intake using food frequency questionnaires (Look Ahead Trial, Japan and Saudi Arabia), food diaries (Italy) and dietary history (Spain) and compared their findings with country specific dietary guidelines for patients with T2DM.

Despite small differences, dietary guidelines are fairly standard across countries and most recommendations were within the same ranges as the SEMDSA guidelines.

5.5.1.1. Carbohydrates

The SEMDSA guideline for carbohydrate consumption is 45-60 % of total energy (TE). In the present study, most participants (56%) consumed less than 45% TE from carbohydrates (Table: 4.7). These results are similar to the Spanish and American studies where most participants consumed less than 45% of TE from CHO – a mean

of 41.1% and 44% respectively. In Spain, only 25.5% of the study population met the guideline for carbohydrate consumption, while in the Look Ahead Trial, very few participants met the recommendations for carbohydrate containing foods. These included only 7% for grains, 36% for fruit and 38% for vegetables (they did not report on total carbohydrate intake as a percentage of TE). Vitolins *et al*. (2009) hypothesise that people with T2DM may purposely be avoiding carbohydrates due to the belief that restricting carbohydrates will help control blood glucose levels more easily (Vitolins *et al*., 2009:1370). The same trends have recently been noted in South Africa, with the media often promoting low carbohydrate diets such as the Noakes and Atkins diets (Naude *et al*., 2014:1).

In Italy, Japan and Saudi Arabia, the mean percentage of carbohydrates consumed was more likely to be within the guidelines (49%, 53.6% and 56.9% of TE respectively) with most participants meeting the guideline (Italy, 72%; Japan, 58% and Saudi Arabia, 61.4%).

All of the participants in the present study met the SEMDSA guideline for fructose (< 60 g/day) (Table: 4.7). In the five comparison studies discussed, none assessed fructose intake individually, although added fructose is a principle driver of T2DM and its consequences (DiNicolantonio *et al.*, 2015:372). The relatively low intake of fructose in the current study is not surprising, as fructose (or high fructose corn syrup) is not routinely used in South Africa as a sweetener.

Sucrose, on the other hand, is widely used as a sweetener in South Africa. According to the SEMDSA guideline, ten percent of TE can come from sucrose. Surprisingly, 92% of participants in the present study met this guideline with only 8% consuming more than 10% of TE from sucrose (Table: 4.7). Most diabetic patients are under the impression that limiting added sugar intake is the most important dietary goal (Vitolins *et al.,* 2009:1371) and this may be the reason that most limited their intake of sugar. For the same reason, it is also possible that participants underreported sugar intake. Vitolins *et al*. (2009:1371) found that generally the intake of all foods seemed to be underreported in their study and foods that were deemed to be less socially acceptable (e.g. added sugar in T2DM) were probably the most likely to be underreported.

The WHO (WHO, 2015: online) now recommends that reducing the intake of added sugars in the diet to less than 5% of TE, will improve glucose tolerance and help curb

the increase in T2DM and the comorbidities that often accompany it (DiNicolantonio *et al.*, 2015:372).

The only comparison study that reported on the intake of sugar intake was the Spanish study, with results showing that Spaniards consumed 16.9% of TE as added sugar and only 10% of participants meeting the recommendation of ≤10% of TE (Munoz-Pareja *et al*., 2012:4). In the Look Ahead study limiting 'fats, oils and sweets' was included in one recommendation, with only 28% of participants meeting the recommendation.

Dietary fibre is essential in all diets but particularly in one for those with T2DM as it helps slow the release of sugar into the blood stream, thus helping to control blood glucose levels (Mohamed *et al*., 2013:113). In all five comparison studies, very low intake of fibre was a common trend. Mohamed *et al.* (2013:113) reported that the patients with T2DM included in their study, had an unfavourable attitude towards the intake of foods containing fibre such as fruits and vegetables, while about 12% of participants in the Saudi Arabian Study stated that they did not include fruit or vegetables in their daily meals at all.

In contrast, more than half of participants in the present study reported fibre intakes between the recommended 25-50g daily (56%) (Table: 4.7). Eighteen percent reported that they consumed more than 50 g of fibre daily and only about one quarter (26%) consumed less than 25 g a day. The fibre consumption in the present study was thus substantially higher than in the comparison studies.

Those with the lowest fibre consumption were participants from Italy and Japan, consuming only 12.5 g and 15 g per day respectively. Only 6% of participants from Italy and 15% from Japan met their fibre recommendation of ≥ 20 g daily (Rivellese *et al*., 2008:663; Horikawa *et al*., 2014:179). In Spain and Saudi Arabia, median daily fibre intakes were fairly similar at 23.8 g and 24.3 g respectively. Only 26.2% of participants met the fibre recommendations in Spain (≥ 20 g daily) and in Saudi Arabia a fibre recommendation was not included (Munoz-Pareja *et al*., 2012:5; Mohamed *et al*., 2013:113). In the Look Ahead Trial the amount of fibre consumed daily was not measured, however, only 7% of participants met the recommendations for grain intake, 36% for fruit intake and 38% for vegetable intake (Vitolins *et al*., 2009:1371).

5.5.1.2. Protein

When comparing protein intake in patients with T2DM, the SEMDSA guidelines (15-20% of TE) were slightly different to the comparison guidelines (10-20% of TE). In the present study, protein intake was lower than that reported in the comparison studies, with 44% of participants in the current study consuming < 15% TE from protein, 42% meeting the guideline and 14% consuming > 20% of TE from protein (Table: 4.8).

Protein consumption did not differ significantly among participants in comparison studies, with Italians consuming the lowest mean percentage of TE from protein (15.7%) and Japanese participants the most (19%) (Rivellese *et al*., 2008:176; Horikawa *et al*., 2014:662). Participants in the American Look Ahead Trial and those from Saudi Arabia, consumed 17% and 17.3% of TE from protein (Vitolins *et al*., 2009:1370; Mohamed *et al*., 2013:112). When comparing categories of protein intake, the percentage of participants that met the requirements for protein consumption in comparison studies was 59.2% in Saudi Arabia, 62.3% in Spain and 72% in Japan (Mohamed *et al*., 2011:112; Munoz-Pareja *et al*., 2012:3; Horikawa *et al*., 2014:179). In the Look Ahead Trial, the percentage of those meeting the protein recommendations was not reported, however, 82% of participants met the meat intake recommendation (minimum recommended servings per day = 2), but only 40% met the dairy intake recommendation (minimum of 2 servings recommended per day) (Vitolins *et al*., 2009:1370).

5.5.1.3. Fat

In the present study 50% of participants met the SEMDSA recommendation for total fat intake (≤ 35% TE) and 50% exceeded the recommendation (Table: 4.9). In comparison studies, those from Saudi Arabia and Spain used the same fat intake recommendations as SEMDSA. Results showed that 54.4% of Saudi Arabians consumed less than 35% of TE from fat (mean consumption 31.2% TE) but only 38.3% of Spanish participants met the recommendation (mean consumption 36.7% TE) (Mohamed *et al*., 2013:111; Munoz-Pareja *et al*., 2012:4).

The American Look Ahead Trial used a recommendation of < 30% TE for total fat and 93% of participants in that study exceeded this recommendation, with a mean of 40%

of TE coming from fat (Vitolins *et al*., 2009:1370). Italy's recommendation of 24 – 35% of TE from fat was met by 62% of participants, with a mean intake of 32% TE from fat (Rivellese *et al*., 2008:662). Japan had a far stricter fat recommendation at < 25% of TE. Not surprisingly, only 30% of Japanese participants met this recommendation. Despite this, Japan had the lowest mean fat consumption at 27.6% of TE, while American participants had the highest (40% of TE) (Horikawa *et al.,* 2014:181; Vitolins *et al*., 2009:1367).

In the present study the vast majority of participants (92%) exceeded the SEMDSA guideline for saturated fat intake (≤ 7% of TE) (Table: 4.9.). Most comparison studies used the same guidelines as SEMDSA for saturated fat, except for the Look Ahead Trial and Italy where ≤ 10% (instead of ≤ 7%) of TE was used. Spanish results were the most similar to the present study, with 92% of participants exceeding recommended guidelines - a mean saturated fat intake of 11.2% of TE was reported (Munoz-Pareja *et al*., 2012:4). In the American Look Ahead Trial, the highest (mean) percentage of saturated fat was consumed (13% of TE) and 85% of participants exceeded the ≤ 10% of TE guideline (Vitolins *et al*., 2009:1367). Italians and Saudi Arabians had fairly similar results with most participants meeting the guideline at 57% and 51.7% respectively, although, different cut points were used: < 10% of TE in Italy and < 7% of TE in Saudi Arabia (Rivellese *et al*., 2008:660; Mohamed *et al*., 2011:111). Again Japan had the lowest mean intake of saturated fat at 7.9% of TE, with 73% of participants meeting the < 7% of TE guideline (Horikawa *et al*., 2014:185).

About three quarters (76%) of participants in the present study met the SEMDSA guideline for polyunsaturated fatty acid (PUFA) intake (< 10% of TE) (Table: 4.9). Although the same cut point was used in all studies, the vast majority of Italian (99%) and Spanish (6.1%) participants met the < 10% guideline, with most (52.4%) Saudi Arabians doing the same (Rivellese *et al*., 2008:662; Munoz-Pareja *et al*., 2012:3; Mohamed *et al*., 2013:111). The Japanese did not include a guideline for PUFA intake in their study, however, the mean PUFA intake was 6.65% of TE (Horikawa *et al.,* 2014:179), well below the < 10% cut point used in other studies. The Americans did not include PUFAs as a variable in the Look Ahead Trial.

