

**Dietary adherence amongst adults with type 2 diabetes mellitus: A South
African urban population perspective**

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Acknowledgements

After four years, I have at last finished my dissertation. It may have taken long but it was worth every minute of my time. Sometimes I did wonder what made me decide to do my Masters degree and there were many times I considered giving up. At this moment I am very pleased that I did decide to do it and persisted and I am now not regretting it at all.

Let me explain why I chose this specific topic; I was diagnosed with diabetes in 2006. During my studies in Dietetics I did not particularly enjoy learning about diabetes and actually found it slightly confusing and boring. In 2010 when my doctor was looking for assistance with diabetes education while her educator went on maternity leave, I considered helping out short-term before I was to go off to Asia to teach English. However, I fell in love with the work and the doctor asked me to continue as the dietician in the clinic when the nurse educator returned from maternity leave. Working in the clinic has been both rewarding and frustrating. Developing a relationship with the patients and being able to offer a sympathetic understanding to their challenges and questions has been wonderful. However, I have felt frustrated when patients who receive gold standard care within the multidisciplinary structure of the clinic still do not achieve optimal health targets. This motivated me to want to understand the patients better and I needed to identify what motivated them to adhere to the recommendations given in the clinic and what the challenges were in complying with the recommendations.

Collecting information took much longer than I expected. I found that getting people to attend a focus group discussion was especially challenging. I want to thank the staff at the clinics where the research was conducted for phoning patients and tirelessly booking new groups when established sessions had to be cancelled due to poor attendance. I am very grateful for all the patients at the Diabetes West clinics who participated in the study.

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The article format has been selected for this article. I planned, executed and wrote the article with guidance from my supervisors that are also the co-authors of this mini-dissertation/article

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The article will be submitted to the *Journal of Endocrinology, Metabolism and Diabetes of South Africa* (JEMDSA) for publication. The co-authors hereby grant permission that the manuscript can be submitted for degree purposes.

H.S. Kruger: Date:

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Abstract

Non-communicable diseases are on the increase and expected to be the most common cause of death by the year 2030. Non-communicable diseases and in particular type 2 diabetes mellitus (T2DM) can be managed effectively to prevent or delay the onset of microvascular and macrovascular complications and improve morbidity and mortality outcomes. T2DM can be managed effectively with improved lifestyle behaviours including healthier food choices, physical activity, and destressing techniques together, in some cases, with pharmaceutical treatment. However, the prevalence of non-adherence to recommended behaviour changes is high. Understanding factors that motivate and challenge the patient with T2DM (T2DM) to change lifestyle will help health professionals design interventions that are sustainably adhered to. The association between dietary adherence and glucose control and metabolic risk was assessed, and factors associated with non-adherence to dietary recommendations were identified.

A structured questionnaire and focus group discussions (FGDs) were used to collect data. Data was analysed using SPSS21 and recordings from FGDs were themed. Ninety-one patients with T2DM attending two private diabetes clinics in Gauteng, South Africa were targeted to answer the structured questionnaire in a short interview. Of these participants, 37 also participated in the FGDs.

A quantitative analysis of diabetes-related biochemical markers was undertaken. The biomarkers included glycated haemoglobin (HbA1c), lipid profile, and microalbuminuria (MAU), as well as an assessment of dietary quality which was used to identify a dietary adherence score. A qualitative analysis of factors influencing dietary adherence was done.

In this study combined low and intermediate adherence to dietary recommendations was 77%. No significant association was found between dietary adherence and the various variables. Glucose control was also suboptimal. Only 32% of the group achieved a recommended HbA1c of less than 7%. This is similar to other South African studies. The main challenges to adherence included difficulty in breaking habits and resisting temptation, challenges in eating out, and feeling the dietary guidelines are too restrictive. The main motivators to adhering to dietary guidelines included the desire to attain and maintain good health and prevent the disease worsening, seeing positive results when actively doing what

is recommended, having a good support system, and being persistent in making lifestyle changes so that eating well becomes a habit. These factors that were found to influence non-adherence are similar to those found in other studies.

Non-adherence to dietary recommendations in over two thirds of the target population is of concern since non-adherence to recommended behavioural changes could have detrimental effects on the progression of the disease and also increases the requirements for pharmaceutical interventions at an added cost to the health industry. Adherence to recommended medication is also questionable but a separate issue. Health professionals should utilise this information to understand how to better assist a patient to adhere to diet.

Keywords: type 2 diabetes, dietary non-adherence, glucose control, motivators to adherence, challenges in non-adherence

OPSOMMING

Kroniese siektes is aan die toeneem en sal waarskynlik die mees algemene oorsaak van sterftes wees teen 2030.

Kroniese siektes en veral tipe 2 diabetes mellitus (T2DM) kan effektief behandel word om -mikro- en makrovaskulêre komplikasies te voorkom. T2DM kan effektief behandel word deur lewenstyl gewoontes te verbeter, insluitend gesonder voedselkeuses, fisiese oefening en ontspanningstegnieke. In sommige gevalle is medikasie nodig. Die geneigdheid tot swak nakoming van aanbevele gedragsverandering is hoog. Om gesondheidsdeskundiges in staat te stel om volhoubare intervensies te ontwerp, is dit nodig dat hulle verstaan wat pasiënte met T2DM motiveer, asook wat die uitdagings is wat keer dat hulle, hulle lewenstyl kan verander. Die assosiasie tussen die volg van 'n dieet en glukosekontrole en metaboliese risikos is ondersoek en faktore wat geassosieer word met nie-nakoming van dieetkundige advies is geïdentifiseer. 'n Gestruktureerde vraelys en fokusgroepbesprekings (FGB) is gebruik om inligting in te samel. Die data is geanaliseer deur die gebruik van SPSS21 en opnames van FGBs is volgens temas geanaliseer. Altesaam 91 pasiënte met T2DM by twee privaat diabetesklinieke Gauteng, Suid Afrika is genader om gestruktureerde vrae te beantwoord in 'n kort onderhoud. Van die 91 het 37 ook aan die FGBs deel geneem.

'n Kwantitatiewe analise van diabetes-verwante biochemiese indikasies is gedoen. Die indikasies was onder andere geglikosileerde hemoglobien (HbA1c), lipogram en mikro-albuminurie (MAU), sowel as 'n analise van dieetkwaliteit, wat gebruik is om dieetnakoming te identifiseer. Kwaliteitsanalise van faktore wat dieetnakoming beïnvloed is uitgevoer.

Die studie het getoon dat lae en gemiddelde nakoming van dieetplanne gesamentlik 77% was. Geen betekenisvolle assosiasie is tussen dieetnavolging en verskeie ander faktore gevind nie. Glukosekontrole was ook suboptimaal. Slegs 32% van die groep het die voorgestelde HbA1c van 7% behaal. Dit is soortgelyk aan ander Suid Afrikaanse studies. Die hoof uitdagings in die nakoming sluit die breek van gewoontes en weerstaan van versoekings in, uiteet en die gevoel dat dieetplanne te beperkend is. Die hoof motivering vir die nakoming van dieetplanne sluit die behoefte om goeie gesondheid te handhaaf in en om te verhoed dat die siekte vererger. Ander motiverings was om positiewe resultate te sien wanneer

hulle doen wat aanbeveel was, en 'n goeie ondersteuningstelsel te hê, en om aanhoudend te werk aan lewenstyl verandering totdat dit 'n gewoonte word. Die faktore wat nie-nakoming beïnvloed het is soortgelyk aan die resultate in ander studies.

Nie-nakoming van die dieetaanbevelings in meer as twee derdes van die teikengroep is 'n bekommernis. Nie-nakoming aan die voorgestelde gedragsverandering kan moontlik die effek op die vordering van die siekte bepaal en ook die gebruik van meer medikasie noodsaak teen addisionele koste aan die gesondheidsindustrie. Die korrekte gebruik van voorgeskrewe medikasie word ook bevraagteken maar is 'n totaal ander kwessie. Gesondheidspersoneel behoort die inligting te gebruik om te verstaan hoe hulle pasiënte beter kan help om 'n dieetplan te volg.

Sleutel woorde: tipe 2 diabetes mellitus, dieet nie-nakoming, glukosebeheer, motivering tot nakoming, uitdagings in nie-nakoming

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List of Abbreviations

ACCORD	Action to control cardiovascular risk in diabetes
ADA	American diabetes association
ADAG	A1c-derived average glucose
ADVANCE	Action in diabetes and vascular disease
BMI	Basal metabolic index
BP	Blood pressure
CAC	Calcified atherosclerotic plaque
CKD	Chronic kidney disease
CVD	Cardiovascular disease
DALYs	Disability adjusted life years
DCCT	Diabetes control and complications trial
DPN	Distal symmetric polyneuropathy
EASD	European association for the study of diabetes
eGFR	Glomerular rate
ESRD	End stage renal disease
FBDG	Food based dietary guidelines
FGD	Focus group discussion
GI	Glycaemic index
HbA1c	Glycated haemoglobin
HDL-C	High density lipoprotein cholesterol
Ht	Height
IDF	International Diabetes Federation
IDNT	Irbesartan in diabetes nephropathy trial
LDL-C	Low density lipoprotein cholesterol
Look AHEAD	Looking forward to the action for health in diabetes
MAU	Microalbuminuria
MNT	Medical nutrition therapy

MUFA	Monounsaturated fatty acids
NCDs	Non communicable diseases
PPG	postprandial glycaemia
PREDIMED	Prevencion con dieta mediterranea
SANHANES	South African national health and nutrition examination survey
SEMDSA	Society of endocrinology, metabolism and diabetes South Africa
SFA	Saturated fatty acids
SMBG	Self-management of blood glucose
T2DM	Type 2 diabetes mellitus
TC	Total cholesterol
TG	Triglycerides
THUSA	Transition and health during urbanisation of South Africa
UACR	Urine albumin creatinine ratio
UKPDS	United Kingdom prospective diabetes study
WC	Waist circumference
WHO	World health organization
Wt	Weight

1 CHAPTER 1: INTRODUCTION

1.1 Background

Non-communicable diseases are on the increase and expected to be the most common cause of death by the year 2030 (UN General Assembly, 2011). Non-communicable diseases and in particular type 2 diabetes mellitus (T2DM) can be managed effectively to prevent or delay the onset of microvascular and macrovascular complications and improve morbidity and mortality outcomes (Gaede *et al.*, 2008). T2DM can be managed effectively with improved lifestyle behaviours, including healthier food choices, physical activity, and destressing techniques together, (in some cases), with pharmaceutical treatment. (Amod *et al.*, 2012b). Misunderstanding, forgetting, or ignoring healthcare advice can result in significant risk to the patient with uncontrolled disease management and an escalation in treatment (Ho *et al.*, 2006; Okolie *et al.*, 2011; Asche *et al.*, 2011). The consequences of non-adherence are costly and a risk factor for poor health outcomes and a possible increase in hospital admissions (Pepper *et al.*, 2007; Bertram *et al.*, 2013). Non-adherence often results in a combination of wasted medical care funds, wasted time and energy for the patients and healthcare providers, and frustration and dissatisfaction for all involved (Ho *et al.*, 2006). Identifying and understanding factors that motivate and challenge the T2DM patient to change their lifestyle will help health professionals design interventions that are sustainably adhered to.

The literature on the benefit of diet on diabetes disease outcomes, as well as factors that influence dietary adherence in type 2 diabetes was reviewed in this dissertation. The factors that motivate behaviour change and the barriers to adherence to dietary recommendations were identified specific to a South African context where a structured multidisciplinary approach to diabetes management was practiced. Although the benefits of adhering to dietary recommendations are assumed, the direct association between dietary adherence, glucose control and metabolic risk was assessed. It was expected that a structured program of care would result in better glucose and metabolic outcomes, although this was not seen. This dissertation presented a literature review on the overview of diabetes and the benefits of optimal management, as well as a review of the current literature on dietary non-adherence.

Two private diabetes clinics on the West Rand of Johannesburg in Gauteng, South Africa were used as the setting for the study. These clinics both ran a structured diabetes management program and all

participants were actively attending the program. Questions regarding dietary practice were compared to international nutritional guidelines for diabetes to determine a dietary adherence score. Biochemical data was collected from patient files and was assessed for associations with dietary adherence. A focus group discussion (FGD) guide was developed and used to collect data on the factors that motivate adherence to dietary guidelines as well as the challenges that patients with type 2 diabetes encountered in adhering to dietary recommendations. Data was analysed using SPSS21 and recordings of the FGDs was transcribed, categorised, and themed.

1.2 Aims

The first aim of this study was to identify whether there was any association between dietary adherence and glucose control, metabolic risk, and socio-economic status using a questionnaire among a sample of type 2 diabetic patients in an urban South African population.

The second aim was to identify factors associated with non-adherence to dietary recommendations from the perspective of type 2 diabetic patients in an urban South African population.

1.3 Research team

Members of the research team included the student (TJ Winskill), the supervisor (Professor HS Kruger), and the co-supervisor (Professor R Blaauw). The student was guided by the supervisors in selecting a feasible research theme and helped the student to clearly outline the problem and aims of the research.

The supervisors guided the student in the planning phase to draw up the research proposal and suggested suitable training to ensure basic training in the selected research methods, including mixed methods research and facilitating focus group discussions.

The supervisors supported the student in obtaining data and overcoming practical problems in the data gathering phase. Supervisors assisted the student in drawing meaningful and logical conclusions from the data appropriate for the study objectives. The supervisors encouraged the student in writing up the report and presenting the results.

1.4 Structure of the mini-dissertation

The min-dissertation is divided into multiple chapters. Chapter One is an introduction of the topic and briefly details the problem and relevancy of the topic as well as the aim of the study. Chapter Two is a literature review of the previous research in the field of dietary non-adherence in T2DM. Chapter Three is presented in the format of the article to be presented for publication in the *Journal for Endocrinology, Metabolism, and Diabetes of South Africa* (JEMDSA). For this reason chapter three is referenced in the format of the journal whereas the rest of the chapters are referenced in the format of the university. Chapter Four is the closing chapter where a summary of the deductions, conclusions and viewpoints from the arguments presented in the article are provided, as well as recommendations on further research in this field.

1.5 References

Amod, A., Ascott-Evans, B.H., Berg, G.I., Blom, D.J., Brown, S.L., Carrhill, M.M., Dave, J.A., Distiller, L.A., Gannie, Y.N., Grobler, N., Heilbrunn, A.G., Huddle, K.R.L., Janse van Rensburg, G., Jivan, D., Joshi, P., Khutsoane, D.T., Levitt, N.S., May, W.M., Mollentze, W.F., Motala, A.A., Paruk, I.M., Pirie, F.J., Raal, F.J., Rauff, S., Raubenheimer, P.J., Randeree, H.A.R., Rheeder, P., Tudhope, L., Van Zyl, D.J., & Young, M. 2012b. The 2012 SEMDSA Guideline for the Management of Type 2 Diabetes. *Journal of endocrinology, metabolism and diabetes of South Africa*, 17(2): S1-S95.

Asche, C., LaFleur, J., & Conner, C. (2011). A review of diabetes treatment adherence and the association with clinical and economic outcomes. *Clinical Therapy*, 33(1): 74-109. Doi:

10.1016/j.clinthera.2011.01.019

Bertram, M.Y., Jaswal, A.V., Van Wyk, V.P., Levitt, N.S. & Hofman, K.J. 2013. The non-fatal disease burden caused by type 2 diabetes in South Africa, 2009. *Global health action*, 6:19244.

Doi:10.3402/gha.v6i0.19244

Gaede P., Lund-Andersen, H., Parving, H.H., & Pedersen, O. 2008. Effect of a multifactorial intervention on mortality in type 2 diabetes. *The New England journal of medicine*, 358(6):580-591. Doi:

10.1056/NEJMoa0706245

Ho, P.M., Rumsfeld, J.S., Masoudi, F.A., McClure, D.L., Plomondon, M.E., Steiner, J.F., & Magid, D.J. 2006. Effect of medication nonadherence on hospitalization and mortality among patients with diabetes mellitus. *Archives of internal medicine*, 166, 1836-1841. (Abstract).

Okolie, U., Ehiemere, I., Ezenduka, P., & Ogbu, S. 2010. Contributory factors to diabetes dietary regimen non adherence in adults with diabetes. *World academy of science, engineering and technology*, 45: 735-742.

Pepper, D.J., Levitt, N., Cleary, S., Burch, V. 2007. Hyperglycaemic emergency admissions to a secondary level hospital - an unnecessary financial burden. *South African medical journal*, 97(10):963-967.

United Nations. 2011. Political declaration of the High-level Meeting of the General Assembly on the Prevention and Control of Non-communicable Diseases High level meeting on prevention and control of non-communicable diseases. http://www.un.org/ga/search/view_doc.asp?symbol=A/66/L.1 Date of access: 30 July 2015.

2 CHAPTER 2: LITERATURE STUDY

2.1 Introduction

In 2011 the UN General Assembly recognised with concern the global increase in non-communicable diseases (NCDs), indicating the importance for global public health and international intervention to combat cardiovascular diseases, cancers, lung disease and diabetes. They recognised that NCDs are among the leading cause of preventable morbidity and mortality and proposes that NCDs will be the most common cause of death by the year 2030 (UN General Assembly, 2011). In South Africa, at the South African Summit on the Prevention and Control of Non-Communicable diseases in 2011, government committed to developing a comprehensive strategic national action plan that addresses prevention, early detection, behavioural change, and universal treatment in order to reduce the incidence and mortality from NCDs (SA DOH, 2011).

In particular, the prevalence of diabetes continues to rise despite continuing advances in treatment approaches and a multitude of new technologies. Reducing blood glucose in patients with T2DM can prevent or delay the onset of microvascular and macrovascular complications and improve morbidity and mortality outcomes (Gaede *et al.*, 2008). The first line treatment of T2DM is for people with diabetes to make significant changes to their lifestyle, including diet, physical activity, and de-stressing techniques to improve their health outcomes and control glycaemia as well as the co-morbidities of diabetes including hypertension, dyslipidaemia, and obesity. Diabetes care is long term and self-management is critical in diabetes management (Amod *et al.*, 2012b).

The prevalence of non-adherence to recommended treatment is high (Mandewo *et al.*, 2014; Worku *et al.*, 2015) and has been shown to be an important cause of increased morbidity and mortality in T2DM (Ho *et al.*, 2006; Asche *et al.*, 2011) This literature review will evaluate the importance of controlling glycaemia, lipids, blood pressure and weight in decreasing the risk for diabetes morbidities and mortalities. Although the treatments and management of these factors are holistic, including (but not limited to) medication, exercise, and diet, this review will specifically focus on the potential benefits of dietary treatment adherence in diabetes management as well as relevant studies to understand potential motivators and obstacles to dietary regimen adherence.

2.2 The prevalence and cost of diabetes

According to the International Diabetes Federation (IDF), T2DM affects at least 387 million people worldwide and is increasing in every country at a worldwide prevalence of 8.3% with a large majority of diabetes cases occurring in low to middle income countries. The IDF reports that although Africa has the lowest prevalence of diabetes (5.1%) it has the highest percentage of undiagnosed people with an estimated 62.5% of people with diabetes being unaware that they have diabetes. In 2014, one in two people were living with diabetes in Africa, with the expectation that this number will almost double to 41.5 million people by the year 2035 (International Diabetes Federation, 2014).

A systematic review of literature from 1999 to 2011 in Sub-Saharan Africa showed that prevalence estimates varied considerably between different studies for some countries. Estimates for rural South Africa ranged from 3.9% to 8.8% and variation between urban and rural populations was observed, with a higher prevalence recorded in urban populations (Hall *et al.*, 2011). Furthermore, about one million South Africans are unaware that they have diabetes (Bertram, 2013). A report on limited South African data suggests that less than a third of the people with diabetes receiving healthcare are able to achieve a glycaemic target of $<7\text{mmol/l}$ (Amod *et al.*, 2012a). According to the 2013 South African National Health And Nutrition Examination Survey (SANHANES), almost one out of five participants (18.4%) had impaired glucose control (where the HbA1c was greater than 6.1%) and 9.5% of participants had diabetes (HbA1c $> 6.5\%$). The prevalence of impaired glucose control and diabetes increased with age, reaching a peak in the age groups 45–64 years of age and was the highest among rural informal (11.9%) and urban formal (11.3%) residents while the highest prevalence of T2DM was determined in the coloured and Indian/Asian race groups (Shisana *et al.*, 2013).

This increase in prevalence of diabetes is thought to be fuelled by rapid urbanization, nutrition transition, and increasingly sedentary lifestyles and an associated increased prevalence in overweight and obesity (Vorster *et al.*, 2011).

Globally, it is estimated that 612 billion US dollars is spent on diabetes annually but only 1% of this is used in Africa (International Diabetes Federation, 2014), at an estimated 8836 US dollars per person with

diabetes per year (Hall *et al.*, 2011). A South African study investigated the cost of hyperglycaemic emergency admissions in South Africa over a two month period in 2005 and reported an average cost of R5309, equivalent to US\$712, per admission (Pepper *et al.*, 2007). Bertram *et al.* (2013) calculated that the non-fatal burden of disease in Disability Adjusted Life Years (DALYs) due to diabetes in South Africa was postulated to be about 78 900 years with 64% coming from diabetes alone and the remainder coming from complications, including retinopathy, neuropathy and cardiovascular events.

2.3 The association between diabetes and health-related outcomes

Ultimately the main reason for treating diabetes is to prevent the onset of microvascular (neuropathy, retinopathy and nephropathy) and macro-vascular (cardiovascular diseases) complications (Amod *et al.*, 2012b), as well as to adequately treat these conditions so as to ultimately prevent further morbidity and mortality.

2.3.1 Prevalence of complications

A Cape Town study of 300 patients with diabetes in the public sector found that the prevalence of diabetes complications and level of glycaemic and blood pressure control was alarmingly high. The average duration of diabetes was eight years. Less than 50% of the patients had acceptable glycaemic control while just over a third of the patients had acceptable blood pressure control. Retinopathy was prevalent in over half of the group and peripheral neuropathy was present in 27.6% of the group with 8.2% having had amputations. Although only 5.3% of these patients with diabetes had persistent proteinuria, 36.7% had an elevated albumin-creatinine ratio (Levitt *et al.*, 1997).

2.3.2 The evidence for glycaemic control in improving complications risk

The Diabetes Control and Complications Trial (DCCT) is an 11 year -long controlled clinical trial in 1441 subjects with Type 1 Diabetes. It compared intensive therapy, where the levels of glycaemia were targeted to as close to the nondiabetic range as possible, with conventional therapy, where safe control without symptoms was the goal. The trial demonstrated that intense control of glycaemia reduces microvascular and macrovascular complications and further contributes to the evidence that

hyperglycemia causes, or is the major contributor, to these complications (Diabetes Control and Complications Trial Group, 1993).

The United Kingdom Prospective Diabetes Study (UKPDS) is the largest and longest study on patients with T2DM that has ever been performed. The 5012 newly diagnosed T2DM patients that were recruited over 14 years were followed for an average of 10 years to determine whether intensive use of different pharmacological therapies to lower blood glucose levels would result in reduced cardiovascular and microvascular complications. The results of the UKPDS were published in four separate papers and demonstrated the importance of tightly and consistently managing glycaemia in non-insulin dependent diabetes patients in preventing vascular complications (UK Prospective Diabetes Study, 1998a,b,c,d).

Cardiovascular disease (CVD) is the major cause of morbidity and mortality for people with diabetes and is the largest contributor to the direct and indirect costs of diabetes (ADA, 2015). Hypertension and dyslipidemia commonly coexist with T2DM and are clear risk factors for CVD. It has been demonstrated that when glycaemia, blood pressure, and lipids are all intensively controlled in patients with T2DM, the risk of death from cardiovascular causes is reduced and cardiovascular events, end-stage renal disease, and retinopathies are reduced (Gaede *et al.*, 2008). Although a number of factors including, but not limited to, age, sex, smoking status, history of CVD, duration of diabetes, glycated haemoglobin (HbA1c), glomerular filtration rate (eGFR), use of blood pressure medications, and insulin use have been associated with increased mortality risk, an analysis of these and more mortality associated predictors found that the two factors most consistently and independently associated with all-cause and CVD mortality in T2DM were coronary artery calcified atherosclerotic plaque (CAC), and urine albumin: creatinine ratio (UACR). It was suggested that these two factors should be most importantly considered in predicting mortality in T2DM (Raffield *et al.*, 2015).

Diabetic nephropathy occurs in 20–40% of patients with diabetes and is the single leading cause of end-stage renal disease (ESRD) (ADA, 2015). Albuminuria measured as UACR is the most important biomarker for diabetic nephropathy. UACR is a marker of generalized endothelial dysfunction, more so than kidney disease specifically, which is better reflected by changes in eGFR. It is a strong predictor for

progression of renal disease and cardiovascular disease and mortality in diabetes (Eijkelkamp *et al.*, 2007).

Microalbuminuria (30-300 mg urinary albumin) always precedes macroalbuminuria (>300 mg of urinary albumin). Renal endpoints (ESRD or doubling of serum creatinine) generally occur within ten years in approximately 20% of microalbuminuric patients, but in 60% of macroalbuminuric patients. The exact duration of diabetes is unclear in T2DM patients as time to diagnosis usually takes five to seven years. Thus, sustained microalbuminuria in T2DM may even be present at diagnosis. However, only 20% of T2DM patients with microalbuminuria progress to overt nephropathy after ten years of follow-up (Waanders *et al.*, 2013).

Diabetic retinopathy is a highly specific vascular complication in T2DM. It can cause blindness, and glaucoma, cataracts, and other disorders of the eye and are found to occur earlier and more frequently in people with diabetes. Duration of diabetes, chronic hyperglycaemia, nephropathy, and hypertension are associated with retinopathy. In both the UKPDS and Action to Control Cardiovascular Risk in Diabetes (ACCORD) studies it was shown that intensive hyperglycaemia management to achieve normal glycaemic targets delays, and even prevents, the onset and progression of diabetic retinopathy (UKPDS, 1998a; Chew *et al.*, 2010).

Distal symmetric polyneuropathy (DPN) and autonomic neuropathy are common neuropathies seen in diabetes. Up to 50% of DPN may be asymptomatic and patients are at risk for injury to the feet due to loss of sensation. Autonomic neuropathy, especially cardiovascular autonomic neuropathy is associated with a high risk for morbidity and even mortality (ADA, 2015). Improved glycaemic control and avoidance of extreme blood glucose fluctuations may modestly slow progression but does not reverse neuronal loss (Callaghan *et al.*, 2012).

2.3.3 Health targets in diabetes management

2.3.3.1 Glycaemic targets

Glycated haemoglobin (HbA1c) is the primary predictor of diabetes complications (ADA, 2015). The DCCT results showed a 35-76% decrease in the early stages of microvascular disease when intense

therapy was used to achieve a 7% HbA1c level, but no significant effect of lowering blood glucose on cardiovascular complications was found. Results from the UKPDS trial showed that intensive therapy to achieve an HbA1c target of 7% resulted in a 25% reduction in microvascular complications including retinopathy, nephropathy and neuropathy. Similarly, the Action in Diabetes and Vascular Disease (ADVANCE) trial showed that patients who had tighter glycaemic control had a reduction in major microvascular events of 14% (Patel *et al.*, 2008).

