PRACTICES AND PERCEPTIONS OF REGISTERED DIETITIANS REGARDING THE USE OF CARBOHYDRATE COUNTING AND BARRIERS ASSOCIATED WITH IT IN THE DIETARY MANAGEMENT OF TYPE 1 DIABETES MELLITUS

BY

MEGAN ESMÈ DIMITRIADES

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ABSTRACT

Introduction: Diabetes mellitus (DM) is one of the most prevalent chronic diseases worldwide with an estimated 451 million people currently living with diabetes between the ages of 18-99 years. Approximately 87-91% of people with diabetes in high-income countries have type 2 diabetes mellitus (T2DM), while 7-12% have type 1 diabetes mellitus (T1DM). In South Africa, there are an estimated 2.3 million people living with diabetes and of those people, 5-15% have T1DM. The diabetic should receive individualised nutrition therapy, which includes promoting and supporting healthy eating by achieving and maintaining body weight and individual glycaemic goals. Carbohydrate counting is a meal planning method that alongside the adjustment of insulin assists in managing and maintaining blood glucose levels and is commonly used in the management of T1DM. With carbohydrate counting, the individual is taught to identify carbohydrates in foods (carbohydrate awareness) and determine the amount of carbohydrates that are consumed at one time. They are then taught to give the correct amount of insulin depending on the portion of carbohydrate eaten to prevent hyperglycaemia and hypoglycaemia, and maintain normal blood glucose levels. Carbohydrate counting has been shown to improve glycaemic control as well as quality of life, however, it must be taught by someone who has clinical expertise in the field, such as an experienced registered dietitian. Although international guidelines recommend that carbohydrate counting be offered to all newly diagnosed patients with T1DM, there are currently no recommendations specific to the South African population and little or no information regarding practices and perceptions of dietitians regarding carbohydrate counting.

Aim: This study aimed to determine the practices and perceptions of registered dietitians regarding the use of carbohydrate counting and the barriers associated with it in the dietary management of T1DM. It also aimed to determine if there is a need for further training on carbohydrate counting amongst dietitians in KZN.

Objectives: i) To determine which dietary management approach is most commonly used by dietitians in KZN when educating patients with T1DM. ii) To determine if dietitians in KZN use carbohydrate counting in the dietary management of patients with T1DM. iii) To determine the perceptions of dietitians in KZN towards the use of carbohydrate counting in the dietary management of T1DM. iv) To determine the barriers which prevent dietitians in KZN from using carbohydrate counting in the dietary management of T1DM. v) To determine if dietitians in KZN see a need for further education/training in the area of carbohydrate counting.

Method: A cross-sectional descriptive study was conducted via a link to a questionnaire on SurveyMonkey that was attached to an email. The link was distributed to the dietitians who were members of the Association of Dietetics in South Africa (ADSA) in KZN. The KZN Department of Health (DOH) uploaded the survey on their intranet website under the surveys section, where the DOH dietitians could access the survey. Data was analysed using the IBM Statistical Package for Social Sciences (SPSS) version 26.0.

Results: Sixty-nine dietitians participated in the survey, 78% (n=54) of which qualified at the University of KwaZulu-Natal (UKZN). Although the majority (76.8%; n=53) of the dietitians indicated that they gave dietary management advice to patients with T1DM, a significant 85.5% (n=59) indicated that most of their patients presented with T2DM ($p<0.05$). The glycaemic index, portion control using the healthy eating plate, carbohydrate counting using nutritional labels, carbohydrate counting using household measures and carbohydrate awareness i.e. making patients aware of which foods contain carbohydrate, were all significant dietary management approaches used by dietitians ($p<0.05$). The majority of the dietitians (60.9%; n=42) indicated that they had not received additional training on diabetes management. Dietitians agreed that they required further training or education on the use of carbohydrate counting as a dietary management approach to manage patients with T1DM ($p<0.05$). Dietitians agreed that there were numerous barriers to their use of carbohydrate counting in the management of diabetes. These barriers included a lack of training, confidence and experience, patient illiteracy, lack of financial resources, time, blood glucose records and poor patient motivation. Dietitians agreed that carbohydrate counting was useful as a dietary management approach ($p<0.05$) and that it was an essential part of the dietary management of T1DM ($p<0.05$).

Conclusion: Although dietitians in KZN stated that they used carbohydrate counting as a dietary management method, their practices varied. There was a willingness amongst dietitians working in both the private and public sectors to receive more training on carbohydrate counting and to apply it to patient care. Although dietitians agreed that carbohydrate counting was a useful and essential method in the dietary management of T1DM, a number of barriers prevented the use of this method. A lack of training, confidence and experience influenced whether or not dietitians taught their patients to carbohydrate count. There is a potential for carbohydrate counting to be used by the dietitians in KZN who participated in the study. However, further training and

resources are required. This study has highlighted a need for South African guidelines on the dietary management of T1DM, as there is currently none in place.

PREFACE

This dissertation was written between June 2018 and November 2019 using data collected from an online questionnaire in KwaZulu-Natal, under the supervision of Dr Kirthee Pillay.

Signed: Date: 19 November 2019

Megan Esmé Dimitriades (Candidate)

As the supervisor of the candidate, I agree to the submission of this dissertation.

Signed: Date: 19 November 2019

Dr Kirthee Pillay (Supervisor)

DECLARATION OF ORIGINALITY

I, Megan Esmé Dimitriades hereby declare that:

1. The entirety of the work contained in this dissertation is my original work, except where otherwise stated.

2. This dissertation, or any part of it, has not been submitted for any degree or examination at any other university.

3. Where other sources have been used, they have not been copied and properly acknowledged.

4. This dissertation does not contain text, graphics or tables copied and pasted from the internet, unless specifically acknowledged, and the source being detailed in the dissertation and in the relevant reference section.

Signed:

Megan Esmé Dimitriades (Candidate) Date: 19 November 2019

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LIST OF ABBREVIATIONS

ADA	American Diabetes Association
ADSA	Association of Dietetics in South Africa
AI	Average Intake
BMI	Body mass index
CDE	Certified Diabetes Educator
CHO	Carbohydrate
CPD	Continuing Professional Development
CSII	Continuous Subcutaneous Insulin Infusion
DAFNE	Dose Adjustment for Normal Eating
DCCT	Diabetes Control and Complications Trial
DESSA	Diabetes Education Society of South Africa
DINE	Diabetes Insulin and Normal Eating
DKA	Diabetic Ketoacidosis
DM	Diabetes Mellitus
DOH	Department of Health
DSME	Diabetes Self-Management Education
DUK	Diabetes United Kingdom
EASD	European Association for the Study of Diabetes
FBDG	Food Based Dietary Guidelines
GI	Glycaemic Index
GIFSA	Glycaemic Index Foundation of South Africa
HbA1c	Glycosylated haemoglobin
HCP	Health Care Professionals
HPCSA	Health Professions Council of South Africa
IDF	International Diabetes Federation

ISPAD	International Society for Paediatric and Adolescent Diabetes
KICk-OFF	Kids in Control of Food
KMO	Kaiser-Meyer-Olkin
KZN	KwaZulu-Natal
MDG	Millennium Development Goals
MDI	Multiple Daily Injections
MNT	Medical Nutrition Therapy
NHIR	National Institute of Health Research
NICE	National Institute for Health and Care Excellence
SEMDSA	Society for Endocrinology, Metabolism and Diabetes of South Africa
SA	South Africa
SPSS	Statistical Package for Social Sciences
SSA	Sub-Saharan Africa
T1DM	Type 1 diabetes mellitus
T2DM	Type 2 diabetes mellitus
RDA	Recommended Dietary Allowance
UK	United Kingdom
UKZN	University of KwaZulu-Natal
USA	United States of America
WHO	World Health Organization

CHAPTER 1
INTRODUCTION, THE PROBLEM AND ITS SETTING

1.1 Importance of the study

According to the International Diabetes Federation (IDF), 424.9 million people worldwide between the ages of 20-79 years were living with diabetes in 2017. This is estimated to increase to 628.6 million by 2045 (IDF Diabetes Atlas 2017, pp43, 44). In 2017, four million deaths globally were attributed to diabetes. Diabetes mellitus (DM) is one of the top ten contributors to deaths worldwide. North America and the Caribbean were listed as having the highest prevalence of people living with diabetes at 13%, while Africa ranked seventh with 3.3% (IDF Diabetes Atlas 2017, p45). In 2017, it was estimated that 50% of people between the ages of 20-79 years worldwide were unaware that they were living with diabetes. In Africa, 69.2% of people were undiagnosed in 2017. South Africa has 1.8 million people living with DM, the highest prevalence in the African region, alongside Ethiopia (2.6 million), Nigeria (1.7 million) and the Democratic Republic of Congo (1.7 million) (IDF Diabetes Atlas 2017, p47).

The IDF (IDF Diabetes Atlas 2017, p16) describes three main types of diabetes i.e. type 1, type 2 and gestational diabetes. Type 1 diabetes mellitus (T1DM) is the most commonly diagnosed type of diabetes in young children (Danne, Phillip, Buckingham, Jarosz-Chobot, Saboo, Urakami, Battelino, Hanas & Codner 2018). Although T1DM has traditionally been associated with children and type 2 diabetes mellitus (T2DM) with adults, this is no longer the case as both types of diabetes can present in either age group [American Diabetes Association (ADA) 2019]. The onset of T1DM is more variable in adults than in children, as an adult may not present with the typical symptoms that children often present with (ADA 2017). A type 1 diabetic requires daily injections of insulin to maintain an optimal glucose level and without insulin, they would not survive (IDF Diabetes Atlas 2017, p17). Factors affecting glycaemic control in T1DM and people with diabetes on insulin include too much or too little carbohydrate consumed with insulin; lack or increase of physical activity; illness; stress; menstruation; medication side-effects; pain and dehydration (ADA 2018). Type 2 diabetes mellitus is the most common type of diabetes. Hyperglycaemia results from a lack of insulin secretion and action due to insulin resistance (IDF Diabetes Atlas 2017, p19). An inadequate intake of fruit, vegetables and fibre-rich foods and a high intake of saturated fat, low

levels of physical activity and being overweight are risk factors for developing T2DM. Type 2 diabetes mellitus is managed mainly through lifestyle changes e.g. diet, physical activity and maintaining a healthy weight. If this does not help to achieve optimal glucose levels, oral antidiabetic medication is introduced. If oral medication does not control hyperglycaemia, insulin injections may be prescribed to prevent hyperglycaemia (IDF Diabetes Atlas 2017, p19). If hyperglycaemia is left untreated, it can cause long-term damage to the organs of the body, which in turn can lead to life-threatening complications such as retinopathy, cardiovascular disease, neuropathy and nephropathy. If diabetes is managed correctly, these complications can be delayed or prevented (IDF Diabetes Atlas 2017, p16).

Diabetes has become part of a twofold burden in sub-Saharan Africa (SSA) due to the increased risk of infectious diseases such as human immunodeficiency virus (HIV), tuberculosis (TB) and pneumonia. Patients with uncontrolled hyperglycemia are at a higher risk for TB compared to those with well-controlled blood glucose levels (Pastakia, Pekny, Manyara & Fischer 2017). Pastakia *et al* (2017) highlights the discrepancy of diabetes care between higher and lower to middle income countries, as well as private and public health care and rural and urban settings. These discrepancies are due to a lack of studies and guidelines specific for the SSA population, poor availability of medications despite this being one of the Millennium Development Goals (MDGs) and lack of funding allocated to non-communicable diseases (Pastakia *et al* 2017). Diabetes care guidelines used in SSA come from the United Kingdom (UK), United States of America (USA) and Europe. These resource-rich countries have been able to define diabetes care through randomised control studies. However, guidelines from these countries may not be relevant to the SSA population. This highlights that further studies are required to develop appropriate guidelines for this population (Pastakia *et al* 2017).