The SEMDSA guideline for omega 3 fatty acid intake is ≥ two portions of oily fish per week. In the present study, only 10% of participants met this guideline (Table: 4.9), a

finding that was quite different from the 69.1% of Spanish participants that met the same guideline (Munoz- Pareja *et al.*, 2012:3). In the Japanese study a mean of 1.55% of TE came from omega 3 fatty acids, thus falling within the WHO guideline of 0.5-2% of TE from omega 3 fatty acids. The Look Ahead Trial and the Italian and Saudi Arabian studies did not include omega 3 fatty acid intake as a variable.

5.5.1.4. Sodium

In the present study, almost three quarters (74%) of participants exceeded the SEMDSA guideline for sodium intake (≤ 2 300 mg) (Table: 4.10). These results do not account for added sodium, therefore the actual percentage of participants that consumed excess amounts of sodium is possibly much higher.

Only three comparison studies assessed sodium intake and all used different cut points, making comparisons almost impossible. In the Look Ahead Trial, 92% of participants exceeded the far stricter guideline of ≤ 1 500 mg daily (Vitolins *et al*., 2009:1367). Japan had the most lenient guideline at ≤ 3 900 mg daily and this was exceeded by 51.5% of participants (mean sodium intake was as high as 4 200 mg daily) (Horikawa *et al*., 2014:181). In Spain a mean of 3 100 mg of sodium was consumed (Munoz-Pareja *et al*., 2012:1). Most Spanish participants (55.4%) met the < 3 000 mg daily guideline (double the amount of sodium recommended in the Look Ahead Trial).

In another trial that included 296 diabetic participants, the Enhancing Adherence in Type 2 Diabetes Trial (an American study), two cut points were used and 20.3% consumed < 2 300 mg and only 2.4% < 1 500 mg sodium daily (Provenzano *et al*., 2014:108), with a mean intake of 3 214 mg. The first cut point is the same as the South African one, indicating that the percentage of South African participants that exceeded the guideline was much higher than the American participants (74% vs 20%).

Sodium intake was alarmingly high in all studies reviewed. This is a dangerous lifestyle habit in patients with T2DM, as they are at a higher risk of hypertension, cardiovascular disease and chronic kidney disease (Provenzano *et a*l., 2014:106), all of which are affected by sodium intake.

5.5.2. Alcohol Consumption and Smoking Habits

In the present study, only three men were regular consumers of alcohol, with one third (33.3%) falling into the 'low' consumption (< 2 units daily) category and two thirds (66.67%) into the 'high' consumption (> 2 units daily) category, while none were in the 'moderate' (2 units daily) category (Table: 4.11). A fairly high percentage of participants (42%) said they never consumed alcohol. These results were similar to the results of the Spanish diabetic diet study where it was noted that most participants (78.4%) followed the European Association for the Study of Diabetes (EASD) and American Diabetes Association (ADA) guidelines (< 10 g alcohol/day for women and < 20 g/day for men) for alcohol consumption (Munoz-Pareja *et al*., 2012:4).

It was concerning to note that the participants that did drink (n=3) in the present study, drank a median of 5 alcohol units per day – equal to the common binge drinking definition "consuming 5 or more drinks on an occasion" (Mukamal, 2007:45). Mukamal found that of the 15 389 respondents (all with T2DM) in the 'Hazardous drinking among adults with diabetes' study, 25% reported a physician diagnosis of diabetic eye disease (Mukamal, 2007: 46) suggesting that binge drinking may accelerate the onset of diabetic microvascular complications, including retinopathy.

Carlsson *et al*. (2000:76) found that a high consumption of alcohol (12 or more units per week) significantly increased the chances of developing T2DM. These results are from the Stockholm Diabetes Prevention Programme, a cross-sectional, population based study. Of the 3 128 Swedish male participants, 55 had T2DM. T2DM prevalence was doubled in high alcohol consumers compared to moderate drinkers (Carlsson *et al*., 2000: 778). The EPIC-InterAct study found that men with a higher alcohol consumption had a higher BMI and waist circumference (Beulens *et al.*, 2012:361).

A study undertaken in Auckland, New Zealand (on the general population and not only those with T2DM), found that there was a reduced risk of T2DM with moderate alcohol consumption in normal and overweight participants but not in those with obesity (Metcalf *et al*., 2014:4). In the present study, no one was classified as a "moderate" drinker.

Smoking cessation is recommended globally and in all T2DM guidelines (SEMDSA, EASD, ADA, Korean Diabetes Association, Diabetes New Zealand, Diabetes Australia

and more). According to the Centers for Disease Control (CDC), smoking dramatically increases one's risk of developing T2DM, with smokers being 30-40% more likely to develop T2DM than non-smokers (CDC, 2016: online).

Nationally, 79.2% of the South African population were classified as non-smokers, while 16.2% were current smokers in the SANHANES (Shisana *et al*., 2012:6). In comparison, 10% of diabetic participants in the present study, were current smokers and about a quarter (26%) had smoked previously (Table: 4.11). Sixty four percent of participants stated they had never smoked, compared to 48.2% in the Spanish Diabetic Diet Study. In the Spanish study, a higher percentage of participants were current smokers (14%) and previous smokers (36.9%) (Munoz-Pareja, *et al*., 2012:4).

Chau *et al*. (2015:2547) recruited 22 current smokers and 20 former smokers, all with T2DM, to investigate smoking behaviours, misconceptions about quitting and intentions to quit in patients with T2DM. Of the 22 current smokers, only eight said that they had never tried to quit. Current smokers stated they had not quit smoking as they were happy with their current health status and there were many barriers to quitting smoking, such as peers who smoked, psychological addiction and perceived weight gain after quitting. Ex-smokers displayed a positive opinion about quitting smoking, and reported a stronger family support system than current smokers.

5.5.3. Exercise

A large number of studies have documented the importance of aerobic exercise and resistance training in controlling and preventing T2DM (Armstrong *et al.,* 2015:14; Lanhers *et al.,* 2015:2; Lumb, 2014:673; Bird & Hawley, 2012:311; Gordon *et al*., 2009:157).

Oberlin *et al*. (2014:232) found that a single bout of exercise significantly lowered average blood glucose levels in patients with T2DM, over 24 hours. Nine sedentary participants (< 30 minutes of exercise per week) consumed an eucaloric diet over 48 hours while wearing a continuous blood glucose monitor. Participants were split into 2 groups, one group performed 60 minutes of aerobic exercise at 60-75% of max heart rate before breakfast on day 1, while the other group remained sedentary. Post-prandial blood glucose levels were lower after all six meals in participants that had

exercised compared to those that had not exercised (only significantly lower after the second meal, lunch, on day 1), suggesting that patients with T2DM can benefit from regular (on most days) physical activity.

In the present study, most participants (54%) were completely sedentary (no exercise at all, including walking for more than ten minutes continuously), and the vast majority did not meet the SEMDSA guidelines for aerobic activity (84%) or resistance training (92%) (Table: 4.13).These results are similar to those reported by the Latin American private practice general practitioners (GPs), where 71% of the participants with T2DM were found to be sedentary (Stewart *et al*., 2007:232).

Another study undertaken in 48 private practices in the Auvergne region of France, looked at barriers to physical activity in diabetes (Lanhers *et al*., 2015:5). In this study, 63.1% of (369) patients did not take part in regular physical activity, although 83.2% reported that their GP's had recommended that they exercise regularly. Fear of suffering a heart attack, their poor physical health status and low levels of fitness were cited as the main reasons for not exercising.

Despite an overwhelming body of evidence regarding the benefits of regular physical activity and clear guidelines on the type and duration of physical activity for managing and preventing T2DM, most patients do not perform sufficient physical activity (Bird and Hawley, 2012:313).

5.6. Associations

In this section relationships and trends between variables (BMI, waist circumference, physical activity, sedentary behaviour, level of education, saturated fat intake and sodium intake) will be discussed.

5.6.1. Association between BMI categories and median minutes spent sitting daily (sedentary behaviour)

In the present study, no statistically significant difference was found between the median number of minutes spent sitting per day and the different BMI categories (Table: 4.18). Unexpectedly, there was a tendency for participants with a normal BMI to spend more time sitting (median minutes 570 daily vs 360 for overweight and obese participants), however this difference was not statistically significant. A possible reason for this finding could be that participants with a lower BMI may feel more comfortable with their weight and therefore feel that they do not need to exercise. Another explanation may be that participants with a normal BMI were more likely to accurately report time sitting, whereas overweight participants may have underreported. The number of normal weight participants in the present study was also relatively few, indicating that results should be interpreted with caution.

In contrast, other studies have found that patients with higher BMIs had higher levels (more minutes spent sitting watching television etc.) of sedentary behaviour than those with lower BMIs. In a study by Cichosz *et al*. (2013:1063) 100 newly diagnosed diabetic patients from outpatient clinics at Aarhus University Hospital, Denmark, were closely matched in age and gender to 100 controls. Participants wore accelerometers for 608 days and 94 patients with T2DM and 84 controls provided suitable data for analysis. Those with T2DM had a significantly higher BMI (30 vs 26 kg/m2) and spent significantly longer sitting, or at a lower activity level than the controls (Cichosz *et al*., 2013:1065). Healy *et al*. (2015:1) also found that a higher BMI (and waist circumference) were significantly associated with prolonged sedentary time and less light intensity activity.