The UKPDS suggests that every HbA1c reduction of about 1% may be associated with a 35% relative risk reduction in non-fatal myocardial infarction, but without benefits on stroke or all-cause mortality. Conversely, the ADVANCE study showed that strict glycaemic targets did not reduce cardiovascular events in the short term with a non-significant reduction in major macrovascular events of only 6% after an average of five years of follow-up. This difference in macrovascular outcomes may be explained by the fact that the ADVANCE trial involved high-risk patients who were eight to twelve years older than the patients in the UKPDS, and had been treated for eight to ten years whereas patients in the UKPDS were newly diagnosed. About a third of the patients in the ADVANCE trial had a history of macrovascular disease, as compared with 7.5% in the UKPDS.

In the ACCORD trial there was a non-significant reduction of 10% in nonfatal myocardial infarction, nonfatal stroke, and death from cardiovascular causes among patients with type 2 diabetes who targeted an HbA1c of 6-7.9%. After three and a half years the study was stopped because of an unexplained excess rate of death from any cause. In this study, there was a high incidence of hypoglycaemia requiring assistance and also in weight gain over 10 kilograms (kg) (Ismail-Beigi *et al.*, 2010). The patients in this study were also older patients with longer duration of diabetes than those on the UKPDS trial. On the contrary, in a follow up of the Veterans Affairs Diabetes Trial intensive glucose lowering resulted in a significantly reduced risk for cardiovascular events including heart attack, stroke, new or worsening congestive heart failure, amputation for ischemic gangrene, or cardiovascular-related death than those assigned to standard therapy, although no improvement was seen in the rate of cardiovascular mortality or all-cause mortality (Hayward *et al.*, 2015). Interestingly, this was in contrast to their earlier publication

after an initial 5.6 years where intense glucose therapy did not reduce the rate of major cardiovascular events (Duckworth *et al.*, 2009).

Long-term control of hyperglycaemia delays, or prevents, development of albuminuria and overt proteinuria (Waanders *et al.*, 2013). However, the importance of tight glycaemic control once diabetic nephropathy has occurred is not as straightforward. In a cohort of diabetic subjects with chronic kidney disease followed up over 48 months, the association between levels of HbA1c and eGFR was studied. In subjects with an eGFR between 30-60 ml/min/1.73m² an HbA1c <7% was associated with a 22% lower event rate of reaching ESRD compared with subjects with an HbA1c between 7% and 9%. In subjects with an eGFR between 15-30ml/min/1.73m² no significant benefit of tight glycaemic control in subsequent subgroups was noted (Lewis *et al.*, 1993). An analysis on renal endpoints at ACCORD's end showed that intensive glycaemic control resulted in a 20-30% reduction in the risk of new-onset microalbuminuria and macroalbuminuria, but without a reduction in the risk of doubling in serum creatinine or the development of ESRD (Ismail-Beigi *et al.*, 2010). Similar results were recently obtained by a post-hoc analysis of the ADVANCE study, where intensive glucose control reduced the risk of ESRD, new-onset microalbuminuria by 9% and new onset macroalbuminuria by 30% (Percovic *et al.*, 2013).

In South Africa, the Society of endocrinology, metabolism and diabetes (SEMDSA) suggested that it is feasible and reasonable for newly diagnosed patients and those without cardiovascular disease to aim for an HbA1c target < 6.5%. However, in the elderly, the infirm, those with limited life expectancy or those with hypoglycaemic unawareness, a target < 7.5% (or even up to 8.0%) may be more acceptable (Amod *et al.*, 2012b).

Both pre-prandial and postprandial hyperglycaemia (PPG) will contribute to an elevated HbA1c. A meta-analysis of 38 studies found an association of increased risk of cardiovascular events with fasting plasma glucose (FPG) above 5.5mmol/l in apparently healthy individuals without diabetes (Levitan *et al.*, 2004). SEMDSA guidelines recommend a fasting target of 4.0-7.0 mmol/l. Additionally SEMSDA suggest that the target PPG is dependent on the HbA1c target. For an HbA1c target of <6.5% a PPG target of 4.4-7.8mmol/l is suggested. If the HbA1c target is <7% then the PPG target is 5-10mmol/l. Finally, if the

HbA1c target is <7.5% the target PPG is then <12mmol/l (Amod *et al.*, 2012b). Table 1 shows the agreement between HbA1c levels and estimated plasma glucose levels based on data from the international A1C-Derived Average Glucose (ADAG) trial (Nathan *et al.*, 2008).

Table 1 Agreement between HbA1c levels and estimated mean plasma glucose levels

HbA1c (%)	Estimated mean plasma glucose (mmol/l)
6	7
7	8.6
8	10.2
9	11.8
10	13.4
11	14.9
12	16.5

In 2015, the American Diabetes Association (ADA) recommended individuals with FPG values within target (4.4-7.2mmol/l) but with HbA1c values above target should monitor PPG levels one to two hours after the start of the meal and also that treatment aimed at reducing PPG values to <10mmol/l may help lower A1C.

In the 2012 ADA and European Association for the Study of Diabetes (EASD) position statement on the management of hyperglycaemia in T2DM (Inzucchi *et al.*, 2012) as well as in the 2015 Addendum (Inzucchi *et al.*, 2015) glycaemic targets of HbA1c <6.5–7.0% was suggested to prevent or delay complications in healthy patients with long life expectancy and low risk for vascular complications. However, it was suggested that the clinician should assess various elements (including patient attitude, risk of hypoglycaemia, duration of disease, life expectancy, co-morbidities, established vascular complications, and resources and support systems available to the patient) in order to establish an individualised glycaemic target. The glycaemic target could increase above 7% as age increases and capacity for self-care, cognitive, psychological and economic status, and support systems decline. Glycaemic targets for elderly with long standing or more complicated diabetes disease was suggested to be acceptable at an HbA1c of <7.5–8.0% if lower targets could not be achieved without hypoglycaemia. Additionally, within the clinician assessment, elements that are potentially modifiable (patient attitude

and support systems available to the patient) should be discussed with the patient to modify their behaviour and refer to suitable support structures so that more suitable glycaemic targets for complication prevention can be set.

2.3.3.2 Lipid and blood pressure targets in diabetes management

Dyslipidaemia is an important factor in the increased incidence of cardiovascular disease associated with diabetes. In the 1998 UKPDS, low density lipoprotein cholesterol (LDL-C) was the strongest independent predictor of CVD followed by high density lipoprotein cholesterol (HDL-C). The evidence for triglycerides as a predictor of CVD has been inconsistent, although low levels of HDL cholesterol, often seen together with elevated triglyceride levels, are the most prevalent pattern of dyslipidaemia in persons with T2DM (ADA, 2015).

SEMSDA and ADA sets the primary target for total cholesterol at <4.5mmol/l. HDL cholesterol goals are set at >1mmol/l for men and >1.2mmol/l for women. The triglycerides target is <1.7mmol/l. The LDL cholesterol goal is < 2.5 mmol/l, however, in T2DM patients who have CVD or Chronic kidney disease (CKD), or are less than 40 years old or have had diabetes for less than 10 years, or have other cardiovascular risk factors, the target is adjusted to <1.8mmol/l (Amod *et al*, 2012b; ADA, 2015).

Reducing total cholesterol to 4.6mmol/l has shown to be effective in reducing cardiovascular events in patients with chronic kidney disease at levels of eGFR >15 ml/min/1.73m², but not in levels below that or in dialysis patients (Waanders *et al.*, 2013). For each 1mmol/l reduction in LDL-C, a 9% reduction in all-cause mortality and 13% reduction in vascular mortality was seen (Kearney, *et al.*, 2008).

In the UKPDS triglycerides did not predict CVD outcome which was also shown in the later analysis of factors to predict all-cause mortality and CVD (Turner *et al.*, 1998; Raffield *et al.*, 2015). However, triglycerides have been shown to predict CVD (Sarwar *et al.*, 2007). Triglycerides have also shown to predict CKD but not diabetic retinopathy events in T2DM. The outcomes in this study were adjusted for variables including LDL-C, and showed that every decile increase in triglycerides above 1.7 mmol/l, increased the odds of developing CKD by 7–20%. The relationship between triglycerides and CKD was

stronger with increasing severity of albuminuria and eGFR loss and was independent of statin treatment (Penno *et al.*, 2015).

Hypertension is both a risk factor for CVD and microvascular complications in T2DM. Systolic blood pressure is associated with a decline in kidney function in patients with diabetes as shown by the UKPDS and they suggest that the ideal systolic blood pressure for patients with diabetes and chronic kidney disease would be between 120-130 mmHg. There was a reduction of 13% in microvascular complications for every 10 mmHg decrease in systolic blood pressure (Bretzel *et al.*, 1998). However, the Irbesartan in Diabetic Nephropathy Trial (IDNT) showed an increase in all-cause mortality in patients with a systolic blood pressure below 120 mmHg (Pohl *et al.*, 2005). ADA suggest a systolic blood pressure of 130-140mmHg and a diastolic blood pressure target of 80-90mmHg (ADA, 2015). The SEMSDA target for blood pressure is below 140/80mmHg (Amod *et al.*, 2012b).

A meta-analysis concluded that a systolic treatment goal of 130–135 mmHg was acceptable. With goals of <130 mmHg, there were greater reductions in stroke, a 10% reduction in mortality, but no reduction of other macrovascular events, and even an increase in serious adverse events was seen. Systolic blood pressure of <130 mmHg was also associated with reduced onset and progression of albuminuria but no significant changes in retinopathy or neuropathy (Bangalore *et al.*, 2011). Conversely, UKPDS showed that lowering blood pressure decreases the progression of retinopathy (Adler *et al.*, 2000).

2.3.3.3 Weight loss and waist circumference targets in diabetes management

It is assumed that in obesity the increased visceral adipocytes flood the portal circulation with free fatty acids leading to an accumulation of triglycerides in the muscle, liver and pancreas. This retards glucose metabolism by interfering with insulin signalling and insulin secretion. A strategy to reduce the excessive fat outflow from the abdominal depots and to prevent free fatty acid deposition is to reduce the volume of visceral fat depots by weight loss. Weight loss has positive effects on adipose tissue. It causes an increase in the beneficial fat cell hormone adiponectin, and a decrease in adipose tissue inflammation. Also, it is associated with a reduction of insulin resistance which improves glycaemic control (Kopp *et al.*, 2005).

Waist circumference (WC) provides an accurate indirect measure of intra-abdominal (visceral) fat and is not greatly influenced by age, standing height and degree of overall adiposity (Snijder *et al.*, 2006). A joint statement of the IDF, National Heart, Lung, and Blood Institute, American Heart Association, World Heart Federation, International Atherosclerosis Society, and International Association for the Study of Obesity recommends using WC cutoff values of >102 cm for men and >88 cm for women to evaluate obesity as a risk factor for coronary heart disease. The World Health Organization (WHO) concurs with this recommendation (Alberti *et al.*, 2009; WHO, 2011).

Increased waist circumference is associated with an increased risk of developing T2DM. Persons with abdominal obesity or upper-body obesity, tend to deposit excess subcutaneous and visceral fat in the abdominal region and have a relatively higher risk of developing chronic diseases including a five-fold increase in risk in developing T2DM compared to individuals who deposit fat in the lower body (Warren *et al.*, 2012). A study of 154,776 men and 90,757 women examined the association between waist circumference and mortality over a nine year period. A large WC was associated with an approximately 25% increased mortality risk. Compared with subjects with a combination of normal basal metabolic index (BMI) ranging between 18.5kg/m² and 25kg/m², and normal waist circumference of ≤88cm for women and ≤102cm for men, those in the normal-BMI group with a large WC had an approximately 20% higher mortality risk. Due to this finding authors of this study suggest that increased WC should be considered a risk factor for mortality, in addition to BMI (Koster *et al.*, 2008).

In the position statement of the ADA for nutrition therapy recommendation for management of adults with T2DM a summary of the large studies that show evidence that obesity is a risk factor for developing diabetes, a weight loss of 7% can delay and in some cases even prevent diabetes onset (Evert *et al.*, 2014). In the revised 2015 position statement of the ADA, a weight loss of 2-8kg is recommended as this may provide clinical benefits in patients with T2DM especially in the early stages of the disease. To achieve this modest weight loss, intensive lifestyle interventions with frequent follow up is recommended (ADA, 2015).

In 1987 Wing and colleagues examined whether modest weight loss would provide a benefit in HbA1c after one year follow up and therefore a reduced risk of diabetes complications. A weight loss of 6.9kg, or

more than 5% reduction in body weight, was significantly correlated with improvements in HbA1c at post treatment. Patients losing less weight had non-significant changes in HbA1c and those gaining weight had significant worsening of glycaemic control (Wing *et al.*, 1987).

The physicians Looking forward to the Action for Health in Diabetes (Look AHEAD) study is a multi-centre, randomised clinical trial examining the long-term effects of lifestyle interventions on cardiovascular morbidity and mortality in 5145 overweight or obese participants with T2DM. The participants were randomly assigned to intensive lifestyle intervention or to usual care. The intensive lifestyle group was seen weekly for six months and then three times per month for the following six months. The participants in this group were prescribed a low fat (30% of total energy) calorie-restricted (1200-1800 kcal/day) diet as well 175 minutes per week of moderate intensity exercise. The intensive lifestyle group were given the option to use meal replacements. The usual care group attended three meetings over the year that focused on diet, activity and social support. The association between the amount of weight loss and the degree of improvement in cardiovascular risk factors including blood pressure and lipid levels at one year into the Look AHEAD cohort was examined. Weight changes were significantly correlated with changes in glycaemic control (observed with just 2-5% reduction in weight), blood pressure, HDL cholesterol, and triglycerides. The greater the weight change, the greater the improvements in each risk factor. Weight loss was not associated with improvements in LDL cholesterol. However, when lipid medication was excluded, there was a significant but weak correlation between weight loss and change in LDL cholesterol when weight loss was 5-10% of body weight. Although the intensive lifestyle group lost more weight than the usual care group, both groups, as well as the group as a whole, showed an association between weight loss and improvements in the risk factors. Irrespective of the weight at baseline, the same improvement occurred with a given percentage change in body weight. This study emphasises that a modest weight loss of 5-10% of body weight should be the clinical message for overweight and obese patients with T2DM. Interestingly though, is that this study did not show any benefit of lifestyle intervention on the incidence of macrovascular outcomes (Wing *et al.*, 2011).

In the Wing studies mentioned above, the improvement in glycaemic control and the risk factors for a given weight loss was greater initially than at one year, suggesting that energy restriction, in addition to

weight loss, may contribute to initial improvement. This may be one of the reasons why studies in bariatric surgery have shown an improvement in glycaemic control and even remission of T2DM before any substantial weight loss has been achieved (Adams *et al.*, 2012). A study of 13 obese T2DM patients undergoing Roux-en-Y gastric bypass surgery showed an improvement in HbA1c levels from an average of 7mmol/l pre-surgery to a non-significant average of 5.9mmol/l at three months post-surgery, and a significant 5.6mmol/l at one year post-surgery. The corresponding weight loss of these patients was a significant average weight loss of 17kg at three month post-surgery and a significant average weight loss of 28kg at one year post-surgery. This study attributes these outcomes to a decrease in pro-inflammatory markers and an increase in anti-inflammatory markers as a result of bariatric Roux-en-Y gastric bypass surgery (Lindegaard *et al.*, 2015).

Wing *et al.* (2011) acknowledges that it is unknown whether the initial benefits of modest weight loss on glycaemic control and risk factors of cardiovascular disease will be maintained long-term. An article looking at the short term medical benefits (including reduction of insulin resistance, diabetes mellitus, hypertension, dyslipidaemia, sleep apnoea, hypoxemia, and osteoarthritis), and the potential adverse effects (including greater risk for gallstone formation and cholecystitis, excessive loss of lean body mass, water and electrolyte problems, mild liver dysfunction, and elevated uric acid levels) concluded that short-term adverse effects are not severe enough to contraindicate weight loss, nor do they outweigh its short-term benefits (Pi-Sunyer, 1993).

2.4 Strategies for improving diabetes control

A systematic review of the effectiveness of lifestyle interventions showed that although comprehensive lifestyle interventions effectively decreased the incidence of T2DM in high-risk patients, in patients who already had T2DM, there was no evidence of reduced all-cause mortality and insufficient evidence to suggest benefit on cardiovascular and microvascular outcomes. An improvement in HDL and HbA1c was seen when pharmacotherapy was included. The comprehensive lifestyle intervention that included an exercise component, a diet component, and at least one other component (such as counselling, smoking cessation, and behaviour modification) was not shown to be better than diet and exercise alone (Schellenberg *et al.*, 2013). Although SEMSDA recommends a holistic approach in diabetes

management, including medication, exercise and dietary treatment, we will focus on dietary and self-management strategies in this review.

2.4.1 Self-management of blood glucose

Self-management of blood glucose (SMBG) can be used to assess individual response to therapy and whether glycaemic targets are being reached. The evidence for SMBG is mixed. In a meta-analysis (Willett, 2012), SMBG reduced HbA1c by 0.25% at six months. In contrast, a Cochrane review concluded that the overall effect of SMBG is small; up to six months after initiation and even less after 12 months. This may be because the accuracy of SMBG is dependent on the instrument being used as well as the user (Malanda *et al.*, 2012). Polonsky and colleagues (2011) suggested that collecting and interpreting seven-point SMBG profiles, where individuals test blood sugars before and after the three main meals and before bed over three days at least quarterly in the year, reduces HbA1c by 0.3% more than when data is collected less frequently.

For SMBG to be useful, the data should be interpreted regularly by the patient and the health provider so that action can be taken when blood sugars are either high or low. Patients should be taught how to use SMBG to adjust for food eaten, exercise, and how to adjust insulin and food intake in order to achieve specific goals including to prevent hypoglycaemia. The frequency of testing should be re-evaluated at each routine visit (ADA, 2015).

2.4.2 Medical Nutrition Therapy

As quoted from the SEMDSA guidelines in 2012: “Medical nutrition therapy (MNT) is important for the prevention, treatment and self-management of diabetes, and the prevention or delay in onset of diabetes-related complications” (Amod *et al.*, 2012). Nutritional counselling and diabetes self-management education are important throughout the management of diabetes. They ensure that the patient has access to information on methods to reduce requirements for medications as well as ways to safely monitor and control blood glucose levels (Inzucchi, *et al.*, 2015). Comprehensive group education, including nutrition therapy or individualised education sessions, can reduce HbA1c by an average of 0.5%-2% (ADA, 2015), and MNT can reduce HbA1c by 1-2%, depending on the duration of diabetes (Amod *et al.*, 2012).

A review of South African data (Vorster *et al.*, 2011) explains that there has been a shift in dietary patterns and nutrient intakes from 1975 to 2005 due to the South African changes in economic development, social development, urbanization, and acculturation. Diets are influenced by the production and trade of agricultural goods, foreign direct investment in food processing and retailing and global food advertising and promotion (Hawkes, 2006).

Data from the Global Nutrition and Epidemiologic Transition Initiative showed that rice and wheat products accounted for over half of the contribution to energy consumption from staple grains, while the trends for contribution from roots and pulses generally decreased (Mattei *et al.*, 2015). The THUSA study identified that there has been decrease in staple foods rich in starch and dietary fibre, increases in foods from animal origin rich in total fat and saturated fatty acids, decreases in plant protein sources such as legumes, and increases in energy-dense snack foods, carbonated sweetened beverages, commercially available alcoholic beverages, as well as added sugar, fats and oils in preparation of food. The changes in the macronutrient intakes can be associated with the increase in overweight, obesity and other NCDs, while the intake in micronutrients, especially of calcium, iron, zinc and some vitamins, did not reach recommended values. The average fat intake increased from approximately 21% of total energy to 30%. A decrease in average carbohydrate intake from 65% to 57% of total energy was also seen. An increase in animal protein and decrease in plant protein was also seen from the data reviewed (MacIntyre *et al.*, 2002).

Eating behaviours were evaluated in relation to glycaemic control. A healthful eating lifestyle resulted in lowered HbA1c levels. Specific food habits, such as limiting the amount of high sugar foods, limiting portion sizes, eating only an occasional dessert, reducing high-fat foods, eating low-fat foods, eating regularly, planning meals, eating large amounts of vegetables, and limiting specific carbohydrates was positively related to improved glycaemic control (Savoca *et al.*, 2004). On the other hand, eating at buffets, fast-food and large-chain restaurants, choosing high-fat menu selections and eating high-fat sources of protein, skipping breakfast, and improper snacking, were negatively correlated with low HbA1c levels (Schmidt *et al.*, 1994). In South Africa there is a low fibre intake from high fibre starches

and fruit and vegetables, a high fat intake, a high sugar intake, and high consumption of sodium (Shisana *et al.*, 2013).

The Prevencion con Dieta Mediterranea (PREDIMED) nutrition intervention trial showed that adherence to Mediterranean diet was associated with 52% reduction of T2DM incidence and approximately 30% reduction in CVD risk (Salas-Salvado *et al.*, 2011). A systematic review on the effects of Mediterranean diet in diabetes control shows that adherence to Mediterranean diet reduce HbA1c, lower fasting blood glucose levels, decrease insulin resistance and decrease mortality (Sleiman *et al.*, 2015). The possible mechanism by which Mediterranean diet may have a protective role on glycaemic control is by decreasing oxidative stress, inflammation, and insulin resistance. In another study in Brazil, for each increment of 5% energy from monounsaturated fatty acids(MUFA) ingested there was a 0.42mmol/l decrease in FPG and a 0.92mmol/l decrease in two-hour PPG. They also showed that a substitution of saturated fatty acids (SFA) for MUFA improves insulin sensitivity. Additionally, a five gram increment of soluble fibre ingested reduced FPG by 0.44mmol/l (Barros *et al.*, 2014).

In 2013 Ajala and colleagues in a systematic review and meta-analysis of the different dietary approaches undertook to find the most suitable diet to induce weight loss, improve glycaemic control, and improve the lipid profile in T2DM. They found in their review of the existing literature on low carbohydrate, low glycaemic index (GI), Mediterranean, and high-protein diets that these diets may be effective in improving various markers of cardiovascular risk in people with diabetes. However they acknowledge that there is no one-size-fits-all approach and that it is more realistic for a dietary modification to be individualized.

There is limited evidence on the optimal dietary approach to control glycaemia in T2DM. It is clear that weight loss and reduced total calorie intake can achieve good glycaemic control, but the ideal proportion of the three main food macronutrients (carbohydrate, fat, and protein) that should be recommended remains unclear.

It has been suggested that more research on how Africans respond to different dietary interventions, aimed at primary and secondary prevention of NCDs and their risk factors, are needed since it is not

known if dietary recommendations to prevent risk factors for NCDs are the same in different populations (Vorster *et al.*, 2011). In order to overcome the challenge of the nutrition transition in Africa and prevent an increase in NCDs, it is recommended that under-nutrition and over-nutrition be addressed simultaneously. Nutritional interventions should aim for optimal, balanced, adequate, but prudent diets for all. Food security is important and all people in a population should be reached with positive messages of how to choose a healthy diet (Vorster, *et al.*, 2011). In an effort to address this problem, food-based dietary guidelines (FBDG), grounded on the best available scientific evidence on the relationship between diet and health, have been developed specifically for South Africa, considering the existing eating patterns and public health problems within the country. The aim of the FBDGs is to inform, educate and empower consumers to change their eating behaviour so that nutrition-related public health problems can be addressed (Vorster, *et al.*, 2013). These practical guidelines are consistent with the dietary recommendations for diabetes management by ADA, EASD and SEMSDA.

For people with diabetic kidney disease, reducing the amount of dietary protein below 0.8 g/kg/day is not recommended because it does not alter glycaemic measures, cardiovascular risk measures, or the course of eGFR decline (ADA, 2015). Changing the source of protein to be more soy-based may improve cardiovascular risk factors but does not improve proteinuria in diabetic kidney disease and macroalbuminuria. Lower dietary sodium intake was associated with lower albuminuria, less progression to ESRD and fewer cardiovascular events in patients with diabetic nephropathy (Lambers *et al.*, 2012). ADA recommends an initial reduction to 2300mg sodium for all people with diabetes and a further reduction should be individualised when there is hypertension. Lowering sodium intake over time to 1500mg/day has shown further beneficial effects on blood pressure (Bray *et al.*, 2004) and the American Heart Association recommends 1500mg/day for people with diabetes. However, a sodium intake of lower than 1500mg/day has been associated with mortality and therefore should be recommended with caution (Ekinici *et al.*, 2011).

2.5 Non-adherence to diabetes diet regimens

2.5.1 Definition and prevalence of non-adherence

Delamater (2007) cites Meichenbaums 1987 practitioners' guide-book and defines adherence as the "active, voluntary, and collaborative involvement of the patient in a mutually acceptable course of behaviour to produce a therapeutic result". Adhering to an advised, mutually agreed treatment option is the patients' choice. Non-adherence to a diabetes regimen is not new or uncommon. Becker and Janz, (1985) addressing the issue of non-adherence, cited earlier studies that revealed levels of non-adherence to diabetes diet regimens to be as low as 65-90%. In a more recent study in Ethiopia the overall proportion of defaulting good dietary practice, including lowering fat and sodium intake and increasing fibre intake, among the T2DM participants was 51.4% (Worku *et al.*, 2015). In a Zimbabwean study of 208 participants, 75% claimed that they followed their dietary plan strictly and 25% indicated they were not able to strictly follow recommended dietary treatment (Mandewo *et al.*, 2014). Low adherence to prescribed treatment can indicate that the patient may not receive the full benefit of the therapy.

To optimize health outcomes, people with diabetes are usually advised to make significant changes to their lifestyle, including diet, physical activity, and de-stressing techniques. Their treatment plan may also include regular finger-pricking to monitor blood glucose, frequent medical examinations with eye and foot screenings, as well as daily prescribed oral medications and/or injected medications. Diabetes care is long term and self-management is critical in diabetes management. However, when preventive or treatment regimens are very complex and/or require lifestyle changes and the modification of existing habits, non-adherence can be as high as 70% (Martin *et al.*, 2005).

2.5.2 Factors associated with non-adherence

If diabetes management goals are to be achieved, then it is necessary to understand the factors and circumstances that predispose or contribute to patients' non-adherence to treatment plans. In the study of T2DM patients in Ethiopia, those who were more likely to have poor dietary practices were more likely to have difficulty choosing foods (Worku *et al.*, 2015). This may be due to cultural and personal food choice, economic reasons, or a lack of detailed understanding of the association between disease and diet.

The adherence of participants with the recommendations provided can skew the outcomes of the study intervention. The way in which patients are recruited can be associated strongly with the motivation to comply with recommendations. Adherence may also depend on cultural attitudes in the respective country as well as on the quality and feasibility of the programs. On the other hand, it could be that interventions using multiple factors overburden some patients since they may be able to focus on one aspect of their life but changing several aspects simultaneously might be too difficult (Angermayr *et al.*, 2010).