According to the ADA (2019), the individual with diabetes should receive individualised nutrition therapy, which includes promoting and supporting healthy eating by achieving and maintaining body weight, and maintaining and achieving individual glycaemic goals. Additional goals include the delay and prevention of complications associated with diabetes as well as to ensure that the individual has the tools needed to practice healthy eating with diabetes (ADA 2019). Individual nutrition needs should be addressed and eating pleasure maintained (ADA 2019). Carbohydrate counting is a meal planning method that alongside the adjustment of insulin assists in managing

and maintaining blood glucose levels (Hirose, Yamanaka, Ishikawa, Sai & Kawamura 2011). It is commonly used in people with T1DM that manage their diabetes with multiple daily injections (MDI) or insulin pumps (Hirose *et al* 2011). Recommendations regarding T2DM are less specific, however, monitoring and regulating carbohydrate intake to maintain glycaemic control is recommended as a key strategy [Society for Endocrinology, Metabolism and Diabetes of South Africa (SEMDSA) 2017]. Although low carbohydrate, high fat diets are increasing in popularity, SEMDSA does not currently recommend this diet for people with diabetes (SEMDSA 2017). The ADA (2019) indicates that low carbohydrate diets may result in improved glycaemic control and potentially reduce the use of glucose lowering pharmacological agents in people with T2DM. However, the long-term sustainability of a low carbohydrate diet is challenging and an individual approach is encouraged (ADA 2019). In a network meta-analysis by Schwingshackl, Chaimani, Hoffmann, Schwedhelm & Boeing (2018), nine dietary approaches were compared in 56 trials consisting of 4937 type 2 diabetic participants. The Mediterranean diet was found to be the best at improving overall glycaemic control in type 2 diabetics (Schwingshackl *et al* 2018). The Mediterranean diet refers to a mainly plant-based diet, which consists of a high amount of cereals and whole grains, fruit and vegetables, legumes, nuts, olive oil, low to moderate consumption of fish and poultry, low consumption of red meat and a moderate consumption of red wine with meals (Esposito & Guiguilano 2014). The ADA (2019), states that for those with T2DM, not on insulin, an emphasis should be placed on portion control and healthy food choices facilitated by the diabetes plate resource (ADA 2019).

With carbohydrate counting, the individual is taught to identify carbohydrates in foods (carbohydrate awareness) and determine the amount of carbohydrates that are consumed at one time (McArdle, Mellor, Rilstone & Taplin 2016). They are then taught to give the correct amount of insulin depending on the portion of carbohydrate to prevent hyper and hypoglycaemia and maintain normal blood glucose levels (Lightfoot & Pytka 2004). The National Institute for Health and Care Excellence (NICE) guidelines recommend that carbohydrate counting should be offered to all adults with T1DM as part of self-management structured education (NICE 2015). For those who are not able to gain access to such structured education groups, it is recommended that it be given on a one on one basis. Carbohydrate counting has been shown to improve glycaemic control as well as quality of life, but must be taught by someone who has clinical expertise in this field, such as an experienced registered dietitian (McArdle *et al* 2016).

Carbohydrate counting is considered a standard for the management of T1DM in the USA and UK (ADA 2019; Dyson, Kelly, Deakin, Duncan, Frost, Harrison, Khatri, Kunka, McArdle, Mellor & Oliver 2011). However, SEMDSA does not address this practice in their current guidelines and there is little or no published data on the use of carbohydrate counting in South Africa (SA) (SEMDSA 2017). There are currently no published dietary guidelines for the management of T1DM in South Africa. The ADA recommends that carbohydrate counting should form part of the standard care for patients with T1DM (ADA 2019; Chaiyakot, Somwang, Hathaidechadusadee, Areevut, Saetung, Saibuathong, Jerawatana, Pabua & Reutrakul 2017). The UK-based NICE Guidance (2015) emphasises that dietary advice given to adults with T1DM should include advice regarding weight control and reduction of cardiovascular risk. It is also required to be sensitive to individual and cultural requirements (NICE 2015). The National Institute for Health and Care Excellence (NICE) also recommends that newly diagnosed type 1 diabetics should be given an opportunity to attend an evidence-based structured education program like Dose Adjustment for Normal Eating (DAFNE), within 6-12 months of diagnosis. It is recommended that carbohydrate counting should be offered as part of the structured education for adult patients with T1DM. According to NICE, advising patients with T1DM to follow a low glycaemic index (GI) diet, is not recommended (NICE 2015).

The Diabetes Control and Complications Trial (DCCT) was a prospective, randomised multicenter trial conducted by the United States National Institute. It compared the effects of intensive insulin therapy to conventional therapy on long-term complications of diabetes in 1441 participants with type 1 diabetes between 1982 and 1993. It found that adhering to a therapeutic diet for diabetes was essential for optimal blood glucose control (Delahanty & Halford 1993). Health care professionals have the challenge of simplifying nutrition interventions to ensure and encourage compliance (Anderson, Richardson, Castle, Cercone, Delahanty, Lyon, Mueller & Snetselaar 1993). Carbohydrate estimation as discussed by Daniels, Grobbelaar & Mufamadi (2016), can be done with the aid of measuring cups, spoons, exchange lists and food scales. According to Anderson *et al* (1993), exchange systems/lists are used as a meal planning approach to provide variety and maintain consistency in carbohydrate content, to achieve glycaemic control. An exchange of starch, fruit and milk contain similar amounts of carbohydrate and can therefore be substituted for each other. This promotes consistency as well as flexibility (Anderson *et al* 1993). The rule of thumb used by dietitians described in this trial was that one unit of insulin will cover

10-15 g of carbohydrate. This is the same principle used in carbohydrate counting. Carbohydrate counting focuses on the amount of carbohydrate eaten and promotes consistency and flexibility. It is said to be more precise than the other methods used. The decision of which intervention to choose is dependent on the experience of the dietitian doing the education, as well as the needs of the patient (Anderson *et al* 1993).

Although carbohydrate counting is used as a method to achieve glycemic control globally, very few studies have shown evidence to support the effectiveness of carbohydrate counting (Laurenzi, Bolla, Panigoni, Doria, Uccellatore, Peretti, Saibene, Galimberti, Bosi & Scavini 2011). A meta-analysis by Shimin, Linjun, Shuhua, Liping & Zhiping (2016), showed that there was little evidence on the effectiveness of carbohydrate counting, however, when comparing carbohydrate counting to other dietary management methods, carbohydrate counting significantly reduced glycosylated haemoglobin (HbA_{1c}) levels (Shimin *et al* 2016). In general, data on carbohydrate counting from the different meta-analyses is conflicting. A meta-analysis by Bell, Barclay, Petocz, Colaguiri & Brand-Miller (2014), found that more evidence is required to support carbohydrate counting over other dietary methods. Carbohydrate intake should be monitored either with carbohydrate counting or experience-based carbohydrate estimation to achieve optimal glycaemic control. Carbohydrate counting and meal planning should be addressed in patients with T1DM (Chiang, Kirkman, Laffel & Peters 2014).

A review by Dube, Van den Broucke, Dhoore, Kalweit & Housiaux (2015), mentioned that a large self-management aspect was required concerning the management of diet, medication and exercise in patients with diabetes. This self-management requires education and support to make it effective and sustainable. Diabetes self-management education (DSME) is recommended in various settings where there are permittable resources. Numerous DSME programs run internationally, however, developing countries such as South Africa have limited data as to what is available (Dube *et al* 2015). According to a review by Beckert & Van der Merwe (2010) on South African approaches to structured education, there are no current structured patient education programs for private or public health patients. A study by Rausch, Labuschagne & Lombard (2014) recognised the need for a diabetes mellitus training manual for health care professionals in South Africa. The authors suggested that manuals from other countries may not be appropriate for the South African population. The authors developed a manual that was reviewed by an expert panel of dietitians.

The manual was found to improve their diabetes knowledge and it was thought that it could help health professionals provide an improved service to their patients (Rausch *et al* 2014).

Although there are dietary management practices in place for T1DM in the USA, UK and other developed countries, there is limited or no literature regarding practices in developing countries like South Africa. There is therefore a need for research regarding carbohydrate counting practices to be able to support patients with T1DM effectively. There is little or no information on which dietary management approach is most commonly used by dietitians in KwaZulu-Natal (KZN) for patients with DM and whether carbohydrate counting is used in the management of T1DM. There have been no studies on dietitian's perceptions towards the use of carbohydrate counting in the dietary management of T1DM and the barriers to teaching patients to carbohydrate count effectively. It is also not known whether there is a need for further training on carbohydrate counting amongst dietitians in KZN.

1.2 Statement of the problem

This study aimed to determine the practices and perceptions of registered dietitians regarding the use of carbohydrate counting and barriers associated with it in the dietary management of T1DM. It also aimed to determine if there is a need for further training on carbohydrate counting amongst dietitians in KZN.

1.3 Research objectives

1.3.1 To determine which dietary management approach is most commonly used by dietitians in KZN when educating patients with T1DM.

1.3.2 To determine if dietitians in KZN use carbohydrate counting in the dietary management of patients with T1DM.

1.3.3 To determine the perceptions of dietitians in KZN towards the use of carbohydrate counting in the dietary management of T1DM.

1.3.4 To determine the barriers which prevent dietitians in KZN from using carbohydrate counting in the dietary management of T1DM.

1.3.5 To determine if dietitians in KZN see a need for further education/training in the area of carbohydrate counting.

1.4 Hypotheses

1.4.1 There is no one specific dietary management approach used by dietitians in KZN when educating patients with T1DM.

1.4.2 There is a low use of carbohydrate counting in the dietary management of T1DM among dietitians in KZN.

1.4.3 Dietitians in KZN perceive carbohydrate counting as a useful and effective method in the dietary management of T1DM; however, they are not able to put it into practice.

1.4.4 The barriers that prevent the use of carbohydrate counting in the dietary management of T1DM are a lack of training, experience, resources, time and support.

1.4.5 Dietitians in KZN see a need for further education/training in the area of carbohydrate counting.

1.5 Study parameters

1.5.1 Only dietitians registered with the Health Professions Council of South Africa (HPCSA) and practicing in the province of KZN, at the time of the study, were invited to participate. The study was conducted in KZN because of the high prevalence of diabetes in KZN. Approximately 34.1% of the KZN population is estimated to have diabetes according to Sahadew, Singaram & Brown (2016). Another report looking at Durban only, reported a prevalence of 12.9%, which is one of the highest in SSA (Hird, Pirie, Esterhuizen, O'Leary, McCarthy, Young, Sandhu & Motala 2016).

1.5.2 Only dietitians involved in the dietary management of patients with T1DM at the time of the study were included.

1.5.3 Dietitians completing their Community Service at the time of the study were not included in this study due to their limited experience in the dietary management of T1DM.

1.6 Assumptions

1.6.1 Dietitians understood the questions in the questionnaire.

1.6.2 Dietitians answered the questionnaire truthfully and without bias.

1.6.3 Dietitians who participated in the study did not discuss their answers with other dietitians participating in the study.

1.7 Definition of terms

Carbohydrate counting - for the purposes of this study, carbohydrate counting is a meal planning approach or technique for patients with diabetes that require the adjustment of insulin in response to the carbohydrate content of their meal.

Diabetes mellitus - a metabolic disorder that has numerous causes but presents with the characteristics of hyperglycaemia and changes in carbohydrate, fat and protein metabolism, due to decreased or defective insulin action and/or secretion. Common complications of diabetes are both macro and micro vascular and include retinopathy, nephropathy and neuropathy (SEMDSA 2017).

Diabetes self-management education (DSME) - is a continuing process of aiding the facilitation of knowledge, skill, and motivation for individuals living with diabetes to self-manage their diabetes (SEMDSA 2017).

Dietary Management – for the purposes of this study, dietary management of diabetes mellitus encompasses a variety of different meal planning methods to nutritionally manage diabetes. One of these methods is carbohydrate counting.

Dietitian - "qualified health professional registered with the Health Professions Council of South Africa (HPCSA) who has a minimum qualification of a four year Bachelor of Dietetics or Bachelor of Science in Dietetics degree or a two-year post-graduate nutrition and dietetics degree with training in all aspects and fields of nutrition therapy. Dietitians are the only qualified health professionals that assess, diagnose and treat diet and nutrition problems, both at an individual and at public health level. Dietitians use the most up-to-date evidence on food, health and disease, which they translate into practical guidelines to enable people to make appropriate lifestyle and food choices" [Association for Dietetics in South Africa (ADSA) 2016].

Glycaemic index - is a comparative ranking of carbohydrate in foods according to how they affect the blood glucose levels. Carbohydrates with a glycaemic index (GI) value of 55 or less are deemed as low GI and are more slowly digested and cause a slower rise in blood glucose and insulin levels. [Glycaemic Index Foundation of South Africa (GIFSA) 2017].

Medical nutrition therapy - is defined as "nutritional, diagnostic, therapy and counselling services for the purpose of disease management, which are furnished by a registered dietitian or nutrition professional." The ADA defines nutrition counselling as "a supportive process to set priorities, establish goals and create individualized action plans which acknowledge and foster responsibility for self-care" (Morris & Wylie-Rosett 2010).

Perceptions - is defined as "the way in which something is regarded, understood, or interpreted" (Concise Oxford English Dictionary 2006, p1063).

Practices - for the purposes of the study, practices are what dietitians are currently doing in terms of treating T1DM through dietary management.

Structured education - for the purposes of the study, structured education is an education program that is skills-based and presented in a structured manner for people with diabetes.

Telemedicine - the use of information and communication technology to improve patient outcomes by increasing access to care and medical information for diagnosis, treatment and prevention of disease and injury (Ryu 2012).