In the Living Well with Diabetes Study, conducted in Queensland, Australia, 285 diabetic, overweight or obese and/or sedentary (< 150 minutes of physical activity per week) participants were fitted with accelerometers and wore these during waking hours for 7 days. Most of the participants in this study were obese (BMI ≥ 30), and spent the majority (62.7%) of observed waking hours in a sedentary position (Healy *et al*., 2015:5).

Another exercise intervention trial that included 61 sedentary (< 160 minutes exercise a week), diabetic outpatients from the Slotevaart Hospital in Amsterdam, found that

encouraging patients to exercise and providing the correct tools to increase physical activity, had no significant impact on BMI (Wisse *et al.*, 2010:e12).

5.6.2. Association between BMI categories and categories of saturated fat intake

In the present study, no significant difference in high saturated fat intake was found between participants in different BMI categories (Table: 4.19). There was, however, a trend for obese participants to consume a higher percentage of saturated fat than those with a normal BMI. Similarly, an Algerian study including 285 participants, reported that 58.59% of participants were overweight/obese with T2DM, while 21.91% had a normal BMI with T2DM and 16.49% were overweight/obese but did not have T2DM. Significantly higher consumption of saturated fat (also total and polyunsaturated fat) was observed in the overweight/obese group with T2DM (Diaf *et al*., 2015:347). Vitolins *et al*. (2009:1369) reported similar results in the Look Ahead Trial. Of the 2 757 participants with T2DM, 36% were overweight and 46% obese. Participants with a higher BMI had a higher consumption of all food groups, including saturated fat.

5.6.3. Association between categories of BMI and categories of education

In the present study, no significant association was found between level of education and BMI categories (Table: 4.20). Fan *et al.* (2015:5) compared age, gender and education level of 1 362 Chinese participants in different BMI and physical activity categories, and also found no significant associations, but did report that there was a tendency for heavier participants to be less educated.

Sheikh *et al*. (2015) studied a large cohort (33 714) of Norwegian women over seven years and reported that diabetic participants had a higher BMI and lower level of education than their non-diabetic counterparts. Similarly, the EPIC-InterAct Study found that lower levels of education were a predictor of T2DM. Although education level itself does not have a direct, biological effect on disease, it is mediated by other modifiable risk factors, including BMI (Sacredote *et al*., 2012:1165).

5.6.4. Association between BMI categories and categories of physical activity

The benefits of physical activity on weight maintenance are well described. One would expect that persons that are more physically active would have a lower BMI than their sedentary counterparts. In a study by Herman *et al.* (2014:908) that included 65 666 participants with T2DM in Germany and Austria, this was confirmed. In their study, diabetic patients that exercised 1-2 times per week had a higher BMI than patients that exercised more than 2 times per week.

The current study found that 36.6% of overweight participants met the SEMDSA guideline for aerobic activity, compared to only 9.1% of obese participants (Table: 4.21). This finding is similar to that reported in a study by Tudor-Locke (2002:191) amongst 160 diabetic patients in Canada. Using pedometers, they found that overweight participants gave significantly more steps per day than their obese counterparts.

In the present study, there was, however, a tendency for participants with a normal BMI to be less physically active than the overweight or obese groups, though this difference was not statistically significant (as mentioned previously they were also more likely to spend more time sitting). Again, the small number of participants that had a normal BMI indicates that caution should be applied when interpreting these results. However, the Chinese study of Fan *et al*. (2015:5) also reported that level of physical activity did not differ significantly between normal weight and overweight participants in their study.

5.6.5. Association between sodium intake, BMI and levels of physical activity

The consumption of convenience and processed foods is commonly linked with obesity (Bodicoat *et al*., 2014:1698). In addition to fat, these foods often contain a large amount of sodium. The results of the current study could not, however, establish an association between high sodium intake (≥ 2 300 mg daily) and BMI in the overweight or obese category (Table: 4.22) or categories of physical activity (Table: 4.23). In contrast, Venezia *et al.* (2010:522) found that sodium intake (measured by sodium excretion) was significantly associated with adiposity and that BMI was an independent determinant of daily sodium intake. Sodium intakes were higher in the

overweight and obese participants of the Italian Olivetti Heart Study Population (940 men), when compared to those of normal weight participants (Venezia *et al.*, 2010:518).

Bodicoat *et al*. (2014) investigated whether the number of fast food outlets in a neighbourhood increased the incidence of obesity and T2DM in that neighbourhood. The study took place in the United Kingdom and included 10 461 participants. As expected, results suggested that increased exposure to fast food outlets increased risk of T2DM and obesity (Bodicoat *et al*., 2014:1698). Provenzano *et al*. (2014) reported a statistically significant relationship between sodium intake and income, with a higher income being associated with a higher sodium intake. Reasons for this finding could be that these participants were working, had less time for food preparation and relied more on convenience foods.

In contrast to the findings of the current study, Moinuddin *et al.* (2016: 12) compared exercise capacity in participants with a high sodium intake to participants with a normal intake, and reported that those that ate less sodium were more likely to exercise (Moinuddin *et al*., 2016:12). Similarly, the Finnish Cardiovascular Risk in Young Finns Multicentre Study, reported that sedentary behaviour (television viewing in particular), was most consistently related to increased BMI, waist circumference and intake of high sodium foods (sausage, beer and sugar sweetened beverages) (Heinonen 2013:1). Sedentary activities are thus more likely to promote overconsumption of food, particularly convenience (high sodium) foods (Chaput *et al*., 2011:e13).

5.6.6. Association between waist circumference and physical activity

In the present study only five participants had a normal waist circumference, making it difficult to draw conclusions. Although those with a normal waist circumference were more likely to be physically active than those with a waist circumference in the high risk category, the difference was not significantly different (Table: 4.26).

A French study including 1 532 older adults (> 60 years old) found that risk for T2DM increased as waist circumference increased. In addition, these authors reported that those participants that took part in ≥ 30 minutes of ‘sport’ (physical activity) per day had a significantly reduced risk for T2DM compared with the group that did less than

30 min of physical activity daily (Defay *et al*., 2001: 515). Similar results were reported in a Japanese study that included patients with early, untreated T2DM or prediabetes, that confirmed that physical activity level (time and duration of daily physical activity) was significantly and negatively associated with waist circumference (Hamasaki *et al*., 2015:1).

In conclusion, the adherence of participants to the SEMDSA guidelines was poor, thus increasing their risk of long term complications and poor glycaemic control. Complying with the SEMDSA guidelines can assist in maintaining a healthy weight, consuming a healthy diet and performing regular exercise.

CHAPTER 6

Conclusion and Recommendations

6.1. Introduction

In the final chapter, conclusions are drawn from the findings of the present study. Recommendations related to addressing the identified challenges associated with T2DM are made and recommendations for future research are suggested.

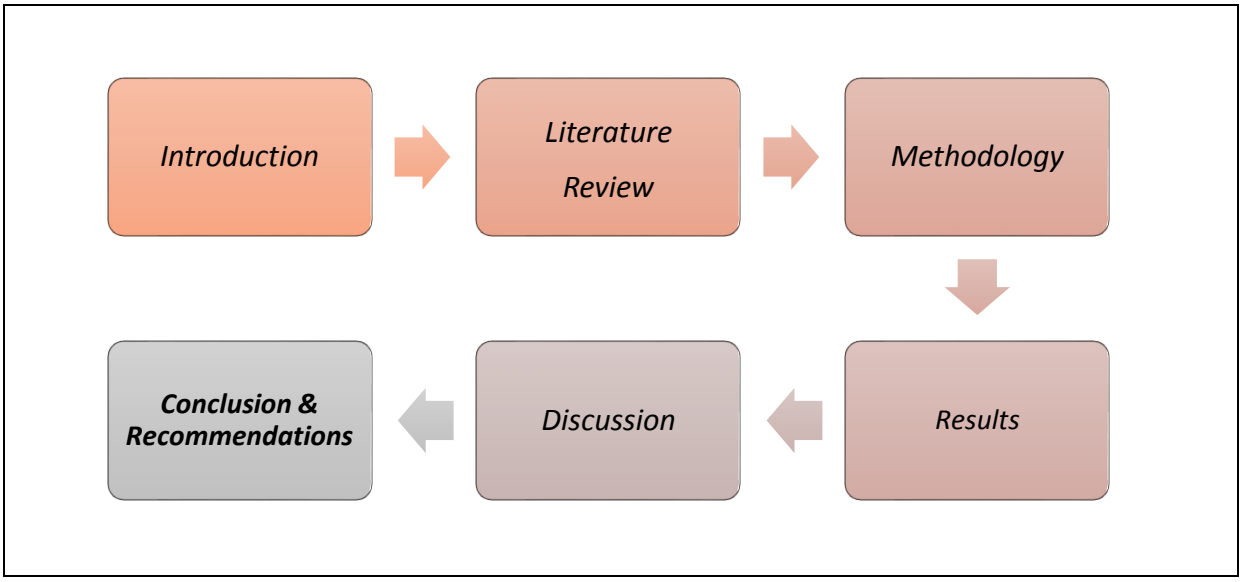

Figure 6.1: Progression of the study: Conclusion and Recommendations

6.2 Conclusions

The main conclusion that can be drawn from the study is that the SEMDSA lifestyle guidelines were poorly adhered to by the study population. More specifically:

6.2.1 Lifestyle

- Overweight and obesity, specifically visceral obesity, were highly prevalent in the studied population

Due to the fact that overweight and obesity increase the risk of developing T2DM and also impact on health in terms of increasing risks for complications, optimising weight control should be an essential component of the management of these patients.