2.5.2.1 Demographic factors

A Task Force for cardiovascular disease has noted the association between demographic characteristics such as gender, age, ethnic groupings, level of education and income with non-adherence to therapy but acknowledge that these characteristics cannot be used to determine whether an individual will adhere to treatment or not since these variables are not causal (Ockene *et al.*, 2002). Boas *et al.* (2012) found no statistically significant differences regarding dietary adherence according to gender, marital status and occupation. Worku *et al.* (2015) also found no association between poor dietary practice and religion, marital status, occupation, smoking habit, drinking habit and duration of disease. Another study conducted in Zimbabwe, also found that there was no significant association between socio-demographic characteristics of the participants and their non-adherent behaviour towards treatment recommendations (Mandewo *et al.*, 2014). A study in Nigeria indicated that socio-demographic characteristics such as female gender, single marital status, secondary or tertiary education, and being employed were significantly associated with medication non-adherence (Uchenna *et al.*, 2010). The differences in these findings may be due to the differences in the way the study was conducted and how factors were identified, and also due to the differences in numbers of participants in the studies. Interestingly, in a study of 162 T2DM patients in Brazil (Boas *et al.*, 2012), dietary adherence was shown to have an inverse and statistically significant correlation with education level, suggesting that, the higher the education level, the lower adherence.

2.5.2.2 Socio-economic and cultural factors

2.5.2.2.1 Eating out, social gatherings, poor self-control, and difficulty changing habits

Meal planning, food selection and food preparation was shown to be influenced by weight control efforts (Savoca & Miller, 2001). However, adopting new food habits is not easy and barriers to dietary adherence, such as incorporating new habits into daily life when eating out or at social events, food preferences with regard to taste, time constraints and the perception of what is convenient in terms of preparation time, temptations, the need for food planning and constant self-care, make it all the more difficult. Unavoidable temptations, difficulty in adhering in social or when eating out, and difficulty in revealing status to hosts of parties influence adherence (Savoca & Miller, 2001; Okolie *et al.*, 2010; Singh *et al.*, 2012; Mandewo *et al.*, 2014).

Social and physical environmental factors drive unhealthy behaviours of individuals via eating increased amounts of energy dense foods when socialising, and increase in fast food outlets that serve high fat foods (Steyn *et al.*, 2001). Almost half (47.6%) of South African people eat out of the home once a week or more where portions are larger and higher in fat (Shisana *et al.*, 2013). Hawkes (2006) suggests that humans have an inherent preference for energy dense, smooth (refined, highly processed), salty, fatty and sweet convenience foods and snacks. Knowing this, the food industry has made sure that these kinds of foods are affordable, available, well-advertised and marketed in developing countries.

2.5.2.2.2 Social support

Receiving support from members of the immediate family, as well as the level of support, was associated with adherence to treatment recommendations (Kagee *et al.*, 2007; Savoca & Miller, 2001; Uchenna, *et al.*, 2010; Mandewo, *et al.*, 2014). In a Brazilian study of 162 people with diabetes, there was a weak correlation with social support, suggesting that the higher the perceived social support, the greater adherence to diet recommendations (Boas *et al.*, 2012). Disruption in social, family and cultural patterns is often associated with poor dietary adherence (Ockene *et al.*, 2002).

Diabetes affects everyone in the family, and how the family responds affects how the person with diabetes feels, and how they take care of their diabetes. Both lack of support and criticism distresses the

person with diabetes and generates feelings of isolation, frustration, guilt and anger. This distress can compromise self-care, affect physical well-being, and influence the quality of relationships. Support from family and friends fluctuate between too little support and harassment. Some patients feel that family and friends tempt them to ignore their diabetes or do not support their efforts to manage the disease and others feel their family and friends go to the opposite extreme, monitoring and criticizing every action that could affect blood glucose levels (Okolie *et al.*, 2010; Singh *et al.*, 2012).

Support can also come from the health team. Having attended more than two health education sessions in six months was shown to be protective against non-adherence (Mandewo *et al.*, 2014). A review of trials investigating the primary and secondary outcomes in preventing cardiovascular disease and T2DM using lifestyle management interventions including physical activity, diet, and stress management techniques, found that a low intensity of one to 30 hours and a minimum of two contact sessions over a six-month period showed a weak, but significant improvement in self-reported risk behaviour in at least two of the three interventions (Angermayr *et al.*, 2010).

2.5.2.2.3 Financial Constraints

The SANHANES report the price of the food items was shown to be considered most when shopping for groceries. The taste of food followed behind, and health considerations, including how long a food item keeps, and nutrient content were less frequently considered, with safety hardly being considered. These results show that irrespective of what food is known to be healthier, people will still buy what they can afford (Shisana *et al.*, 2013). Respondents in an Ethiopian study (Worku *et al.*, 2015) who thought about the high cost of foods were over two times more likely to have poor dietary practice than those who did not think about the high cost of foods. Cost and financial constraints were also seen to be barriers to adherence in other studies (Ockene *et al.*, 2002; Kagee *et al.*, 2007; Okolie, *et al.*, 2010; Mandewo, *et al.*, 2014). It is costly to buy different types of foods to fulfil the daily requirements. Those who have financial constraints are forced to buy only what they can afford and are, therefore, exposed to poor dietary practices and non-adherence to diet recommendations. Food availability and food shortage was also shown to affect meal planning, food selection, and food preparation (Savoca & Miller, 2001; Mandewo *et al.*, 2014).

2.5.2.3 Dietary and disease knowledge

A poor understanding of diet-disease associations, or misinformation, compound the difficulties in adapting change in eating behaviour. The purpose of nutrition education is to improve knowledge about food so that beliefs can be influenced and healthier food intake practices can be facilitated. An Ethiopian study showed those who did not get diabetic nutrition education were 4.47 times more likely to have poor dietary practice than those who received nutrition education (Worku *et al.*, 2015).

In South Africa, it has been shown that there is a clear association between a lack of knowledge regarding healthy food choices, food preparation, and acceptable portion sizes and Basal Metabolic Index (BMI) (Kruger *et al.*, 2002). Overall, South African adults have an average and inadequate knowledge of nutrition, regardless of their financial status and education level. Unlike the general population, diabetic patients usually receive extensive information on food so that they can adjust portion sizes and monitor daily intake in order to achieve glycaemic control. In spite of an apparently increased awareness about their dietary intake, people with T2DM still do not make healthy food choices. In the SANHANES report, 75% of people believed that what you eat and how much you eat can affect weight and health, although this has not translated into dietary practice (Shisana *et al.*, 2013).

2.5.2.4 Psychological factors

It has been difficult to consistently make associations between factors and adherence since these factors do not necessarily relate to the motivations or intentions of the patients. Yannakoulia (2006) suggests that food choice and intake also reflects learning mechanisms, cognitive influences and meanings. Cultural values, beliefs, attitudes and existing eating habits influence adherence (Yannakoulia, 2006; Kagee *et al.*, 2007; Shisana *et al.*, 2013).

Negative aspects associated with treatment, including the duration of therapy, how simple the treatment is, side effects of therapy, and a lack of immediate or perceived benefits, are most frequently associated with poor adherence (Ockene *et al.*, 2002). Often T2DM patients report associated meanings and negative emotions, such as the loss of pleasure in eating, control and freedom when following a diet. Feelings of fear, guilt and anger are frequently accompanied with non-adherent eating whereas diet adherence elicits

restrictive attitudes. Patients perceive diet recommendations to be restraining and not adapted to individual needs and thoughts of deprivation are common (Yannakoilia, 2006; Okolie *et al.*, 2010).

Despondency, or a feeling of hopelessness, was another factor identified for poor dietary practice (Okolie *et al.*, 2010; Worku *et al.*, 2015). Similarly, a study by Egede & Ellis (2010) showed that despondency was associated with decreased adherence to treatment with a likelihood of forgetting and not giving value to food planning, and eating whatever is edible was doubled. Poor metabolic control and decreased quality of life was also associated with despondency (Worku *et al.*, 2015). Cognitive function and depression were also shown to affect adherence (Kagee *et al.*, 2007).

Hemphill *et al.* (2013) suggests that the disease symptoms that an individual experiences alters how they behave with regards to what they believe about the disease. In other words, in those with T2DM who perceive their condition as fluctuating or episodic have been found to adhere less consistently to treatment recommendations, compared to patients who view their disease as a stable condition. The authors surmise that perhaps these patients fail to adhere on a regular basis because they believe that symptoms represent the disease itself and, thus, that disease management behaviours are not needed when symptoms are absent. In Zimbabwean outpatients, there was an association between perceived seriousness of the disease and taking positive initiatives to control and manage their diabetes by taking medications and following recommendations for diet and exercise. Also, although the majority of the participants in this study (77.4%) believed that diet and exercise help to control blood sugar levels and reduce complications associated with hypoglycaemia and hyperglycaemia, more of the participants believed medication was more beneficial in controlling blood sugars, preventing complications, and helping them to stay well, feel better, and increase life-expectancy (Mandewo *et al.*, 2014). An awareness of the importance of adherence, despite the absence of actual symptoms, has been shown to be associated with adherence (Kagee *et al.*, 2007).

Additionally, the degree of self-efficacy, as well as time management skills can impede or facilitate an individual's dietary care practices (Savoca & Miller, 2001; Mandewo, *et al.*, 2014). A cross-sectional survey of 507 in- and-out patients at a tertiary hospital in India with T2DM found that self-efficacy along with adherence to dietary restrictions was the single most important determinant of diabetes control. Self-

efficacy was influenced by educational status, employment, availability of family support, and positive mental attitudes (Venkataraman *et al.*, 2012).

2.5.3 The consequences of non-adherence

More than 40% of patients sustain significant risks in the outcomes of their disease when they misunderstand, forget, or ignore the advice of healthcare professionals (Okolie *et al.*, 2010). Healthier lifestyle habits, including physical activity and healthier dietary choices, have many health benefits, including skeletal muscle adaptations that improve fat and glucose metabolism, as well as insulin action, enhanced endothelial function; favourable changes in blood lipids, reduced blood pressure, reduced postprandial blood lipids and glycaemia, and reduced pro-inflammatory markers. Health benefits of lifestyle adaptations occur independently of changes in body weight or body fat and it is therefore suggested that regardless of whether healthier lifestyle leads to weight loss, T2DM patients should engage in physical activity and improve their diet (Gaesser *et al.*, 2011).

The consequences of non-adherence are costly and a risk factor for poor health outcomes. Non-adherence often results in a combination of wasted medical care funds, wasted time and energy for the patients and healthcare providers, and frustration and dissatisfaction for all involved (Martin *et al.*, 2005). A study examining adherence to medication regimens and the outcome on hospitalization and mortality risk in T2DM, found during follow-up, that non-adherent patients expectedly have higher HbA1c, blood pressure (BP), and LDL cholesterol levels. They also found, not unexpectedly, that non-adherent patients have higher all-cause hospitalization and higher all-cause mortality. Each 25% increase in medication adherence was associated with reductions in HbA1C, BP, and LDL-C levels. More interestingly however, is that the amount that 25% increase in adherence elicited on the reduction for hospitalization and mortality was greater than expected, suggesting that medication adherence may also be correlated with self-care behaviours that are directly or indirectly related to outcomes. It was surmised that adherent patients may be more likely to follow lifestyle recommendations and other healthy behaviours, leading to improved outcomes. Therefore it was suggested that outcomes from medication adherence may be due to the direct effect of the medication on outcomes as well as the indirect effect of adherence to behaviours such as diet and exercise recommendations that affect outcomes (Ho *et al.*, 2006).

2.5.4 Measuring adherence

Samuel-Hodge *et al.* (2002) found a high incidence of under-reporting dietary intake in patients with T2DM and that their reported diets closely matched the currently recommended diet for diabetes. It was regarded as plausible that they were more likely to report what they should be eating rather than what they were eating. Yannakoulia (2006) hypothesised that T2DM patients may intentionally omit reporting some foods that do not conform to the recommendation due to a perceived pressure to change eating patterns and adopt a healthy diet.

2.5.5 The Importance of education in improving adherence

In a systematic review of reviews of intervention components associated with increased effectiveness in dietary and exercise interventions, there was more likely to be changes when both physical activity and diet were targeted, when established behaviour change techniques were used, when social support was mobilised, when there was a clear plan on maintaining behaviour change, and when a higher frequency of contacts with a health worker are provided. The established behaviour techniques include self-monitoring, stimulus control, barrier identification, problem solving, relapse prevention management, cognitive restructuring, modifying thoughts, self-assertion, social support, coping strategies and coping imagery, goal setting and developing action plans, and self-reinforcement. The study also found that motivational interviewing was more effective than traditional advice-giving for initiating changes as long as the intervention includes a variety of behaviour change techniques or more contact time or is of a longer duration (although how long intervention should continue is unclear). No differences in outcomes were found between individual or group-based delivery of information. The evidence suggests that interventions can be delivered successfully by a wide range of health providers in a wide range of settings (Greaves *et al.*, 2011).

Barriers to adopting recommendations were shown in a study by Okolie and colleagues (2010). The study revealed some obstacles in the associations between health care providers/organizational factors and non-adherence, including poor attitude of health workers, irregular diabetes education, limited number of nutrition education sessions, no reminder post cards or phone calls about upcoming appointments, delay

start of appointments and time-wasting in the clinics. Participation, engagement, collaboration, negotiation, and sometimes compromise enhance opportunities for optimal therapy, in which patients take responsibility for their part of the adherence equation. When the health professional and the patients are able to communicate clearly and effectively with each other, there is greater patient satisfaction, a reduced risk of non-adherence, and improved health outcomes in the patient.

A realistic assessment of patients' knowledge and understanding of the regimen, and their belief in it, will enable a more effective targeting of the potential for adherence problems. Knowing the patient and his experiences in the illness better, allows the health professional to understand elements that are crucial to the patient's adherence including his beliefs, attitudes, cultural context in dealing with the disease, as well as available social supports and emotional health challenges, particularly depression (Martin *et al.*, 2005).

2.6 Conclusion

The aim of treating T2DM to target is to prevent macro-vascular and microvascular complications. Even when patients receive advice about desirable changes to be made in order to reach health-related targets, some patients do not make the necessary adjustments. Non-adherence to dietary treatment prescriptions is difficult to measure due to under-reporting by patients in their actual dietary intake and a desire for patients to obey the advice under perceived pressure of the health professional, and perhaps to deny failure. A review of the literature has identified some factors that facilitate change, as well as some factors that are obstacles to change in behaviour. These motivators and challenges were collated into groups and included demographic factors, socio-economic factors, diabetes and diet knowledge, and psychological factors. In educating patients, it is important for health care providers to understand what motivates people to change and what the barriers to change are, so that practices can be adapted to encourage compliance and achieve health targets.

2.7 References

Adams, T.D., Davidson, L.E., Litwin, S.E., Kolotkin, R.L., LaMonte, M.J., Pendleton, R.C., Strong, M.B., Vinik, R., Wanner, N.A., Hopkins, P.N., Gress, R.E., Walker, J.M., Cloward, T.V., Nuttall, R.T., Hammoud, A., Greenwood, J.L., Crosby, R.D., McKinlay, R., Simper, S.C., Smith, S.C., & Hunt, S.C.

2012. Health benefits of gastric bypass surgery after 6 years. *Journal of American Medical Association*, 308,1122–31.

Adler, A.I., Stratton, I.M., Neil, H.A.W., Yudkin, J.S., Matthews, D.R., Cull, C.A., Wright, A.D., Turner, R.C., & Holman, R.R. 2000. Association of systolic blood pressure with macrovascular and microvascular complications of type 2 diabetes (UKPDS 36): prospective observational study. *British medical journal*, 321:412–419.

Ajala, O, English, P, & Pinkney, J. 2013. Systematic review and meta-analysis of different dietary approaches to the management of type 2 diabetes. *American journal of clinical nutrition*, 97:505–16. Doi:10.3945/ajcn.112.042457.

Alberti, K.G., Eckel, R.H., Grundy, S.M., Zimmet, P.Z., Cleeman, J.I., Donato, K.A., Fruchart, J.C., James, W.P., Loria, C.M., & Smith, S.C. Jr.; (2009). Harmonizing the metabolic syndrome: a joint interim statement of the International Diabetes Federation Task Force on Epidemiology and Prevention; National Heart, Lung, and Blood Institute; American Heart Association; World Heart Federation; International Atherosclerosis Society; and International Association for the Study of Obesity. *Circulation*, 120(16): 1640-1645. Doi: 10.1161/CIRCULATIONAHA.109.192644. Epub 2009 Oct 5

American Diabetes Association (ADA). 2015. Standards of medical care in diabetes - 2015. *Diabetes care*, 38(1): S1-S66.

American Diabetes Association (ADA). 2002. Implications of the United Kingdom Prospective Diabetes Study. *Diabetes Care*, 25(1): S28-S32. Doi: 10.2337/diacare.25.2007.S28

Amod, A., Riback, W., & Schoeman, H.S. 2012a. Diabetes guidelines and clinical practice: is there a gap? The South African cohort of the International Diabetes Management Practices Study. *Journal of endocrinology, metabolism and diabetes of South Africa*, 17(2): 85-90.

Doi/pdf/10.1080/22201009.2012.10872282

Amod, A., Ascott-Evans, B.H., Berg, G.I., Blom, D.J., Brown, S.L., Carrhill, M.M., Dave, J.A., Distiller, L.A., Gannie, Y.N., Grobler, N., Heilbrunn, A.G., Huddle, K.R.L., Janse van Rensburg, G., Jivan, D., Joshi, P., Khutsoane, D.T., Levitt, N.S., May, W.M., Mollentze, W.F., Motala, A.A., Paruk, I.M., Pirie, F.J., Raal, F.J., Rauff, S., Raubenheimer, P.J., Randeree, H.A.R., Rheeder, P., Tudhope, L., Van Zyl, D.J., & Young, M. 2012b. The 2012 SEMDSA Guideline for the Management of Type 2 Diabetes. *Journal of endocrinology, metabolism and diabetes of South Africa*, 17(2): S1-S95.

Angermayr, L., Melchart, D., & Linde, K. (2010). Multifactorial lifestyle interventions in the primary and secondary prevention of cardiovascular disease and type 2 diabetes mellitus—a systematic review of randomized controlled trials. *Annals of behavioural medicine*, 40:49–64. Doi:10.1007/s12160-010-9206-4

Asche, C., LaFleur, J, & Conner, C. (2011). A review of diabetes treatment adherence and the association with clinical and economic outcomes. *Clinical Therapy*, 33(1): 74-109. Doi: 10.1016/j.clinthera.2011.01.019

Bangalore, S., Kumar, S., Lobach, I., & Messerli, F.H. 2011. Blood pressure targets in subjects with type 2 diabetes mellitus/impaired fasting glucose: observations from traditional and bayesian random-effects meta-analyses of randomized trials. *Circulation*, 123:2799–2810.

Barros, C.R., Cezaretto, A., Curti, M.L.R., Pires, M.M., Folchetti, L.D., Siqueira-Catania, A., & Ferreira, S.R.G. 2014. Realistic changes in monounsaturated fatty acids and soluble fibers are able to improve glucose metabolism. *Diabetology and metabolic syndrome*, 6: 136. Doi:10.1186/1758-5996-6-136

Becker, M.H. & Janz, N.K. 1985. The health belief model applied to understanding diabetes regimen compliance. *Diabetes educator*, 41-47.

Bertram, M.Y., Jaswal, A.V., Van Wyk, V.P., Levitt, N.S. & Hofman, K.J. 2013. The non-fatal disease burden caused by type 2 diabetes in South Africa, 2009. *Global health action*, 6:19244. Doi:10.3402/gha.v6i0.19244

Boas, L.C., Foss, M.C., de Freitas, M.C., & Pace, A.E. 2012. Relationship among social support, treatment adherence and metabolic control of diabetes mellitus patients. *Rev. Latino-Am. Enfermagem*, 20(1): 52-58. (English Abstract).

Bray, G.A., Vollmer, W.M., Sacks, F.M., Obarzanek, E., Svetkey, L.P., & Appel, L.J.: DASH collaborative research group. 2004. A further subgroup analysis of the effects of the DASH diet and three dietary sodium levels on blood pressure: results of the DASH-sodium trial. *American journal of cardiology*, 94: 222-227. Doi:10.1016/j.amjcard.2004.03.070

Bretzel, R.G, Voigt, K., & Schatz, H. 1998. The United Kingdom Prospective Diabetes Study (UKPDS) implications for the pharmacotherapy of type 2 diabetes mellitus. *Experimental and clinical endocrinology and diabetes*, 106:369-372.

Callaghan, B.C., Little, A.A., Feldman, E.L., & Hughes, R.A.C. 2012. Enhanced glucose control for preventing and treating diabetic neuropathy. *Cochrane database of systematic reviews*,6. Doi:10.1002/14651858.CD007543.pub2

Chew, E.Y., Ambrosius, W.T., Davis, M.D., Danis, R.P., Gangaputra, S., Greven, C.M., Hubbard, L., Esser, B.A., Lovato, J.F., Perdue, L.H., Goff, D.C. Jr., Cushman, W.C., Ginsberg, H.N., Elam, M.B., Genuth, S., Gerstein, H.C., Schubart, U., & Fine, L.J.: ACCORD Study Group; ACCORD Eye Study Group. 2010. Effects of medical therapies on retinopathy progression in type 2 diabetes. *New England journal of medicine*, 15: 363(3): 233-244. Doi:10.1056/NEJMoa1001288

Diabetes Control and Complications Trial Research Group. 1993. The effect of intensive treatment of diabetes on the development and progression of long-term complications in insulin-dependent diabetes mellitus. *New England journal of medicine*, 329:977-986. Doi:10.1056/NEJM199309303291401

Delamater, A.M. 2006. Improving patient adherence. *Clinical diabetes*, 24(2): 71-77. Doi:10.2337/diaclin.24.2.71

Duckworth, W., Abaira, C., Moritz, T., Reda, D., Emanuele, N., Reaven, P.D., Zieve, F.J., Marks, J., Davis, S.N., Hayward, R., Warren, S.R., Goldman, S., McCarren, M., Vitek, M.E., Henderson, W.G., &

Huang, G.D.: VADT Investigators. 2009. Glucose control and vascular complications in veterans with type 2 diabetes. *New England journal of medicine*, 360(2):129–139. Doi:10.1056/NEJMoa0808431

Egede, L.E., & Ellis, C. 2010. Diabetes and depression: global perspectives. *Diabetes research and clinical practice*, 87(3): 302-12. Doi:10.1016/j.diabres.2010.01.024. (Abstract).

Eijkelkamp, W.B., Zhang, Z., Remuzzi, G., Parving, H.H., Cooper, M.E., Keane, W.F., Shahinfar, S., Gleim, G.W., Weir, M.R., Brenner, B.M., & de Zeeuw, D. 2007. Albuminuria is a target for renoprotective therapy independent from blood pressure in patients with type 2 diabetic nephropathy: post hoc analysis from the Reduction of Endpoints in NIDDM with the Angiotensin II Antagonist Losartan (RENAAL) trial. *Journal of American Society of Nephrology*, 18:1540-1546.

Ekinci, E.I., Clarke, S., Thomas, M.C., Moran, J.L., Cheong, K., MacIsaac, R.J., & Jerums, G. 2011. Dietary salt intake and mortality in patients with type 2 diabetes. *Diabetes care*, 34: 703-709. Doi:10.2337/dc10-1723

Evert, A.B., Boucher, J.L., Cypress, M., Dunbar, S.A., Franz, M.J., Mayer-Davis, E.J., Neumiller, J.J., Nwanko, R., Verdi, C.L., Urbanski, P., & Yancy, W.S. Jr. 2014. Nutrition therapy recommendations for the management of adults with diabetes. *Diabetes care*, 37(1): S120-S143. Doi:10.2337/dc14-S120

Gaede P., Lund-Andersen, H., Parving, H.H., & Pedersen, O. 2008. Effect of a multifactorial intervention on mortality in type 2 diabetes. *The New England journal of medicine*, 358(6):580-591. Doi: 10.1056/NEJMoa0706245

Gaesser, G.A., Angadi, S.S., Sawyer, B.J. 2011. Exercise and diet, independent of weight loss, improve cardiometabolic risk profile in overweight and obese individuals. *Physician and sports medicine*, 39(2): 87-97. Doi:10.3810/psm.2011.05.1898

Greaves, C.J., Sheppard, K.E., Abraham, C., Hardeman, W., Roden, M., Evans, P.H., & Schwarz, P. 2011. Systematic review of reviews of intervention components associated with increased effectiveness in dietary and physical activity interventions. *Biomed central public health* 11:119. Doi: 10.1186/1471-2458-11-119

Grundy, S.M., Cleeman, J.I., Merz, C.N., Brewer, H.B. Jr., Clark, L.T., Hunninghake, D.B., Pasternak, R.C., Smith, S.C. Jr., & Stone, N.J. 2004. The Coordinating Committee of the National Cholesterol Education Program; National Heart, Lung, and Blood Institute; American College of Cardiology Foundation, and American Heart Association: Implications of recent clinical trials for the National Cholesterol Education Program Adult Treatment Panel III guidelines. *Circulation*, 110: 227-239.

Hall, V., Thomsen, W., Henriksen, O., & Lohse, N. (2011). Diabetes in Sub Saharan Africa 1999-2011: Epidemiology and public health implications. A systematic review. *Biomed central public health*, 11: 564.

Hayward, R.A., Reaven, P.D., Wiitala, W.L., Bahn, G.D., Reda, D.J., Ge, L., McCarren, M., Duckworth, W.C., & Emanuele, N.V.: VADT Investigators. 2015. Follow-up of glycemic control and cardiovascular outcomes in type 2 diabetes. *New England Journal of medicine*, 372: 2197-2206.

Doi.1056/NEJMoa1414266

Hawkes, C. (2006). Uneven dietary development: Linking the policies and processes of globalization with the nutrition transition, obesity and diet-related chronic diseases. *Global Health*, 2, 4–22.

Doi:10.1186/1744-8603-2-4

Hemphill, R.C., Stephens, M.A., Rook, K.S., Franks, M.M., & Salem, J.K. 2013. Older adults' beliefs about the timeline of type 2 diabetes and adherence to dietary regimens. *Psychology and health* 28(2),139-153. Doi: 10.1080/08870446.2012.685740

Ho, P.M., Rumsfeld, J.S., Masoudi, F.A., McClure, D.L., Plomondon, M.E., Steiner, J.F., & Magid, D.J. 2006. Effect of medication nonadherence on hospitalization and mortality among patients with diabetes mellitus. *Archives of internal medicine*, 166, 1836-1841. (Abstract).

Hu, J., Amirehsani, K., Wallace, D.C., & Letvak, S. 2013. Perceptions of barriers in managing diabetes: Perspectives of Hispanic immigrant patients and family members. *Diabetes Educator*, 39: 494-509.

Doi:10.1177/0145721713486200

Inzucchi, S.E., Bergenstal, R.M., Buse, J.B., Diamant, M., Ferrannini, E., Nauck, M., Peters, A.L., Tsapas, A., Wender, R., & Matthews, D.R.: American Diabetes Association (ADA); European Association for the Study of Diabetes (EASD). 2012. Management of hyperglycemia in type 2 diabetes: a patient-centered approach: position statement of the American Diabetes Association (ADA) and the European Association for the Study of Diabetes (EASD). *Diabetes Care*, 35(6):1364-79.