Type 1 diabetes mellitus - a type of diabetes that results from the destruction of pancreatic beta cells, which causes an insulin deficiency. Although the cause is unknown, it may be immune-mediated and/or idiopathic. Type 1 diabetes can lead to ketoacidosis, coma and death (SEMDSA 2017).

Type 2 diabetes mellitus - a type of diabetes that occurs due to a progression in the loss of insulin secretion coupled with insulin resistance, which is a disorder of insulin action. This type of diabetes can range from insulin resistance to relative insulin deficiency to primarily an insulin secretory deficiency with insulin resistance (SEMDSA 2017).

1.8 Summary

There are many facets to diabetes management and medical nutrition therapy (MNT) is one of them. Carbohydrate counting forms part of MNT and has been shown to improve glycosylated haemoglobin (HbA_{1c}). Although the results are not conclusive, it is still a preferred method to other insulin dosing procedures. Carbohydrate counting is not widely used by dietitians in SA, for unknown reasons. Due to a lack of published data in this area, this study aimed to determine the practices and perceptions of registered dietitians regarding the use of carbohydrate counting in the dietary management of T1DM. It also aimed to identify possible barriers to implementing carbohydrate counting and to determine if there is a need for further training on carbohydrate counting amongst dietitians in KZN.

CHAPTER 2
REVIEW OF RELATED LITERATURE

2.1 Introduction

This chapter reviews the definition and types of diabetes mellitus as well as diagnosis, prevalence and complications. The management of diabetes mellitus, including the role of carbohydrate counting is also reviewed.

2.2 Diabetes mellitus

Diabetes mellitus (DM) is a metabolic disorder that is characterised by persistent hyperglycaemia and carbohydrate, fat and protein metabolism disturbances, due to a lack of insulin secretion and action (SEMDSA 2017). It is classified according to the following categories: type 1, where there is autoimmune beta cell destruction leading to absolute insulin deficiency, type 2 where there is a progressive loss of beta cell function, gestational diabetes and other types of diabetes due to additional causes (ADA 2017).

2.2.1 Definition and types of diabetes mellitus

Type 1 diabetes mellitus (T1DM) is an autoimmune condition that requires insulin to be administered lifelong due to pancreatic insufficiency. Insulin is required to prevent hyperglycaemia and diabetic ketoacidosis (DKA) (Iqbal, Novodvorsky & Heller 2018). Diabetic ketoacidosis is defined by the biochemical criteria of hyperglycaemia (blood glucose >11 mmol/l), venous pH < 7.3 and ketonuria. The severity of DKA is categorised by the degree of acidosis. To manage T1DM, both the health professional and the patient require knowledge and understanding of T1DM (Wolfsdorf, Allgrove, Craig, Edge, Glaser, Jain, Lee, Mungai, Rosenbloom, Sperling & Hanas 2014). Optimal management of T1DM is required to prevent micro and microvascular complications and avoid hypoglycaemia (Iqbal *et al* 2018). Type 1 diabetes mellitus is found in only 5-10% of all cases of diabetes globally, and these patients are prone to ketoacidosis, coma and death. This type of diabetes has no known aetiology, but it may be immune-mediated or idiopathic (ADA 2017; SEMDSA 2017).

Type 2 diabetes mellitus (T2DM) is characterised by insensitivity to insulin due to insulin resistance or a decrease in insulin production, where the result is pancreatic beta cell failure (Olokoba, Obateru & Olokoba 2012). This in turn leads to a decrease in glucose transportation and uptake and therefore an increase in the breakdown of fat and hyperglycaemia. Inadequate levels of insulin and insulin resistance result in hyperglycaemia (Olokoba *et al* 2012). Type 2 diabetes mellitus is managed by diet and lifestyle modification; however, pharmacological agents are used if diet and lifestyle modifications are not adequate. Metformin is a commonly used pharmacological agent that suppresses hepatic glucose production, increases insulin sensitivity and enhances glucose uptake (Olokoba *et al* 2012). Type 2 diabetes mellitus also has no specific known aetiology, but most patients who present with T2DM are overweight or obese and the increased weight in turn causes a degree of insulin resistance (ADA 2017; SEMDSA 2017).

2.2.2 Diagnosis of diabetes mellitus

Early diagnosis of diabetes is crucial for better health outcomes [World Health Organization (WHO) 2016]. Easy access to healthcare for diagnosis at a primary care level is essential to increase the chances of these improved health outcomes (WHO 2016). The WHO stipulates that diabetes should be diagnosed by measuring glucose in a fasting blood sample or a blood sample taken two hours after a 75 g oral glucose load. A glycosylated haemoglobin (HbA_{1c}) measurement may also be useful as it reflects the average blood glucose levels over the previous few weeks or months, rather than a blood glucose measurement at a specific point in time (WHO 2016). It is not easy to differentiate and diagnose the different types of diabetes, especially in adolescents and young adults. However, it is important to determine the type of diabetes at diagnosis so that the appropriate therapy can be determined (ADA 2017). Type 1 diabetes mellitus typically has an acute onset, and usually occurs in patients 30 years and younger, with a lower body mass index (BMI). The provision of insulin is essential at diagnosis for survival and the prevention of ketoacidosis. Patients who are newly diagnosed with T1DM have a characteristic presentation of polyuria, polydipsia, weight loss, blurred vision, and occasionally increased appetite (ADA 2017; SEMDSA 2017). Type 2 diabetes mellitus has a much slower onset and often goes undetected for a long period of time (WHO 2016). The criteria for the diagnosis of diabetes, adapted from the ADA (2018) is tabulated in Table 2.1.

Table 2.1: Criteria for the diagnosis of diabetes (adapted from the ADA 2018)

Fasting plasma glucose (FPG) ≥ 126 mg/dl (7.0 mml/l). Fasting is defined as no caloric intake for at least 8 hours.*
OR
2 hours plasma glucose (PG) ≥ 200 mg/dl (11.1 mmol/l) during an oral glucose tolerance test (OGTT). This test should be performed as described by the World Health Organization (WHO), using a glucose load containing the equivalent of 75 g anhydrous glucose dissolved in water.*
OR
Glycosylated haemoglobin [HbA_{1c} ≥ 6.5% (48 mmol/l)]. This test should be done in a laboratory using a method that is National Glycohaemoglobin Standardization Program (NGSP) certified and standardised to the Diabetes Control and Complications Trial (DCCT) assay.*
OR
In a patient with classic symptoms of hyperglycaemia or hyperglycaemic crisis, a random plasma glucose ≥ 200 mg/dl (11.1 mmol/l)
*In the absence of unequivocal hyperglycaemia, results should be confirmed by repeat testing.

2.2.3 Prevalence

According to the IDF (IDF Diabetes Atlas 2017, pp6, 12), DM is one of the most prevalent chronic diseases worldwide. There are an estimated 451 million people currently living with diabetes globally, between the ages of 18-99 years (IDF Diabetes Atlas 2017, p43). According to the IDF (IDF Diabetes Atlas 2017, p43), 87-91% of people with diabetes in high-income countries have T2DM, while 7-12% have T1DM. The global prevalence of diabetes has increased substantially, especially in sub-Saharan Africa (SSA) (Pastakia *et al* 2017). It is estimated that there are 15.5 million adults in the African region with diabetes; this number is estimated to increase to 40.7 million by 2040 (IDF Diabetes Atlas 2017, p45). In South Africa, there are an estimated 2.3 million people living with diabetes (IDF Diabetes Atlas 2017, pp68-69; Pastakia *et al* 2017). Type 2 diabetes mellitus is the predominant form of diabetes in SSA. An estimated 85-95% of all cases are T2DM, while only 5-15% are T1DM. With increasing urbanisation, the SSA population has experienced increased exposure to a sedentary lifestyle, increased consumption of calories, fat and sugar and a lower fibre intake (Pastakia *et al* 2017). The IDF estimates that 5.4% of the adult

population in South Africa are living with diabetes. However, South Africa has a lower prevalence compared to the USA (10.8%), but higher than the UK (4.3%) (IDF Diabetes Atlas 2017, pp112, 116, 120).

Sahadew *et al* (2016) investigated the distribution, incidence and prevalence of diabetes over a two-year period in KwaZulu-Natal, South Africa. The crude prevalence of diabetes mellitus in KZN was 34.1% in 2014. Of the 34.1%, 14.3% had access to the public health sector only. Data collection did not differentiate between T1DM and T2DM, however, when analysed according to age profile, the data correlated with the existing literature that the prevalence of diabetes is higher in those over the age of 19 years, compared to those under the age of 19 years (Sahadew *et al* 2016).

2.2.4 Complications

Glycaemic control is strongly associated with the risk of progression of diabetes-related complications such as diabetic nephropathy, gastroparesis, neuropathy, retinopathy, cardiovascular disease, peripheral heart disease and stroke (SEMDSA 2017; Dyson *et al* 2011). As the prevalence of DM increases, the complications associated with diabetes do too, which in turn makes it a very costly disease to manage. Although there is a lack of data regarding the economic burden of diabetes in Africa, the IDF estimates that Africa spends 6% of its health care budget on diabetes care (IDF Diabetes Atlas 2017, p54). Diabetes complications are common in patients with T1DM and T2DM. They encompass both macrovascular and microvascular complications, with microvascular complications having a much higher prevalence (Papatherodorou, Banach, Bekiari, Rizzo & Edmonds 2018). The long-term vascular complications of diabetes include nephropathy, neuropathy, retinopathy and macrovascular diseases. These result in renal failure and hypertension, blindness and visual impairment, pain, muscle weakness and autonomic dysfunction as well as cardiovascular diseases (Donaghue, Marcovecchio, Wadwa, Chew, Wong, Calliari, Zabeen, Salem & Craig 2018).

2.2.4.1 Macrovascular complications

Cardiovascular disease is a group of disorders of the heart and blood vessels and includes coronary heart disease, cerebrovascular disease, congenital heart disease and rheumatic heart disease (IDF Diabetes Atlas 2017, p86). Cardiovascular disease is a major cause of mortality in those with

diabetes (SEMDSA 2017). Diabetics are at a twofold increased risk of cardiovascular disease (Dyson, Twenefour, Breen, Duncan, Elvin, Goff, Hill, Kalsi, Marsland, McArdle & Mellor 2018; IDF Diabetes Atlas 2017, p86). High levels of blood glucose can cause increased coagulation. Diabetes is also associated with high blood pressure and cholesterol levels, which can also lead to increased cardiovascular complications. Lipid abnormalities and disturbances are common in patients with diabetes and should be assessed and treated in all patients with diabetes (SEMDSA 2017).

2.2.4.2 Microvascular complications

Microvascular complications of diabetes can lead to death and disability. Although persistently high glucose levels is the primary cause of diabetic complications, it is not the only one. Diabetic complications are increased in those with high blood pressure and dyslipidaemia. The current approach to prevent diabetic complications is to achieve targets for glycaemic, blood pressure and lipid control (Nickerson & Dutta 2012).

Nephropathy

In South Africa, T2DM and hypertension are associated with kidney failure. According to SEMDSA (2017), the prevalence of nephropathy (diabetic kidney disease) in South Africa in 2017 was 14-16%. Approximately 30% of patients with diabetes were on renal replacement therapy (SEMDSA 2017). Chronic kidney disease is defined as the presence of kidney damage or decreased kidney function over a period of three or more months. Lowering blood pressure is the most effective way of preventing nephropathy and intensive glycaemic control may help to slow down the progression of the disease (SEMDSA 2017).

Diabetic eye disease

Diabetic eye disease consists of diabetic retinopathy, diabetic macular oedema, cataract and glaucoma. It is a direct result of chronic hyperglycaemia, which damages the retinal capillaries, leading to capillary blockage and leakage, with possible blindness. The risk for retinopathy is increased in people with T1DM, people that have diabetes for a longer period and those of a lower socioeconomic status (IDF Diabetes Atlas 2017, p88). Diabetic retinopathy is the most common complication of diabetes. Patients with T1DM are known to develop retinopathy 20 years after

diagnosis, whereas those with T2DM can develop retinopathy as early as seven years after diagnosis (Fowler 2008).

Neuropathy

Diabetic neuropathies manifest in different clinical ways and the early management and treatment of them is important. Neuropathy can be symptomatic or asymptomatic and can be classified as peripheral or autonomic neuropathy. It can be described as the presence of signs and symptoms of peripheral nerve dysfunction in people with diabetes after ruling out other causes (ADA 2019). Patients that have had T1DM for longer than five years and all patients with T2DM should be assessed for peripheral neuropathy (ADA 2019). The risk of developing neuropathy is dependent on the duration and severity of hyperglycaemia, as with other microvascular complications (Fowler 2008). Peripheral neuropathy manifests in different forms including sensory, focal/multifocal and autonomic neuropathies. Diabetic autonomic neuropathies can cause mortality and morbidity in patients with diabetes and manifest in the following forms: gastroparesis, constipation, diarrhoea, erectile dysfunction and bladder dysfunction amongst others (Fowler 2008).