6.2.1.1 Diet

- The majority of participants consumed a diet high in saturated fat and sodium, and low in omega 3 fatty acids.
- In a large percentage of participants, total fat intake was high, whereas carbohydrate intake was relatively low.
- Reported fibre, fructose and sucrose intake was satisfactory.

The diet followed by most participants did not meet the SEMDSA guidelines. The influences of secular society, including the media, were demonstrated in some of the dietary choices being made (especially the choice of eating foods with a high fat content).

6.2.2.1 Exercise

- The vast majority of participants did not meet the guidelines for aerobic exercise or resistance training.
- Sedentary lifestyles were the norm.

Lack of physical activity and sedentary lifestyles were a common occurrence in the study population. Industrialisation and office jobs are contributing factors to a sedentary society. This was confirmed in the present study, with most participants using their own cars (or public taxis) for travel to work and shops, and being involved in jobs that required them to spend many sedentary hours at work. Most cited lack of time to exercise as the main reason for not engaging in physical activity.

6.2.1.3 Alcohol consumption and smoking

- A relatively small percentage of participants reported regularly consuming alcohol and smoking.
- Those who did consume alcohol, consumed large amounts.
- Despite the negative impact of smoking on health, some individuals still smoked.

6.3 Recommendations

The link between urbanisation, overweight and obesity, unhealthy and disordered eating patterns, lack of physical activity and T2DM has been clearly established (Amod *et al*., 2012:S4). Globally, obesity, insulin resistance and T2DM are reaching epidemic proportions (Imamura *et al*., 2016:3). Unless a paradigm shift is made from a 'patient-based treatment approach' to a 'global-government based, everyone-working-together-to-help-each-other treatment approach', prevention and treatment of overweight, obesity and T2DM will most probably continue to be unsuccessful (Amod *et al*., 2012:S4).

Findings in the present study indicated that patients with T2DM require encouragement and support to make better lifestyle choices. There needs to be an emphasis on relevant and culturally acceptable nutrition education that emphasises the importance of following the guidelines that have been compiled by evidence-based organisations such as SEMDSA, while at the same time taking individual circumstances into consideration. In addition to describing the benefits of following a healthy lifestyle, attention should also be given to explaining the implications of not adhering to these guidelines (Mohamed *et al*., 2013:113).

6.3.1 Recommendations for practice

In terms of recommendations for practice, high risk patients should be screened regularly to improve early detection of T2DM. Effective and early control of glycaemia, hypertension and dyslipidaemia and regular examinations for micro and macrovascular complications, can make a meaningful contribution to reducing and preventing the morbidity and mortality associated with T2DM (Amod *et al*., 2012:S4).

In both the private and public healthcare system, time is often limited. Due to this, many healthcare practitioners have relied on the use of generic guidelines, pamphlets and diets. More recent evidence has shown that a real understanding and comprehension of individual needs and requirements related to lifestyle choices of persons with T2DM, is associated with better compliance and health outcomes (Amod *et al*, 2012:S13).

This approach can, however, be time consuming, and for this reason, patients with T2DM should be referred to healthcare professionals in diabetes specific fields, to allow adequate time to translate scientific guidelines into practical advice that has been tailored to the needs of each individual. General practitioners and ophthalmologists are often the first to identify that a person has T2DM (Fenwick *et al*., 2013:1). These practitioners have the responsibility of referring patients to other health care practitioners like dietitians and diabetes educators, who can spend more time explaining the aetiology, pathophysiology and implications of the disease to patients. Patients that understand the condition, are more likely to comply with lifestyle recommendations (Persell *et al*., 2004:746).

6.3.1.1 Diet

Nutrition intervention is a critical aspect of diabetes care (Mohamed *et al*, 2013:113). Dietary advice should be individualised and tailored to reduce energy intake in overweight and obese patients, and to prevent weight gain in normal weight patients. In addition the reduction of saturated fat and sodium intake in patients with T2DM should be a priority (Rivellese *et al.*, 2008: 663).

In an effort to improve compliance, evidence-based nutrition guidelines need to be translated into practical advice. In terms of the patient, a food-based approach has more value than a nutrient-based approach (e.g. stating that 45 – 60% of TE should come from carbohydrates is impossible for the patient to understand).

A highly individualised flexible approach has the potential to improve the compliance of patients with T2DM (Evert *et al*., 2014:S124). A 'flexible diet' should focus on meeting individual requirements, with an emphasis on goals rather than guidelines. Patients are educated on eating and enjoying the types of food that won't compromise their weight or glucose control within the recommended macronutrient distribution, instead of placing the emphasis on kilojoules, sugar and other foods that are not allowed.

In essence, the guidelines remain the same, but the implementation is adjusted for each individual. More time needs to be spent on patient education, reading and understanding food labels and flexible diet construction. This approach has the potential to instil a sense of ownership and responsibility.

In patient groups with limited levels of literacy, including visual images such as photographs or pictures, may make it easier for patients to grasp concepts. Aids such as food models and the 'My Plate' model can also be helpful. The main aim of nutrition education is to establish nutrition concepts and facilitate healthy meal planning on an individualised basis (Mohamed *et al*., 2013:113).

6.3.1.2 Sedentary behaviour and physical activity

As confirmed in this study, high levels of sedentary behaviour and low levels of physical activity are critical issues that need to be addressed in the management of patients with T2DM.

In terms of health care professionals, biokineticists and physiotherapists can make a meaningful contribution to improving the daily functioning and physical activity of patients with T2DM. However, the high prevalence of overweight and obesity in the general population, shows that interventions on a community level are also required. This will require a pro-active approach from government in terms of public safety as well as public spaces and facilities for sports and recreation. Trade and Industry,

Agriculture, Education, Sports and Recreation and Health Departments all need to work together in this regard.

Physical activity initiatives in other countries include the UK government's cycle to work initiative (Cyclesheme) where participants are afforded tax-free bicycles and employers are afforded up to 13.8% National Insurance savings (Cyclescheme, 2017: online). Outdoor gyms are popular in Brazil, America and the UK with South Africa slowly adopting the concept. This allows individuals a safe and cost-effective opportunity to be physically active (Chow, 2013:1216).

Another concept that has become popular in Taiwan and Japan is standing/ walking meetings and active lunch breaks. These have been shown to significantly reduce sedentary behaviour in the corporate environment (King *et al*., 2016:1).

6.3.2 Recommendations for future research

In view of the poor compliance of patients with T2DM with the SEMDSA lifestyle guidelines that was identified in the present study, research regarding barriers to compliance of dietary and exercise guidelines in South African patients with T2DM, is warranted.

Future studies would benefit from larger sample sizes that are more representative of patients with T2DM in both the private and public sector. Such studies would have the statistical power to confirm lifestyle behaviours that need attention in terms of adherence to national diabetes guidelines, which would assist in planning and implementing relevant nutrition interventions.

"The doctor of the future will give no medicine, but will instruct his patient in the care of the human frame, in diet and in the cause and prevention of disease"

Thomas Edison (1847 – 1931)

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Appendix A

Adherence of Patients with Type 2 Diabetes Mellitus with the SEMDSA Lifestyle Guidelines

LIFESTYLE QUESTIONNAIRE

Interview date: | D | D | M | M | Y | Y | 1-6 **Participant number:** | | | | 7-9

Gender:
1. Male
2. Female

| | 10

What is your date of birth?

| D | D | M | M | Y | Y | 11-16

_____ **(ddmmyy)**

What is your marital status?

1. Married
2. Divorced
3. Never Married
4. Widow/er

| 17

What is your home language?
1. English
2. Afrikaans
3. Sotho
4. Tswana
5. Xhosa
6. Zulu
7. Other, specify: _____

| 18

What is the time since T2DM diagnosis was made:

| Y | Y | M | M | 19-22

_____ **(yymm)**

What is your highest level of education?
1. None
2. Primary school
3. Std 6-8
4 Std 9-10
5. Tertiary Education

| 23

What is your current employment status?
1. Housewife by choice
2. Unemployed
3. Self-employed
4. Full time wage earner (receives a salary)
5. Other, specify (part-time, piece-job etc.)

| 24

Do you smoke?
1. Yes
2. Never
3. Quit

| 25

If you smoke, how many cigarettes do you smoke daily?

| | 26-27

If you quit smoking, how long ago was that? ☐ 28-29

_____ **(yymm)**

Do you drink alcohol? ☐ 30
1. Never
2. Everyday
3. Most days
4. Only over weekends
5. Only on special occasions