Doi:10.2337/dc12-0413

Inzucchi, S.E., Bergenstal, R.M., Buse, J.B., Diamant, M., Ferrannini, E., Nauck, M., Peters, A.L., Tsapas, A., Wender, R., & Matthews, D.R. 2015. Management of hyperglycemia in type 2 diabetes, 2015: a patient-centered approach: update to a position statement of the American Diabetes Association and the European Association for the Study of Diabetes, *Diabetes Care*, 38:140–149. Doi:10.2337/dc14-2441

International Diabetes Federation. 2014. IDF Diabetes Atlas sixth edition. <http://www.idf.org/diabetesatlas> Date of access: 30 June 2015.

Ismail-Beigi, F., Craven, T., Banerji, M.A., Basile, J., Calles, J., Cohen, R.M., Cuddihy, R., Cushman, W.C., Genuth, S., Grimm, R.H. Jr., Hamilton, B.P., Hoogwerf, B., Karl, D., Katz, L., Krikorian, A., O'Connor, P., Pop-Busui, R., Schubart, U., Simmons, D., Taylor, H., Thomas, A., Weiss, & D., Hramiak, I: ACCORD trial group. 2010. Effect of intensive treatment of hyperglycaemia on microvascular outcomes in type 2 diabetes: an analysis of the ACCORD randomised trial. *Lancet*, 376(9739): 419-430.

Doi:10.1016/S0140-6736(10) 60576-4

Kearney, P.M., Blackwell, L., Collins, R., Keech, A., Simes, J., Peto, R., Armitage, J., & Baigent, C. 2008. Efficacy of cholesterol-lowering therapy in 18,686 people with diabetes in 14 randomised trials of statins: a meta-analysis. *Lancet*, 371, 9607, 117-125.

Kopp, H.P., Krzyzanowska, K., Möhlig, M., Spranger, J., Pfeiffer, A.F., & Schernthaner, G. 2005. Effects of marked weight loss on plasma levels of adiponectin, markers of chronic subclinical inflammation and insulin resistance in morbidly obese women. *International journal of obesity*, 29(7): 766-771. Doi:10.1038/sj.ijo.0802983

Koster, A., Leitzmann, M.F., Schatzkin, A., Mouw, T., Adams, K.F., van Eijk, J.T.M., Hollenbeck, A.R., & Harris, T.B. 2008. Waist circumference and mortality. *American journal of epidemiology*, 167(12):1465-75. Doi:10.1093/aje/kwn079

Kagee, A., Le Roux, M.J., & Dick, J. (2007). Treatment adherence among primary care patients in a historically disadvantaged community in South Africa: A Qualitative study. *Health psychology*, 12, 444. Doi:10.1177/1359105307076232

Kruger, H.S.; Venter, C.S.; Vorster, H.H., & Margetts, B.M. 20012. Physical inactivity is the major determinant of obesity in black women in the North West Province, South Africa: the THUSA study. *Transition and Health During Urbanisation of South Africa. Nutrition*, 18(5): 422-427. Doi:10.1016/S0899-9007(01)00751-1

Levitt, N.S., Bradshaw, D., Zwarenstein, M.F., Bawa, A.A., Maphumolo, S. (1997). Audit of public sector primary diabetes care in Cape Town, South Africa: high prevalence of complications, uncontrolled hyperglycaemia, and hypertension. *Diabetic medicine*, 14, 1073–1077.

Lambers H.H.J., Holtkamp, F.A., Parving, H.H., Navis, G.J., Lewis, J.B., Ritz, E., de Graeff, P.A., & de Zeeuw, D. 2012. Moderation of dietary sodium potentiates the renal and cardiovascular protective effects of angiotensin receptor blockers. *Kidney International*, 82, 3, 330-337. Doi: 10.1038/ki.2012.74

Levitan, E.B., Song, Y., Ford, E.S., & Liu, S. 2004. Is nondiabetic hyperglycemia a risk factor for cardiovascular disease? A meta-analysis of prospective studies. *Archives of internal medicine*, 164(19):2147-2155. Doi:10.1155/2010/170393

Lewis, E.J., Hunsicker, L.G., Bain, R.P., & Rohde, R.D. 1993. The effect of angiotensin-converting-enzyme inhibition on diabetic nephropathy. *New England journal of medicine*, 329:1456-1462. Doi:10.1056/NEJM199311113292004

Lindegaard, K.K., Jorgensen, N.B., Just, R., Heegaard, P.M.H., & Madsbad, S. 2015. Effects of Roux-en-Y gastric bypass on fasting and postprandial inflammation-related parameters in obese subjects with normal glucose tolerance and in obese subjects with type 2 diabetes. *Diabetology and metabolic syndrome*, 7. Doi:10.1186/s13098-015-0012-9

Martin, L.R., Williams, S.L., Haskard, K.B., & DiMatteo, M.R. 2005. The challenge of patient adherence. *Journal of therapeutics and clinical risk management*, 1(3), 189–199.

MacIntyre, U.E.; Kruger, H.S.; Venter, C.S., & Vorster, H.H. (2002). Dietary intakes of an African population in different stages of transition in the North West Province, South Africa: The THUSA study. *Nutrition research*, 22: 230–256. Doi:10.1016/S0271-5317(01)00392-X

Malanda, U.L., Welschen, L.M., Riphagen, I.I., Dekker, J.M., Nijpels, G., & Bot, S.D. 2012. Self-monitoring of blood glucose in patients with type 2 diabetes mellitus who are not using insulin. *Cochrane database of systematic reviews*, 1. Doi:10.1002/14651858.CD005060.pub3

Mandewo, W., Edward, E. D., Chideme-Munodawafa, A., & Mandewo, G. 2014. Non-adherence to treatment among diabetic patients attending outpatients clinic at Mutare provincial hospital, Manicaland province, Zimbabwe. *International journal of scientific and technology research*, 3(9): 66-86.

Mattei, J., Malik, V., Wedick, N.M., Hu, F.B., Spiegelman, D., Willett, W.C., Campos, H. 2015. Reducing the global burden of type 2 diabetes by improving the quality of staple foods: The Global Nutrition and Epidemiologic Transition Initiative. *Global Health*, 11(1):23. (Abstract).

Nathan, D.M., Kuenen, J., Borg, R., Zheng, H., Schoenfeld, D., Heine, R.J.: A1c-Derived Average Glucose Study Group. 2008. Translating the A1C assay into estimated average glucose values. *Diabetes care*, 31:1473–1478. Doi:10.2337/dc08-0545

Nathan, M. 2014. The Diabetes Control and Complications Trial/Epidemiology of Diabetes Interventions and Complications Study at 30 Years: Overview. *Diabetes Care*, 37(1):9-16. Doi:10.2337/dc13-2112

Ockene, I.S., Hayman, L.L., Pasternak, R.C., Schron, E., & Dunbar-Jacob, J. 2002. Task Force #4— Adherence issues and behavior changes: Achieving a long-term solution. *Journal of the American College of Cardiology*, 40(4): 579–651. Doi:10.1016/S0735-1097(02)02078-8

Okolie, U., Ehiemere, I., Ezenduka, P., & Ogbu, S. 2010. Contributory factors to diabetes dietary regimen non adherence in adults with diabetes. *World academy of science, engineering and technology*, 45: 735-742.

Patel, A., MacMahon, S., Chalmers, J., Neal, B., Billot, L., Woodward, M., Marre, M., Cooper, M., Glasziou, P., Grobbee, D., Hamet, P., Harrap, S., Heller, S., Liu, L., Mancia, G., Mogensen, C.E., Pan, C., Poulter, N., Rodgers, A., Williams, B., Bompoint, S., de Galan, B.E., Joshi, R., & Travert, F.: The ADVANCE Collaborative Group. 2008. *New England journal of medicine*, 358:2560-2572. Doi:10.1056/NEJMoa0802987

Penno, G., Solini, A., Zoppini, G., Fondelli, C., Trevisan, R., Vedovato, M. Gruden, G., Lamacchia, O., Pontiroli, A.E., Arosio, M., Orsi, E., & Pugliese, G. (2015) Hypertriglyceridemia is independently associated with renal, but not retinal complications in subjects with type 2 diabetes: A cross-sectional analysis of the renal insufficiency and cardiovascular events (RIACE) Italian Multicenter Study. *PLoS one*, 10(5): e0125512. Doi: 10.1371/journal.pone.0125512

Pepper, D.J., et al. (2007). Hyperglycaemic emergency admissions to a secondary level hospital - an unnecessary financial burden. *South African medical journal*, 97(10):963-7.

Perkovic, V., Heerspink, H.L., Chalmers, J., Woodward, M., Jun, M., Li, Q., MacMahon, S., Cooper, M.E., Hamet, P., Marre, M., Mogensen, C.E., Poulter, N., Mancia, G., Cass, A., Patel, A., & Zoungas, S.: ADVANCE Collaborative Group. 2013. Intensive glucose control improves kidney outcomes in patients with type 2 diabetes. *Kidney International*, 83(3): 517-523. Doi:10.1038/ki.2012.401

Pi-Sunyer, F.X. 1993. Short-term medical benefits and adverse effects of weight loss. *Annals of internal medicine*, 119(7):722-726. (Abstract).

Pohl, M.A., Blumenthal, S., Cordonnier, D.J., DeAlvaro, F., DeFerrari, G., Eisner, G., Esmatjes, E., Gilbert, R.E., Hunsicker, L.G., Lopes de Faria, J., Mangili, R., moore, J. Jnr., Reisin, E., Ritz, E., Scherthaner, G., Spitalowitz, S., Tindall, H., Rodby, R.A., & Lewis, E.J. 2005. Independent and additive impact of blood pressure control and angiotensin II receptor blockade on renal outcomes in the irbesartan diabetic nephropathy trial: clinical implications and limitations. *Journal of the American Society of Nephrology*, 16:3027-3037.

Polonsky, W.H., Fisher, L., Schikman, C.H., Hinnen, D.A., Parkin, C.G., Jelsovsky, Z., Petersen, B., Schweitzer, M., & Wagner, R.S. 2011. Structured self-monitoring of blood glucose significantly reduces A1C levels in poorly controlled, noninsulin-treated type 2 diabetes: results from the Structured Testing Program study. *Diabetes care*, 34:262–267. Doi:10.2337/dc10-1732

Raffield, L.M., Hsu, F.C., Cox, A.J., Carr, J.J., Freedman, B.I., & Bowden, D.W. (2015). Predictors of all-cause and cardiovascular disease mortality in type 2 diabetes: Diabetes Heart Study. *Diabetology and metabolic syndrome*, 7:58. Doi: 10.1186/s13098-015-0055-y

Salas-Salvado, J., Bullo, M., Babio, N., Martinez-Gonzalez, M.A., Ibarrola-Jurado, N., Basora, J., Estruch, R., Covas, M.I., Corella, D., Aros, F., Ruiz-Gutierrez, V., & Ros, E.: PREDIMED Study Investigators. 2011. Reduction in the incidence of type 2 diabetes with the Mediterranean diet: results of the PREDIMED-Reus nutrition intervention randomized trial. *Diabetes care*, 34(1):14–19. Doi:10.2337/dc10-1288

Samuel-Hodge, C.D., DeVellis, R.F., Ammerman, A., Keyserling, T.C., & Elasy, T.A. 2002. Reliability and validity of a measure of perceived diabetes and dietary competence in African American women with type 2 diabetes. *Diabetes educator*, 28(6):979-88. (Abstract).

Savoca M., & Miller, C. 2001. Food selection and eating patterns: themes found among people with type 2 diabetes mellitus. *Journal of nutrition education*, 33(4):224-233.

Savoca, M.R., Miller, C.K., & Ludwig, D.A. 2004. Food habits are related to glycemic control among people with type 2 diabetes mellitus. *Journal of American Dieticians Association*, 104(4):560-566.

Sarwar, N., Danesh, J., Eiriksdottir, G., Sigurdsson, G., Wareham, N., Bingham, S., et al. (2007). Triglycerides and the risk of coronary heart disease: 10,158 incident cases among 262,525 participants in 29 Western prospective studies. *Circulation*, 115: 450–458.

Schellenberg, E.S., Dryden, D.M., Vandermeer, B., Ha, C., & Korownyk, C. (2013). Lifestyle interventions for patients with and at risk for type 2 diabetes - A systematic review and meta-analysis. *Annals of internal medicine*, 159:543-551. Schmidt, L.E., Rost, K.M., McGill, J.B., & Santiago, J.V. 1994. The relationship between eating patterns and metabolic control in patients with non-insulin-dependent diabetes mellitus (NIDDM). *Diabetes Educator*, 20(4):317-321.

Shisana, O., Labadarios, D., Rehle, T., Simbayi, L., Zuma, K., Dhansay, A., Reddy, P., Parker, W., Hoosain, E., Naidoo, P., Hongoro, C., Mchiza, Z., Steyn, N.P., Dwane, N., Makoae, M., Maluleke, T., Ramlagan, S., Zungu, N., Evans, M.G., Jacobs, L., Faber, M., & SANHANES-1 Team. 2013. *South African National Health and Nutrition Examination Survey (SANHANES-1)*. Cape Town: HSRC Press.

Singh, H., Cinnirella, M., & Bradley, C. 2012. Support systems for and barriers to diabetes management in South Asians and Whites in the UK: qualitative study of patients' perspectives. *British medical journal Open*, 2:e001459. Doi:10.1136/bmjopen-2012-001459

Sleiman, D., Al-Badri, M.R. & Azar, S.T. 2015. Effect of Mediterranean diet in diabetes control and cardiovascular risk modification: a systematic review. *Frontiers in public health*, 3:69.

Doi:10.3389/fpubh.2015.00069

Snijder, M.B., van Dam, R.M., Visser, M., & Seidell, J.C. 2006. What aspects of body fat are particularly hazardous and how do we measure them? *International journal of epidemiology*, 35:83–92.

Doi:10.1093/ije/dyi253

South Africa. Department of Health (SA DOH). 2011. South African declaration on the prevention and control of non-communicable diseases. http://www.health.uct.ac.za/usr/health/research/groupings/cdia/downloads/SA_NCD_Declaration.pdf Date of access: 30 June 2015.

Steyn, K., Lombard, C., Gwebushe, N., Fourie, J.M., Everett_Murphy, K., Zwarenstein, M., & Levitt, S. 2013. Implementation of nutritional guidelines, incorporated within structured diabetes and hypertension records at primary level care in Cape Town, South Africa: a randomised controlled trial. *Global health action*, 6: 20796. Doi:10.3402/gha.v6i0.20796

Turner, R.C., Millns, H., Neil, H.A., Stratton, I.M., Manley, S.E., Matthews, D.R., & Holman, R.R. 1998. Risk factors for coronary artery disease in non-insulin dependent diabetes mellitus: UKPDS. *British medical journal*, 316: 823-828.

UK Prospective Diabetes Study Group. 1998a. Intensive blood-glucose control with sulphonylureas or insulin compared with conventional treatment and risk of complications in patients with type 2 diabetes (UKPDS 33). *Lancet*, 352:837–853.

UK Prospective Diabetes Study Group. 1998b. Effect of intensive blood-glucose control with metformin on complications in overweight patients with type 2 diabetes (UKPDS 34). *Lancet*, 352:854–865.

UK Prospective Diabetes Study Group. 1998c. Tight blood pressure control and risk of macro-vascular and microvascular complications in type 2 diabetes (UKPDS 38). *British medical journal*, 317:703–713.

UK Prospective Diabetes Study Group. 1998d. Efficacy of atenolol and captopril in reducing risk of both macrovascular and microvascular complications in type 2 diabetes (UKPDS 39). *British medical journal*, 317:713–720.

United Nations. 2011. Political declaration of the High-level Meeting of the General Assembly on the Prevention and Control of Non-communicable Diseases High level meeting on prevention and control of non-communicable diseases. http://www.un.org/ga/search/view_doc.asp?symbol=A/66/L.1 Date of access: 30 July 2015.

Venkataraman, K., Kannan, A.T., Kalra, O.P., Gambhir, J.K., Sharma, A.K., Sundaram, K.R., & Mohan, V. (2012). Diabetes self-efficacy strongly influences actual control in patients attending a tertiary hospital in India. *Journal of community health*. 37 (3): 653-662. Doi:10.1007/s10900-011-9496-x

Vorster, H.H., Kruger, A, & Margetts, B.M. 2011. The nutrition transition in Africa: Can it be steered into a more positive direction? *Nutrients*, 3(4), 429-441. Doi:10.3390/nu3040429

Vorster, H.H., Badham, J.B., & Venter, C.S. 2013. An introduction to the revised food- based dietary guidelines for South Africa. *South African journal of clinical nutrition*, 26(3):S1-S164.

Waanders, F., Visser, F.W., & Gans, R.O. 2013. Current concepts in the management of diabetic nephropathy. *Netherlands journal of medicine*, 71,448–458.

Warren, T.Y., Wilcox, S., Dowda, M., & Baruth, M. 2012. Independent Association of Waist Circumference With Hypertension and Diabetes in African American Women, South Carolina, 2007–2009. *Preventing chronic disease*, 9. Doi:10.5888/pcd9.110170

Willett, L.R. 2012. Meta-analysis: self-monitoring in non-insulin-treated type 2 diabetes improved HbA1c by 0.25%. *Annals of internal medicine*, 156:JC6–JC12. Doi:10.7326/0003-4819-156-12-201206190-02012

Wing, R.R., Koeske, R., Epstein, L.H., Nowalk, M.P., Gooding, W., & Becker, D. 1987. Long-term effects of modest weight loss in type II diabetic patients. *Archives of internal medicine*, 147(10):1749-53. (Abstract).

Wing, R.R., Lang, W., Wadden, T.A., Safford, M., Knowler, W.C., Bertoni, A.G, Hill, J.O., Brancati, F.L., Peters, A., Wagenknecht, L., & the Look AHEAD Research Group. 2011. Benefits of modest weight loss in improving cardiovascular risk factors in overweight and obese individuals with type 2 diabetes. *Diabetes care*, 34: 1481-1486. Doi:10.2337/dc10-2415

World Health Organization. 2011. Waist circumference and waist–hip ratio: Report of a WHO expert consultation, Geneva, 8-11 December 2008.

Worku, A., Mekonnen, A., & Mesele-Wassie, M. 2015. Dietary practice and associated factors among type 2 diabetic patients: a cross sectional hospital based study, Addis Ababa, Ethiopia. *SpringerPlus*, 4. Doi:10.1186/s40064-015-0785-1

3 CHAPTER 3: ARTICLE

Title:

**DIETARY ADHERENCE AMONGST ADULTS WITH TYPE 2 DIABETES
MELLITUS: A South African urban population perspective**

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3.1 INTRODUCTION

Non-communicable diseases (NCDs) are on the increase and are among the leading causes of preventable morbidity and mortality.¹ In particular, the prevalence of diabetes continues to increase with 387 million people worldwide reportedly living with diabetes, despite continuing advances in treatment approaches and a multitude of new technologies.² The consequence of uncontrolled type 2 diabetes mellitus (T2DM) is the onset of microvascular and macrovascular complications which can lead to morbidity and mortality.³ Control of glycaemia,⁴⁻⁸ blood pressure and lipids,^{3, 9} and urine albumin creatinine ratio (UACR)^{5, 9-11} reduces microvascular and macrovascular complications. The prevalence of diabetes complications and poor glycaemic control is alarmingly high, with less than 50% of patients achieving acceptable glycaemic control.¹² The first line treatment of T2DM is for people with diabetes to make significant changes to their lifestyle, including diet, physical activity, and de-stressing techniques to improve their health outcomes and control glycaemia as well as the co-morbidities of diabetes, including hypertension, dyslipidaemia, and obesity. Dietary strategies to optimize glycaemia,^{4, 5, 13-15} lipids,^{11, 16, 17} blood pressure,¹⁸⁻²¹ and weight,²²⁻²⁶ are well researched, with mixed outcomes, although it is generally accepted that diabetes care is long-term and self-management is critical in diabetes management.²⁷ The prevalence of non-adherence to recommended treatment is high,^{28, 29, 30} even as high as 70% if the regimens are complex or require lifestyle changes and the modification of existing habits.³¹ Non-adherence has been shown to be an important cause of increased morbidity and mortality in T2DM.^{32, 33} If diabetes management goals are to be achieved, then it is necessary to understand the factors and circumstances that predispose or contribute to patients' non-adherence to treatment plans. Although the treatments and management of these morbidities are holistic, including (but not limited to) medication, exercise, and diet, this study focused on dietary treatment adherence in diabetes management. The factors that facilitate adherence and obstacles that are barriers to dietary regimen adherence were also studied. Previous studies to understand and help predict adherence to dietary treatment have

looked at understanding the patients' beliefs about their illness,³⁴ determining obstacles and the difficulties in managing diet,^{29,30,35-41} investigating the benefits of support structures,^{36, 39, 42} and identifying the needs in health education.^{36, 43}

The first aim of this study was to identify whether there is any association between dietary adherence and glucose control, metabolic risk, and socio-economic status using a questionnaire among a sample of type 2 diabetic patients in an urban South African population.

The second aim was to identify factors associated with non-adherence to dietary recommendations from the perspective of type 2 diabetic patients in an urban South African population.

3.2 METHODOLOGY

3.2.1 Participants

Convenience purposive sampling of diabetic patients on the diabetes management program at two diabetes clinics on the West Rand of Johannesburg, South Africa was undertaken. These clinics are privately run for cash patients and patients on medical aid. A multi-disciplinary team approach to diabetes management was followed at the clinics, and patients were seen by a diabetes educator, a specialist physician, and a dietician. Only the patients on the diabetes management program were considered for the study. There were 404 T2DM patients on the management program at the time of the study. Patients enrolled in the study were coherent, alert and willing to participate in the study through giving of written informed consent. All patients had consulted with the diabetes educator or the dietician at the clinic and received some manner of dietary advice. Patients taking blood pressure and lipid lowering medications were included in the study. According to the inclusion criteria for this study, the sample patients had records of biochemical and anthropometric data within the previous year. Also, blood tests including a lipid profile (total cholesterol, triglycerides [TG], low density lipoprotein cholesterol [LDL-C], and high density lipoprotein cholesterol [HDL-C], and glycated haemoglobin [HbA1c], as well as a

urine microalbuminuria (MAU), were measured in at least the last year preceding the study. Patients who were not on the diabetes management program, those who had been with the clinic for less than three months, and patients with type 1 diabetes were excluded from the study. Also, patients with chronic renal failure (defined as glomerular filtration rate <60ml/minute in two out of three tests) were excluded. Additionally, those patients who had not consulted with a diabetes educator or registered dietician were not eligible.

To determine the appropriate sample size, twelve adherence studies which assessed non-adherence and factors associated with non-adherence were considered.^{29,30,34-43} The sample size in qualitative studies ranged from 31 to 36, whereas quantitative studies included a huge range from eight to 403 patients. It was decided that 100 subjects would be targeted for this study. Of the 93 patients who gave written informed consent, complete data was available for a total of 91 patients. From this group, patients were given a choice whether to participate in the discussions. Thirty seven patients agreed to participate in the focus group discussions (FGDs) and were placed into groups that suited their time availability. The study protocol was approved by the Ethics committee of the North-West University (project number NWU – 00185-13-51).

3.2.2 Procedure

Data collection was done in May 2014 to March 2015. The two instruments that were used to obtain data were a structured questionnaire and focus group discussions (FGDs).

3.2.2.1 Quantitative data

A structured questionnaire was developed by the researcher based on the literature. The questionnaire was pilot tested for comprehension of the questions and ease of completion in two patients, not included in this study. All questions were clear and no changes were required. The questionnaire was administered by the dietician in the clinic in a structured interview. The questionnaire was divided into sections. Section A recorded biochemical data from the patients file as well as anthropometric measurements taken on the day the questionnaire was

administered. Data included the latest glycated haemoglobin (HbA1c), lipid profile including total cholesterol (TC), triglycerides (TG), low density lipoprotein cholesterol (LDL-C), and high density lipoprotein cholesterol (HDL-C), as well as microalbuminuria (MAU), waist circumference (WC), height (Ht), and weight (Wt). BMI was calculated. Section B was used to elicit information on socio-demographic and health data. This section recorded gender, age, duration of diabetes, medication taken, and employment status. Questions regarding the home and number of people living at the house, as well as water source and cooking methods were used to assess living conditions and questions about food security were used to estimate food availability and money available for food. Section C consisted of three questions regarding where participants' sourced nutritional information, whether they trusted the information and where they would have preferred to get nutritional information. Section D consisted of 25 questions on dietary practice which was adapted for South Africans.

The questionnaire in the study was based on the literature. Food records, food frequency questionnaires, and diet history recalls are the most well-known and widely used methods to measure dietary intake. However, these are most useful in assessing dietary quality when they are used together rather than alone.⁴⁴ In search for a method to evaluate diet in adults requiring fewer resources, a Scandinavian study formulated a 55 item food-based consumption questionnaire and evaluated it against seven day food records. Questions that best reflected the health-promoting diet defined in nutritional recommendations were identified by correlating and analysing the comparison to calculated food and nutrient intakes from the food records. They then scored a shorter questionnaire and compiled 18 questions. Dietary quality was considered low (0-9) or high (10-15) and reflected dietary intake of foods associated with health, as well as depicted adherence to dietary recommendations.⁴⁵ Although the Finnish questionnaire was not used in this study, since it was specific for the Finnish population, the basis of the 25 questions regarding dietary practice was adapted for South Africans using the dietary guidelines from the

South African Society of Endocrinology, Metabolism and Diabetes (SEMDSA);²⁷ the South African Food Based Dietary Guidelines (FBDG);⁴⁶ and the American Diabetes Association.⁴⁷

The variables that were assessed for dietary practice included whether participants ate a variety of foods; ate 5-7 (women) or 6-10 (men) portions of starch daily; ensure that $\geq \frac{2}{3}$ of starch portions were wholegrain; consumed ≥ 1 serving of vegetables daily; ate two portions of fruit a day; limited red meat to \leq three portions of a week; had less than one portion of processed meat a week; ate fish two or more times a week; removed fat from meat and chicken; ate at least one cup of legumes a week; used olive oil or canola oil for cooking; ate food fried in oil less than twice a month; consumed less than six teaspoons of fat a day; used a spread that has less than 60% fat, did not use additional salt at the table, ate 30g of nuts once to seven times a week; did not drink sweetened beverages; did not use sugar; ate sweet foods like cake, biscuits and sweets only on special occasions or never; consumed less, or within the recommended weekly limits of, alcohol; consumed one to two cups of dairy daily; drank at least 1.25 litres of clean and safe water daily; and did not skip meals.

One point was given for each variable that was correctly practiced and no score was given for incorrect practice. A total score out of 25 was calculated from the dietary practice questions to determine dietary adherence to guidelines. A maximum score of 25 was calculated as a continuous variable. A higher score denoted adherence whereas a low score denoted non-adherence to diet guidelines. A score of 0-12 (<50%) was considered low; 13-19 was considered intermediate; and 20-25 (80% or more) was considered high level of adherence. Also, one question to assess whether the participant believes they adhered to a diabetic diet or not was included in the questionnaire. An additional two open-ended questions regarding motivators and challenges to diet adherence were asked at the end of the questionnaire. The collected data from the questionnaires was coded and computerised in an Excel database.