Gastroparesis

Gastroparesis or chronic delayed gastric emptying without a mechanical obstruction is associated with poor glycaemic control. A diagnosis of gastroparesis should be considered when blood glucose control becomes unpredictable and hypoglycaemia is increased. It can cause vomiting, poor oral intake and weight loss and is associated with a diet deficient in energy, vitamins and minerals (Dyson *et al* 2018)

2.2.4.3 Co-morbidities

Obesity

Approximately 80-90% of patients with T2DM worldwide are overweight or obese (SEMDSA 2017). Weight gain is a risk factor in the development of diabetes. A 5-10% weight loss is associated with the prevention of diabetes and this has also been shown to reduce the risk of cardiovascular disease (SEMDSA 2017). A minimum of 15% weight loss has been shown to improve blood glucose levels and potentially reverse diabetes (SEMDSA 2017).

Hypertension

Hypertension is a modifiable risk factor for microvascular and macrovascular diseases. Blood pressure should be monitored in diabetics at every clinic visit. People with T2DM and hypertension are at increased risk for organ damage (SEMDSA 2017). Lifestyle modifications such as weight loss, dietary sodium restriction, increased consumption of fruit and vegetables and increased activity levels are all important in managing hypertension. These modifications can enhance the effectiveness of some antihypertensive medications and also promote overall cardiovascular health. Lifestyle modifications alongside pharmacologic therapy are used in the management of hypertension (ADA 2019).

The next section reviews the management and treatment of T1DM, with greater emphasis on dietary management practices.

2.3 Management of diabetes mellitus

2.3.1 Aims of management

The aims of diabetes management are to avoid acute decompensations, prevent or delay complications and mortality and maintain quality of life (ADA 2019). The management plan for diabetes should take the patient's age, current lifestyle, cognitive abilities, and health beliefs, support systems, eating patterns, physical activity, cultural factors, financial concerns, diabetic complications, co-morbidities and other medical conditions into consideration (ADA 2019). According to Hommel, Schmidt, Vistisen, Neergaard, Gribhild, Almdal & Nørgaard (2017), the aim of insulin treatment in individuals with T1DM is to obtain as near as normal blood glucose levels to prevent complications associated with diabetes. To maintain normoglycaemia, the insulin dose should match both food intake and exercise, as both these influence blood glucose levels (Hommel *et al* 2017). This can either be achieved by a fixed insulin dose method, where individuals adjust their intake and activity according to the amount of insulin prescribed, or a more flexible approach where insulin dose is adjusted according to meals and activities performed (Hommel *et al* 2017). This method of insulin dose calculation is complex as it involves estimating the carbohydrate content of the meal consumed, and an evaluation of factors that affect blood glucose levels such as stress, illness and activity (Hommel *et al* 2017). Postprandial blood glucose levels play a significant role in glycaemic control and the aim is for patients to maintain a two-

hour postprandial blood glucose level of less than 10 mmol/l (Fortin, Rhabasa-Lhoret, Roy-Fleming, Desjardins, Brazeau, Ladouceur & Gingras 2017). To achieve this, patients need to adjust their insulin dose to the quantity of carbohydrate ingested (Fortin *et al* 2017). The management of T2DM is seen as more complex because it affects both insulin secretion and insulin action. Therefore, the management will depend on the stage of the disease progression as well as the individual being treated (Simó & Hernández 2002).

2.3.2 Challenges with management

Managing diabetes is a challenge in African countries, as diabetes is often undiagnosed because of a weak health care system and a failure to screen patients for diabetes. Management of the disease is further hindered by a lack of diabetes education and the use of traditional healers in management. A lack of trained health care professionals in SSA leads to diabetes being managed by traditional healers and general practitioners, who are inadequately integrated into the healthcare system (Mutyambizi, Pavlova, Chola, Hongoro & Groot 2018; Kengne, Amoah & Mbanya 2005). In a South African study, traditional healers were reluctant to refer patients to medical practitioners and diabetics would consult traditional healers alongside medical practitioners. Treatments used by traditional healers in this study included prayers, herbs and diet, but no physical activity. It was recommended that medical practitioners monitor patients that use natural products given by traditional healers (Peltzer, Khoza, Lekhuleni, Madu, Cherian & Cherian 2001). In a pilot study by Mbeh, Edwards, Ngufor, Assah, Fezeu & Mbanya (2010), 106 traditional healers in Cameroon were trained on a range of topics related to diabetes prevention and care. It was concluded that traditional healers could learn diabetes prevention strategies quickly and could contribute to health promotion (Mbeh *et al* 2010).

According to Mbanya, Motala, Sobngwi, Assah & Enoru (2010), a major challenge faced by diabetics in Africa is the lack of access to insulin, which leads to poor glycaemic control and complications associated with diabetes. The indirect and direct costs of diabetes per person in African countries is more than double the gross national income per head (Mbanya *et al* 2010). Idemyor (2010) also highlights that the challenges faced by diabetics in sub-Saharan Africa include a lack of health system organisational structure for the management of chronic diseases and a lack of experience to make informed decisions about prevention and treatment strategies (Idemyor

2010). In most parts of SSA, a newly diagnosed type 1 diabetic is not expected to survive longer than a year after diagnosis, due to poorly equipped health care facilities (Pastakia *et al* 2017).

2.3.3 Nutritional management

One of the biggest challenges with diabetes management is making the decision about what to eat (Evert, Boucher, Cypress, Dunbar, Franz, Meyer-Davis, Neumiller, Nwankwo, Verdi, Urbanski & Yancy 2014). The ADA recognises that there is a no one size fits all approach to eating patterns and recommends that nutrition therapy should play an integral role in diabetes management (Evert *et al* 2014). According to the ADA Standards of Diabetes Care, the newly diagnosed diabetic should ideally be referred to a registered dietitian for nutrition therapy, as soon as possible after diagnosis (Evert *et al* 2014). Nutrition therapy should include intensive flexible insulin therapy education using carbohydrate counting meal planning, which has been shown to improve glycaemic control. In the USA, only half of the people living with diabetes reported receiving diabetes education and less are reported to have been seen by a dietitian. It is recommended that MNT should include a nutrition assessment, nutritional diagnoses, nutrition interventions as well as nutrition monitoring and evaluation, which includes ongoing follow-up to support, evaluate and modify any changes, where needed. The registered dietitian is the preferred member of the health care team to provide MNT based on training, skills and expertise (Evert *et al* 2014).

2.3.3.1 Medical nutrition therapy

Medical nutrition therapy is defined and described by Pastors, Warshaw, Daly, Franz & Kulkarni (2002), as the use of specific nutrition services to treat an illness, injury or condition, including diabetes. For diabetes, MNT includes the following steps:

1). Assessing the patient's nutritional knowledge, skills and management of diabetes.

2). Identification of individual nutritional goals.

3). Nutrition intervention matching a meal planning method to the patient individual needs, with an emphasis on remaining flexible, so that the patient can implement the plan at home.

4). Evaluation of outcomes and ongoing monitoring (Pastors *et al* 2002).

The provision of MNT by a registered dietitian has been shown to decrease HbA_{1c} by 0.3-1% in people with T1DM. In T2DM, the evidence shows a reduction in HbA_{1c} of between 0.5-2% when MNT was used in management (SEMDSA 2017). Focus should not be placed on specific nutrients, but on healthy eating, that contains nutrient-dense high quality foods (ADA 2017). Medical nutrition therapy encompasses nutritional, diagnostic, therapy and counselling services provided by a registered dietitian or nutrition professional to assist in disease management (Morris & Wylie-Rosett 2010). Table 2.2 shows the characteristics of effective MNT (SEMDSA 2017).

Table 2.2: Characteristics of effective medical nutrition therapy (adapted from SEMDSA 2017)

Contact sessions:
A series of 3-4 encounters with a registered dietitian (RD) lasting for 45-90 minutes. This should start at diagnosis and should be completed within 3-6 months. The RD should determine whether additional encounters are needed. At least one annual follow-up is recommended for reinforcement, monitoring and evaluation of outcomes.
Assessment:
Age, gender, anthropometric measurements, weight history, associated conditions, glycaemic control, nutrition history (24-hour recall and food frequency questionnaire), economic status, lifestyle factors (e.g. work logistics), cultural eating patterns, activity patterns, psychological and cognitive factors impacting on eating behaviour, level of literacy, use of medication and supplements.
Education:
Acquiring good nutritional knowledge is the first step towards change. Patients need to develop an understanding of food composition classification, how nutrients influence weight status, glycaemic control and associated conditions. The former serves to empower patients to make informed food choices. Patients often know what to do but find it difficult to apply the knowledge practically to achieve positive outcomes. Patients require practical tools such as a personalised, practical eating plan, a seven day cycle menu, and a shopping list that is in line with the family's lifestyle, culture, socio-economic status and food preferences. It is important to maintain the pleasure of eating by providing positive messages about food.
Monitoring
Monitoring sessions provide accountability and assist the patient to formulate solutions to their barriers to adherence. The tools dietitians use include; the five A's approach (ask, assess, assist, advice and arrange) goal setting, self-monitoring (food diaries), cognitive restructuring, relapse prevention, incentives, motivational interviewing and modelling. Problem solving together with positive feedback and reinforcement enhance the patient's level of self-efficacy, which is important to create and sustain healthy eating habits.

Wylie-Rosett, Delahanty & Diabetes Prevention Program Research Group (2002) investigated the dietitians' role in the context of diabetes prevention. Conclusive evidence was found that dietitians play a key role in lifestyle intervention. It was found that lifestyle intervention is more effective than medication in the prevention of T2DM. Lifestyle interventions included healthy eating, exercise, self-monitoring of eating habits and portion sizes (Wylie-Rosett *et al* 2002).

2.3.3.2 Nutritional guidelines and recommendations

Dyson *et al* (2011) recommends that the carbohydrate content in the diet should be the main nutritional consideration for determining glycaemic control in people living with T1DM. Consistent carbohydrate intake is beneficial for individuals on a fixed or biphasic insulin regime (Dyson *et al* 2011). People that use multiple daily injections and continuous subcutaneous insulin infusion therapy may benefit from adjusting their insulin to their carbohydrate intake. They should be offered support for this as there is evidence that carbohydrate counting can improve glycaemic control, quality of life and general wellbeing, without increasing severe hypoglycaemia, body weight or blood lipids (Dyson *et al* 2011).

The International Society for Paediatric and Adolescent Diabetes (ISPAD) recommends that children and adolescents with diabetes should eat a variety of healthy foods appropriate for age and energy requirements (Smart, Annan, Higgins, Jelleryd, Lopez & Acerini 2018). Growth monitoring is essential in children as there could be numerous reasons for poor growth e.g. insulin omission and food insecurity. An experienced paediatric dietitian is recommended to be a part of the diabetes care team. Nutrition advice should be culturally and ethnically appropriate and psychosocial needs should also be taken into consideration. Insulin should be matched to the carbohydrate content of the food and insulin should be given before the meal. For those on a fixed insulin regime, the carbohydrate content of the meal should be consistent and given according to the type and timing of the insulin regime (Smart *et al* 2018).

A summary of the dietary management for diabetes mellitus from Dyson *et al* (2018) (Diabetes UK), ADA (2019), SEMDSA (2017) and Smart *et al* (2018) (ISPAD) are presented in Table 2.3.

Table 2.3: Summary of dietary management guidelines for diabetes mellitus [ADA 2019; Dyson *et al* 2018 (Diabetes UK); Smart *et al* 2018 (ISPAD); SEMDSA 2017]

	ADA	**ISPAD**	**Diabetes UK**	**SEMDSA**
Goal 1	Promote and support healthy eating patterns • Achieve and maintain body weight goals. • Achieve individual glycaemic goals. • Delay or prevent diabetes complications.	Encourage and promote appropriate lifelong healthy eating habits.	Everyone with diabetes should receive ongoing nutritional advice and education from a registered dietitian.	Achieve individual glycaemic control, blood pressure and lipid goals.
Goal 2	Address individual nutritional requirements based on numerous factors.	Aim to provide three meals a day incorporating a variety of nutritious foods from each food group to maintain a healthy weight.	All people with diabetes should be offered structured education at the time of diagnosis with annual follow-up.	Achieve and maintain weight body goals.
Goal 3	To maintain the pleasure of eating without judgement.	Provide sufficient nutrient and energy intake to promote and support optimal growth.	Education should involve a person-centred approach and a variety of learning styles.	Delay and prevent complications of diabetes.
Goal 4	To provide or equip the individual with diabetes with practical tools for healthy eating patterns.	Achieve and maintain an appropriate body mass index, while promoting physical activity.		
Goal 5		Achieve a balance between food intake, metabolic requirements, insulin requirements and energy expenditure to achieve optimal glycaemic control.		
Goal 6		Prevent, treat and reduce risk of micro and macrovascular complications.		
Goal 7		Maintain and preserve quality of life and support positive behaviour change.		