How many units of alcohol do you consume daily? ☐ 31-32

_____**units**

How many times per week do you do resistance training? ☐ 33-34

_____minutes

Weight:_____ **kg** ☐☐☐.☐ 35-39

Height:_____**cm** ☐☐☐.☐ 40-44

Waist circumference:_____**cm** ☐☐☐.☐ 45-49

Appendix B

ADHERENCE OF PATIENTS WITH TYPE 2 DIABETES MELLITUS WITH THE SEMDSA LIFESTYLE GUIDELINES

FOOD	DESCRIPTION	AMOUNT USUALLY EATEN	TIMES EATEN				CODE	AMOUNT/DAY
			Per day	Per week	Per month	Seldom/ Never		
Maize-meal porridge	Stiff (pap)						**3400**	
Maize-meal porridge	Soft (slappap)						**3399**	
Maize-meal porridge	Crumbly (phutu)						**3401**	
Sour porridge	Specify ratio Mabella/Maize						**3399**	
Mabella porridge	Stiff, coarse, fine						**3437**	
Mabella porridge	Soft, coarse, fine						**3437**	
Oats porridge	Brand name:						**3239**	
Breakfast cereals	Puffed Wheat, plain						**3325**	
	Corn Flakes, plain						**3243**	
	Weet Bix						**3244**	
	Puffed Rice, sweet						**3372**	
	Specify types usually eaten _____ _____ Brand names of cereals available at home now:_____							
Milk on porridge or cereal: Circle type usually used	None							
	Whole/fresh						**2718**	
	Sour						**2787**	
	2% fat						**2772**	
	Fat free/skimmed						**2775**	
	Milk blend						**2771**	
	Soy milk						**2737**	
	Condensed (whole,sweet)						**2714**	
	Condensed (skim, sweet)						**2744**	
	Evaporated whole						**2715**	
	Evaporated low fat						**2827**	
	Non-dairy creamer						**2751**	
Is sugar added to porridge or cereal?	None □ White □						**3989**	

(Tick box)	Brown □ Syrup □ Honey □ Sweetener: type_____						**4005** **3988** **3984**	
Is fat added to porridge or cereal? **(Tick box)**	None □ Animal fat (butter) □ Hard margarine □ Soft margarine □ Oil □ Peanut Butter □						 **3479** **3484** **3496** **3507** **3485**	
Samp/Maize rice **Samp and beans** **Samp and peanuts**	Bought Self ground Specify ratio (1:1) Specify ratio						**3250** **3725** **3402**	
Rice: specify brands names:	White Brown Sorghum rice						**3247** **3315** **3437**	
Stamped wheat							**3249**	
Pastas	Macaroni Spaghetti Spaghetti in tomato sauce Other:						**3262** **3262** **3258**	

HOW MANY TIMES A WEEK DO YOU EAT PORRIDGE OR BREAKFAST CEREAL AT ANY TIME OF THE DAY (NOT ONLY BREAKFAST)?_____

FOOD	DESCRIPTION	AMOUNT USUALLY EATEN	TIMES EATEN				CODE	AMOUNT/DAY
			Per day	Per week	Per month	Seldom/ Never		
Bread/Bread rolls	White						**3210**	
Bread slices: thin	Brown						**3211**	
Medium, thick	Whole wheat						**3212**	
Other breads	Specify types e.g. Raisin Maize meal Sweetcorn Rye Other						 **3214** **3278** **3379** **3213**	

Pizza (specify toppings) **Hot Dogs(specify sausage)** **Hamburgers (specify meat)**	Cheese, tomato & onion _____ _____ _____ _____						**3353**	
Are any the following spreads used on bread? **Fat spreads** **(Tick box)**	Butter □ Butro □ Animal fat (beef tallow) □ Lard □ Hard margarine (brick) □ Soft margarine (light) □ Cooking Fat □						**3479** **3523** **3494** **3495** **3484** **3496** **3516**	
Peanut butter							**3485**	
Sweet spreads	Jam Syrup Honey						**3985** **3988** **3984**	
Marmite/ **OXO/** **Bovril**							**4030** **4029** **4029**	
Fish paste **Meat paste**							**3109** **2917**	
Cheese	Specify types: Cottage low-fat cheese Cream cheese Gouda Cheddar Other:_____						 **2760** **2725** **2723** **2722**	
Cheese spreads	Low fat Full fat Specify types						**4310** **2730**	
Atchar							**3117**	
Other spreads: **(Specify tipes)**	_____ _____							
Dumpling							**3210**	
Vetkoek							**3257**	
Provita **Crackers (refined)** **Crackers (whole wheat)**							**3235** **3331** **3391**	

Rusks *Home-made:*	Bran Buttermilk White Boerebeskuit, white All-bran Raisins Buttermilk, white Buttermilk, whole wheat Other						**3330** **3329** **3364** **3364** **3380** **3380** **3215** **3255**	
Scones							**3237**	
Muffins	Plain Bran						**3408** **3407**	

HOW MANY TIMES A DAY DO YOU EAT BREAD? _____

FOOD	DESCRIPTION	AMOUNT USUALLY EATEN	TIMES EATEN				CODE	AMOUNT/DAY
			Per day	Per week	Per month	Seldom/ Never		
Chicken **Do you eat the chicken with the skin?** **Yes □ No □**	Boiled: with skin without skin						**2926** **2963**	
	Fried: in batter/crumbs Fried, but not coated						**3018** **2925**	
	Roasted/grilled with skin without skin						**2925** **2950**	
Chicken bones stew							**A003**	
Chicken heads, raw							**2999**	
Chicken stew, with veg. & skin							**3005**	
Chicken feet, raw							**2997**	
Chicken offal	Giblets						**2998**	
Chicken pie	Commercial Home-made						**2954** **2954**	
Red meat: Beef	Fried/grilled: with fat without fat						**2908** **2959**	
	Stewed/boiled: with fat						**3006**	

	without fat						**2909**	
	Mince with tomato and onion						**2987**	
Red meat: Mutton	Fried/grilled: with fat without fat						**2927** **2934**	
	Stewed/boiled: with fat without fat						**3040** **2916**	
Red meat: Pork	Fried/grilled: with fat without fat						**2930** **2977**	
	Stewed/boiled: with fat without fat						**3046** **3045**	
Red meat: Goat	Fried/grilled: with fat without fat						**4281**	
	Stewed/boiled: plain with veg						**4281** **4282**	
Offal: Specify type:	Intestines: boiled, nothing added						**3003**	
	"Vetderm" fried						**3003**	
	Stewed with vegetables							
	Liver						**2955**	
	Kidney						**2956**	
	Tripe "pens" trotters, head						**3003**	
	Pluck (lungs, heart, gullet)						**3019**	
Specify vegetables used in meat stews (only if not mentioned elsewhere)								
Wors / sausage	Fried						**2931**	
Bacon							**2906**	
Cold meats	Polony						**2919**	
	Ham						**2967**	
	Vienna's canned						**2936**	
	Russian						**2948**	
	Frankfutter						**2937**	
	Other (specify)							
Canned meat	Bully beef						**2940**	
	Other (specify)							
Meat pie	Bought						**2939**	

FOOD	DESCRIPTION	AMOUNT USUALLY EATEN	TIMES EATEN				CODE	AMOUNT/DAY
			Per day	Per week	Per month	Seldom/ Never		
Legumes: specify dried beans/peas/ Lentils	Stews & curries (specify) Soups Salad						**3157** **3174**	
Baked beans							**3176**	
Soya products e.g. Toppers/ Imana	Brands at home now Don't know_____ **Show examples**						**3196**	
Fried fish (fresh or frozen fried in sun oil)	With batter/crumbs Without batter/crumbs						**3072** **3060**	
Fresh water fish **Specify type**	**Specify cooking method** Medium fat, batter, fried						**3094**	
Canned fish:								
Pilchards	In brine						**3055**	
	In tomato sauce						**3102**	
	Mashed with fried onion						**A005**	
Sardines	In oil In tomato sauce						**3087** **3087**	
Tuna	In oil In brine						**3093** **3054**	
Mackerel							**3113**	
Salmon							**3101**	
Pickled fish/curried							**3076**	
Do you remove fish bones before eating canned fish	YES □ NO □							
Fish cakes **Specify canned or other**	Fried: oil/butter/margarine, commercial						**3080**	
Salted dried fish							**3077**	
Eggs	Boiled/poached Scrambled in: oil butter						**2867** **2889** **2886**	

	margarine Fried in: oil butter margarine bacon fat Curried						**2887** **2869** **2868** **2877** **2870** **2902**	

HOW MANY TIMES A WEEK DO YOU EAT MEAT _____,

BEANS _____,

CHICKEN _____,

FISH _____ **AND**

EGGS _____**?**

FOOD	DESCRIPTION	AMOUNT USUALLY EATEN	TIMES EATEN				CODE	AMOUNT/DAY
			Per day	Per week	Per month	Seldom/ Never		
Cabbage	Boiled, nothing added						**3756**	
	Boiled with potato and onion and fat						**3813**	
	Fried, in margarine (nothing added)						**3810**	
	Fried, in oil (nothing added)						**3912**	
	Boiled, then fried with potato, onion						**A006**	
	Other:							
Spinach/morogo/imfino/other green leafy vegetables: List names	Boiled, nothing added						**3913**	
	Boiled fat added (margarine)						**3898**	
	Boiled with onion/tomato and fat						**A011**	
	-onion &potato (margarine)						**3901**	
	- onion, tomato & potato							
	- with peanuts							
	Other:							
Tomato and onion 'gravy'/relish/chow	Home made -with fat without fat						**3910** **3925**	