3.2.2.2 **Qualitative data**

FGDs were used in this study to add depth, clarity and to gain a greater understanding of why people with T2DM adhere to dietary principles. This method allowed for open discussions and focus on concerns of the participant and insight into the perceptions of this population.⁴⁸ The FGDs consisted of a homogenous group of people diagnosed with T2DM. The FGDs gave the participants the opportunity to express their beliefs and attitudes towards the diabetic diet. Open ended questions were used to explore their perceptions of barriers and motivators to dietary adherence. A focus group discussion guide was developed by the researcher (Table I). Open-ended questions were constructed and posed by the facilitator to elicit the challenges, difficulties or barriers encountered in adhering to diet as well as the factors that motivate good dietary adherence. Participants were able to hear other peoples' responses and were allowed to make additional comments as they went along and they were encouraged to talk to one another. A final question of what would make a diet easier and more sustainable was also asked.

3.2.2.3 **Data analysis**

The data from the questionnaires were exported to the Statistical Package for Social Science (SPSS) version 21 for exploratory univariate and bivariate analyses with central trend measures including average and median scores, as well as variability measures including standard deviation. Descriptive statistics were used for general description of study participant socio-economic, clinical and biochemical variables, and to evaluate the frequency of the respondents' responses to what motivated them and what the challenges were to dietary adherence. Biochemical and anthropometric data including lipid profile, HbA1c, BP, MAU, Wt, Ht, BMI, and WC were used as continuous variables to show associations with dietary adherence score. Blood pressure and lipid lowering medication were considered as confounding variables. Correlation analysis was used to investigate associations

Table I Focus group discussion guide on beliefs and attitudes towards the diabetic diet and perceptions of barriers and motivators to dietary adherence

Introduction:

Good day. My name isI am so pleased that you have agreed to join today.

Purpose:

We are here to talk about the motivators and challenges in adhering to a diabetic diet. You were asked to participate in this discussion because you have important knowledge about your experience with diabetes and your perspective on what helps you to eat right and what you find challenging when trying to follow a healthy diet for your diabetes. I hope to learn more as a result of this group. I am here to learn from you and whatever you contribute to this discussion will be very helpful in understanding the factors that affect whether we follow dietary guidelines which will help me as well as other dieticians and educators and coaches to better adapt dietary advice and educate on diet more effectively for people with diabetes.

Rules:

There are no right and wrong answers. I think everyone has important experiences and ideas regarding diet. I want everyone to feel safe and comfortable to participate in the discussion. In order to have a successful and respectful discussion I want us to draw up some ground rules together: These rules are written on a flip chart.

My role today is to see that we have a productive discussion and to summarize the groups views. I will be facilitating the session and moving us along so that we touch on all of the key subjects. I would like to avoid getting side-tracked and want to make sure we keep to time. If I think that we are spending too much time on one point I will step in to keep the discussion moving.

I have asked (assistants name) to take notes of the discussion in case I miss anything. She will not be part of the discussion at all and will only observe. If no-one has objections would it be acceptable if I record this discussion (wait for any signaled objections). Lastly, be respectful of what others say and allow one person to speak at a time. I assure you that what you say will be kept confidential and I will not refer to any participant by name in the reports that I prepare. Let's begin.

Questions:

Icebreaker: “”Tell us your name and your favourite food.”

Introductory question: “when are your feelings and thoughts when you hear the word diet?”

Key questions: Document what is said and flow of themes

1. How important do you think it is to follow a healthy diet in the management of your diabetes?
2. In your experience what challenges exist in adhering to a diabetic diet?
3. Thinking back to when you are able to stick to a diet - what do you think motivates you?
4. Considering the challenges and motivators to follow a diabetic diet, what would make it easier and more sustainable?

In our discussion we mentioned (discuss factors here). Is this an adequate summary?

The purpose of this study is to understand the factors that affect whether we follow dietary guidelines. Have we missed anything?

between clinical and biochemical variables (serum lipids, HbA1c, BP, MAU, BMI and WC) and dietary adherence score. Chi-square tests was used to assess associations between identified motivators or challenges (yes/no) and socio-demographic and dietary adherence categories. The p-values at <0.05 was used to obtain the level of significance in this study.

The transcripts of the notes from the FGDs were assessed and coded to capture the essence of what was discussed. Codes were then grouped into common broad categories. Connections between the abstract categories were made to form most important themes. The answers from the question regarding motivators and challenges to dietary adherence from the questionnaires were quantified according to the structured responses. Having coded all of the data, the responses from the questionnaires were compared with the themes from the FGDs to obtain similarities or contradictions. This was done using guidelines for FGDs where themes from the interviews and questionnaires were each systematically charted according to the way the theme occurred in the transcript.⁴⁸ Citations from the participants were used to demonstrate the link between the data and the results.

3.3 RESULTS

There were a total of 91 participants in the study of which the majority (56, 61.5%) were men. The mean age of the participants was 65 years (range 31-85 years). More than half (55.9 %) of the study group were pensioners and 34.3% of the women and 42.9% of the men were employed full time. Mean duration of diagnosis of T2DM was 11.1 years, ranging from one to 43 years. Almost half of both the men and women were taking oral hypoglycaemic agents (51.8%, 45.7% respectively) as treatment for their T2DM and a further 42.9% of men and 45.7% of women were taking both tablets and insulin. Only a small minority were treated with diet alone (3 %) or only insulin (3 %). Most (70%) of the study population were taking blood pressure medication and 80% were taking cholesterol medication at the time of assessment.

Table II summarises the clinical findings of the participants. All blood values were distributed normally except for triglycerides and MAU for both men and women.

Table II: Summary of age, anthropometric, health, diabetes duration, and dietary adherence in participants

	n	Mean \pm SD		
		All	Women	Men
Age (years)	91	65.6 \pm 12.3	64.0 \pm 11.4	66.5 \pm 12.9
Height (m)		1.68 \pm 0.09	1.60 \pm 0.07	1.73 \pm 0.07
Weight (kg)		89.9 \pm 20.3	86.4 \pm 20.5	92.1 \pm 20.0
Body mass index (kg/m ²)		31.9 \pm 6.62	33.6 \pm 6.91	30.82 \pm 6.25
Glycated haemoglobin (%)		7.87 \pm 1.51	8.27 \pm 1.79	7.62 \pm 1.26
Total cholesterol (mmol/L)		3.88 \pm 0.92	4.12 \pm 0.90	3.72 \pm 0.91
Low density lipoprotein cholesterol (mmol/l)		1.94 \pm 0.77	1.99 \pm 0.86	1.91 \pm 0.71
High density lipoprotein cholesterol (mmol/L)		1.17 \pm 0.4	1.3 \pm 0.46	1.09 \pm 0.33
Waist circumference (cm)		107.4 \pm 12.9	104.0 \pm 12.9	109.5 \pm 12.7
Years with Type 2 diabetes mellitus (years)		11.1 \pm 7.48	10.5 \pm 6.17	11.5 \pm 8.22
Dietary adherence score (maximum 25)		16.9 \pm 3.51	17.4 \pm 2.89	16.51 \pm 3.83
		Median (interquartile range)		
Triglycerides (mmol/L)	91	1.74 (1.1-2.48)	1.85 (1.20, 2.56)	1.54 (1.01, 2.39)
Microalbuminuria (mg)	91	10.5 (3.2-29.2)	7.50 (2.10, 30.4)	11.3 (3.95, 28.0)

SD – Standard deviation

All of the participants reported that they had enough food to eat, although 18.6% reported having enough food but not always the food they wanted. Lack of money was one of the main reasons why people did not have the food they wanted, followed by dietary restrictions and unavailability of the kind of food they wanted. All participants had access to clean water and all participants

had a fridge, television and electricity. These assessments indicated that all participants were above the social-economic poverty line.

The majority got nutritional information from a variety of sources rather than from just a single source. When more than one source could be stated, 14.3% got nutritional information from friends, 11.0% got nutritional information from family, 43.6% from media, 25.2% from the internet, 3.6% from work wellness clinic or wellness days. Most (89.6%) received information from the diabetes clinic, more specifically from the dietician (89%). Most of the participants (85.15%) trusted the information they got from the various sources, but 14% only trusted the information if they felt it would work for them or knew somebody for which the advice had worked.

A score out of 25 was calculated from the dietary practice questions to determine dietary adherence to diabetes dietary recommendation. The scores of the participants ranged from 8-24 and independent T-tests showed no significant difference between adherence scores of women and men (17.4 vs. 16.5, respectively, $p = 0.21$). In this study, adherence was defined as low when a score of 1-12 out of 25 was achieved ($\leq 48\%$ adherence), intermediate when a score of 13-19 out of 25 was achieved (52-76% adherence), and high adherence when a score of 20-25 was scored out of 25 ($\geq 80\%$ adherence). Only 11% of the participants had a low adherence score, the majority (66%) of the participants had an intermediate score, and 23% of the participants had a high adherence score. Adherence to dietary guidelines in practice among the participants is presented in Table III. The dietary guidelines are listed from most adhered to the least adhered to. Eating a variety of food is the most adhered to guideline and eating two portions of fruit a day is the dietary guideline that was least adhered to. Dietary practice varied between men and women. Only 42.9% of women and 44.6% of men were of the opinion that they adhered to dietary guidelines for diabetes strictly. A further 54.3% of women and 46.4% of men adhered to dietary guidelines sometimes and six of the 91 participants believed that they did not.

Table III: Percentage of participants who adhered to the various dietary guidelines

Dietary practice	n	All	Women	Men
Eat a variety of foods	91	96.7	97.1	96.4
Consume ≤ 7 (women) and ≤ 14 (men) units of alcohol a week		92.3	94.3	91.1
Use olive oil or canola oil for cooking		91.2	91.4	91.1
Use a spread that is less than 60% fat		86.8	94.3	82.1
Consume less than 6 teaspoons of fat a day		82.4	85.7	80.4
Do not drink sweetened beverages		81.3	85.7	78.6
Remove fat from meat and chicken		80.2	85.7	76.8
Do not skip meals		75.8	71.4	78.6
Eat food fried in oil less than twice a month		73.6	74.3	73.2
Eat ≤ 1 portion of processed meat a day		71.4	80.0	66.1
Eat 5-7 (women) and 6-10 (men) portions of starch daily		69.2	68.6	69.6
Do not use additional salt at the table		69.2	77.1	64.3
Do not use sugar		67.0	51.4	76.8
Consume 1-2 cups of dairy daily		64.8	62.9	66.1
Eat ≤ 3 portions of red meat a day		63.7	77.1	55.4
Eat ≥ 1 serving of vegetables daily		62.9	71.4	57.1
$\geq \frac{2}{3}$ of starch portions are wholegrain		54.9	45.7	60.7
Drink at least 1.25 litres of clean and safe water daily		51.6	51.4	51.8
Eat sweet food only on special occasions or never		48.4	54.3	44.6
Eat at least one cup of legumes a week		46.2	45.7	46.4
Eat 30g of nuts 1 to 7 times a week		41.8	51.4	35.7
Eat fish 2 or more times a week		38.5	31.4	42.9
Eat 2 portions of fruit a day		35.2	48.6	26.8

The challenges and motivators to adherence to dietary guidelines that were reported by the participants were placed into common themes and are presented in Table IV.

Very few (4.4%) of the participants reported that they did not experience any challenges and were able to adhere to a suitable diabetes diet, and eight of the participants did not answer the question and did not report a challenge. Also, very few of the participants (2.2%) said that they were unable to motivate themselves and felt demotivated to adhere to dietary guidelines, and six of the participants did not answer the question and did not report a motivator.

This study failed to prove that a higher dietary adherence score correlates with a lower HbA1c value (Table V). No correlation between adherence score and HbA1c was found when duration of diabetes ($r = -0.07$, $p = 0.53$), or gender was controlled for ($r = -0.09$, $p = 0.39$), or when age was controlled for ($r = 0.001$, $p = 0.99$), even though there was a weak positive correlation between adherence score and age (Table V).

Furthermore, no correlation between duration of diabetes and HbA1c was found ($r = 0.08$, $p = 0.43$). There was a slight trend for a negative correlation between Total cholesterol (TC) and adherence score (Table V), and when cholesterol medication was controlled for, the correlation did not change ($r = -0.13$, $p = 0.23$). Adherence score showed a weak negative correlation with BMI and WC (Table V). Significant correlation at the 0.01 level was seen between WC and BMI ($r=0.80$; $p=0.00$), TC and TG ($r=0.32$; $p=0.000$), TC and LDL-C ($r=0.71$; $p=0.00$), TC and HDL-C ($r=0.44$; $p=0.00$), TC and MAU ($r=0.30$; $p=0.00$), as well as LDL-C and MAU ($r=0.31$; $p=0.00$). Additionally, a significant association at the 0.05 level was seen between BMI and TG ($r=0.23$; $p=0.03$). Also significantly, a negative correlation between WC and HDL-C ($r=-0.23$; $p=0.03$) was seen, suggesting that as WC increases HDL-C decreases even though no association was seen between BMI and HDL-C ($r=-0.06$; $p=0.59$).

Table IV: The frequency of reported challenges and motivators to dietary adherence among participants

	n	Frequency (%)		
		All	Women	Men
Themes of reported challenges	91			
Temptation, habits too hard to break		37.4	45.8	32.2
Difficulty when eating out		35.2	34.3	35.8
Too restrictive		18.7	17.1	19.7
Too much effort		12.1	20.0	7.2
Unconvinced of benefits of diet		11.0	5.8	14.3
Good quality food unavailable		6.6	8.6	3.6
Money		5.5	11.5	1.8
Time		3.3	2.9	1.8
Untasty food		2.2	2.9	3.6
Stress		2.2	2.9	1.8
Illness		1.1	0	1.8
Themes of reported motivators				
Good health, to prevent complications, fear of disease worsening		78.8	81.3	77.4
Seeing my blood sugars, want good blood glucose values		15.3	18.8	13.2
Other people motivate me		14.1	12.5	15.1
Eating well is a habit, easy to follow diet		12.9	6.3	17.0
Weight loss, want to lose weight		7.1	12.5	3.8
Seeing the doctor, want doctors approval		2.4	3.1	1.9
Accessible and available good foods		2.4	3.1	1.9
Able to compensate for poor choices		1.2	0	1.9
Like experimenting with healthy recipes		1.2	0	1.9
Want to be a good example to others		1.2	3.1	0

Table V: The correlation between clinical variables and dietary adherence score of the participants

Clinical variable	Adherence score (maximum 25)
Glycated haemoglobin (%)	r=-0.06; p=0.55
Total cholesterol (mmol/L)	r=-0.13; p=0.22
Low density lipoprotein cholesterol (mmol/L)	r=-0.04; p=0.73
High density lipoprotein cholesterol (mmol/L)	r=-0.10; p=0.34
Triglycerides (mmol/L)	r=0.08; p=0.43
Microalbuminuria (mg)	r=-0.00; p=1
Waist circumference (cm)	r=-0.14; p=0.20
BMI (kg/m ²)	r=-0.14; p=0.18
Age (years)	r = 0.19, p = 0.08
Duration of diabetes (years)	r = 0.04, p = 0.70

No association was seen between employment and adherence score when a chi-square test was used to cross tabulate the differences between unemployed vs. employed participants who had low, intermediate or high scores ($X^2 = 0.04$; $p = 0.98$). As expected, a trend of significant association was seen when the adherence scores of people who had enough food, were compared to the adherence scores of people who did not have enough food. More of those who had enough food had high adherence scores ($X^2 = 5.08$, $p = 0.08$).

Of the 91 participants who answered the questionnaire, 37 agreed to participate in the FGDs.

Participants were allocated to one of the four groups according to their time availability but only 18 arrived on the appointed FGD days. Therefore the FGDs ranged from two to six participants.

Participants in the FGDs discussed their experiences in what motivated them to adhere to dietary principles that were recommended by their health professional and what the challenges were in adhering to the recommendations. Participants were asked about their feelings and thoughts

about diet (Box 1). Diet was mostly perceived as negative, even though most agreed that diet was important in controlling their blood sugars and improving their health. Although it was acknowledged that diet is how and what you eat and that, if you eat what and how you are supposed to, then you would be adhering to the diet, there were connotations associated with diet. Diet elicited feelings of being punished, being deprived of nice foods (including sugar), and restriction. Diet was generally thought to be prescriptive and boring, making it difficult to follow especially when the diets of other family members were considered, as participants did not want to be a nuisance, be a burden to others, or feel left out. Although some participants found that adhering to a diet was restrictive and boring, they still felt that when they were able to be more self-disciplined in the restrictions, they saw positive results and this as well as the hope that adhering to diet will cure their diabetes motivated them to continue with the diet. However, the slow progress in seeing sustained progress in outcomes from improved eating caused impatience and demotivation.

Participants identified the difficulties and frustrations they experienced in adhering to dietary constraints. Only one of the groups mentioned that healthy eating takes too much time and that having time to plan is a big challenge. One of the groups said that following a diet takes too much effort because “the rest of the family still has to eat normally and you have to satisfy everybody,” and “you have to cook something else for everybody else.” One participant in this group also commented “sometimes it takes a lot of effort to say no,” and another said “I don’t want to say no to foods... there are many temptations and sometimes I just want to give in.” On the other hand, a participant in one of the groups felt that he makes every effort to eat healthy foods, and although he likes healthy foods, he finds that they are more expensive, and therefore he buys the less healthy foods as he can buy more groceries at the end of the month. No other participants in any of the groups mentioned money as a challenge to following a diet. Difficulty when eating out, including social gatherings like birthday parties or visiting friends and family,

and when on the road, was identified as a challenge in two of the groups and was the most common theme among the challenges experienced in these groups.

Box 1. Feelings and thoughts about diet

“It’s a bad word.”

“...you have to say no to nice things.”

“Stop all the foods you like.”

“...it means you must have untasty food.”

“...diet is a regimen that I must try and stick to.”

“When I go visit my family, I can’t tell them you mustn’t give me this and that; you must give me that one. No, I have to try and force myself to eat everything they give me.”

“Diet is short term, a quick fix.”

“Lose weight and diabetes will go away.”

“Eat better to lose weight and improve blood sugars and get healthier.”

“Be strict with what you put in your mouth.”

Some participants expressed the opinion that it was rude to not eat food that was offered to you, and that they find it difficult to tell a host that they have diabetes as they do not want to be a nuisance. They also felt that it was difficult to resist the food they are offered, even when they know they should not eat it.

Although eating out was challenging for some, eating at home was also a challenge and not only when the family was unsupportive and separate meals were needed to be prepared, but also because participants found it difficult to make behaviour changes and break old habits and did not want their family to resent them for the changes that needed to take place, and some had a fear of being hungry (Box 2).

Box 2. Challenges at home and in the family

“Portion control is difficult as I am used to large portions.”

“If I ask (my wife) to dish less she still dishes up too much.”

“You grow up with certain habits and addictions and now you have to change after years of doing one thing.”

“Often foods that are prohibited (on a diet) are the foods that are used for a reward. So it doesn't feel like I am being rewarded if I don't get the treat. Actually instead I feel like I am being punished.”

“You are trying (with the diet) and you see no results and you get frustrated and fed up and start eating the stuff you used to eating.”

“Sometimes it seems unfair. You only have to change if you have a condition so everybody does not have to change. It makes it difficult to have a separate diet in families because your family can resent you for their diets having to change because of your condition.”

“Sometimes I am very hungry and I have to eat more than what is recommended on the diet.”

“If I eat too little then I wake up empty during the night and want to snack.”

“I dish a big plate of food for myself. Why do I do that? Maybe in the back of my mind I am saying that I would hate to die of hunger.”

Participants also felt that there is no short-term reward for eating healthy and often poor eating habits do not have immediate consequences or the effects are confusing. One participant said, “when there is too much being said about which diet is best, it gets very confusing” which makes it challenging to adhere to guidelines that are given by their health professionals.

In one group, some of the participants had a pessimistic outlook on the benefits of diet in the management of diabetes, as they perceived the disease to be hopeless. One participant said, “it's like hitting a brick wall every time, and eventually you just say, ‘well it's my hard luck’”.

Another participant followed to say, “getting diabetes is your hard luck, bad luck, your fate. That's all. And you can't do anything to change it. You just have to live the best you can.”

Participants were then asked what motivated them to follow a diet. Wanting to prevent complications, fear of disease worsening, and wanting good health were the most frequently mentioned motivators reported by the participants (Box 3). As one participant said, “diabetes is a serious disease and needs to be treated that way. If you are too casual or have a ‘don’t care’ attitude then you are setting yourself up for worse health.” Many found that testing their blood sugars regularly helped to make better food choices (Box 3), although one participant said that they are not motivated by their blood sugars.

Box 3. Good health and blood sugar testing as motivators

“The consequences of poor control remind me that I need to control my blood sugars now because I don’t want to have an amputation or a heart attack because my blood sugars have been badly controlled.”

“Real life situations motivate me. When I see people getting amputation around me or dying then I get scared and realise I must get my butt in gear.”

“The fear of the effects of long term bad blood sugars like amputations, heart attacks and kidney failure.”

“When I test my blood sugars it will determine what I will eat at my next meal. If it’s high I eat less and if it’s low I eat more.”

“...if my blood sugars were right then I may be tempted to take more food and fill up my stomach.”

“When I ... gradually see my blood sugars go down because I am eating better then I know I am doing right and it makes me continue doing that.”

“I like it when I go to the clinic and they download my meter and I can see on the graphs how my blood sugars are doing. From one month to the next they can show the graph and the averages and I can see when I have been good and when I haven’t.”

Only one participant from one of the groups mentioned support as a motivator to adhere to diet. When family at home are supportive and cook the right food, and when colleagues at work know about their diabetes and cater for them in meetings and don’t offer the wrong types of food, it is easier to adhere to the diet. One participant mentioned that she was very motivated to adhere to diet when she was pregnant but battles to motivate herself now that she is no longer pregnant. It

was also mentioned that it is very encouraging when changes are seen in weight and clothes fit better. One participant said that they like to have a target to work towards since, as long as it is realistic, they are motivated to achieve it.

3.4 DISCUSSION

3.4.1 Dietary adherence

In this study the majority (66%) of the participants had an intermediate score, 11% of the participants had a low adherence score (< 48%), and 23% of the participants achieved higher than 80% adherence scores. In other studies non-adherence was defined as anything less than 80% compliance to dietary recommendations and non-adherence was as low as 51-90%.^{28,29,30}

In the current study if the same guideline was used, non-adherence would be 77% (intermediate and low adherence scores). Low adherence to prescribed treatment could relate to the patient not receiving the full benefit of the therapy. This study showed a trend of correlation between dietary adherence score and BMI, WC, TC, LDL-C, and HbA1c. Although these results were not significant, it does reaffirm that nutrition remains an important factor in diabetes management. Medical nutrition therapy promoting a healthy eating lifestyle has been shown to reduce HbA1c by 0.5-2% in other studies.^{23,46} Specific food habits such as limiting the amount of high sugar foods, limiting portion sizes, eating only an occasional dessert, reducing high-fat foods, eating low-fat foods, eating regularly, planning meals, eating large amounts of vegetables, and limiting specific carbohydrates was positively related to improved glycaemic control.⁵⁶ Reported dietary practice in this study was generally good, particularly in having a variety of foods; using suitable fat options, removing visible fat and restricting added fat intake; abstaining from beverages containing sugar; and consuming less, or no more, alcohol than advised. Shortcomings in dietary practice included an inadequate intake of fruit, fish, nuts and legumes. Although the dietary practice in this study was self-reported rather than measured, there are some similarities to the data from the Global Nutrition and Epidemiologic Transition Initiative⁴⁹ and the THUSA study⁵⁰ that showed that the intake of roots and pulses generally decreased and a decrease in staple foods

rich in starch and dietary fibre. The data from the THUSA also found that there were trends of increases in foods from animal origin, rich in total fat and saturated fatty acids, and increases in energy-dense snack foods, carbonated sweetened beverages, commercially available alcoholic beverages, as well as added sugar, fats and oils in preparation of food, which was not seen in this study. This may be because the participants in this study were all living with a chronic illness requiring dietary change to manage the illness and therefore made better food choices than the general population. A high prevalence of under-reporting dietary intake in patients with T2DM and that their reported diets closely matched the currently recommended diet for diabetes has been documented.⁵¹ It was regarded as plausible that they were more likely to report what they should be eating, rather than what they were eating. This may well have been the case in this study. It has been hypothesised that T2DM patients may intentionally omit reporting some foods that do not conform to the recommendation due to a perceived pressure to change eating patterns and adopt a healthy diet.⁵²

3.4.2 Glycaemic control

Glycaemic control was expected to be better in this study than in the public sector since patients in this study received a comprehensive and multidisciplinary package of managed care. In this study although the HbA1c (mean = 7.87%) was relatively good, only 35% of the participants had acceptable glycaemic control. A study in the public sector in Cape Town found that 49% of patients with diabetes had acceptable glycaemic control (HbA1c \leq 7mmol/L).⁵³ However, considering that the clinics where the study was conducted are diabetes specialised clinics, it may be that the patients attending the clinics are patients who are struggling with their diabetes control and have sought help at the specialised clinic, and this may possibly explain the higher than normal unacceptable glycaemic control. Unexpectedly, HbA1c was not significantly correlated with any other variables including BMI, WC, TC, TG, HDL-C, LDL-C, or MAU.

3.4.3 Anthropometric factors

There was no correlation seen between HbA1c and BMI and WC. This may be because only four of the 91 participants in this study had a BMI in the target range (19-24) and in this study, the WC of most of the men (96.4%) and all women were above the international cut-off value recommendations of 94 cm for men and 80 cm for women.^{54,55} BMI and WC were obviously correlated, and interestingly, there was an association seen between HDL-C and WC, showing that, as WC increased, HDL-C decreased. However, no association was found between BMI and HDL-C. There was a significant correlation between BMI and TG, strengthening the theory that in obesity, the increased visceral adipocytes flood the portal circulation with free fatty acids leading to an accumulation of triglycerides in the muscle, liver and pancreas.⁵⁶

3.4.4 Biochemical factors

Dyslipidaemia is an important risk factor in the increased incidence of cardiovascular disease associated with diabetes.²³ In this study TC, LDL-C, HDL-C, and TG were controlled with the mean averages within SEMSDA²⁷ and ADA²³ targets. As expected, TC showed significant correlation with TG, HDL-C and LDL-C. The most prevalent pattern of dyslipidaemia in T2DM, as per the ADA,²³ is elevated TG with low HDL-C, but no association was seen in this study. This may be because 80% of the participants were on cholesterol medication and followed a low-fat diet.