A variety of dietary approaches has been shown to be effective in the management of T2DM. These include low fat diets, low glycaemic index diets, low carbohydrate diets and the Mediterranean diet. The evidence does not suggest that any method is preferred over others in terms of an effective weight loss strategy. Table 2.4 presents a list of recommendations for carbohydrate intake in diabetics adapted from SEMDSA (2017).

Table 2.4: Recommended nutrient intake for carbohydrates (adapted from SEMDSA 2017)

Monitoring/regulating carbohydrate intake remains a key strategy for glycaemic control.
Carbohydrate intake (both quality and quantity) should be individualised and guided by the patient's glycaemic control.
Carbohydrates that come from whole grains, legumes, low fat milk, vegetables and fruit should be used instead of refined carbohydrates and carbohydrates with added sugar, fats and sodium.
Sugars (including fructose powder and high fructose corn syrup) should ideally contribute < 5% of total energy intake per day to improve overall health. This equates to the sugar found in commercial products e.g. sauces, without adding additional sugar to the diet.
The use of non-nutritive sweeteners (NNS) may reduce overall calorie and carbohydrate intake if substituted for caloric sweeteners. NNS are considered safe if used within the acceptable daily intake levels.
Often vitamins and minerals, herbs and spices are marketed as having clinical benefits for people with diabetes. However, there is no evidence to support the use of such products and thus should not be included in MNT.

2.3.3.3 Diabetes self-management education

Diabetes self-management education (DSME) is designed to provide a structured programme to be able to teach and transfer the skills of insulin dose adjustment from the healthcare professional to the diabetic, hereby enabling the diabetic to take control and responsibility for their diabetes (Harris, Joyce, Miller, Connor, Amiel & Mulnier 2018). Diabetes has a large self-management aspect concerning management of diet, medication and exercise. This self-management requires education and support to make it effective and sustainable. The objectives of DSME are to support informed decision-making, self-care behaviours and problem solving and work together with the

patient's health care professionals to improve clinical outcomes, health status, and quality of life (Burke, Sherr & Lipman 2014). Diabetes self-management education is recommended in various settings where there are permittable resources. Numerous DSME programmes are run internationally; however, developing countries such as South Africa have limited data as to what is available (Dube *et al* 2015).

Diabetes educators are health care professionals who provide in-depth knowledge and skills, counselling and communication to enable diabetic patients to manage their diabetes daily. They are an integral part of diabetes management as they provide individualised education and promote behaviour change. They empower the patient to make shared informed decisions about their diabetes management (Burke *et al* 2014). Globally, there are a number of accredited diabetes educators courses and associations that are recognised. There are two in South Africa namely, Diabetes Education Society of South Africa (DESSA) and Certified Diabetes educators (CDE). According to Daniels (2019), there are no official training courses for dietitians to enable them to teach carbohydrate counting. A small section is covered in the Certified Diabetes Educator course, however, it is not a carbohydrate counting course. Dietitians in South Africa are not legally allowed to adjust insulin doses according to the amount of carbohydrate consumed. The UK-based course DAFNE is not funded in South Africa; therefore, there is no official training for dietitians on the dietary management of diabetes (Daniels 2019).

According to a review article on South African approaches to structured education for T1DM, there are no current structured patient education programmes for private or public health patients. There are numerous factors that contribute to this, namely transport problems or geographical distance to health care facilities, lack of educated health care professionals, lack of human resources, lack of current material and practical time constraints, as structured education programmes are often held over three to five days (Beckert & Van der Merwe 2010). Guidelines on treating and managing diabetes in a resource-limited setting states that diabetes education should be delivered by a trained diabetes educator and should be centered on self-management (Smart *et al* 2018). It should also focus on the needs and education level of the patient and the family being educated. Due to limited resources, blood glucose testing is often not possible, especially at the recommended frequency of testing. Therefore, there are different methods described in the guideline to assist the health care professional and patient to make informed

decisions based on blood glucose readings. Testing blood glucose levels before and after different meals helps to evaluate meals, while testing 3-4 times per day instead of only once a day assists in better decisions making processes. Although urine glucose monitoring has also been mentioned, it has numerous limitations (Smart *et al* 2018).

Dose adjustment for normal eating (DAFNE) is a quality, skills-based structured educational programme for the self-management of T1DM. It is based on UK recommendations for the National Service Framework, which suggests that self-management is essential in the treatment of T1DM. This programme teaches self-management of diabetes using intensive insulin therapy that is tailored to the diet. It is run over five days and is taught by a specialist diabetes nurse and dietitian. The first structured education course, which originated in Germany was a five-day group-training programme and has been used as a standard for people with T1DM for over 30 years. According to Owen & Woodward (2012), there is evidence that DAFNE is an effective education programme that has been shown to improve glycaemic control and quality of life, without increasing the risk of severe hypoglycaemia (Owen & Woodward 2012).

Kids in control of food (KICk-OFF) is a UK-based five-day structured education course for 11-16 year olds with T1DM. A study was conducted with 396 participants (199 intervention; 197 control) recruited from 31 UK paediatric centres. Glycaemic control and quality of life were the main outcome measures and these were measured at 6, 12 and 24 months, respectively (Price, Knowles, Fox, Wales, Heller, Eiser, Freeman & KICk-OFF Study Group 2016). According to Price *et al* (2016), effective diabetes self-management with specific blood glucose targets plays a key role in good glycaemic control in patients with T1DM. A nurse and a dietitian taught carbohydrate counting and insulin adjustment to the patients in a practical and interactive way, as well as the management of hypoglycaemia and hyperglycaemia, ketosis and long-term complications of T1DM (Price *et al* 2016). Results showed that KICk-OFF was associated with a significant improvement in the quality of life at six months, but there was no significant improvement in glycaemic control at 24 months (Price *et al* 2016).

Diabetes, insulin and normal eating (DINE) is a five-day South African course based on the UK curriculum of the evidence-based course DAFNE. Topics covered by DINE include glucose self-monitoring, practical nutrition sessions, insulin dose adjustment and exercise. Statistically significant results were seen concerning quality of life, treatment satisfaction and improved

glycaemic control. Patients must be able to attend a five-day course in order to be suitable for DINE (Daniels 2010).

2.3.3.4 Studies supporting nutritional management

Various randomised control trials [Sadur, Moline, Costa, Michalik, Mendlowitz, Roller, Watson, Swain, Selby & Javorski (1999); Kulkarni, Castle, Gregory, Holmes, Leontos, Powers, Snetselaar, Splett & Wylie-Rosett (1998); Franz, Monk, Barry, McClain, Weaver, Cooper, Upham, Bergenstal & Mazze (1995); United Kingdom (UK) Prospective Diabetes Study 7 (1990)], showed an improvement in HbA_{1c} and blood glucose levels when dietitians incorporated the steps of MNT into diabetes management (Pastors *et al* 2002). This review article commented on the Diabetes Control and Complications Trial (DCCT), which reported that there were four nutrition behaviours associated with significant reductions in HbA_{1c}. These behaviours involved adhering to a prescribed meal and snack plan, adjusting insulin in response to the size of the meal consumed, treating hyperglycaemia promptly and avoiding over treating of hypoglycaemia (Pastors *et al* 2002).

A survey conducted in the UK evaluating the dietary advice given to people with T2DM by dietitians, found that the there was a large variation in the current practice of UK dietitians (McArdle, Greenfield, Avery, Adams & Gill 2017). Three hundred and twenty dietitians participated in the survey and were asked what the term ‘carbohydrate awareness’ meant to them. Two hundred and eighty one participants stated that carbohydrate awareness meant identifying foods and drinks that contain carbohydrate; 228 stated that it was education about portions of common foods that contain equivalent amounts of carbohydrates and 161 indicated that it was education about the actual quantities of carbohydrate in common foods. In this survey 78% of the participants reported that carbohydrate awareness was ‘almost always’ given. The most popular definition for carbohydrate awareness was education about identifying foods and drinks that contain carbohydrate. However, due to the frequency of the use of the term ‘carbohydrate awareness’ amongst dietitians, McArdle *et al* (2017) identified that there was a need for this term to be further described and defined as a dietary intervention (McArdle *et al* 2017).

In a retrospective study of 141 participants aged 2-18 years, it was found that more frequent blood glucose testing had a beneficial effect on HbA_{1c} (Davey & Segal 2015). It was shown that there was a statistical significance in the reduction of HbA_{1c} in correlation to an increase in the amount

of injections per day, as well as an increase in blood glucose monitoring. It was stated that blood glucose analysis aids in meal planning and dosage adjustments, and this in turn decreases variability in glycaemia (Davey & Segal 2015). According to Delahanty & Halford (1993), diet is an essential part of treating diabetes. People with T1DM often find that managing the diet is one of the most difficult aspects of diabetes management. The DCCT trial found that HbA_{1c} was significantly lower in the population that followed their meal plan more than 90% of the time, compared to those who followed it only 45% of the time. According to this study, limitations made it impossible to determine whether one meal planning method was better than another was. Those patients that adjusted their insulin dose according to diet changes had a significantly lower HbA_{1c}, than those who never adjusted their insulin dose (Delahanty & Halford 1993).

2.3.4 Medical therapy

Insulin therapy started in 1922 with an injection of regular insulin given before every meal, and one given at night or in the early hours of the morning. In 1935, intermediate and long-acting insulins were developed and patients moved to one or two injections a day, as opposed to multiple daily injections (MDI) (Danne *et al* 2018). A study by Johnsson in 1960 found that patients receiving only one or two injections a day, were at a much higher risk of retinopathy than those receiving MDI therapy (Johnsson 1960). According to recommendations from Smart *et al* (2018), intensive insulin therapy with basal and prandial insulin is the gold standard. This includes insulin pump therapy as well as MDI (Smart *et al* 2018*)*. Current recommendations for T1DM treatment are that subcutaneous background or long-acting insulin should be given to cover the basal requirements, while rapid-acting insulin should be used to prevent and correct rises in blood glucose. This should be done alongside frequent self-monitoring of blood glucose levels (Tascini, Berioli, Cerquiglini, Santi, Mancini, Rogari, Toni & Esposito 2018).

The provision of exogenous insulin via insulin injections does not always guarantee adequate metabolic control to avoid diabetic complications. Therefore, some developed countries make use of insulin analogues and technology such as continuous insulin infusion therapy (CSII) and continuous glucose monitoring, to improve the treatment of T1DM. This allows therapies to try to emulate the physiological role of the pancreas in the future, in turn improve lifestyle, and decrease complications (Atkinson, Eisenbarth & Michels 2014). Danne *et al* (2018) recommends that insulin therapy be started as soon as possible after diagnosis (within six hours), to prevent diabetic

ketoacidosis. Optimal glycaemic control and treatment as close to physiological insulin replacement as possible, should be given using locally available basal and prandial insulins (Danne *et al* 2018). It has also been recommended that regardless of which insulin regime is chosen, comprehensive education should support the choice. Table 2.5 shows a summary of the different types of insulin with their descriptions (Danne *et al* 2018).

Table 2.5: Insulin types and descriptions (Danne *et al* 2018)

Insulin type	**Description**
Regular insulin (short-acting)	• Regular soluble insulin. • Used for pre-meal bolus injections 20-30 minutes before meals. • Combined with intermediate acting insulin or basal analogue.
Rapid-acting insulin analogue	• Short duration of action. • Given immediately before a meal. • Quicker effect to regular insulin.
Intermediate-acting analogues	• Suitable for twice daily regimes. • Associated with greater variability compared to soluble basal insulins. • Used in a twice daily regime to allow for coverage of snacks.
Basal insulin analogue	• Reduced daily variability. • Longer duration of action. • More expensive.
Premixed insulin preparations	• Suitable for twice daily regimes. • Fixed meal ratios of pre-meal and basal insulins.

New treatments such as improved rapid-acting and basal analogue insulins as well as insulin pumps, require a degree of carbohydrate counting to maintain glycaemic control (Kawamura 2007). More recently, the use of insulin analogues have been shown to be similar to the body's natural insulin response. They have a much quicker action time than that of regular insulin. Basal insulins as well as the insulin pump allow patients with T1DM to have more stable glycaemic control, independent of meals and meal bolus insulin (Kawamura 2007). A German study that investigated the cost-effectiveness of treating patients with T1DM with rapid-acting insulin analogue versus regular human insulin, found that it was more cost-effective to use the rapid-acting insulin analogue as the prandial insulin, when used as part of the basal bolus regime (Valentin, Van Brunt, Boye & Pollock 2018).