	Canned						**4129**	
Pumpkin	Cooked in fat & sugar						**A010**	
Specify type:	Boiled, little sugar and fat						**A010**	
	Boiled						**4164**	
_____	Other:							
Carrots	Boiled, sugar & fat						**3819**	
	Boiled, nothing added						**3757**	
	Boiled, potato, onion, no fat						**3934**	
	Boiled, potato, onion, margarine						**3822**	
	Boiled, with sugar						**3818**	
	With potato/onion						**3934**	
	Raw, salad (orange juice)						**3711**	
	Chakalaka							
	Other:							
Mealies/Sweet corn	On cob						**3725**	
	Off cob -creamed sweet corn Off cob whole kernel						**3726** **3942**	
Beetroot	Cooked Salad (bought or home-made)						**3698** **3699**	
Potatoes	Boiled with skin						**4155**	
	- without skin						**3737**	
	Baked in skin(flesh and skin) - in skin (flesh only)						**3736** **3970**	
	Mashed - skim milk, margarine						**3875**	
	Mashed - whole milk, margarine						**3876**	
	Roasted in beef fat						**3878**	
	French fries/potato chips (oil)						**3740**	
	Salad (mayonnaise and egg)						**3928**	
	Other:							
Sweet potatoes	Boiled with skin						**3748**	
	without skin						**3903**	
	Baked with skin						**3748**	
	- without skin						**3903**	
	Mashed						**3903**	
	Other:							
Peas	Green, frozen						**4146**	

	Green, frozen with sugar With sugar and butter Tinned peas						**3720** **3859** **4149**	
Green peppers	Raw Cooked (stew with oil)						**3733** **3865**	
Brinjal/egg plant	Cooked Fried in oil Stew (oil, onions, tomato)						**3700** **3802** **3798**	
Mushrooms	Raw Sautéed in brick margarine Sautéed in oil						**3842** **3839** **3841**	
Onions	Sauteed in sun oil Sauteed in margarine						**3730** **3844**	
Salad vegetables	Raw tomato						**3750**	
	Lettuce						**3723**	
	Cucumber						**3718**	
	Avocado's						**3656**	
Green Beans	Boiled, nothing added						**3696**	
	Cooked, potato, onion, margarine						**3792**	
	Cooked, potato, onion, no fat						**3933**	
Cauliflower	Boiled							
Other vegetables; specify	_____ _____							
If you fry veg or add fat specify type of fat usually used	Butter □ Butro □ Animal fat (beef tallow) □ Lard □ Hard margarine (brick) □ Soft margarine (tub) □ Soft margarine (light) □ Sunflower oil □						**3479** **3523** **3494** **3495** **3484** **3496** **3524** **3507**	

HOW MANY TIMES A WEEK DO YOU EAT VEGETABLES? _____

FOOD	DESCRIPTION	AMOUNT USUALLY EATEN	TIMES EATEN				CODE	AMOUNT/DAY
			Per day	Per week	Per month	Seldom/ Never		
Mayonnaise/salad dressing	Mayonnaise: bought home-made Cooked salad dressing Salad dressing low-oil Salad dressing French Oil: Olive Sunflower Canola						**3488** **3506** **3503** **3505** **3487** **3509** **3507** **4280**	
Apples	Fresh Canned, unsweetened						**3532** **4216**	
Pears	Fresh Canned, in syrup						**3582** **3583**	
Bananas							**3540**	
Oranges **Naartjie**							**3560** **3558**	
Grapes							**3550**	
Peaches	Fresh Canned, in syrup						**3565** **3567**	
Apricots	Fresh Canned, in syrup						**3534** **3535**	
Mangoes	Fresh						**3556**	
Pawpaw	Raw						**3563**	
Pineapple	Raw Canned (syrup)						**3581** **3648**	
Guavas	Fresh Canned (syrup)						**3551** **3553**	
Watermelon							**3576**	
Spanspek	Orange flesh Green flesh						**3541** **3575**	
Wild fruit/berries (Specify types)	_____ _____ _____ _____ _____							

Dried fruit (also as snacks)	Raisins Prunes (raw) Prunes (cooked with sugar) Peaches (raw) Peach (cooked with sugar) Apples (raw) Dried fruit sweets Other _____ _____ _____						**3552** **3596** **3564** **3568** **3569** **3600** **3995**	
Other fruit	_____ _____ _____	_____ _____ _____	_____ _____ __	_____ _____ __	_____ _____ _____	_____ _____ _____		_____ _____ _____

HOW MANY TIMES A WEEK DO YOU EAT FRUITS? _____

WE NOW WILL ASK YOU QUESTIONS ABOUT WHAT YOU USUALLY DRINK

BEVERAGES	**DESCRIPTION**	**AMOUNT USUALLY TAKEN**	**TIMES TAKEN**				**CODE**	**AMOUNT/DAY**
			Per day	**Per week**	**Per month**	**Seldom/ Never**		
Water							**4042**	
Tea	Ceylon Rooibos						**4038** **4054**	
Coffee							**4037**	
Sugar per cup of tea or coffee	White Brown						**3989** **4005**	
Milk per cup of tea or coffee What type of milk do you put in tea and/or coffee?	Fresh/long life whole						**2718**	
	Fresh/long life 2% Goat						**2772** **2738**	
	Fresh/long life/fat free (skimmed)						**2775**	
	Whole milk powder, reconstituted Specify brand: _____						**2831**	

	Skimmed milk powder, reconstituted Specify brand: _____						**2719**	
	Milk blend, reconstituted Specify brand: _____						**2771**	
	Whitener/non-dairy creamer Specify brand: _____						**2751**	
	Condensed milk (whole)						**2714**	
	Condensed milk (skim)						**2744**	
	Evaporated milk (whole)						**2715**	
	Evaporated milk (low-fat)						**2827**	
	None							
Milk as such: **What type of milk do you drink as such?**	Fresh/long life/whole Fresh/long life/2% Fresh/longlife/fat free (skimmed) Goat						**2718** **2772** **2775** **2738**	
	Sour / Maas						**2787**	
	Buttermilk						**2713**	

BEVERAGES	DESCRIPTION	AMOUNT USUALLY TAKEN	TIMES TAKEN				CODE	AMOUNT/ DAY
			Per day	Per week	Per month	Seldom/ Never		
Milk drinks Specify brands, Including milk supplements and type of milk used	Nestle Nesquik Milo Flavoured milk Other						**4287** **2735** **2774**	
Yoghurt	Drinking yoghurt Thick yoghurt, plain, fruit						**2756** **2732**	
Squash	SixO Oros Lecol with sugar -artificial sweetener Kool Aid Other_____ _____						**3990** **3982** **3982** **3990** **3982**	
Fruit juice	Fresh/Liquifruit/Ceres/						**2866**	
	"Tropica"/ mixtures with milk						**2791**	
Fruit syrups	Average Guava syrup						**2865** **2864**	
Fizzy drinks **Coke, Fanta**	Sweetened Diet						**3981** **3990**	
Mageu/Motogo							**4056**	
Alcoholic beverages such as Sorghum beer	Sorghum beer Specify:						**4039**	
Other , specify:	Beer average Wine Cider _____ _____ _____ _____ _____						**4031** **4033** **4057**	

PLEASE INDICATE WHAT TYPES AND AMOUNTS OF SNACKS, PUDDINGS AND SWEETS YOU EAT:

FOODS	DESCRIPTION	AMOUNT USUALLY EATEN	TIMES EATEN				CODE	AMOUNT/DAY
			Per day	Per week	Per month	Seldom/ Never		
Potato crisps/chips							**3417**	
Peanuts	Roasted, unsalted Roasted, salted						**3452** **3458**	
Cheese curls: **Niknaks etc.**	Average Savoury						**3267** **3418**	
Popcorn	Plain (no salt and butter) Plain (salt and butter added) Sugar coated						**3332** **3359**	
Raisins (seeds)							**4231**	
Chocolates	Milk Kit Kat Peppermint crisp Specify types and names _____						**3987** **4024** **3997**	
Candies	Sugus, gums, hard sweets (specify) Peppermint						 **3986** **4004**	
Sweets	Toffees Hard boiled Fudge, caramels (specify)						**3991** **3986** **3991**	
Biscuits/cookies	Specify type Home made plain Shortbread, butter Commercial, plain Commercial with filling						 **3233** **3296** **3216** **3217**	
Cakes & tarts	Chocolate, plain						**3419**	
Pancakes/crumpets							**3344**	
Koeksisters							**3231**	
Savouries	Sausage rolls Samoosas - vegetable Samoosa - mutton Biscuits e.g. bacon kips Other: _____						**2939** **3414** **3355** **3331**	

Pudding: jelly							**3983**	
Baked pudding	Plain batter						**3429**	
Instant pudding	Skim milk Whole milk						**3314** **3266**	
Ice cream	Commercial regular Commercial rich Soft serve Sorbet Ice lollies Chocolate coated individual ice creams (e.g. Magnum)						**3483** **3519** **3518** **3491** **3982**	
Custard	Home made, whole milk Ultramel						**2716** **2716**	
Cream	Fresh						**3520/** **3480**	
Other puddings (Specify):	_____							

HOW MANY TIMES A WEEK DO YOU EAT SNACK FOODS? _____

SAUCES / GRAVIES / CONDIMENTS

FOODS	**DESCRIPTION**	**AMOUNT USUALLY EATEN**	**TIMES EATEN**				**CODE**	**AMOUNT/DAY**
			Per day	**Per week**	**Per month**	**Seldom/ Never**		
Tomato Sauce **Worcester sauce**							**3139** **4309**	
Chutney	Fruit						**3168**	
	Tomato						**3114**	
Pickles							**3866**	
Packet soups							**3158**	
Beef/chicken stock							**4029**	
Others:								

WILD BIRDS, ANIMALS, INSECTS OR FRUITS AND BERRIES (hunted or collected in rural areas or on farms: (specify)								

PLEASE MENTION ANY OTHER FOODS YOU EAT MORE THAN ONCE EVERY TWO WEEKS WHICH WE HAVE NOT TALKED ABOUT AND OR FOODS EATEN IN OTHER HOMES OR PLACES DURING THE PAST WEEK

FOOD	DESCRIPTION	AMOUNT USUALLY EATEN	TIMES EATEN				CODE	AMOUNT/DAY
			Per day	Per week	Per month	Seldom/ Never		

ARE THERE ANY FOODS THAT YOU EAT WHICH WE HAVEN'T TALKED ABOUT? PLEASE LIST THEM.