Also, this study showed an association between MAU and TC. Albuminuria is an important predictor of all-cause and CVD mortality in T2DM,⁹ as well as the most important biomarker for diabetic nephropathy and predictor for progression of renal disease, CVD and mortality in diabetes.¹⁰ Reducing TC to 4.6mmol/L has been shown to be effective in reducing cardiovascular events in patients with chronic renal disease.¹⁶

3.4.5 Demographic factors

A Task Force for cardiovascular disease has noted the association between demographic characteristics such as gender, age, ethnic groupings, level of education and income with non-adherence to therapy, but acknowledge that these characteristics cannot be used to determine whether an individual will adhere to treatment or not since these variables are not causal.⁵⁷ However, in other studies^{29,30,42} and similar to this study, no association was found between dietary adherence according to gender, occupational status, and duration of disease. Another study in Nigeria indicated that socio-demographic characteristics such as female gender, single marital status, secondary or tertiary education, and being employed were significantly associated with medication non-adherence.³⁷ The differences in these findings may be due to the differences in the way the study was conducted and how factors were identified and also due to the differences in numbers of participants in the studies.

3.4.6 Factors affecting dietary adherence

3.4.6.1 Situational and behavioural factors

Adopting new food habits is not easy and barriers to dietary adherence such as incorporating new habits into daily life when eating out or at social events, food preferences with regard to taste, time constraints and the perception of what is convenient in terms of preparation time, temptations, the need for food planning and constant self-care, make it all the more difficult.⁵⁸ Similar to other studies,^{30,37,39,59} unavoidable temptations, difficulty in adhering in social events or when eating out, and difficulty in revealing status to hosts of parties, was found to influence dietary adherence. In this study, difficulty in breaking habits and resisting temptation was the most common barrier to dietary adherence, followed closely by the difficulty in adhering to diet when eating out. In one of the studies³⁰, a small percentage (8.6%) of the participants reported that their culture hindered them from adhering to diet when they attended social gatherings such as weddings or funerals where food is expected to be served. Refusing to eat may be associated with negative connotations. Some of the participants in this study mentioned that it is offensive

to not eat food that is offered. Social and physical environmental factors drive unhealthy behaviours of individuals via eating increased amounts of energy dense foods when socialising, and increase in fast food outlets that serve high fat foods.⁶⁰ Almost half (47.6%) of South African people eat out of the home once a week or more where portions are larger and higher in fat.⁶¹ It has been suggested that humans have an inherent preference for energy dense, smooth (refined, highly processed), salty, fatty and sweet convenience foods and snacks and this may be why people feel deprived and punished when these foods are restricted.⁶²

3.4.6.2 Support

Participants in this study found it difficult to change behaviours and break long-developed habits and often felt guilty for necessitating change in their families and did not want their family to resent them for the changes that needed to take place. One of the studies reviewed found a significant association between limited spousal support and diet non-adherence as well as a significant association between no family conflicts and diet adherence.³⁷ Diabetes affects everyone in the family, and how the family responds affects how the person with diabetes feels, and how they take care of their diabetes.^{37, 39} Receiving support from members of the immediate family, as well as the level of support, was associated with adherence to treatment recommendations.^{30, 36, 37, 59} Both lack of support and criticism distresses the person with diabetes and generates feelings of isolation, frustration, guilt and anger. This distress can compromise self-care, affect physical well-being, and influence the quality of relationships. Support from family and friends fluctuate between too little support and harassment. Some patients feel that family and friends tempt them to ignore their diabetes or do not support their efforts to manage the disease, and others feel their family and friends go to the opposite extreme; monitoring and criticizing every action that could affect blood glucose levels.^{37, 39} In this study some participants mentioned that they comply to diet because their spouse prepares, packs and serves their food for them.

Support can also come from the health team. A few participants mentioned that the multidisciplinary care at the clinic helped them to make better choices and they felt it beneficial to have regular follow up appointments. However, it was expected that the structured, multidisciplinary, comprehensive management program would have elicited more frequent mention. It would be interesting if the management program followed in this study was to be compared to those not receiving regular follow-up sessions. Other studies have shown that having attended more than two health education sessions in six months was shown to be protective against non-adherence and improve self-reported risk behaviour.^{30,63} Two of the previous studies highlighted obstacles in dietary adherence in the health care system^{30,37}. This included bad attitude of health workers, no reminders of appointments, long waiting times, and poor communication between the patient and the health professional.

3.4.6.3 Financial factors

Only one participant in the study group mentioned that healthy food is expensive and therefore buys less healthy food as he can get more groceries for his money. However, of the participants that said that they do not have enough food to eat and those that said they had enough to eat but not the foods they wanted, the main reason given was financial constraints. Similarly, the SANHANES report that the price of the food items was shown to be considered most when shopping for groceries. The taste of food followed behind, and health considerations, how long a food item keeps, and nutrient content were less frequently considered, with safety hardly being considered. These results show that irrespective of what food is known to be healthier, people will still buy what they can afford.⁶¹ Respondents in an Ethiopian study who thought about the high cost of foods were over two times more likely to have poor dietary practice than those who did not think about the high cost of foods.²⁹ Cost and financial constraints were also seen to be barriers to adherence in other studies^{30,36,37,59} It is costly to buy different types of foods to fulfil the daily requirements although, in this study, most participants were able to eat a variety of foods. Those who have financial constraints are forced to buy only what they can afford and are

therefore exposed to poor dietary practices and non-adherence to diet recommendations. Only one participant remarked that good foods are often unavailable. Other studies have shown that food availability and food shortage affects meal planning, food selection, and food preparation.
30, 59

3.4.6.4 Dietary and disease knowledge

A poor understanding of diet-disease associations or misinformation compound the difficulties in adapting change in eating behaviour. It has been suggested that the disease symptoms that an individual experiences alters how they behave with regards to what they believe about the disease. In other words, in those with T2DM who perceive their condition as fluctuating or episodic, adherence to treatment recommendations is less consistent, compared to patients who view their disease as a stable condition. The authors surmised that perhaps these patients failed to adhere on a regular basis because they believed that symptoms represented the disease itself and, thus, that disease management behaviours are not needed when symptoms are absent.³⁴ In this study this was also expressed and participants were demotivated and confused when their blood sugars did not reflect their behaviour. Participants were frustrated by inconsistent outcomes when they made healthy food choices and also when they did not. Often they felt they were doing the right thing but not seeing the correct results in improving their disease outcomes. An association between perceived seriousness of the disease by the patients and taking positive initiatives to control and manage their diabetes by taking medications and following recommendations for diet and exercise has been shown.³⁰ An awareness of the importance of adherence, despite the absence of actual symptoms, has been shown to be associated with adherence.³⁶ The most frequently mentioned motivator in this study was maintaining good health, the fear of the disease worsening and the development of complications. Even so, the glycaemic control was not in target and non-adherence to dietary guidelines was high. It has been difficult to consistently make associations between factors and adherence since these factors do not necessarily relate to the motivations or intentions of the patients. It has been

suggested that food choice and intake also reflects learning mechanisms, cognitive influences and meanings.⁵⁸ Cultural values, beliefs, attitudes and existing eating habits influence adherence.^{36, 58, 61}

Also, the magnitude of options in dietary management of diabetes that is presented by different medium including varying guidelines given by different health professionals and also the vast information available through the different media sources, often caused confusion and misinformation.⁵⁷ Nutrition and disease knowledge was not directly measured in this study. Although most of the participants in this study received information on diet from the dietician in this clinic, many still sourced information from additional sources, including, friends, family, and various forms of media. The purpose of nutrition education is to improve knowledge about food so that beliefs can be influenced and healthier food intake practices can be facilitated. An Ethiopian study showed those who did not get diabetic nutrition education were 4.47 times more likely to have poor dietary practice than those who received nutrition education.²⁹ In South Africa, it has been shown that there is a clear association between a lack of knowledge regarding healthy food choices, food preparation, and acceptable portion sizes and BMI.⁶¹ Overall, South African adults have an average and inadequate knowledge of nutrition regardless of their financial status and education level.⁶⁴ Unlike the general population, diabetic patients usually receive extensive information on food so that they can adjust portion sizes and monitor daily intake in order to achieve glycaemic control. In spite of an apparently increased awareness about their dietary intake, people with T2DM still do not always make healthy food choices. In this study every participant had received individual dietary education by a dietician but only 44% of the participants believed that they adhered to a diabetic diet although dietary practice showed only 33% adherence. In the SANHANES report, 75% of people believed that what you eat, and how much you eat, can affect weight and health, although this has not translated into dietary practice.⁶¹

3.4.6.5 Psychological factors

Negative aspects associated with treatment, including the duration of therapy, how simple the treatment is, side effects of therapy, and a lack of immediate or perceived benefits, have been shown to be frequently associated with poor adherence.⁵⁷ This was seen in this study, participants expressed that they were looking for a quick fix solution and got demotivated when the perceived benefits took too long to achieve. Often T2DM patients report associated meanings and negative emotions, such as the loss of pleasure in eating, control and freedom when following a diet.⁵⁹ In this study, participants mentioned that they found a diabetes diet boring and restrictive. Feelings of fear, guilt and anger are frequently accompanied with non-adherent eating, whereas diet adherence elicits restrictive attitudes.^{37,59} Similar to how the participants in this study felt, other studies have noted that patients perceive diet recommendations to be restraining and not adapted to individual needs and thoughts of deprivation are common.^{37,59}

Despondency, or a feeling of hopelessness, was another factor identified for poor dietary practice which is consistent with other studies.^{29,37} The effects of despondency was shown in a study where it was associated with decreased adherence to treatment with a likelihood of forgetting and not giving value to food planning, and eating whatever is edible was doubled.⁶⁵ Poor metabolic control and decreased quality of life was also associated with despondency.²⁹ Cognitive function and depression were also shown to affect adherence in other studies.³⁶

Additionally, the degree of self-efficacy, as well as time management skills can impede or facilitate an individual's dietary care practices.^{30,59} Some participants in this study felt that it was too time consuming to eat healthily and that it was too much effort to resist temptations. A cross-sectional survey of 507 in-and-out patients at a tertiary hospital in India with T2DM found that self-efficacy, along with adherence to dietary restrictions, was the single most important determinant of diabetes control. Self-efficacy was influenced by educational status, employment, availability of family support, and positive mental attitudes.⁶⁶

3.4.7 Consequences of non-adherence

Misunderstanding, forgetting, or ignoring healthcare advice can result in significant risk to the patient.³⁷ Healthier lifestyle habits, including physical activity and healthier dietary choices, have many health benefits, including skeletal muscle adaptations that improve fat and glucose metabolism as well as insulin action, enhanced endothelial function; favourable changes in blood lipids, reduced blood pressure, reduced postprandial blood lipids and glycaemia, and reduced pro-inflammatory markers. Health benefits of lifestyle adaptations occur independently of changes in body weight or body fat and it is therefore suggested that, regardless of whether healthier lifestyle leads to weight loss, T2DM patients should engage in physical activity and improve their diet.⁶⁷

The consequences of non-adherence are costly and a risk factor for poor health outcomes. Non-adherence often results in a combination of wasted medical care funds, wasted time and energy for the patients and healthcare providers, and frustration and dissatisfaction for all involved.³¹ A study examining adherence to medication regimens and the outcome on hospitalization and mortality risk in T2DM, found during follow-up, that non-adherent patients expectedly have higher HbA1c, blood pressure, and LDL cholesterol levels. They also found, not unexpectedly, that non-adherent patients have higher all-cause hospitalization and higher all-cause mortality. Each 25% increase in medication adherence was associated with reductions in HbA1C, BP, and LDL-C levels. More interestingly however, is that the amount that 25% increase in adherence elicited on the reduction for hospitalization and mortality was greater than expected, suggesting that medication adherence may also be correlated with self-care behaviours that are directly or indirectly related to outcomes. It was surmised that adherent patients may be more likely to follow lifestyle recommendations and other healthy behaviours, leading to improved outcomes. Therefore, it was suggested that outcomes from medication adherence may be due to the direct effect of the medication on outcomes as well as the indirect effect of adherence to behaviours such as diet and exercise recommendations that affect outcomes.³²

3.5 CONCLUSION

A realistic assessment of patients' knowledge and understanding of the regimen, their belief in the treatment regimen, as well as knowing what motivates a patient to adhere to the regimen, and what the challenges are in adhering to the regimen, will enable a more effective targeting of the potential for adherence problems. Knowing the patient and his experiences in the illness better, allows the health professional to understand elements that are crucial to the patient's adherence, including his beliefs, attitudes, cultural context in dealing with the disease, as well as available social supports and emotional health challenges, particularly depression.

In this study combined low and intermediate adherence to dietary recommendations was 77% and the main challenges to adherence included difficulty in breaking habits and resisting temptation, difficulty in eating out, and feeling the dietary guidelines are too restrictive. The main motivators to adhering to dietary guidelines included the desire to attain and maintain good health and prevent the disease worsening, seeing positive results when actively doing what is recommended, having a good support system, and being persistent in making lifestyle changes so that eating well becomes a habit.

This study found a trend of a correlation between dietary adherence score and BMI, WC, TC, LDL-C, and HbA1c, respectively. However, it must be considered that actual dietary intake was not measured and participants may have reported what they should be eating to the dietician rather than what they actually were eating.

3.6 REFERENCES

1. United Nations. Political declaration of the High-level Meeting of the General Assembly on the Prevention and Control of Non-communicable Diseases High level meeting on prevention and control of non-communicable diseases. Available from: http://www.un.org/ga/search/view_doc.asp?symbol=A/66/L.1. Accessed 30 July 2015.

2. International Diabetes Federation. IDF Diabetes Atlas sixth edition. Available from: <http://www.idf.org/diabetesatlas>. Accessed 30 June 2015.
3. Gaede P, Lund-Andersen H, Parving HH, Pedersen O. Effect of a multifactorial intervention on mortality in type 2 diabetes. *N Engl J Med*. 2008; 358(6):580-591.
4. Diabetes Control and Complications Trial Research Group. The effect of intensive treatment of diabetes on the development and progression of long-term complications in insulin-dependent diabetes mellitus. *N Engl J Med*. 1993; 329:977–986.
5. UK Prospective Diabetes Study Group. Efficacy of atenolol and captopril in reducing risk of both macrovascular and microvascular complications in type 2 diabetes (UKPDS 39). *BMJ*. 1998; 317:713–720.
6. Chew EY, Ambrosius WT, Davis MD, et al.: ACCORD Study Group; ACCORD Eye Study Group. Effects of medical therapies on retinopathy progression in type 2 diabetes. *N Engl J Med*. 2010; 363(3):233-244.
7. Lewis EJ, Hunsicker LG, Bain RP, Rohde RD. The effect of angiotensin-converting-enzyme inhibition on diabetic nephropathy. *N Engl J Med*. 1993; 329:1456-1462.
8. Perkovic V, Heerspink HL, Chalmers J, et al. ADVANCE Collaborative Group. Intensive glucose control improves kidney outcomes in patients with type 2 diabetes. *Kidney Int*. 2013; 83(3):517-523. Doi:10.1038/ki.2012.401
9. Raffield LM, Hsu FC, Cox AJ, Carr JJ, Freedman BI, Bowden DW. Predictors of all-cause and cardiovascular disease mortality in type 2 diabetes: Diabetes Heart Study. *Diabetol Metab Syndr*. 2015 June 28;7:58. Doi: 10.1186/s13098-015-0055-y
10. Eijkelkamp WB, Zhang Z, Remuzzi G, et al. Albuminuria is a target for renoprotective therapy independent from blood pressure in patients with type 2 diabetic nephropathy: post hoc analysis from the Reduction of Endpoints in NIDDM with the Angiotensin II Antagonist Losartan (RENAAL) trial. *J Am Soc Nephrol*. 2007;18:1540-1546.

11. Waanders F, Visser FW, Gans RO. Current concepts in the management of diabetic nephropathy. *Neth J Med.* 2013;71:448–458.
12. Levitt NS, Bradshaw D, Zwarenstein MF, Bawa AA, Maphumolo S. Audit of public sector primary diabetes care in Cape Town, South Africa: high prevalence of complications, uncontrolled hyperglycaemia, and hypertension. *Diabet Med.* 1997;14:1073–1077.
13. Patel A, MacMahon S, Chalmers J, et al.: The ADVANCE Collaborative Group. *N Engl J Me.* 2008;358:2560-2572. Doi:10.1056/NEJMoa0802987
14. Hayward RA, Reaven PD, Wiitala WL, et al.: VADT Investigators. Follow-up of glycaemic control and cardiovascular outcomes in type 2 diabetes. *N Engl J Med.* 2015;372:2197-2206. Doi.1056/NEJMoa1414266
15. Ismail-Beigi F, Craven T, Banerji MA, et al.: ACCORD trial group. Effect of intensive treatment of hyperglycaemia on microvascular outcomes in type 2 diabetes: an analysis of the ACCORD randomised trial. *Lancet.* 2010;376(9739):419-430. Doi:10.1016/S0140-6736(10) 60576-4
16. Kearney PM, Blackwell L, Collins R, et al. Efficacy of cholesterol-lowering therapy in 18,686 people with diabetes in 14 randomised trials of statins: a meta-analysis. *Lancet.* 2008 Jan 12;371(9607):117-125.
17. Penno G, Solini A, Zoppini G, et al. Hypertriglyceridemia is independently associated with renal, but not retinal complications in subjects with type 2 diabetes: A cross-sectional analysis of the renal insufficiency and cardiovascular events (RIACE) Italian Multicenter Study. *PLoS one.* 2015;10(5):e0125512. Doi: 10.1371/journal.pone.0125512
18. Bretzel RG, Voigt K, Schatz H. The United Kingdom Prospective Diabetes Study (UKPDS) implications for the pharmacotherapy of type 2 diabetes mellitus. *Exp Clin Endocrinol Diabetes.* 1998;106:369-372.
19. Pohl MA, Blumenthal S, Cordonnier DJ, et al. Independent and additive impact of blood pressure control and angiotensin II receptor blockade on renal outcomes in the irbesartan

- diabetic nephropathy trial: clinical implications and limitations. *J Am Soc Nephrol.* 2005;16:3027-3037.
20. Adler AI, Stratton IM, Neil HAW, et al. Association of systolic blood pressure with macrovascular and microvascular complications of type 2 diabetes (UKPDS 36): prospective observational study. *BMJ.* 2000;321:412–419.
 21. Bangalore S, Kumar S, Lobach I, Messerli FH. Blood pressure targets in subjects with type 2 diabetes mellitus/impaired fasting glucose: observations from traditional and bayesian random-effects meta-analyses of randomized trials. *Circulation.* 2011;123:2799–2810.
 22. Adams TD, Davidson LE, Litwin SE, et al. Health benefits of gastric bypass surgery after 6 years. *JAMA.* 2012;308:1122–1131.
 23. American Diabetes Association. Standards of medical care in diabetes - 2015. *Diabetes care* 2015;38(1):S1-S66.
 24. Koster A, Leitzmann MF, Schatzkin A, et al. Waist circumference and mortality. *Am J Epidemiol.* 2008;167(12):1465-1475. Doi:10.1093/aje/kwn079
 25. Wing RR, Koeske R, Epstein LH, Nowalk MP, Gooding W, Becker D. Long-term effects of modest weight loss in type II diabetic patients. *Arch Intern Med.* 1987;147(10):1749-53. (Abstract).
 26. Wing RR, Lang W, Wadden TA, et al.: Look AHEAD Research Group. Benefits of modest weight loss in improving cardiovascular risk factors in overweight and obese individuals with type 2 diabetes. *Diabetes care.* 2011;34:1481-1486. Doi:10.2337/dc10-2415
 27. Amod A, Ascott-Evans BH, Berg GI, et al. The 2012 SEMDSA Guideline for the Management of Type 2 Diabetes. *JEMDSA.* 2012;17(2):S1-S95.
 28. Becker MH, Janz NK. The health belief model applied to understanding diabetes regimen compliance. *Diabetes educator.* 1985;41-47.

29. Worku A, Mekonnen A, Mesele-Wassie M. Dietary practice and associated factors among type 2 diabetic patients: a cross sectional hospital based study, Addis Ababa, Ethiopia. SpringerPlus. 2014; 4. Doi:10.1186/s40064-015-0785-1
30. Mandewo W, Edward E D, Chideme-Munodawafa A, Mandewo G. Non-adherence to treatment among diabetic patients attending outpatients clinic at Mutare provincial hospital, Manicaland province, Zimbabwe. International Journal of Scientific and Technology Research. 2014;3(9):66-86.
31. Martin LR, Williams SL, Haskard KB, DiMatteo MR. The challenge of patient adherence. Journal of Therapeutics and Clinical Risk Management. 2005;1(3):189–199.
32. Ho PM, Rumsfeld JS, Masoudi FA, et al. Effect of medication nonadherence on hospitalization and mortality among patients with diabetes mellitus. Arch Intern Med. 2006;166:1836-1841. (Abstract).
33. Asche C, LaFleur J, Conner C. A review of diabetes treatment adherence and the association with clinical and economic outcomes. Clin Ther. 2011 Jan;33(1):74-109. Doi: 10.1016/j.clinthera.2011.01.019
34. Hemphill RC, Stephens MA, Rook KS, Franks MM, Salem JK. Older adults' beliefs about the timeline of type 2 diabetes and adherence to dietary regimens. Psychol Health. 2013;28(2):139-153. Doi: 10.1080/08870446.2012.685740
35. Schlundt DG, Rea MR, Kline SS, Pichert JW. Situational obstacles to dietary adherence for adults with diabetes. J Am Diet Assoc. 1994;94(8):874-879. (Abstract)
36. Kagee A, Le Roux MJ, Dick J. Treatment adherence among primary care patients in a historically disadvantaged community in South Africa: A Qualitative study. Health Psychol. 2008;12:444. Doi:10.1177/1359105307076232
37. Okolie U, Ehiemere I, Ezenduka P, Ogbu S. Contributory factors to diabetes dietary regimen non adherence in adults with diabetes. World Academy of Science, Engineering and Technology. 2010;45:735-742.

38. Franks MM, Hemphill RC, Seidel AJ, Stephens MAP, Rook KS, Salem J.K. Setbacks in dietary adherence and emotional distress: a study of older patients with type 2 diabetes and their spouses. *Aging and Mental Health*. 2012;16(7):902-910.
Doi:10.1080/13607863.2012.674486
39. Singh H, Cinnirella M, Bradley C. Support systems for and barriers to diabetes management in South Asians and Whites in the UK: qualitative study of patients' perspectives. *BMJ Open*. 2012;2:e001459. Doi:10.1136/bmjopen-2012-001459
40. Hu J, Amirehsani K, Wallace DC, Letvak S. Perceptions of barriers in managing diabetes: Perspectives of Hispanic immigrant patients and family members. *Diabetes Educator*. 2013; 39:494-509. Doi:10.1177/0145721713486200
41. Ebrahim Z, Ahmed T, De Villiers A. Factors influencing adherence to dietary guidelines: a qualitative study on experiences of patients with type 2 diabetes attending a clinic in Cape Town: original research. *JEMDSA*. 2014;19(2):76-84. Doi: 10.1080/16089677.2014.11073604
42. Gomes-Villas Boas LC, Foss MC, Freitas MCF, Pace AE. Relationship among social support, treatment adherence and metabolic control of diabetes mellitus patients. *Revista Latino-Americana de enfermagem*, 2012;20(1): 52-58.
43. Muchiri JW, Gericke GJ, Rheeder P. Needs and preferences for nutrition education of type 2 diabetic adults in a resource-limited setting in South Africa. *Health SA Gesondheid*, 2012;17(1):1-13. Doi:10.4102/hsag.v17i1.614
44. Bingham SA, Gill C, Welch A, et al. Comparison of dietary assessment methods in nutritional epidemiology: weighed records v. 24 h recalls, food-frequency questionnaires and estimated-diet records. *Br J Nutr*. 1994;72:619-643.
45. Leppala J, Lagstrom H, Kaljonen A, Laitinen K. Construction and evaluation of a self-contained index for assessment of diet quality. *Scand J Public Health*. 2010;38:794-802.
Doi:10.1177/1403494810382476

46. Evert AB, Boucher JL, Cypress M, et al. Nutrition therapy recommendations for the management of adults with diabetes. *Diabetes care*. 2014;37(1):S120-S143.
Doi:10.2337/dc14-S120
47. Vorster HH, Badham JB, Venter CS. An introduction to the revised food- based dietary guidelines for South Africa. *South Afr J Clin Nutr*. 2013;26(3):S1-S164.
48. Robinson N. The use of focus group methodology – with selected examples from sexual health research. *J Adv Nurs*. 1999;29(4):905-913.
49. Mattei J, Malik V, Wedick NM, et al. Reducing the global burden of type 2 diabetes by improving the quality of staple foods: The Global Nutrition and Epidemiologic Transition Initiative. *Global Health*. 2015;11(1):23. (Abstract).
50. MacIntyre UE, Kruger HS, Venter CS, Vorster HH. Dietary intakes of an African population in different stages of transition in the North West Province, South Africa: The THUSA study. *Nutrition Res*. 2002;22: 230–256. Doi:10.1016/S0271-5317(01)00392-X
51. Samuel-Hodge CD, DeVellis RF, Ammerman A, Keyserling TC, Elasy TA. Reliability and validity of a measure of perceived diabetes and dietary competence in African American women with type 2 diabetes. *Diabetes Educator*, 2002;28(6):979-88. (Abstract).
52. Yannakoulia M. Eating behavior among type 2 diabetic patients: A poorly recognized aspect in a poorly controlled disease. *Rev Diabet Stud*. 2006;3:11-16. Doi:10.1900/RDS.2006.3.11
53. Levitt NS, Bradshaw D, Zwarenstein MF, Bawa AA, Maphumolo S. Audit of public sector primary diabetes care in Cape Town, South Africa: high prevalence of complications, uncontrolled hyperglycaemia, and hypertension. *Diabet Med*. 1997;14:1073–1077.
54. Alberti KG, Eckel RH, Grundy SM, et al. Harmonizing the metabolic syndrome: a joint interim statement of the International Diabetes Federation Task Force on Epidemiology and Prevention; National Heart, Lung, and Blood Institute; American Heart Association; World Heart Federation; International Atherosclerosis Society; and International Association for

- the Study of Obesity. *Circulation*. 2009;120(16):1640-1645. Doi: 10.1161/CIRCULATIONAHA.109.192644. Epub 2009 Oct 5
55. World Health Organization. Waist circumference and waist-hip ratio: Report of a WHO expert consultation, Geneva, 8-11 December 2008. 2011. World health Organization.
 56. Kopp HP, Krzyzanowska K, Möhlig M, Spranger J, Pfeiffer AF, Scherthaner G. Effects of marked weight loss on plasma levels of adiponectin, markers of chronic subclinical inflammation and insulin resistance in morbidly obese women. *Int J Obes*. 2005;29(7):766-771. Doi:10.1038/sj.ijo.0802983
 57. Ockene IS, Hayman LL, Pasternak RC, Schron E, Dunbar-Jacob J. Task Force #4—Adherence issues and behavior changes: Achieving a long-term solution. *J Am Coll Cardiol*. 2002;40(4):579–651. Doi:10.1016/S0735-1097(02)02078-8
 58. Savoca MR, Miller CK, Ludwig DA. Food habits are related to glycemic control among people with type 2 diabetes mellitus. *J Am Diet Assoc*. 2004;104(4):560-566.
 59. Savoca M, Miller C. Food selection and eating patterns: themes found among people with type 2 diabetes mellitus. *J Nutr Educ*. 2001;33(4):224-233.
 60. Steyn K, Lombard C, Gwebushe N, et al. Implementation of nutritional guidelines, incorporated within structured diabetes and hypertension records at primary level care in Cape Town, South Africa: a randomised controlled trial. *Global Health Action*. 2013;6: 20796. Doi:10.3402/gha.v6i0.20796
 61. Shisana O, Labadarios D, Rehle T, et al.: SANHANES-1 Team (2013). South African National Health and Nutrition Examination Survey (SANHANES-1). Cape Town: HSRC Press. 2013. Available from <http://www.hsrc.ac.za>. Accessed on 30 June 2015.
 62. Hawkes C. Uneven dietary development: Linking the policies and processes of globalization with the nutrition transition, obesity and diet-related chronic diseases. *Global Health*. 2006;2:4–22. Doi:10.1186/1744-8603-2-4

63. Angermayr L, Melchart D, Linde K. Multifactorial lifestyle interventions in the primary and secondary prevention of cardiovascular disease and type 2 diabetes mellitus—a systematic review of randomized controlled trials. *Ann Behav Med.* 2010;40:49–64. Doi:10.1007/s12160-010-9206-4
64. Kruger HS, Venter CS, Vorster HH, Margetts BM. Physical inactivity is the major determinant of obesity in black women in the North West Province, South Africa: the THUSA study. *Transition and Health During Urbanisation of South Africa. Nutrition.* 2012;18(5):422-427. Doi:10.1016/S0899-9007(01)00751-1
65. Egede LE, Ellis C. Diabetes and depression: global perspectives. *Diabetes Res Clin Pract.* 2010;87(3): 302-12. Doi:10.1016/j.diabres.2010.01.024. (Abstract).
66. Venkataraman K, Kannan AT, Kalra OP, et al. Diabetes self-efficacy strongly influences actual control in patients attending a tertiary hospital in India. *J Community Health.* 2012;37(3):653-662. Doi:10.1007/s10900-011-9496-x
67. Gaesser GA, Agadi SS, Sawyer BJ. Exercise and diet, independent of weight loss, improve cardiometabolic risk profile in overweight and obese individuals. *Physician and Sports Medicine.* 2011;39(2):87-97. Doi:10.3810/psm.2011.05.1898

4 CHAPTER 4: CLOSING AND RECOMMENDATIONS

The essence of this investigation was to first evaluate the beneficial effect of dietary adherence on T2DM health outcomes measured by biochemical markers and then to identify the factors that influence dietary adherence both positively and negatively. Although a correlation trend was seen between dietary adherence and biochemical markers, a significant correlation was expected since it was assumed that better dietary adherence would consequently mean better health outcomes. A possible reason as to why a stronger correlation was not seen may be because actual intake was not measured. Rather participants reported what they usually ate according to the guidelines which means that adherence to dietary intake may in fact have been worse. All of the participants in this study had already received nutrition education which could have influenced the dietary reporting, where participants offered what they knew was correct rather than what they actually did. In the planning phase of this study, it was decided that food frequency questionnaires and 24-hour recalls, although the superior tools for assessing dietary intake, would not be used. However, any reporting of actual intake will be flawed since the researcher relies on the honesty and full-disclosure of the participant which cannot be guaranteed.