According to Danne *et al* (2018), continuous subcutaneous insulin infusion (CSII) is safe for all ages and this therapy allows for precise insulin dosing in a flexible manner, without the need for injections. The pump can be set to have hourly basal insulin rates and different prandial bolus options. It is therefore an insulin regimen of choice in areas that have access to them (Smart *et al* 2018). Continuous glucose monitoring is a system, which measures interstitial glucose and has the ability to alert the patient to hyperglycaemic and hypoglycaemic episodes. However, it requires the calibration of self-monitoring blood glucose tests and has been confirmed to be associated with lower HbA_{1c} levels. A closed loop insulin pump and continuous glucose monitoring system, which automatically adjusts insulin rates based on blood glucose levels, is one of the newest technologies currently available in the USA (Chamberlain, Kalyani, Leal, Rhinehart, Shubrook, Skolnik & Herman 2017).

The choice of treatment for diabetes mellitus should consider the patient, the healthcare provider as well as the resources available for the choice. Treatment can be complex and the use of insulin therapy in T2DM is an example of this (SEMDSA 2017). According to SEMDSA (2017), patients with T2DM that are considered stable and have suboptimal glycaemic control will be considered for insulin therapy (SEMDSA 2017).

In a South African survey by Amod, Riback & Schoeman (2012), 54 healthcare centres recruited 899 patients across South Africa. The average waist circumference for type 1 and type 2 diabetic patients was above the IDF cut off point (94 cm for males and 80 cm for females). This emphasised the importance of lifestyles changes in the form of nutritional advice, exercise and support to the

individual patient. The mean HbA_{1c} was found to be 8.2%, with 8.8% for T1DM and 8.1% for T2DM. The target as defined by this study was <7%. Following on, it was found that the reason for HbA_{1c} not being within the target was due to a lack of compliance with lifestyle changes (29.5%), as mentioned earlier, and a lack of effectiveness with the diabetic treatment (23.5%). It was noted that 15% of participants diagnosed with T1DM in the survey were taking oral antidiabetic agents, in addition to their insulin therapy. Reasons for this included insulin resistance due to the increased waist circumference. This survey showed that the management of T1DM was suboptimal as they reflected worse HbA_{1c} values when compared to the reference value of <7%. Health care providers are responsible for closing the gap between guidelines, targets and what is actually happening in practice (Amod *et al* 2012).

2.3.5 Physical activity

Physical activity, which encompasses all movement that increases energy expenditure, is essential to diabetes management (ADA 2017). There is more evidence that exercise and physical activity play a role in the prevention of diabetes-related complications in T2DM, compared to T1DM. However, the health benefits associated with physical activity for T1DM are increased cardiovascular fitness, muscle strength and an improved sensitivity to insulin. High levels of physical activity have been shown to improve HbA_{1c} levels (ADA 2018; ADA 2017); however, there is no strong association between physical activity and better glycaemic control. Physical activity may decrease blood glucose levels because it is associated with hypo and hyperglycaemia. The activity is also dependent on the amount, type and timing of insulin and carbohydrate consumed (Dyson *et al* 2018; ADA 2017).

Physical activity has numerous benefits for people living with diabetes. It can contribute to a reduction in cardiovascular risk, prevent or decrease complications associated with diabetes and can aid in reducing stress and anxiety. Glycaemic control is seen to be improved in individuals with T2DM, but the effect on HbA_{1c} for individuals with T1DM is not as strong. However, physical activity is encouraged in all individuals with all types of diabetes due to the benefits previously mentioned (Hayes & Kriska 2008). There are no guidelines for physical activity for South Africans living with T1DM as SEMDSA guidelines only address T2DM (SEMDSA 2017).

2.4 The role of carbohydrate counting in the management of type 1 diabetes mellitus

2.4.1 Definition of carbohydrate counting

Carbohydrate counting is a technique that is used for the adjustment of insulin dose levels according to the carbohydrate content of the meal (Hirose *et al* 2011). Kawamura (2007) describes carbohydrate counting as a meal planning approach for people with T1DM or T2DM, which focuses on carbohydrates as the primary macronutrient affecting postprandial glycaemic response (Kawamura 2007). Carbohydrate counting is a meal-planning tool for patients with T1DM that use either multiple daily injections (basal bolus regime) or continuous subcutaneous insulin infusion, to manage their diabetes. With carbohydrate counting, the patient is made aware of the effect that carbohydrate-containing foods have on blood glucose levels (Tascini *et al* 2018). Consistent carbohydrate intake in relation to timing improves glycaemic control in diabetics using fixed dosages of insulin. Those on a more intensive insulin regime will benefit from carbohydrate counting (ADA 2017).

2.4.2 Carbohydrate counting in the 21st century

After the discovery of insulin in 1922, it was soon discovered that the total glucose value of the meal consumed could be used to calculate the insulin dosages required (Kawamura 2007). The optimal diabetes diet in 1927 contained 100 g of carbohydrate per day, regardless of the insulin used (Wheeler & Pi-Sunyer 2008). Historically, the meal plan for patients with T1DM was calculated using exchanges, lines and portions, with carbohydrates that were equally distributed throughout the day. Other forms of counselling included weighed carbohydrate exchanges in the 1950s and the food plate model of the 1980s. In the 1980s, people living with T1DM were expected to follow rigid meal plans with controlled and restricted amounts of carbohydrate. The carbohydrate was distributed to match the twice daily insulin regimes that were available at the time. In the 1990s, the effect of intensified insulin therapy on glycaemic control was studied in the DCCT. It was shown that intensive insulin therapy had a positive effect on glycaemic control and reduced the long-term complications of T1DM, as well as allowing patients more flexibility with food choices (Kawamura 2007).

Improved blood glucose monitoring systems allow the patient with T1DM to vary the carbohydrate content of their meals by adjusting their insulin dosages, based on blood glucose levels and physical activity. This then has the benefit of avoiding hyperglycaemia and hypoglycaemia, while

allowing the patient to feel less restricted by their diet (Connor, Annan, Bunn, Frost, McGough, Sarwar & Thomas 2003). Carbohydrate counting was first reported to be used in 1987 and was one of the four meal planning approaches used in the DCCT trial. This method was effective in achieving glycaemic control as well as allowing for flexibility with food choices (Kawamura, Takamura, Hirose, Hashimoto, Higashide, Kashihara, Hashimura & Shintaku 2015; Kawamura 2007). According to Tascini *et al* (2018), patients should be taught to quantify the amount of carbohydrates by visualisation, using education tools like plate models or hand portions.

2.4.2.1 Level one, two and three carbohydrate counting

Gillespie, Kulkarni & Daly (1998) identified three levels of carbohydrate counting, in order to achieve glycaemic control. Level one is the basic level, where patients are introduced to the concept of carbohydrate counting and encourages consistent carbohydrate intake. This level can be used in T1DM, T2DM and gestational diabetes. This method involves reading nutritional labels and suits patients who are able to master basic skills. It is also suitable for those whose carbohydrate intake is inconsistent and require a less structured meal planning method (Gillespie *et al* 1998).

Level two introduces factors, which affect the blood glucose levels i.e. exercise, and medication and considers the relationship between food and blood glucose pattern management. In this level, the patient works alongside the dietitian and looks at recorded blood glucose levels to identify possible reasons for hypoglycaemia and hyperglycaemia. The solution involves adjustment of insulin, timing of activity levels and the amount of carbohydrate eaten. This method can be used in T1DM, T2DM and gestational diabetes and are for patients who have mastered level one. It also requires more advanced skills in carbohydrate counting (Gillespie *et al* 1998).

Level three is for patients who are on an intensive insulin regime, namely multiple daily injections, or continuous insulin infusion therapy. This level introduces the concept of insulin to carbohydrate ratio and using this, allows the patient to match their insulin dose to their carbohydrate intake. This level uses short or rapid acting insulin and the dietitian is able to calculate the insulin to carbohydrate ratio in one of two ways. The carbohydrate gram method looks at the amount of consistently eaten carbohydrate at the meal and the amount of insulin used to achieve the blood glucose target (Gillespie *et al* 1998). Equation one shows an insulin to carbohydrate ratio calculation and equation two shows how to calculate insulin using carbohydrate choices.

Equation one: Insulin to carbohydrate ratio

60 g carbohydrate consumed ÷ 6 units Lispro (rapid acting human insulin analog)
= 1 unit Lispro: 10 g carbohydrate

E.g. 60g carbohydrate eaten, divided by 6 units Lispro (rapid acting human insulin analog) allows the insulin to carbohydrate ratio to be 1 unit Lispro=10g carbohydrate (Gillespie *et al* 1998).

Equation two: Carbohydrate choices

6 carbohydrate choices consumed
= 9 units insulin required to meet postprandial blood glucose target

Therefore

Insulin to carbohydrate ratio = 1 carbohydrate choice: 1.5 units rapid acting insulin

E.g. If a patient consumes six carbohydrate choices at a meal and requires nine units of insulin to meet the blood glucose target postprandially, the insulin to carbohydrate ratio would be 1.5 units insulin per carbohydrate choice (Gillespie *et al* 1998). All three methods are useful for adjusting portion sizes. Blood glucose levels are used as a measure of success for all three levels of carbohydrate counting (Gillespie *et al* 1998).

2.4.2.2 Carbohydrate counting methods

According to Gillespie *et al* (1998), the insulin to carbohydrate ratio uses two methods, i.e. the carbohydrate gram method and the carbohydrate choices method. The carbohydrate gram method uses the carbohydrate consumed at each meal divided by the dose of rapid acting insulin that is required to obtain optimal individualised glycaemic control. If the patient consumes 80 g carbohydrate per meal and uses eight units of rapid acting insulin to achieve glycaemic control postprandially, the insulin to carbohydrate ratio is one unit of rapid acting insulin to 10 g carbohydrate (Gillespie *et al* 1998). The carbohydrate choices method is described as using the number of rapid acting insulin units to achieve optimal glycaemic control, divided by the number of carbohydrate choices or exchanges consumed at a meal. Once the patient understands the

method explained to them, they can adjust their insulin according to the amount of carbohydrate being eaten (Gillespie *et al* 1998).

According to Walsh & Roberts (1994, pp35-44), the '500' rule method seems to be the most commonly used: 450/500 divided by the total daily insulin dose (basal + bolus). The number calculated is therefore the insulin to carbohydrate ratio (Gillespie *et al* 1998). Kawamura (2007) also use this approach in calculating the insulin to carbohydrate ratio and state that some health professionals start with a 1:15 g ratio for adults and 1:20-25 g for children. If a patient used 50 units of total insulin in a day, their ratio would be 1:10 g (Kawamura 2007).

Although carbohydrate counting is an essential part of diabetes management, there is no clear evidence on which method of carbohydrate estimation is better, when comparing precise 1 g increments, 10 g portion estimations or 15 g exchanges (Smart, Ross, Edge, Collins, Colyvas & King 2009). The level of precision with carbohydrate estimation accuracy required to obtain optimal postprandial glycaemic control is unknown. Smart *et al* (2009) aimed to determine whether there would be a difference in postprandial glycaemic control if the same individualised insulin dose was given for 50 g, 60 g and 70 g carbohydrate. This study concluded that small estimation errors of 10 g and less would not make a difference to postprandial glycaemic control, and therefore precise carbohydrate estimation using 1 g increments was not necessary to obtain optimal postprandial glycaemic control in subjects using intensive insulin therapy (Smart *et al* 2009).

2.4.2.3 Glycaemic index and carbohydrate percentage

Since 1940, there has been much debate as to how much and what type of carbohydrate is optimal for people with diabetes. The Recommended Dietary Allowance (RDA) for carbohydrate is 130 g/day for adults and children. This is based on the minimum amount of glucose that is needed by the brain. The average intake (AI) for carbohydrate for men is 220-330 g/day and 180-230 g/day for women. This allows carbohydrate to contribute between 45-65% of total energy. Carbohydrate intake exceeding this range may increase the risk of coronary heart disease and obesity (Wheeler & Pi-Sunyer 2008). According to Wheeler & Pi-Sunyer (2008), there are two methods to improve GI and manage carbohydrate intake. These methods include adjusting insulin dose to match the carbohydrate content of the meal (carbohydrate counting) or having a day-to-day consistency in

carbohydrate intake, and adjusting insulin, dependent on the meal. There is no specific percentage of energy assigned to carbohydrate and the amount is based on the individual preferences, medication and physical activity level. In terms of the GI and overall glycaemic control, there is very little evidence for the use of the GI. However, an improvement has been noted in glycaemic control when those eating a diet with a higher GI switched to a diet with a lower GI (Wheeler & Pi-Sunyer 2008). Chiesa, Piscopo, Rigamonti, Azzinari, Bettini, Bonfanti, Viscardi, Meschi & Chiumello (2005), reiterated in a conference report that the amount of carbohydrate in a diabetic diet is more important than the type. Consistency in the amount and type of carbohydrate has been shown to improve glycaemic control. Therefore, the variation in the amount of carbohydrate consumed has been shown to improve HbA_{1c}, rather than the GI (Chiesa *et al* 2005).