FOODS	DESCRIPTION	AMOUNT USUALLY EATEN	TIMES EATEN				CODE	AMOUNT/ DAY
			Per day	Per week	Per month	Seldom/ Never		

Thank you for your time and patience while completing this questionnaire.

Appendix C

Global Physical Activity Questionnaire

Physical Activity		
Next I am going to ask you about the time you spend doing different types of physical activity in a typical week. Please answer these questions even if you do not consider yourself to be a physically active person. Think first about the time you spend doing work. Think of work as the things that you have to do such as paid or unpaid work, study/training, household chores, harvesting food/crops, fishing or hunting for food, seeking employment. *[Insert other examples if needed]*. In answering the following questions 'vigorous-intensity activities' are activities that require hard physical effort and cause large increases in breathing or heart rate, 'moderate-intensity activities' are activities that require moderate physical effort and cause small increases in breathing or heart rate.		
Question	**Response**	**Code**
Work		
Does your work involve vigorous-intensity activity that causes large increases in breathing or heart rate like *[carrying or lifting heavy loads, digging or construction work]* for at least 10 minutes continuously? *[INSERT EXAMPLES] (USE SHOWCARD)*	Yes 1 No 2 *If No, go to P 4*	P1
In a typical week, on how many days do you do vigorous-intensity activities as part of your work?	Number of days ⌊__⌋	P2
How much time do you spend doing vigorous-intensity activities at work on a typical day?	Hours : minutes ⌊__⌋ : ⌊__⌋ hrs mins	P3 (a-b)
Does your work involve moderate-intensity activity, that causes small increases in breathing or heart rate such as brisk walking *[or carrying light loads]* for at least 10 minutes continuously? *[INSERT EXAMPLES] (USE SHOWCARD)*	Yes 1 No 2 *If No, go to P 7*	P4
In a typical week, on how many days do you do moderate-intensity activities as part of your work?	Number of days ⌊__⌋	P5
How much time do you spend doing moderate-intensity activities at work on a typical day?	Hours : minutes ⌊__⌋ : ⌊__⌋ hrs mins	P6 (a-b)
Travel to and from places		
The next questions exclude the physical activities at work that you have already mentioned. Now I would like to ask you about the usual way you travel to and from places. For example to work, for shopping, to market, to place of worship. *[Insert other examples if needed]*		
Do you walk or use a bicycle *(pedal cycle)* for at least 10 minutes continuously to get to and from places?	Yes 1 No 2 *If No, go to P 10*	P7
In a typical week, on how many days do you walk or bicycle for at least 10 minutes continuously to get to and from places?	Number of days ⌊__⌋	P8
How much time do you spend walking or bicycling for travel on a typical day?	Hours : minutes ⌊__⌋ : ⌊__⌋ hrs mins	P9 (a-b)

Physical Activity, Continued		
Question	**Response**	**Code**
Recreational activities		
The next questions exclude the work and transport activities that you have already mentioned. Now I would like to ask you about sports, fitness and recreational activities (leisure), *[Insert relevant terms]*.		
Do you do any vigorous-intensity sports, fitness or recreational *(leisure)* activities that cause large increases in breathing or heart rate like *[running or football]* for at least 10 minutes continuously? *[INSERT EXAMPLES] (USE SHOWCARD)*	Yes 1 No 2 *If No, go to P 13*	P10
In a typical week, on how many days do you do vigorous-intensity sports, fitness or recreational *(leisure)* activities?	Number of days ⌊__⌋	P11
How much time do you spend doing vigorous-intensity sports, fitness or recreational activities on a typical day?	Hours : minutes ⌊__⌋⌊__⌋ : ⌊__⌋⌊__⌋ hrs mins	P12 (a-b)
Do you do any moderate-intensity sports, fitness or recreational *(leisure)* activities that cause a small increase in breathing or heart rate such as brisk walking, *[cycling, swimming, volleyball]* for at least 10 minutes continuously? *[INSERT EXAMPLES] (USE SHOWCARD)*	Yes 1 No 2 *If No, go to P16*	P13
In a typical week, on how many days do you do moderate-intensity sports, fitness or recreational *(leisure)* activities?	Number of days ⌊__⌋	P14
How much time do you spend doing moderate-intensity sports, fitness or recreational *(leisure)* activities on a typical day?	Hours : minutes ⌊__⌋⌊__⌋ : ⌊__⌋⌊__⌋ hrs mins	P15 (a-b)
Sedentary behaviour		
The following question is about sitting or reclining at work, at home, getting to and from places, or with friends including time spent sitting at a desk, sitting with friends, traveling in car, bus, train, reading, playing cards or watching television, but do not include time spent sleeping. *[INSERT EXAMPLES] (USE SHOWCARD)*		
How much time do you usually spend sitting or reclining on a typical day?	Hours : minutes ⌊__⌋⌊__⌋ : ⌊__⌋⌊__⌋ hrs mins	P16 (a-b)

Appendix D

Approval - UFS Ethics Committee

UNIVERSITY OF THE FREE STATE
UNIVERSITEIT VAN DIE VRYSTAAT
YUNIVESITHI YA FREISTATA

UFS·UV
HEALTH SCIENCES
GESONDHEIDSWETENSKAPPE

IRB nr 00006240
REC Reference nr 230408-011
IORG0005187
FWA00012784

31 January 2017

MS A BIRKINSHAW
DEPT OF NUTRITION AND DIETETICS
CR DE WET BUILDING
UFS

Dear Ms Birkinshaw

ECUFS NR 89/2015
PROJECT TITLE: ADHERENCE OF PATIENTS WITH TYPE 2 DIABETES MELLITUS COMPARED TO SEMDSA GUIDELINES

We refer to the approval letter dated 26 February 2016. This letter replaces that letter, and is the first and only official approval letter.

1. You are hereby kindly informed that, at the meeting held on 26 February 2016, the Health Sciences Research Ethics Committee (HSREC) approved this protocol after all conditions were met.
2. The Committee must be informed of any serious adverse event and/or termination of the study.
3. Any amendment, extension or other modifications to the protocol must be submitted to the HSREC for approval.
4. A progress report should be submitted within one year of approval and annually for long term studies.
5. A final report should be submitted at the completion of the study.
6. Kindly use the **ECUFS NR** as reference in correspondence to the HSREC Secretariat.
7. The HSREC functions in compliance with, but not limited to, the following documents and guidelines: The SA National Health Act. No. 61 of 2003; Ethics in Health Research: Principles, Structures and Processes (2015); SA GCP(2006); Declaration of Helsinki; The Belmont Report; The US Office of Human Research Protections 45 CFR 461 (for non-exempt research with human participants conducted or supported by the US Department of Health and Human Services- (HHS), 21 CFR 50, 21 CFR 56; CIOMS; ICH-GCP-E6 Sections 1-4; The International Conference on Harmonization and Technical Requirements for Registration of Pharmaceuticals for Human Use (ICH Tripartite), Guidelines of the SA Medicines Control Council as well as Laws and Regulations with regard to the Control of Medicines, Constitution of the HSREC of the Faculty of Health Sciences.

Yours faithfully

DR SM LE GRANGE
CHAIR: HEALTH SCIENCES RESEARCH ETHICS COMMITTEE

Health Sciences Research Ethics Committee
Office of the Dean: Health Sciences
T: +27 (0)51 401 7795/7794 | F: +27 (0)51 444 4359 | E: ethicsfhs@ufs.ac.za
Block D, Dean's Division, Room D104 | P.O. Box/Posbus 339 (Internal Post Box G40) | Bloemfontein 9300 | South Africa
www.ufs.ac.za

Appendix E

Approval - Private Practice

Telephone: 0514022415
Cell: 0833480345
Email: amybirkinshaw@gmail.com
Enquiries: Amy Birkinshaw

22 January 2016

MASTERS THESIS: ADHERENCE OF PATIENTS WITH TYPE 2 DIABETES MELLITUS WITH THE SEMDSA LIFESTYLE GUIDELINES.

1. Researchers. I am currently doing my master's degree in Dietetics (MSc Dietetics) at the University of the Free State (UFS) (Student number: 2013183351). My supervisor at the university is Prof. C. Walsh, Department of Nutrition and Dietetics.