Measuring dietary adherence is tricky and an assessment would most likely elicit best results if dietary intake is measured for a few days over an extended period of time. Although in other countries short dietary questionnaires was comparable to longer dietary assessments including food frequency questionnaires and 24-hour recalls. Perhaps, a further investigation into validating this questionnaire would prove helpful for the South African context.

The secondary objective to identify the factors that motivate and challenge dietary adherence showed similar results to other studies. Unexpectedly though, was that more personal factors were mentioned as challenges rather than organizational and community based factors. For example, challenges in resisting temptation and changing behaviour, and less so family support were more commonly reported and health organization support, food accessibility and expense of food was less commonly reported. This may suggest that the participants recognized that they were responsible for their own health and this may be because the participants received regular education regarding T2DM and therefore it is surmised that the participants in this study had adequate health literacy. Unfortunately this did not translate into better

health outcomes when compared to other studies and it did not translate into higher dietary adherence scores. Perhaps, irrespective of health literacy and knowing what is right and wrong and the consequences of wrong choices, whether the understanding of the disease concurs with personal and cultural beliefs is of more importance than actual knowledge. Also knowledge may not always mean that the patient has the confidence to carry out the recommendations. The more serious the disease is perceived, the more likely the patient will take initiatives to manage their disease.

During the FGD sessions, the feeling of restriction was a common theme. Difficulty in social situations and resisting temptation as well as trouble breaking habits can be explained by another possible aspect where participants feel that their quality of life is compromised by following the diet. They may feel they have a better time socially when they are not restricted by what they can eat and drink. On the other hand, some of the participants said that they found it difficult to reveal that they were diabetic to their host at social functions. Many said that this was because it is impolite to make requests and did not want to be a nuisance. Similarly many did not want to inconvenience their families or cause them to have to change for the benefit of them.

The most commonly reported facilitator to dietary adherence was a desire to attain and maintain good health, and prevent worsening of disease and onset of diabetes complications. This is as expected since diabetes education and management revolves around improving health and disease outcomes. Similarly, seeing the benefits of adhering to dietary regimen in improved blood glucose values and weight loss motivates one to continue adhering to the regimen.

Understanding the factors that facilitate adherence and the barriers to adherence will help a health professional to assist a patient with T2DM to make significant changes by unpacking the reasons that they may not adhere to recommendations. A questionnaire to identify what is important to them may be beneficial in identifying real motivators and issues of concern. Although no new factors were identified, it is reassuring to know that worldwide, patients with T2DM, are motivated by similar factors and face the same challenges in adhering to diet.

Knowing what motivates people and what challenges them in adhering to recommendations is not the endpoint but rather the starting point. Many health professionals are not trained or skilled in coaching patients through behaviour change. From this investigation it seems that education and giving instructions is not enough. Health professionals need interpersonal skills that will help the patients to trust them and be convinced of the necessity for change and health professionals need to be empathetic to the challenges that the patient may face and be able to compromise with suitable alternative strategies that may be better adhered to. The biggest obstacle to changing the statistics of non-adherence is time. To really understand what influences a person's ability to change takes time and this is a resource that is mostly unavailable in both private and public practice.

5 Annexure 1: Study questionnaire

A. Biochemical and clinical data (from patient records) Taken from file on the same day as interview. Most recent data is to be used. Data older than 1 year is invalid.

Measurement	Value	Date	Measurement	Value	Date
1 Latest HbA1c			6 Latest MAU		
2 Latest total cholesterol			7 Waist circumference over the naval		
3 Latest triglycerides			8 Height (m)		
4 Latest LDL (date)			9 Latest Weight (kg)		
5 Latest HDL (date)			10 BMI		

B. Socio-demographic and health data

11. What is your gender?	Male	Female
12. What is your age?		

13. When were you diagnosed with Diabetes? (year)		Years with T2DM	
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14. What do you use to control your Diabetes in addition to diet?	No tablets or insulin	Tablets only	Insulin and tablets	Only insulin
15. What other medications do you use? please list	15.1 Blood pressure: 15.2 Cholesterol: 15.3 Anti-inflammatory: 15.4 Other (specify):			

16. What is your employment status?	Unemployed	Retired/Pensioner	Full time work	Part time/ piece jobs
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17. How many people in each of the following age categories live in your house?	0-<2 years____	2-<18 years____	18-60 years__	60+ years____
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18. How many rooms are in your household?rooms
19. How many rooms in your household are used for sleeping?rooms
20. Do you have a food garden? (circle)	Yes No

21.1 Which of these statements best describes the food eaten in your household in the last 12 months:
a. we always have enough to eat and the kinds of food we want
b. we have enough to eat but not always the kinds of food we want

<p>c. sometimes we don't have enough to eat at all</p> <p>d. often we don't have enough to eat?</p>
<p>21.2 <i>If sometimes or often we don't have enough to eat (c or d) is the answer above answer this question</i></p> <p>Here are some reasons why people don't always have enough to eat. For each one, please tell me if that is a reason why <u>you</u> don't always have enough to eat.</p> <p>a. Not enough money for food</p> <p>b. Too hard to get to the store</p> <p>c. On a diet</p> <p>d. No working stove available</p> <p>e. Not able to cook or eat because of health problems</p>
<p>21.3 <i>If enough food, but not the kinds we want in (b) is the answer then answer this question</i></p> <p>Here are some reasons why people don't always have the kinds of food they want or need. For each one, please tell me if that is a reason why you don't always have the kinds of food you want or need.</p> <p>a. Not enough money for food</p> <p>b. Too hard to get to the store</p> <p>c. My prescribed diet restricts the kinds of food I am allowed to eat</p> <p>d. Kinds of food we want not available</p> <p>e. Good quality food not available</p>

22. What is the source of drinking water at home?					
Tap water in the house	Tap water in the yard	Public tap	Bottled water	Stream/ dam	Other(specify)
23. What do you use for cooking at home?					
Electricity	Gas	Paraffin	Wood	Coal	Other (specify)
24. What equipment do you use for cooking at home (mark all used)					
Oven (bake or grill)	Stove top	Microwave	Braai	Slow cooker	Other (specify)
25. Does your household have one or more of the following:					
Electricity	Radio	Television	Refrigerator	Washing machine	Personal computer

C. Information about nutrition and diabetes

26. From whom do you get information on nutrition and diabetes? (circle all applicable)						
26.1 Friends	26.2 Family	26.3 TV/ magazines/ newspapers/ radio	26.4 Internet	26.5 Computer	26.6 Clinic sister/ Doctor	26.7 Dietician
27. Do you trust the information that you get? Specify						

28. From whom would you prefer to get correct information on diabetic diet?
You can mention more than one.

D. Diet adherence

Questions	Criteria for 1 point
29. Do you eat a variety of foods (where more than one type of food is eaten at a meal, eating different foods on different days and preparing food in different, healthy ways) a. At every meal b. At one meal a day c. Less than 3 meals a week d. Never	
30. How many servings of starch foods do you eat a day? (1 serving is equal to 1 slice of bread or 3 crackers, or ½ cup of cereal, cooked porridge, cooked rice, or cooked potatoes)	
31. How many of the above servings are whole-grain (brown rice, whole-wheat bread etc)? a. all of them b. about ⅔ of them c. about ½ of them d. none of them	
32. How many days per week do you eat vegetables?	
33. How many vegetable servings do you consume per day? (1 serving is equal to 1 cup cooked or raw vegetables or 2 cups leafy vegetables)	
34. How many fruit servings do you consume per day (1 serving is equal to 1 tennis ball size fruit or ½ cup chopped fruit or juice)	
35. How many days per week do you consume red meat (beef, lamb, game, or pork)	
36. How many days per week do you consume processed meats (like polony, viennas, sausages)?	
37. How many days per week do you eat fish (tinned or fresh/frozen)	
38. Do you remove visible fat from meat and chicken?	
39. How many days a week do you eat beans, lentils or soya?	
40. How many servings of beans, lentils, or soya do you eat a week? (1 serving is equal to 1 cup)	
41. Do you use olive or canola oil for your cooking?	
42. How many days a week do you fry food in oil? a. daily b. 3 to 5 days a week c. 1 to 2 times a week d. twice a month e. less than once a month f. never	
43. How many servings of butter, margarine, or cream do you consume per day? (1 serving is equal to 2 teaspoons).	
44. The type of spread you usually use with bread is? a. none b. spread with max 40% fat (Floro Light, Canola Lite) c. spread with max 60% fat (regular soft margarines) d. spread with 70-80% fat (hard brick margarines) e. butter-vegetable oil-mix (e.g. Butro)	

	f. butter g. plant sterol margarine (e.g. Flora Proactive)	
45.	Do you add salt onto your food after it has been cooked?	
46.	How many servings of nuts do you consume per week? (1 serving is equal to 30g or 2 tablespoons)	
47.	How many sweet or carbonated beverages do you drink per day?	
48.	Do you consume sugar (in your beverages like tea/coffee or on cereal)?	
49.	How often do you consume sugary foods (pastries, cake, chocolate, sweets, or biscuits)? a. Daily b. One to three times a week c. Only on special occasions d. Almost never	
50.	How many servings of alcohol do you drink per week? (1 serving is equal to 125ml wine, 1 tot of spirit, or 340ml beer, or 60ml sherry)	
51.	How many servings of milk, yoghurt, or maas do you consume a day? (1 serving is equal to 1 cup)	
52.	How many glasses of clean and safe water do you drink a day	
53.	How many days in the last week do you skip a meal (breakfast, lunch, or supper)	

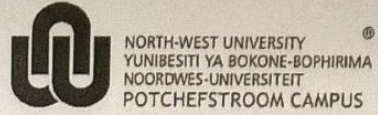
54.	In your opinion do you adhere to a diabetic diet?	yes	no	sometimes
55.	If/ when you do NOT adhere to the diabetic diet: what are some of the reasons (the challenges) for non-adherence?			
56.	If/ when you do adhere to the diabetic diet: what do you think the reasons for adhering to the diabetic diet are (what motivates you)?			

E. The questionnaire is based on the following information.

ADA Guidelines	SEMDSA 2012 Guidelines
Weight loss is recommended	Weight loss is recommended
The mix of carbohydrate, protein, and fat may be adjusted to meet the metabolic goals and individual preferences of the person with diabetes	----
Include carbohydrate from fruits, vegetables, whole grains, legumes, and low-fat daily	Carbohydrate should make up 45-60%
----	Eat a variety of fresh fruit and vegetables daily, avoid fruit juice

Glycemic index and load may be beneficial	Glycemic index and load may be beneficial
Consume a variety of fibre-containing foods. Aim for 14g/1000kcal	Increase intake of soluble and insoluble fibre to 25-50g per day
----	Limit the intake of sugar alcohols to less than 10g a day
----	A sucrose intake of up to 10% of total energy per day is acceptable
----	Limit the total fructose intake to 60g per day
----	Restrict fat to less than 35% of total energy intake
Limit saturated fat to <7% of total calories.	Limit saturated fat to <7% of total calories.
----	Restrict polyunsaturated fat intake to less than 10% of total daily intake
Intake of <i>trans</i> fat should be minimized	Intake of <i>trans</i> fat should be minimized
----	Consume monounsaturated fat and omega-3 fatty acids from plant and marine sources instead of saturated fat
Lower dietary cholesterol to <200 mg/day	----
Two or more servings of fish per week (with the exception of commercially fried fish filets)	Two or more servings of fish per week
Protein intake (15–20% of energy)	Protein intake (15–20% of energy)
----	Limit the intake of processed and convenience foods Reduce sodium to <2300mg per day if blood pressure is high
One drink per day or less for women and two drinks per day or less for men	One drink per day or less for women and two drinks per day or less for men Consume alcohol with food to reduce the risk of hypoglycaemia
No clear evidence of benefit from vitamin or mineral supplementation although may be beneficial in the elderly	No clear evidence of benefit from vitamin or mineral supplementation although may be beneficial in the elderly, lactating and pregnant women, and vegans

6 Annexure 2: Ethics certificate



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Prof HS Kruger
Nutrition

Faculty of Health Sciences
Tel: 018 299-2092
Fax: 018 299-2088
Email: Minrie.Greeff@nwu.ac.za

18 March 2014

Dear Prof Kruger

Ethics application: NWU-00185-13-S1

"Dietary adherence amongst adults with type 2 diabetes mellitus: A South African urban population perspective"

Thank you for the amendments made to your application. All ethical concerns have now been addressed and ethical approval is granted.

Yours sincerely

Prof Minrie Greeff
Research Ethics Committee – Humans Chairperson

Original details: Prof Minrie Greeff(10187308) C:\Users\13210572\Documents\ETIEK\2014 ETHICS\NWU-00185-14-S1.docm
18 March 2014

File reference: NWU-00185-13-S1

7 Annexure 3: Informed consent form



NORTH-WEST UNIVERSITY
YUNIBESITI YA BOKONE-BOPHIRIMA
NOORDWES-UNIVERSITEIT

Tammy Winskill

Registered Dietician

Bsc Diet, PG Dip Diet (UNP), PDM (Wits)

Practice Number: 0188999

HPCSA number: DT0020923

Informed consent Form

General Project Information

The part below provides you as participant in the project with more information, so that you can make an informed decision about your voluntary participation or not.

1. Title of the Project:

Dietary adherence amongst adults with type 2 diabetes mellitus: A South African urban population perspective.

2. Subject group:

Adults who have type 2 diabetes and follow the diabetes management program at Diabetic West diabetes clinic will be included in this study.

3. Names & contact details of Project Staff:

(These persons are your first line contact for enquiries, help and complaints related to the project or your participation in the project. If you need any help, feel uncertain or have any questions regarding the project, or if you experience any unwanted effects of the project interventions, feel victimised or have any other complaints related to the project, or wish to terminate your participation to the project, you may contact these persons at any time.)

	Contact Person	Project Head
Title, name & surname	Tammy Winskill	Prof Salome Kruger
Function in Project	Masters student	Supervising lecturer from the University
Telephone (work)	011 660 8887	018 2992482

4. You have been approached to take part in this project and may now have the following questions:

a) What are the set requirements that persons must meet to be able to take part in the project? Why and how was I chosen?

In order to be eligible to partake in this study you must:-

- ❖ be 18 years of age or older,
- ❖ be a patient at the Diabetic West diabetes clinic for at least 3 months,
- ❖ have been diagnosed with type 2 diabetes for at least 3 months,
- ❖ have seen the dietician or diabetes educator and been advised on dietary guidelines,
- ❖ have valid biochemical and anthropometric data (including HbA1c, lipid profile, Blood pressure, waist circumference, weight and height)

You may not participate in the study if you have type 1 diabetes or if you have chronic renal failure, or if you are too confused or ill to communicate, or if you have been attending the clinic for less than 3 months.

b) What is the purpose of this project?

The purpose of this project is to identify whether there is any association between dietary adherence and glucose control, metabolic risk, or socio-economic status among a sample of type 2 diabetic patients in an urban South African population and also to identify factors associated with non-adherence to dietary recommendations from the perspective of type 2 diabetic patients in an urban South African population.

c) What will be expected of me as participant?

- ❖ You will be required to honestly answer a questionnaire regarding your socio-demographic information (including age, gender, medication used, socio-economic status, education level, occupation, and household characteristics, and food security) as well questions regarding dietary practice and what motivates you and challenges you face in adhering to the diabetes diet guidelines.
- ❖ Biochemical data including HbA1c and your lipid profile (all the cholesterol types) and blood pressure will be recorded from your clinic file. No other information will be taken from your file
- ❖ Weight, height, waist circumference will be taken on the day that you do the interview for the questionnaire.
- ❖ You will also be asked to participate in a focus group discussion where you will discuss your experiences with diet with regards to your diabetes. There will be no more than eight people in a focus group and the group will consist of people who are also living with diabetes. The purpose of the focus group is to identify factors that motivate and factors that are challenging when adhering to a diet.

d) What are the potential discomfort and/or dangers and/or consequences that participation in this project holds and what precautions have been taken to protect me?

Confidentiality, privacy, and emotional discomfort: Questionnaires and measurements will be administered by the researcher in her office. No names will be written on your questionnaire –only a participant number. All data from questionnaire will be computerised and will be password protected. None of your information will be given to any other person in the clinic. During focus groups, no full names will be used and nothing you say will be shared with the clinic or any person outside of the clinic. You are encouraged to speak freely with no repercussions to your diabetes treatment in the clinic. Whatever you say will remain confidential.

e) How long am I expected to be involved in the project?

A 15 minute short interview to answer the questionnaire and take measurements will be required. This can be done on a day that you collect your medication. Focus group discussions will be 1 hour.

f) What potential benefits are there for the broader community which can arise from the project?

The results of this study will be used to structure patient education to achieve desirable change in dietary practice and adherence in order to better control blood sugars in type 2 diabetes patients.

g) How will the findings of the project be made available? A summary of the results will be available from the dietician at request at the clinic once the study has been completed. The dietician will report the results to other health professionals at a diabetes conference and in a scientific journal without identifying any of the study participants.

h) What measures have been taken to handle and store my data confidentially?

All original data will stored at the Centre of Excellence for Nutrition at North-West University under secure environment as per the law for 10 years, after which time it will be destroyed by shredding.

PART 2: General Principles

To the signatory of the consent contained in Part 3 of this document:

You are invited to take part in the research project as described in Part 1 of this informed consent form. It is important that you also read and understand the following general principles, which are applicable to all participants in our research projects:

1. Participation in the project is completely voluntary and no pressure, however subtle, may be placed on you to take part.
2. It is possible that you may not derive any benefit personally from your participation in the project, although the knowledge that may be gained by means of the project, may benefit other persons or communities. In exceptional cases where you do receive personal financial benefits, these are usually for transport to participate and for personal sustenance (e.g. meals) during your participation. You may not be coerced to participate.
3. You are free to withdraw from the project at any time, without stating reasons, and you will in no way be harmed by so doing. You may also request that your data no longer be used in the project and/or that any biological materials must be destroyed. However, you are kindly requested not to withdraw from the project without careful consideration, since it may have a detrimental effect on, inter alia, the statistical reliability of the project.
4. By agreeing to take part in the project, you are also giving consent for the data that will be generated to be used by the researchers for scientific purposes as they see fit, with the caveat that it will be confidential and that your name will not be linked to any of the data without your consent.
5. The NWU Ethics Committee, Medicines Control Council, Department of Health and/or a Court of Law may request access to information to ensure/inspect the ethical responsibility of practices, in the interest of participants and the public.
6. You will be given access to your own data upon request, unless the Ethics Committee has approved temporary non-disclosure (in the latter case, the reasons in Part 1 will be explained to you).
7. A summary of the nature of the project, the potential risks, factors that may cause you possible inconvenience or discomfort, the benefits that can be expected and the known and/or probable permanent consequences that your participation in the project may have for you as participant, are set out for you in Part 1 hereof.
8. You are encouraged to ask the Project Head or co-workers any questions you may have regarding the project and the related procedures at any stage. They will gladly answer your queries. They will also discuss the project with you in detail.
9. If you are a minor, the written consent of your parent or legal guardian is required before you participate in this project, as well as (in writing if possible) your voluntary assent to take part – no coercion may be placed on you.
10. The project objectives are always secondary to your well-being and actions taken will always place your interests above those of the project.
11. No project may be commenced before it is approved by the Ethics Committee. Furthermore, the Project Head must report any detrimental effects experienced during the implementation of the project in full and without delay to the chairman of the Ethics Committee. If any unforeseen serious detrimental effects are observed during the project, it may be necessary to terminate the project immediately

PART 3: Consent

Title of the Project:

Dietary adherence amongst adults with type 2 diabetes mellitus: A South African urban population perspective

I, the undersigned

Full names & Surname

have read the preceding premises in connection with the project, as discussed in **Part 1** and **Part 2** of this informed consent form, and have also heard the oral version thereof and I declare that I understand it. I have also initialled every page of **Part 1** and **Part 2**. I was given the opportunity to discuss relevant aspects of the project with the Project Head and I hereby declare that I am taking part in the project voluntarily.

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Signed at

Place of Signature

WITNESSES

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8 BIBLIOGRAPHY

Adams, T.D., Davidson, L.E., Litwin, S.E., Kolotkin, R.L., LaMonte, M.J., Pendleton, R.C., Strong, M.B., Vinik, R., Wanner, N.A., Hopkins, P.N., Gress, R.E., Walker, J.M., Cloward, T.V., Nuttall, R.T., Hammoud, A., Greenwood, J.L., Crosby, R.D., McKinlay, R., Simper, S.C., Smith, S.C., & Hunt, S.C. 2012. Health benefits of gastric bypass surgery after 6 years. *Journal of American Medical Association*, 308,1122–31.

Adler, A.I., Stratton, I.M., Neil, H.A.W., Yudkin, J.S., Matthews, D.R., Cull, C.A., Wright, A.D., Turner, R.C., & Holman, R.R. 2000. Association of systolic blood pressure with macrovascular and microvascular complications of type 2 diabetes (UKPDS 36): prospective observational study. *British medical journal*, 321:412–419.

Ajala, O, English, P, & Pinkney, J. 2013. Systematic review and meta-analysis of different dietary approaches to the management of type 2 diabetes. *American journal of clinical nutrition*, 97:505–16. Doi:10.3945/ajcn.112.042457.

Alberti, K.G., Eckel, R.H., Grundy, S.M., Zimmet, P.Z., Cleeman, J.I., Donato, K.A., Fruchart, J.C., James, W.P., Loria, C.M., & Smith, S.C. Jr.; (2009). Harmonizing the metabolic syndrome: a joint interim statement of the International Diabetes Federation Task Force on Epidemiology and Prevention; National Heart, Lung, and Blood Institute; American Heart Association; World Heart Federation; International Atherosclerosis Society; and International Association for the Study of Obesity. *Circulation*, 120(16): 1640-1645. Doi: 10.1161/CIRCULATIONAHA.109.192644.Epub 2009 Oct 5

American Diabetes Association. 2015. Standards of medical care in diabetes - 2015. *Diabetes care*, 38(1): S1-S66.

American Diabetes Association. 2002. Implications of the United Kingdom Prospective Diabetes Study. *Diabetes Care*, 25(1): S28-S32. Doi: 10.2337/diacare.25.2007.S28

Amod, A., Riback, W., & Schoeman, H.S. 2012a. Diabetes guidelines and clinical practice: is there a gap? The South African cohort of the International Diabetes Management Practices Study. *Journal of endocrinology, metabolism and diabetes of South Africa*, 17(2): 85-90.

Doi/pdf/10.1080/22201009.2012.10872282

Amod, A., Ascott-Evans, B.H., Berg, G.I., Blom, D.J., Brown, S.L., Carrihill, M.M., Dave, J.A., Distiller, L.A., Gannie, Y.N., Grobler, N., Heilbrunn, A.G., Huddle, K.R.L., Janse van Rensburg, G., Jivan, D., Joshi, P., Khutsoane, D.T., Levitt, N.S., May, W.M., Mollentze, W.F., Motala, A.A., Paruk, I.M., Pirie, F.J., Raal, F.J., Rauff, S., Raubenheimer, P.J., Randeree, H.A.R., Rheeder, P., Tudhope, L., Van Zyl, D.J., & Young, M. 2012b. The 2012 SEMDSA Guideline for the Management of Type 2 Diabetes. *Journal of endocrinology, metabolism and diabetes of South Africa*, 17(2): S1-S95.

Angermayr, L., Melchart, D., & Linde, K. (2010). Multifactorial lifestyle interventions in the primary and secondary prevention of cardiovascular disease and type 2 diabetes mellitus—a systematic review of randomized controlled trials. *Annals of behavioural medicine*, 40:49–64. Doi:10.1007/s12160-010-9206-4

Asche, C., LaFleur, J., & Conner, C. (2011). A review of diabetes treatment adherence and the association with clinical and economic outcomes. *Clinical Therapy*, 33(1): 74-109. Doi:

10.1016/j.clinthera.2011.01.019

Bangalore, S., Kumar, S., Lobach, I., & Messerli, F.H. 2011. Blood pressure targets in subjects with type 2 diabetes mellitus/impaired fasting glucose: observations from traditional and bayesian random-effects meta-analyses of randomized trials. *Circulation*, 123:2799–2810.