According to SEMDSA (2017), there is no ideal percentage of energy that should come from carbohydrates, protein and fat. The intake should rather be based on individual assessment. Specifically with regard to carbohydrate, it states that carbohydrate monitoring and regulation is essential for diabetes control and both carbohydrate intake and quality should be individualised according to patient needs (SEMDSA 2017). Steyn & Levitt (2004, pp759-760) describe the diabetes dietary guidelines of the American Diabetes Association (ADA) as well as the European Association for the study of Diabetes (EASD), however, the paucity of published data on the guidelines of the dietary management of diabetes in South Africa, is also highlighted. To date, the only published guidelines in South Africa come from the Journal of Endocrinology, Metabolism and Diabetes of South Africa (JEMDSA) and it is for T2DM. There are no current South African recommendations for the dietary management of T1DM (Steyn & Levitt 2004, p760). The published guidelines are similar to the ADA and EASD, although the South African guidelines recommend a lower intake of carbohydrate, compared to the ADA. This may pose a problem for patients in the African context, as carbohydrates make up 70-80% of the total energy intake in African countries and 63-80% of the total energy intake in sub-Saharan African countries. These carbohydrates are made up of maize, wheat and sorghum, while sugar also plays a substantial role in the energy intake. Protein comes mostly from animal sources with a low dairy consumption. It was reported that low to middle-income groups consumed 70% carbohydrate, 15% fat and 15% protein, while higher income groups consumed 43% protein, 40% carbohydrate and 17% fat (Steyn & Levitt 2004, p761).

Nutrition therapy should take into account the cultural, economic and literacy levels of the patient (Steyn & Levitt 2004, p761). According to Steyn & Levitt (2004, p761), practical guidelines for meal planning are required to educate people with diabetes about dietary management. As these guidelines are not available in South Africa, Steyn & Levitt (2004, p761) suggest that the ADA guidelines for meal planning approaches should be followed. These include the 'plate model', which involves making healthy food choices by following simple diabetic exchanges or carbohydrate counting, as described earlier. Steyn & Levitt (2004, p762) highlight that there are additional recommendations required for patients with T1DM regarding the use of pre-meal insulin, adjusted to the carbohydrate content of their meal (Steyn & Levitt 2004, p762).

2.4.3 Studies on the use of carbohydrate counting

Exchange systems are used as a meal planning approach in the management of diabetes to provide variety and maintain consistency in carbohydrate content, in order to achieve glycaemic control (Anderson *et al* 1993). This is the same principle used in carbohydrate counting. One starch, fruit and milk exchange contain similar amounts of carbohydrate and can therefore be substituted for each other. This promotes consistency as well as flexibility. The rule of thumb used by dietitians described in this trial is that one unit of insulin will cover 10-15 g carbohydrate. Carbohydrate counting focuses on the amount of carbohydrate eaten and promotes consistency and flexibility. It is said to be more precise than the other methods used (Anderson *et al* 1993).

A study by Fortin *et al* (2017) that aimed to identify the practice, perceptions and expectations of patients about carbohydrate counting, found that patients used the following tools to facilitate carbohydrate counting: reading nutritional labels, using carbohydrate exchange tables and quantifying carbohydrate using measuring instruments. Eighty-nine percent read nutrition labels and only 42% reported visiting a health care professional in the previous year to revise carbohydrate counting. The survey also showed that 78% of the participants (n=180) were confident in incorporating carbohydrate counting into their daily lives. Participant's suffering from depression had a significantly decreased level of confidence and those that had a lower level of education, found it significantly more difficult to carbohydrate count (Fortin *et al* 2017).

Thirty-three participants with T1DM who participated in a controlled open-label clinical trial were randomised to those using advanced carbohydrate counting or those using basic carbohydrate counting. All patients were on a basal bolus regime using either multiple daily injections or CSII.

Patients were assigned to either basic or advanced carbohydrate counting, according to their ability to understand blood glucose pattern management and insulin to carbohydrate ratios (Souto, Zajdenverg, Rodacki & Rosado 2014). According to Souto *et al* (2014), basic carbohydrate counting is where the individual eats a consistent amount of carbohydrate at meals, is able to understand the effect of food and medication/insulin on their glucose levels, and is able to identify food portion sizes. The advanced method requires the patients to understand glucose pattern management and insulin to carbohydrate ratios. This study showed an increase in BMI and waist circumference in the patients that used advanced carbohydrate counting, when compared with the basic carbohydrate counting. However, when nutritional counselling was implemented, these differences disappeared. Patients that used advanced carbohydrate counting were seen to have increased food intake, which was likely due to the increased flexibility in eating and diversity in food choice (Souto *et al* 2014).

2.4.4 Effectiveness of carbohydrate counting versus other meal planning methods

The DCCT trial emphasised that adhering to a therapeutic diet for diabetes is essential for optimal blood glucose control. Health care professionals have the challenge of simplifying nutrition interventions to ensure and encourage compliance. In this trial, four nutrition interventions were described. These included healthy food choices, total available glucose (these are not currently used in South Africa in this specific format), exchange systems and carbohydrate counting. Carbohydrate counting and the exchange system are the most common methods used in the South African context. The aim of these interventions was to provide the dietitian with meal planning approaches that would assist patients to achieve glycaemic control, by adjusting their insulin dosage and food intake accordingly (Anderson *et al* 1993). The decision of which intervention to choose is dependent on the experience of the dietitian, as well as what meets the needs of the patient (Anderson *et al* 1993). The South African Food Based Dietary Guidelines (FBDGs) are science-based policy recommendations to promote healthy eating within a population. They have been designed and adapted for the general South African population and include guidelines on starch and sugar consumption. The purpose of the guidelines is to inform the South African population about healthy eating and to motivate the public to make choices that will result in healthy, balanced diets, which protect again non-communicable diseases like diabetes (Vorster, Badham & Venter 2013).

Although carbohydrate counting is used as a method to achieve glycaemic control and has been shown to be effective, more global studies are required to provide further evidence. In a prospective, clinical trial done by Laurenzi *et al* (2011), 61 adults with T1DM using CSII were randomised to learn carbohydrate counting. The primary outcome of the study was a change in HbA_{1c} at 24 weeks and the secondary outcomes were changes in the quality of life, BMI, waist circumference, hypoglycaemic events, total daily insulin dose, fasting plasma glucose and hypoglycaemia and hyperglycaemia risk indexes. A significant reduction in HbA_{1c}, BMI and waist circumference and a significant improvement in the quality of life, was noted in the carbohydrate counting group (Laurenzi *et al* 2011).

A meta-analysis of the current literature on the effectiveness of carbohydrate counting in comparison to other diet methods, showed that carbohydrate counting resulted in a significant reduction in HbA_{1c}. In the studies analysed, 773 participants contributed to the data on HbA_{1c}. This was shown for the adult population group and not children and young people, possibly, because adults are more likely to learn and apply knowledge on carbohydrate counting (Shimin *et al* 2016).

Carbohydrate counting has been seen to be an effective approach to mealtime insulin dose adjustment with T1DM, but has not been extensively assessed in T2DM (Bergenstal, Johnson, Powers, Wynne, Vlajnic, Hollander & Rendell 2008). There have been no large randomised control studies investigating basal bolus therapy and T2DM or the efficacy of carbohydrate counting in T2DM. In a multi-centre randomised control group study by Bergenstal *et al* (2008), a comparison was made between algorithms for adjusting insulin in 273 patients with T2DM. One group was given set doses of rapid acting insulin pre-meal and the other group was taught to carbohydrate count and adjust their rapid acting insulin, according to the carbohydrate amount consumed. There was a significant improvement in HbA_{1c} in the carbohydrate counting group. A reduction of 1.59% in HbA_{1c} was seen in the carbohydrate counting group, whereas a 1.46% reduction was seen in the control group (Bergenstal *et al* 2008).

A South African study by Kalweit, Briers & Olorunju (2015), aimed to determine the effectiveness of different management techniques used by South African children with T1DM. Quality of life and HbA_{1c} were markers used to determine whether regular insulin use, carbohydrate counting, use of insulin to correct hyperglycaemia and type of insulin used, were successful treatment methods. Eighty children from both public and private health care facilities were included in the

study and a large proportion (89.6%), were not using carbohydrate counting as a management strategy. There was a notable significant difference between those attending the public and private health care sectors. Patients in the public health care setting showed a greater use of premixed insulin and did not correct hyperglycaemia with a correction dose. Children with low compliance are often prescribed premixed insulin, as fewer injections are needed, however, patients on this type of insulin require consistent carbohydrate intake, as opposed to flexible intake. If patients are not compliant with taking their insulin, they invariably have poor dietary compliance. It is recommended that these patients have access to rapid acting insulin to treat hyperglycaemia (Kalweit *et al* 2015). Although premixed insulins cost less, if the patients requiring premixed insulin require additional rapid acting insulin to control hyperglycaemia, the costs are not lower (Kalweit *et al* 2015).

2.4.5 Barriers to the use of carbohydrate counting among patients and dietitians

Leung, Broughton, Scott & Haniak (2014), assessed the barriers to carbohydrate counting among 19 adults with T1DM in Vancouver, Canada. Six main barriers emerged from the focus group discussions: 1) eating out at restaurants; 2) the perception that carbohydrate counting lacks normalcy; 3) added burden to daily life; 4) unpredictability in daily routines; 5) perceived lack of value and 6) inadequate resources. The researchers concluded that there was a need for improved strategies to support the use of carbohydrate counting among diabetics, as part of intensive insulin therapy (Leung *et al* 2014).

A cross-sectional study by Lancaster, Pfeffer, McElligott, Ferguson, Miller, Wallace & Lane (2010), assessed treatment barriers in young adults with T1DM. The study found that although carbohydrate counting was essential in managing blood glucose on a daily basis, the young adults that participated found it difficult to incorporate carbohydrate counting into their daily lives. Eighty-three participants between the ages of 17-29 years were recruited and it was found that the statement: ‘It is easy to make a mistake counting the number of carbohydrates (servings or grams) in a meal’, was statistically significantly correlated to HbA_{1c} levels. If a patient did not feel comfortable in counting carbohydrates or if they felt it was too difficult or inconvenient to their lifestyle, they avoided counting carbohydrates and rather injected a standard amount of insulin or skipped a meal. This then led to the young adult not following the treatment regime planned for them. The study hypothesised that if young adults with T1DM were more confident with

carbohydrate counting, they would not see it as inconvenient and may use it more frequently (Lancaster *et al* 2010).

According to Steyn & Levitt (2004, pp766-767), there are a number of barriers to effective and efficient dietary management of diabetes. There is a lack of trained dietitians to deliver nutrition education to those with diabetes, and only 16% of patients with diabetes in rural areas of South Africa have access to a dietitian. Guidelines that originate in the USA or Europe are not specific to the South African population, and adapting these guidelines have drawn on economic resources. Health care professionals often misunderstand or are unaware of their patients' health beliefs regarding diabetes, therefore it is a great challenge to overcome these barriers to provide optimal nutrition therapy (Steyn & Levitt 2004, pp766-767).

In the Steno Automated Bolus Calculator (ABC) study by Hommel *et al* (2017), two groups (n=130) of adult patients on multiple daily injections, who were unaware of carbohydrate counting, were randomised to advanced carbohydrate counting. The two groups used either mental arithmetic or an automated bolus calculator to calculate insulin dose adjustments. This study was conducted over a 12-month period, with HbA_{1c} as the primary outcome. Estimation of carbohydrates in a meal and the calculation of insulin that goes with it requires good mathematical skills. Low numeracy levels are common and in type 1 diabetics, poor glycaemic control and poor numeracy skills have been documented (Hommel *et al* 2017). It was found that the group using an automated bolus calculator had significantly lower HbA_{1c} than those using mental arithmetic (Hommel *et al* 2017).

In a study that aimed to determine ways to overcome barriers to dietary adherence among people living with diabetes, dietitians identified several barriers. These included lack of time, lack of symptoms, lack of education, poor self-esteem/lack of empowerment and misinformation from people other than health care workers. The recommendations for overcoming these barriers were individualised meal plans, forward planning, and goal setting and teaching about complications. The dietitians interviewed in this study emphasised the importance of individualised dietary counselling (Williamson, Hunt, Pope & Tolman 2000)

2.4.6 Dietitian's perceptions of carbohydrate counting

Medical nutrition therapy is vitally important for achieving optimal diabetic control and health care professionals educating these patients need to stay up to date with current practice, in order to treat these patients effectively (Rausch *et al* 2014). Rausch *et al* (2014) assessed the diabetes nutrition and management knowledge of a random sample of dietitians and nurses (n=100), using a validated nutrition and diabetes management questionnaire. It was found that health care professionals lacked adequate basic management knowledge as well as medical nutritional knowledge on diabetes mellitus. The authors developed a manual for health care professionals and when reviewing the manual, the panel of expert dietitians (n=77) commented that the manual improved their diabetes knowledge. The manual included topics such as insulin therapy, carbohydrate counting, exercise and children with diabetes. The authors highlighted that dietitians' knowledge of diabetes with an emphasis on carbohydrate counting, requires ongoing improvement (Rausch *et al* 2014).