2. Sample. I have written my proposal which will be evaluated by the Ethics Committee of the Faculty of Health Sciences, UFS. I would like to do my data collection at your private practice: Drs. Bester & Bosch, Interniste/ Specialist Physicians

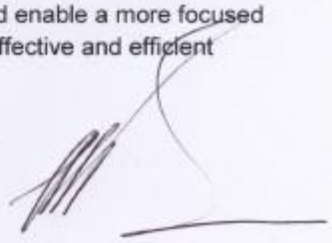
3. Participants. One hundred patients with type 2 diabetes (T2DM) will be asked to take part in the study. Patients will be weighed and measured and a diet and lifestyle questionnaire will be administered in a structured interview with each participant.

This study aims to measure dietary intake, smoking, alcohol consumption and physical activity and to compare these with the latest Society for Endocrinology, Metabolism and Diabetes of South Africa (SEMDSA) Guidelines (2012). Patients will participate voluntarily and all data will be kept strictly confidential.

Patients that take part in the study will be counselled by a registered dietician. The symptoms, causes and medical nutrition management of T2DM will be explained.

4. Benefits of the study. This study will assess the lifestyles of patients with type 2 diabetes and determine how well they compare with the SEMSDA guidelines.

Adherence of patients with type 2 diabetes, in the Free State, will be brought to light and gaps in knowledge and diabetic education will be identified. This will give doctors, nurses and dieticians an overview of the lifestyles of patients with T2DM and enable a more focused and relevant approach when it comes to diabetes education. More effective and efficient diabetic education can be given if a few focus areas are identified.



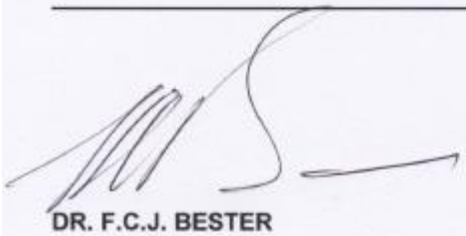
Time in hospital and overall medical expenses due to uncontrolled blood glucose and the complications thereof (dialysis etc.) can be greatly reduced.

5. Thank you for your support in this regard.

(A. BIRKINSHAW)
REGISTERED DIETICIAN: DT0035793

APPROVED / NOT APPROVED

_____
_____
_____
_____



DR. F.C.J. BESTER

Appendix F

Patient Consent and Information Document - English

FORM EC 31

CONSENT TO PARTICIPATE IN RESEARCH

PROJECT TITLE**: Adherence of Patients with Type 2 Diabetes Mellitus Compared to the SEMDSA Guidelines**

You have been asked/ invited to participate in a research study.

You have been informed about the study by **Amy Birkinshaw**

You may contact Amy Birkinshaw at (051) 4022415 any time if you have questions about the research or if you are injured as a result of the research.

You may contact the Secretariat of the Ethics Committee of the Faculty of Health Sciences, UFS at telephone number (051) 4052812 if you have questions about your rights as a research subject.

Your participation in this research is voluntary, and you will not be penalized or lose benefits if you refuse to participate or decide to terminate participation.

If you agree to participate, you will be given a signed copy of this document as well as the participant information sheet, which is a written summary of the research.

The research study, including the above information has been verbally described to me. I understand what my involvement in the study means and I voluntarily agree to participate.

_____ _____

Signature of Participant Date

_____ _____

Signature of Witness Date

INFORMATION DOCUMENT

Study title: **Lifestyles of Patients with Type 2 Diabetes Mellitus Compared to the SEMDSA Guidelines**

Good day, thank you for your interest in our research study.

Introduction: We are doing research on patients with type 2 diabetes (T2DM) and looking at how their lifestyles compare to the Society of Endocrinology, Metabolism and Diabetes in South Africa's (SEMDSA) latest (2012) guidelines. Research is just the process to learn the answer to a question. In this study we want to learn how closely the lifestyles of patients with T2DM relate to the SEMDSA guidelines.

Invitation to participate: We are asking/inviting you to participate in a research study.

What is involved in the study:

Study design-

A descriptive study design will be applied.

What is required of you -

As a participant in the study you will be required to answer two questionnaires. These will be read to you by the researcher.

The first questionnaire is a lifestyle questionnaire; this will look at smoking habits, alcohol consumption and exercise participation. The next questionnaire is a food frequency questionnaire and will determine the amounts and types of foods consumed.

Weight, height and waist circumference will be measured.

100 Participants will take part in the study; all of them will be recruited from a physicians' private practice in Bloemfontein.

Risks: There are no risks involved in taking part in this research study.

Benefits: All participants will receive a free consultation and T2DM explanation from a registered dietician.

The subject will be given pertinent information on the study while involved in the project and after the results are available.

Participation is voluntary and refusal to participate will involve no penalty or loss of benefits to which the subject is otherwise entitled; the subject may discontinue participation at any time without penalty or loss of benefits to which the subject is otherwise entitled.

Confidentiality: Efforts will be made to keep personal information confidential. Absolute confidentiality cannot be guaranteed. Personal information may be disclosed if required by law.

Organizations that may inspect and/or copy your research records for quality assurance and data analysis include groups such as the Ethics Committee for Medical Research and the Medicines Control Council *(where appropriate).*

If results are published, this may lead to individual/cohort identification.

Contact details of researcher(s) – for further information/reporting of study-related adverse events contact Amy Birkinshaw (051) 4022415

Contact details of Secretariat and Chair: Ethics Committee of the Faculty of Health Sciences, University of the Free State – for reporting of complaints/problems: Telephone number (051) 4052812

Appendix G

Patient consent form and information document - Afrikaans

FORM EC 31

TOESTEMMING OM DEEL TE NEEM IN NARVORSING

PROJEK TITEL: **Adherence of Patients with Type 2 Diabetes Mellitus Compared to the SEMDSA Guidelines**

U is gevra / genooi om deel te neem aan 'n navorsingstudie.

U is ingelig oor die studie deur **Amy Birkinshaw**

U kan Amy Birkinshaw kontak by (051) 4022415 indien u vrae oor die narvorsing het of as u beseer is as gevolg van die navorsing.

U kan die sekretariaat van die Etiekkomitee van die Fakulteit Gesondheidswetenskappe, UV by telefoonnommer (051) 4052812 kontak as u vrae oor u regte as deelnemer het.

U deelname aan hierdie navorsing is vrywillig, en u sal nie voordele verloor indien u weier om deel te neem of besluit om deelname te beëindig nie.

As u instem om deel te neem, sal u 'n getekende afskrif van hierdie dokument sowel as die deelnemer inligtingsblad, wat 'n skriftelike opsomming van die navorsing is, ontvang.

Die navorsingstudie, insluitend die bogenoemde inligting is mondelings aan my beskryf. Ek verstaan wat my betrokkenheid in die studie beteken en ek stem vrywillig in om deel te neem.

_____ _____

Handtekening van Deelnemer Datum

_____ _____

Handtekening van Getuie Datum

INLIGTINGSDOKUMENT

Studie Titel: **Lifestyles of Patients with Type 2 Diabetes Mellitus Compared to the SEMDSA Guidelines**

Goeie dag, baie dankie vir u belangstelling in ons navorsingstudie.

Inleiding: Ons doen navorsing oor pasiënte met tipe 2-diabetes (T2DM) en kyk hoe hul lewenswyse vergelyk met die riglyne van die Society of Endocrinology, Metabolism en Diabetes in Suid-Afrika (SEMDSA).

Navorsing is net die proses om die antwoord op 'n vraag te leer. In hierdie studie wil ons leer hoe die lewenstyl van pasiënte met T2DM ooreenstem met die SEMDSA riglyne.

Uitnodiging om deel te neem: Ons vra / nooi u om deel te neem aan die navorsingstudie.

Wat behels die studie:

Studie ontwerp

‘n Beskrywende studie ontwerp sal toegepas word.

Wat word van jou verwag?

As 'n deelnemer in die studie sal daar van u verwag word om twee vraelyste te beantwoord. Dit sal aan jou gelees word deur die navorser.

Die eerste vraelys is 'n leefstylvraelys; wat rookgewoontes, alkoholgebruik en deelname aan oefening sal bepaal. Die volgende vraelys is 'n voedsel frekwensie vraelys en sal die tipes en hoeveelheid voedsel wat u inneem bepaal.

Gewig, lengte en middellyfomtrek sal gemeet word.

Daar word beplan om 100 deelnemers in te sluit. Almal sal gewerf word uit ‘n dokter se privaat praktyk in Bloemfontein.

Risiko's: Daar is geen risikos betrokke aan deelname aan hierdie navorsingstudie nie.

Voordele: Na afloop van die studie, sal alle deelnemers 'n gratis konsultasie deur 'n geregistreerde dieetkundige ontvang.

Deelname is vrywillig en weiering om deel te neem, sal geen verlies van voordele waarop u geregtig is inhou nie. U mag enige tyd u deelname aan die studie staak.

Vertroulikheid: Pogings sal aangewend word om persoonlike inligting vertroulik te hou. Absolute vertroulikheid kan egter nie gewaarborg word nie. Persoonlike inligting kan bekend gemaak word indien dit deur die wet vereis word. Indien resultate gepubliseer word, kan dit lei tot groep identifikasie.

Kontakbesonderhede van navorser (s) - vir verdere inligting / verslaggewing van studie-verwante newe effekte, kontak Amy Birkinshaw (051) 4022415

Kontakbesonderhede van sekretariaat en Voorsitter: Etiekkomitee van die Fakulteit Gesondheidswetenskappe, Universiteit van die Vrystaat - vir verslaggewing van klagtes / probleme: Telefoonnommer (051) 4052812