Barros, C.R., Cezaretto, A., Curti, M.L.R., Pires, M.M., Folchetti, L.D., Siqueira-Catania, A., & Ferreira, S.R.G. 2014. Realistic changes in monounsaturated fatty acids and soluble fibers are able to improve glucose metabolism. *Diabetology and metabolic syndrome*, 6: 136. Doi:10.1186/1758-5996-6-136

Becker, M.H. & Janz, N.K. 1985. The health belief model applied to understanding diabetes regimen compliance. *Diabetes educator*, 41-47.

Bertram, M.Y., Jaswal, A.V., Van Wyk, V.P., Levitt, N.S. & Hofman, K.J. 2013. The non-fatal disease burden caused by type 2 diabetes in South Africa, 2009. *Global health action*, 6:19244.

Doi:10.3402/gha.v6i0.19244

Boas, L.C., Foss, M.C., de Freitas, M.C., & Pace, A.E. 2012. Relationship among social support, treatment adherence and metabolic control of diabetes mellitus patients. *Rev. Latino-Am. Enfermagem*, 20(1): 52-58. (English Abstract).

Bray, G.A., Vollmer, W.M., Sacks, F.M., Obarzanek, E., Svetkey, L.P., & Appel, L.J.: DASH collaborative research group. 2004. A further subgroup analysis of the effects of the DASH diet and three dietary sodium levels on blood pressure: results of the DASH-sodium trial. *American journal of cardiology*, 94: 222-227. Doi:10.1016/j.amjcard.2004.03.070

Bretzel, R.G, Voigt, K., & Schatz, H. 1998. The United Kingdom Prospective Diabetes Study (UKPDS) implications for the pharmacotherapy of type 2 diabetes mellitus. *Experimental and clinical endocrinology and diabetes*, 106:369-372.

Callaghan, B.C., Little, A.A., Feldman, E.L., & Hughes, R.A.C. 2012. Enhanced glucose control for preventing and treating diabetic neuropathy. *Cochrane database of systematic reviews*, 6.

Doi:10.1002/14651858.CD007543.pub2

Chew, E.Y., Ambrosius, W.T., Davis, M.D., Danis, R.P., Gangaputra, S., Greven, C.M., Hubbard, L., Esser, B.A., Lovato, J.F., Perdue, L.H., Goff, D.C. Jr., Cushman, W.C., Ginsberg, H.N., Elam, M.B., Genuth, S., Gerstein, H.C., Schubart, U., & Fine, L.J.: ACCORD Study Group; ACCORD Eye Study Group. 2010. Effects of medical therapies on retinopathy progression in type 2 diabetes. *New England journal of medicine*, 15: 363(3): 233-244. Doi:10.1056/NEJMoa1001288

Diabetes Control and Complications Trial research Group. 1993. The effect of intensive treatment of diabetes on the development and progression of long-term complications in insulin-dependent diabetes mellitus. *New England journal of medicine*, 329:977-986. Doi:10.1056/NEJM199309303291401

Delamater, A.M. 2006. Improving patient adherence. *Clinical diabetes*, 24(2): 71-77.

Doi:10.2337/diaclin.24.2.71

Duckworth, W., Abaira, C., Moritz, T., Reda, D., Emanuele, N., Reaven, P.D., Zieve, F.J., Marks, J., Davis, S.N., Hayward, R., Warren, S.R., Goldman, S., McCarren, M., Vitek, M.E., Henderson, W.G., & Huang, G.D.: VADT Investigators. 2009. Glucose control and vascular complications in veterans with type 2 diabetes. *New England journal of medicine*, 360(2):129–139. Doi:10.1056/NEJMoa0808431

Egede, L.E., & Ellis, C. 2010. Diabetes and depression: global perspectives. *Diabetes research and clinical practice*, 87(3): 302-12. Doi:10.1016/j.diabres.2010.01.024. (Abstract).

Eijkelkamp, W.B., Zhang, Z., Remuzzi, G., Parving, H.H., Cooper, M.E., Keane, W.F., Shahinfar, S., Gleim, G.W., Weir, M.R., Brenner, B.M., & de Zeeuw, D. 2007. Albuminuria is a target for renoprotective therapy independent from blood pressure in patients with type 2 diabetic nephropathy: post hoc analysis from the Reduction of Endpoints in NIDDM with the Angiotensin II Antagonist Losartan (RENAAL) trial. *Journal of American Society of Nephrology*, 18:1540-1546.

Ekinci, E.I., Clarke, S., Thomas, M.C., Moran, J.L., Cheong, K., MacIsaac, R.J., & Jerums, G. 2011. Dietary salt intake and mortality in patients with type 2 diabetes. *Diabetes care*, 34: 703-709.

Doi:10.2337/dc10-1723

Evert, A.B., Boucher, J.L., Cypress, M., Dunbar, S.A., Franz, M.J., Mayer-Davis, E.J., Neumiller, J.J., Nwanko, R., Verdi, C.L., Urbanski, P., & Yancy, W.S. Jr. 2014. Nutrition therapy recommendations for the management of adults with diabetes. *Diabetes care*, 37(1): S120-S143. Doi:10.2337/dc14-S120

Gaede P., Lund-Andersen, H., Parving, H.H., & Pedersen, O. 2008. Effect of a multifactorial intervention on mortality in type 2 diabetes. *New England journal of medicine*, 358(6):580-591. Doi: 10.1056/NEJMoa0706245

Gaesser, G.A., Angadi, S.S., Sawyer, B.J. 2011. Exercise and diet, independent of weight loss, improve cardiometabolic risk profile in overweight and obese individuals. *Physician and sports medicine*, 39(2): 87-97. Doi:10.3810/psm.2011.05.1898

Greaves, C.J., Sheppard, K.E., Abraham, C., Hardeman, W., Roden, M., Evans, P.H., & Schwarz, P. 2011. Systematic review of reviews of intervention components associated with increased effectiveness in dietary and physical activity interventions. *Biomed central public health* 11:119. Doi: 10.1186/1471-2458-11-119

Grundy, S.M., Cleeman, J.I., Merz, C.N., Brewer, H.B. Jr., Clark, L.T., Hunninghake, D.B., Pasternak, R.C., Smith, S.C. Jr., & Stone, N.J. 2004. The Coordinating Committee of the National Cholesterol Education Program; National Heart, Lung, and Blood Institute; American College of Cardiology Foundation, and American Heart Association: Implications of recent clinical trials for the National Cholesterol Education Program Adult Treatment Panel III guidelines. *Circulation*, 110: 227-239.

Hall, V., Thomsen, W., Henriksen, O., & Lohse, N. (2011). Diabetes in Sub Saharan Africa 1999-2011: Epidemiology and public health implications. A systematic review. *Biomed central public health*, 11: 564.

Hayward, R.A., Reaven, P.D., Wiitala, W.L., Bahn, G.D., Reda, D.J., Ge, L., McCarren, M., Duckworth, W.C., & Emanuele, N.V.: VADT Investigators. 2015. Follow-up of glycemic control and cardiovascular outcomes in type 2 diabetes. *New England Journal of medicine*, 372: 2197-2206.
Doi:1056/NEJMoa1414266

Hawkes, C. (2006). Uneven dietary development: Linking the policies and processes of globalization with the nutrition transition, obesity and diet-related chronic diseases. *Global Health*, 2, 4-22.
Doi:10.1186/1744-8603-2-4

Hemphill, R.C., Stephens, M.A., Rook, K.S., Franks, M.M., & Salem, J.K. 2013. Older adults' beliefs about the timeline of type 2 diabetes and adherence to dietary regimens. *Psychology and health* 28(2),139-153. Doi: 10.1080/08870446.2012.685740

Ho, P.M., Rumsfeld, J.S., Masoudi, F.A., McClure, D.L., Plomondon, M.E., Steiner, J.F., & Magid, D.J. 2006. Effect of medication nonadherence on hospitalization and mortality among patients with diabetes mellitus. *Archives of internal medicine*, 166, 1836-1841. (Abstract).

Hu, J., Amirehsani, K., Wallace, D.C., & Letvak, S. 2013. Perceptions of barriers in managing diabetes: Perspectives of Hispanic immigrant patients and family members. *Diabetes Educator*, 39: 494-509.
Doi:10.1177/0145721713486200

Inzucchi, S.E., Bergenstal, R.M., Buse, J.B., Diamant, M., Ferrannini, E., Nauck, M., Peters, A.L., Tsapas, A., Wender, R., & Matthews, D.R: American Diabetes Association (ADA); European Association for the Study of Diabetes (EASD). 2012. Management of hyperglycemia in type 2 diabetes: a patient-centered approach: position statement of the American Diabetes Association (ADA) and the European Association for the Study of Diabetes (EASD). *Diabetes Care*, 35(6):1364-79.
Doi:10.2337/dc12-0413

Inzucchi, S.E., Bergenstal, R.M., Buse, J.B., Diamant, M., Ferrannini, E., Nauck, M., Peters, A.L., Tsapas, A., Wender, R., & Matthews, D.R. 2015. Management of hyperglycemia in type 2 diabetes, 2015: a patient-centered approach: update to a position statement of the American Diabetes Association and the European Association for the Study of Diabetes, *Diabetes Care*, 38:140–149. Doi:10.2337/dc14-2441

International Diabetes Federation. 2014. IDF Diabetes Atlas sixth edition. <http://www.idf.org/diabetesatlas> Date of access: 30 June 2015.

Ismail-Beigi, F., Craven, T., Banerji, M.A., Basile, J., Calles, J., Cohen, R.M., Cuddihy, R., Cushman, W.C., Genuth, S., Grimm, R.H. Jr., Hamilton, B.P., Hoogwerf, B., Karl, D., Katz, L., Krikorian, A., O'Connor, P., Pop-Busui, R., Schubart, U., Simmons, D., Taylor, H., Thomas, A., Weiss, & D., Hramiak, I: ACCORD trial group. 2010. Effect of intensive treatment of hyperglycaemia on microvascular outcomes in type 2 diabetes: an analysis of the ACCORD randomised trial. *Lancet*, 376(9739): 419-430.
Doi:10.1016/S0140-6736(10) 60576-4

Kearney, P.M., Blackwell, L., Collins, R., Keech, A., Simes, J., Peto, R., Armitage, J., & Baigent, C. 2008. Efficacy of cholesterol-lowering therapy in 18,686 people with diabetes in 14 randomised trials of statins: a meta-analysis. *Lancet*, 12, 371, 9607, 117-125.

Kopp, H.P., Krzyzanowska, K., Möhlig, M., Spranger, J., Pfeiffer, A.F., & Schernthaner, G. 2005. Effects of marked weight loss on plasma levels of adiponectin, markers of chronic subclinical inflammation and insulin resistance in morbidly obese women. *International journal of obesity*, 29(7): 766-771. Doi:10.1038/sj.ijo.0802983

Koster, A., Leitzmann, M.F., Schatzkin, A., Mouw, T., Adams, K.F., van Eijk, J.T.M., Hollenbeck, A.R., & Harris, T.B. 2008. Waist circumference and mortality. *American journal of epidemiology*, 167(12):1465-75. Doi:10.1093/aje/kwn079

Kagee, A., Le Roux, M.J., & Dick, J. (2007). Treatment adherence among primary care patients in a historically disadvantaged community in South Africa: A Qualitative study. *Health psychology*, 12, 444. Doi:10.1177/1359105307076232

Kruger, H.S.; Venter, C.S.; Vorster, H.H., & Margetts, B.M. 20012. Physical inactivity is the major determinant of obesity in black women in the North West Province, South Africa: the THUSA study. Transition and Health During Urbanisation of South Africa. *Nutrition*, 18(5): 422-427. Doi:10.1016/S0899-9007(01)00751-1

Levitt, N.S., Bradshaw, D., Zwarenstein, M.F., Bawa, A.A., Maphumolo, S. (1997). Audit of public sector primary diabetes care in Cape Town, South Africa: high prevalence of complications, uncontrolled hyperglycaemia, and hypertension. *Diabetic medicine*, 14, 1073–1077.

Lambers H.H.J., Holtkamp, F.A., Parving, H.H., Navis, G.J., Lewis, J.B., Ritz, E., de Graeff, P.A., & de Zeeuw, D. 2012. Moderation of dietary sodium potentiates the renal and cardiovascular protective effects of angiotensin receptor blockers. *Kidney International*, 82, 3, 330-337. Doi: 10.1038/ki.2012.74

Levitan, E.B., Song, Y., Ford, E.S., & Liu, S. 2004. Is nondiabetic hyperglycemia a risk factor for cardiovascular disease? A meta-analysis of prospective studies. *Archives of internal medicine*, 164(19):2147-2155. Doi:10.1155/2010/170393

Lewis, E.J., Hunsicker, L.G., Bain, R.P., & Rohde, R.D. 1993. The effect of angiotensin-converting-enzyme inhibition on diabetic nephropathy. *New England journal of medicine*, 329:1456-1462. Doi:10.1056/NEJM199311113292004

Lindegaard, K.K., Jorgensen, N.B., Just, R., Heegaard, P.M.H., & Madsbad, S. 2015. Effects of Roux-en-Y gastric bypass on fasting and postprandial inflammation-related parameters in obese subjects with normal glucose tolerance and in obese subjects with type 2 diabetes. *Diabetology and metabolic syndrome*, 7. Doi:10.1186/s13098-015-0012-9

Martin, L.R., Williams, S.L., Haskard, K.B., & DiMatteo, M.R. 2005. The challenge of patient adherence. *Journal of therapeutics and clinical risk management*, 1(3), 189–199.

MacIntyre, U.E.; Kruger, H.S.; Venter, C.S., & Vorster, H.H. (2002). Dietary intakes of an African population in different stages of transition in the North West Province, South Africa: The THUSA study. *Nutrition research*, 22: 230–256. Doi:10.1016/S0271-5317(01)00392-X

Malanda, U.L., Welschen, L.M., Riphagen, I.I., Dekker, J.M., Nijpels, G., & Bot, S.D. 2012. Self-monitoring of blood glucose in patients with type 2 diabetes mellitus who are not using insulin. *Cochrane database of systematic reviews*, 1. Doi:10.1002/14651858.CD005060.pub3

Mandewo, W., Edward, E. D., Chideme-Munodawafa, A., & Mandewo, G. 2014. Non-adherence to treatment among diabetic patients attending outpatients clinic at Mutare provincial hospital, Manicaland province, Zimbabwe. *International journal of scientific and technology research*, 3(9): 66-86.

Mattei, J., Malik, V., Wedick, N.M., Hu, F.B., Spiegelman, D., Willett, W.C., Campos, H. 2015. Reducing the global burden of type 2 diabetes by improving the quality of staple foods: The Global Nutrition and Epidemiologic Transition Initiative. *Global Health*, 11(1):23. (Abstract).

Nathan, D.M., Kuenen, J., Borg, R., Zheng, H., Schoenfeld, D., Heine, R.J.: A1c-Derived Average Glucose Study Group. 2008. Translating the A1C assay into estimated average glucose values. *Diabetes care*, 31:1473–1478. Doi:10.2337/dc08-0545

Nathan, M. 2014. The Diabetes Control and Complications Trial/Epidemiology of Diabetes Interventions and Complications Study at 30 Years: Overview. *Diabetes Care*, 37(1):9-16. Doi:10.2337/dc13-2112

Ockene, I.S., Hayman, L.L., Pasternak, R.C., Schron, E., & Dunbar-Jacob, J. 2002. Task Force #4— Adherence issues and behavior changes: Achieving a long-term solution. *Journal of the American College of Cardiology*, 40(4): 579–651. Doi:10.1016/S0735-1097(02)02078-8

Okolie, U., Ehiemere, I., Ezenduka, P., & Ogbu, S. 2010. Contributory factors to diabetes dietary regimen non adherence in adults with diabetes. *World academy of science, engineering and technology*, 45: 735-742.

Patel, A., MacMahon, S., Chalmers, J., Neal, B., Billot, L., Woodward, M., Marre, M., Cooper, M., Glasziou, P., Grobbee, D., Hamet, P., Harrap, S., Heller, S., Liu, L., Mancia, G., Mogensen, C.E., Pan, C., Poulter, N., Rodgers, A., Williams, B., Bompoint, S., de Galan, B.E., Joshi, R., & Travert, F.: The ADVANCE Collaborative Group. 2008. *New England journal of medicine*, 358:2560-2572. Doi:10.1056/NEJMoa0802987

Penno, G., Solini, A., Zoppini, G., Fondelli, C., Trevisan, R., Vedovato, M. Gruden, G., Lamacchia, O., Pontiroli, A.E., Arosio, M., Orsi, E., & Pugliese, G. (2015) Hypertriglyceridemia is independently associated with renal, but not retinal complications in subjects with type 2 diabetes: A cross-sectional analysis of the renal insufficiency and cardiovascular events (RIACE) Italian Multicenter Study. *PLoS one*, 10(5): e0125512. Doi: 10.1371/journal.pone.0125512

Pepper, D.J., et al. (2007). Hyperglycaemic emergency admissions to a secondary level hospital - an unnecessary financial burden. *South African medical journal*, 97(10):963-7.

Perkovic, V., Heerspink, H.L., Chalmers, J., Woodward, M., Jun, M., Li, Q., MacMahon, S., Cooper, M.E., Hamet, P., Marre, M., Mogensen, C.E., Poulter, N., Mancia, G., Cass, A., Patel, A., & Zoungas, S.: ADVANCE Collaborative Group. 2013. Intensive glucose control improves kidney outcomes in patients with type 2 diabetes. *Kidney International*, 83(3): 517-523. Doi:10.1038/ki.2012.401

Pi-Sunyer, F.X. 1993. Short-term medical benefits and adverse effects of weight loss. *Annals of internal medicine*, 119(7):722-726. (Abstract).

Pohl, M.A., Blumenthal, S., Cordonnier, D.J., DeAlvaro, F., DeFerrari, G., Eisner, G., Esmatjes, E., Gilbert, R.E., Hunsicker, L.G., Lopes de Faria, J., Mangili, R., moore, J. Jnr., Reisin, E., Ritz, E., Schernthaner, G., Spitalowitz, S., Tindall, H., Rodby, R.A., & Lewis, E.J. 2005. Independent and additive impact of blood pressure control and angiotensin II receptor blockade on renal outcomes in the irbesartan diabetic nephropathy trial: clinical implications and limitations. *Journal of the American Society of Nephrology*, 16:3027-3037.

Polonsky, W.H., Fisher, L., Schikman, C.H., Hinnen, D.A., Parkin, C.G., Jelsovsky, Z., Petersen, B., Schweitzer, M., & Wagner, R.S. 2011. Structured self-monitoring of blood glucose significantly reduces A1C levels in poorly controlled, noninsulin-treated type 2 diabetes: results from the Structured Testing Program study. *Diabetes care*, 34:262–267. Doi:10.2337/dc10-1732

Raffield, L.M., Hsu, F.C., Cox, A.J., Carr, J.J., Freedman, B.I., & Bowden, D.W. (2015). Predictors of all-cause and cardiovascular disease mortality in type 2 diabetes: Diabetes Heart Study. *Diabetology and metabolic syndrome*, 7:58. Doi: 10.1186/s13098-015-0055-y

Salas-Salvado, J., Bullo, M., Babio, N., Martinez-Gonzalez, M.A., Ibarrola-Jurado, N., Basora, J., Estruch, R., Covas, M.I., Corella, D., Aros, F., Ruiz-Gutierrez, V., & Ros, E.: PREDIMED Study Investigators. 2011. Reduction in the incidence of type 2 diabetes with the Mediterranean diet: results of the PREDIMED-Reus nutrition intervention randomized trial. *Diabetes care*, 34(1):14–19. Doi:10.2337/dc10-1288

Samuel-Hodge, C.D., DeVellis, R.F., Ammerman, A., Keyserling, T.C., & Elasy, T.A. 2002. Reliability and validity of a measure of perceived diabetes and dietary competence in African American women with type 2 diabetes. *Diabetes educator*, 28(6):979-88. (Abstract).

Savoca M., & Miller, C. 2001. Food selection and eating patterns: themes found among people with type 2 diabetes mellitus. *Journal of nutrition education*, 33(4):224-233.

Savoca, M.R., Miller, C.K., & Ludwig, D.A. 2004. Food habits are related to glycemic control among people with type 2 diabetes mellitus. *Journal of American Dieticians Association*, 104(4):560-566.

Sarwar, N., Danesh, J., Eiriksdottir, G., Sigurdsson, G., Wareham, N., Bingham, S., et al. (2007). Triglycerides and the risk of coronary heart disease: 10,158 incident cases among 262,525 participants in 29 Western prospective studies. *Circulation*, 115: 450–458.

Schellenberg, E.S., Dryden, D.M., Vandermeer, B., Ha, C., & Korownyk, C. (2013). Lifestyle interventions for patients with and at risk for type 2 diabetes - A systematic review and meta-analysis. *Annals of internal medicine*, 159:543-551.

Schmidt, L.E., Rost, K.M., McGill, J.B., & Santiago, J.V. 1994. The relationship between eating patterns and metabolic control in patients with non-insulin-dependent diabetes mellitus (NIDDM). *Diabetes Educator*, 20(4):317-321.

Shisana, O., Labadarios, D., Rehle, T., Simbayi, L., Zuma, K., Dhansay, A., Reddy, P., Parker, W., Hoosain, E., Naidoo, P., Hongoro, C., Mchiza, Z., Steyn, N.P., Dwane, N., Makoae, M., Maluleke, T., Ramlagan, S., Zungu, N., Evans, M.G., Jacobs, L., Faber, M., & SANHANES-1 Team. 2013. *South African National Health and Nutrition Examination Survey (SANHANES-1)*. Cape Town: HSRC Press.

Singh, H., Cinnirella, M., & Bradley, C. 2012. Support systems for and barriers to diabetes management in South Asians and Whites in the UK: qualitative study of patients' perspectives. *British medical journal Open*, 2:e001459. Doi:10.1136/bmjopen-2012-001459

Sleiman, D., Al-Badri, M.R. & Azar, S.T. 2015. Effect of Mediterranean diet in diabetes control and cardiovascular risk modification: a systematic review. *Frontiers in public health*, 3:69.

Doi:10.3389/fpubh.2015.00069

Snijder, M.B., van Dam, R.M., Visser, M., & Seidell, J.C. 2006. What aspects of body fat are particularly hazardous and how do we measure them? *International journal of epidemiology*, 35:83–92.

Doi:10.1093/ije/dyi253

South Africa. Department of Health. 2011. South African declaration on the prevention and control of non-communicable diseases. http://www.health.uct.ac.za/usr/health/research/groupings/cdia/downloads/SA_NCD_Declaration.pdf Date of access: 30 June 2015.

Steyn, K., Lombard, C., Gwebushe, N., Fourie, J.M., Everett_Murphy, K., Zwarenstein, M., & Levitt, S. 2013. Implementation of nutritional guidelines, incorporated within structured diabetes and hypertension records at primary level care in Cape Town, South Africa: a randomised controlled trial. *Global health action*, 6: 20796. Doi:10.3402/gha.v6i0.20796

Turner, R.C., Millns, H., Neil, H.A., Stratton, I.M., Manley, S.E., Matthews, D.R., & Holman, R.R. 1998. Risk factors for coronary artery disease in non-insulin dependent diabetes mellitus: UKPDS. *British medical journal*, 316: 823-828.

UK Prospective Diabetes Study Group. 1998a. Intensive blood-glucose control with sulphonylureas or insulin compared with conventional treatment and risk of complications in patients with type 2 diabetes (UKPDS 33). *Lancet*, 352:837–853.

UK Prospective Diabetes Study Group. 1998b. Effect of intensive blood-glucose control with metformin on complications in overweight patients with type 2 diabetes (UKPDS 34). *Lancet*, 352:854–865.

UK Prospective Diabetes Study Group. 1998c. Tight blood pressure control and risk of macro-vascular and microvascular complications in type 2 diabetes (UKPDS 38). *British medical journal*, 317:703–713.

UK Prospective Diabetes Study Group. 1998d. Efficacy of atenolol and captopril in reducing risk of both macrovascular and microvascular complications in type 2 diabetes (UKPDS 39). *British medical journal*, 317:713–720.

United Nations. 2011. Political declaration of the High-level Meeting of the General Assembly on the Prevention and Control of Non-communicable Diseases High level meeting on prevention and control of non-communicable diseases. http://www.un.org/ga/search/view_doc.asp?symbol=A/66/L.1 Date of access: 30 July 2015.

Venkataraman, K., Kannan, A.T., Kalra, O.P., Gambhir, J.K., Sharma, A.K., Sundaram, K.R., & Mohan, V. (2012). Diabetes self-efficacy strongly influences actual control in patients attending a tertiary hospital in India. *Journal of community health*. 37 (3): 653-662. Doi:10.1007/s10900-011-9496-x

Vorster, H.H., Kruger, A, & Margetts, B.M. 2011. The nutrition transition in Africa: Can it be steered into a more positive direction? *Nutrients*, 3(4), 429-441. Doi:10.3390/nu3040429

Vorster, H.H., Badham, J.B., & Venter, C.S. 2013. An introduction to the revised food- based dietary guidelines for South Africa. *South African journal of clinical nutrition*, 26(3):S1-S164.

Waanders, F., Visser, F.W., & Gans, R.O. 2013. Current concepts in the management of diabetic nephropathy. *Netherlands journal of medicine*, 71,448–458.

Warren, T.Y., Wilcox, S., Dowda, M., & Baruth, M. 2012. Independent Association of Waist Circumference With Hypertension and Diabetes in African American Women, South Carolina, 2007–2009. *Preventing chronic disease*, 9. Doi:10.5888/pcd9.110170

Willett, L.R. 2012. Meta-analysis: self-monitoring in non-insulin-treated type 2 diabetes improved HbA1c by 0.25%. *Annals of internal medicine*, 156:JC6–JC12. Doi:10.7326/0003-4819-156-12-201206190-02012

Wing, R.R., Koeske, R., Epstein, L.H., Nowalk, M.P., Gooding, W., & Becker, D. 1987. Long-term effects of modest weight loss in type II diabetic patients. *Archives of internal medicine*, 147(10):1749-53. (Abstract).

Wing, R.R., Lang, W., Wadden, T.A., Safford, M., Knowler, W.C., Bertoni, A.G, Hill, J.O., Brancati, F.L., Peters, A., Wagenknecht, L., & the Look AHEAD Research Group. 2011. Benefits of modest weight loss in improving cardiovascular risk factors in overweight and obese individuals with type 2 diabetes. *Diabetes care*, 34: 1481-1486. Doi:10.2337/dc10-2415

World Health Organization. 2011. Waist circumference and waist-hip ratio: Report of a WHO expert consultation, Geneva, 8-11 December 2008.

Worku, A., Mekonnen, A., & Mesele-Wassie, M. 2015. Dietary practice and associated factors among type 2 diabetic patients: a cross sectional hospital based study, Addis Ababa, Ethiopia. *SpringerPlus*, 4. Doi:10.1186/s40064-015-0785-1