A study by Bloise, Xuereb, Baldelli & Maldonato (2003), conducted a carbohydrate counting workshop with 39 healthcare professionals (29 doctors, nine nurses and one dietitian). At the end, the healthcare professionals completed a questionnaire listing the difficulties encountered and feelings experienced during the workshop. Just under half (47%) of the healthcare professionals found that assessing the weight of food portions was the most difficult practical application, while 44% of the respondents indicated that the workshop encouraged them to increase experiential learning and group work with patients. The workshop also encouraged them to check that the patients were given precise instructions and that the patient's knowledge on carbohydrate counting was evaluated regularly (Bloise *et al* 2003). The study concluded that all healthcare professionals and not just dietitians, should teach carbohydrate counting to diabetics. This would allow for greater support for patients with T1DM (Bloise *et al* 2003).

2.4.7 Strategies to increase the use of carbohydrate counting amongst diabetics with type 1 diabetes mellitus

In resourced countries, carbohydrate counting and adjusting the insulin to carbohydrate ratio accordingly, forms the basis of the basal bolus regime. In under-resourced countries, most individuals are on a fixed dose regime. Although this does not allow for the same flexibility, carbohydrate counting can ensure that the correct amount of carbohydrates are consumed to match the insulin peaks and to minimise hypoglycaemia and hyperglycaemia (Sunni, Brunzell, Kyllo, Purcell, Plager & Moran 2018). Carbohydrate counting alongside the use of a bolus calculator may decrease plasma glucose fluctuations and increase plasma glucose fluctuations post meal, to within the set target range (Yamada, Okada, Nakajima, Bastie, Tagaya, Osaki, Shimoda, Shibusawa, Saito, Ozawa & Yamada 2017).

A cross-sectional study reviewed 46 mobile applications that were designed to calculate insulin dosages using planned carbohydrate intake and blood glucose measurements. Mobile applications may enhance insulin dosing by assisting in accurately quantifying carbohydrate intake, and may reduce the perceived burden on calculations associated with carbohydrate counting. Approximately 1 050 000 people worldwide downloaded the applications that were associated with this study. Although these applications have the potential to help protect against unwanted calculation errors, they do carry a risk of incorrect dose calculations. Authors recommended that health care professionals should proceed with caution when recommending these applications to patients and make sure that they have been regulated by the appropriate authorities (Huckvale, Adomaviciute, Prieto, Leow & Car 2015). There has been a great interest in diabetes self-management recently, as diabetes is one of the only chronic diseases that can be self-managed, and the need for a diabetes self-management tool is becoming increasingly necessary. The number of mobile applications supporting diabetes self-management was 260 in February 2011. Mobile applications are reliant on the patient to input data, which makes the information increasingly inaccurate (Jung, Kim, Chung & Park 2014). The usability and utility of these patient-centred applications should be investigated and should take the patient's needs, limitations and expectations into consideration, when being designed in order to increase accuracy and usage (Demiris, Afrin, Speedie, Courtney, Sondhi, Vimarlund, Lovis, Goossen & Lynch 2008).

2.5 Conclusion

Carbohydrate counting is one of the dietary management approaches that can be used in the management of T1DM. There is evidence that the use of carbohydrate counting decreases HbA_{1c} and improves quality of life for those living with diabetes. Medical nutrition therapy and diabetes management require an individualised approach to achieve glycaemic control. Carbohydrate counting is a key dietary management intervention to achieve glycaemic control and an optimal HbA_{1c}. There is a lack of South African data on the practices and perceptions of registered dietitians regarding carbohydrate counting, and to what extent it is used in the dietary management of diabetes. Because there are currently no published South African guidelines regarding the treatment and dietary management of T1DM, it would be useful to determine which dietary methods are being used by registered dietitians to manage patients with T1DM. This study aimed to determine the practices and perceptions of registered dietitians regarding the use of carbohydrate counting in the dietary management of T1DM. It also aimed to identify possible barriers to implementing carbohydrate counting and to determine if there is a need for further training on carbohydrate counting amongst dietitians in KZN. The methods used to meet the objectives of the study are discussed in the next chapter.

CHAPTER 3
METHODOLOGY

This chapter describes the methods used in the study. It outlines the literature supporting the methodology used, the study design, the study population and sample selection. The study pilot study, data quality control, statistical analysis of the data, reduction of bias and ethical considerations are also discussed.

3.1 Study design

This was a cross-sectional descriptive study. Cross-sectional studies are the most commonly used research designs in the area of social science. This design is best suited to studies aimed at investigating prevalence, situations, problems or attitudes. This type of design studies a specific cross-section of the population at one time (Kumar 2011, p107). A descriptive study describes a situation or problem and collects information about attitudes, perceptions, practices and knowledge of a specific community or group (Kumar 2011, p10). Survey research is described and defined by Ponto (2015) as 'The collection of information from a sample of individuals through their responses to questions.' Ponto (2015) continues by saying that this type of research can use a variety of methods to obtain the information required.

3.2 Study population and sample selection

The study population included dietitians that were registered with the HPCSA and working in private and government settings within the province of KZN, at the time of the study. KwaZulu-Natal was chosen as the study site due to the high prevalence of diabetes in the province. Approximately 34.1% of the KZN population is estimated to have diabetes (Sahadew *et al* 2016). Durban has a diabetes prevalence of 12.9%, which is one of the highest in SSA (Hird *et al* 2016). Dietitians that were completing their community service at the time of the study were excluded, due to limited exposure to practice. This was ensured by only allowing an option for more than one year of practice experience within the questionnaire itself. Community Service dietitians would have less than one year of practice experience, at the time of data collection. The KwaZulu-Natal Department of Health was approached via the National Institute for Health Research (NHIR) to invite dietitians employed by the Department of Health to participate in the study. The Association for Dietetics in South Africa (ADSA) in KZN was also approached to

recruit their members to participate in the study. A total of 173 ADSA members and approximately 100 Department of Health (DOH)-employed dietitians were eligible to participate in the study. The ADSA members received an email from ADSA with a link to the online questionnaire, while a link was uploaded to the DOH intranet for the DOH-employed dietitians.

3.3 Study methods and materials

3.3.1 Self-administered questionnaire

A self-administered questionnaire was developed for this study. This questionnaire was used to collect the data needed to meet the study objectives and was administered electronically. With self-administered questionnaires, there is no researcher to explain or clarify the meaning of the questions; therefore, the questions must be clear and easy to understand. The sequence of the questions should be in such a way that it is easy to follow and appeasing to the eye. A statement explaining the relevance of the question should precede a difficult or sensitive question (Kumar 2011, p146).

Survey questionnaires are one of the main research methods used in health-related research (Bowling 2005). With survey questionnaires, there are many different modes of administration and data collection and these modes have varied potential influences on the responses. Data for self-administered questionnaires/surveys can be collected in different ways such as post or electronic mail (Alreck & Settle 2004, p7). Web surveys can be defined as self-administered questionnaires collected via a survey on the internet. Advantages of this method include reduction of data collection costs, they can be conducted quickly compared to other methods as well as reduced data handling issues. The disadvantages are that it requires internet access, the population may be limited and literacy is essential (Leedy & Ormrod 2010, pp190-191). According to a review of the barriers and advantages of online surveys by Jones (2017), barriers to online survey participation included the appropriate timing of the survey with regards to when would be the best time of the year for participants to answer the survey. Due to the timing of the approval from the DOH, the survey was sent out over a three month period (December-January) and this could have been seen as a good time for people to answer a survey as their work load would be potentially lower during the holiday period. Email security was another barrier as certain email security settings might have prevented respondents from answering the survey. An additional barrier was that an unintended recipient could have answered the survey (Jones 2017).

Electronic based self-administered questionnaires have the advantage of slowing the pace of the questioning, therefore potentially yielding more accurate, carefully considered answers. With electronic questionnaires, the order in which the questions are answered is controlled. This prevents the respondent from previewing the questions or not answering the questions in the order laid out (Bowling 2005). According to Bowling (2005), when questions are presented visually in a self-administered survey, respondents are quite likely to choose the first option presented to them. Self-administered surveys have the ability to increase the willingness to answer questions that are more sensitive because there is greater anonymity. Surveys have the advantages of being flexible and versatile as they can measure basic information such as demographics and more complex information such as perceptions and attitudes (Alreck & Settle 2004, p7). This is one of the reasons why a self-administered survey type of questionnaire was chosen for this study. A self-administered web survey was used to collect data using the above-mentioned guidelines in this study. A web survey was used, as the study population were graduate health professionals who would most likely have access to the internet. Wright (2005) states that a web survey also saves time and money and allows for easy data collection.

3.3.1.1 Development of the questionnaire

The questions in a questionnaire should be focused, brief and clear (Alreck & Settle 2004, p89). This entails that a single specific issue is addressed in the question. It is important to be as brief as possible so that there is less subject error as the longer the question, the more difficult it is for the respondent to answer. The questions are required to have clarity so that the meaning of the question is clear to all respondents. This ensures that there is only one interpretation of the question (Alreck & Settle 2004, pp89-91). The questions are also required to contain words that the respondent will understand and the grammar used should be based on what the least sophisticated respondents will understand (Alreck & Settle 2004, pp 93-94). Questions can be open or close-ended. Open-ended questions are where the participant writes down the answer in their own words or if interviewed, it is recorded verbatim or summarised. Statistical analysis for this method may be difficult, but questions can be answered in-depth. A closed-ended question is one where a set of responses is provided and the respondent chooses the appropriate answer. These are used to elicit factual responses, but the information lacks depth and variety (Kumar 2011, p153; Maree 2007, pp161-164).

A Likert scale is one of the most widely used scales in questionnaires and the most common scale is the 'agreement' scale. It provides a way to measure the respondents' attitude and usually comprises four to seven categories. It states the opinion and obtains the level of agreement or disagreement. The answers are in an already coded format and can be easily compared. An advantage of this method includes ease of use and flexibility (Alreck & Settle 2004, pp120-122).

The questionnaire (Appendix A) was divided into six sections, namely Section A: Demographic data; Section B: Diabetes management and practice; Section C: Dietary management practices; Section D: Training regarding carbohydrate counting; Section E: Barriers to carbohydrate counting; Section F: Perceptions regarding carbohydrate counting. Table 3.1 describes the questions in each section. A Likert scale of agreement was one of the types of questions used in the questionnaire. The coding used for the Likert scale in the questionnaire was according to the agreement scale where: Strongly disagree =1; Disagree=2; Slightly disagree=3; Slightly agree=4; Agree=5; Strongly agree=6. Section C, D, E and F used this type of scale, whereas Section F used an additional scale with the following coding: Not at all effective=1; Extremely effective=5. The average agreement score was tested against the central score of 3.5. If the result was significant it meant that the average agreement score was significantly different from 3.5. There was significant agreement/disagreement if the mean score was greater or less than 3.5, respectively.

Table 3.1: Sections in the self-administered questionnaire

Section A	Demographic data	Questions included age, years of practice, qualifications, and in which sector the participant worked.
Section B	Diabetes management and practice	Questions included what type of diabetes the dietitian managed, the age of the patients, and the time spent with the patient.
Section C	Dietary management practices	Scales of agreement were used to determine which practices were mostly used by the dietitians.
Section D	Training regarding carbohydrate counting	Questions were asked on which training the dietitians had regarding diabetes management and which guidelines were followed.
Section E	Barriers to carbohydrate counting	An agreement scale was used to identify the barriers to carbohydrate counting.
Section F	Perceptions regarding carbohydrate counting	Likert scale questions were used to determine the dietitian's perceptions of different carbohydrate counting methods.

Table 3.2 shows the study objectives, the section in which it was covered and the specific question numbers in the questionnaire.

Table 3.2: Sections, objectives and variables measured in the questionnaire

Objective	Section	Question
1. To determine which dietary management approach is most commonly used by dietitians in KZN when educating patients with T1DM.	C	1,3,4
2. To determine if dietitians in KZN use carbohydrate counting in the dietary management of patients with T1DM.	C	1,3,4
3. To determine the perceptions of dietitians in KZN towards the use of carbohydrate counting in the dietary management of T1DM.	F	1,3
4. To determine the barriers which prevent dietitians in KZN from using carbohydrate counting in the dietary management of T1DM.	C,E	2,1
5. To determine if dietitians in KZN see a need for further education/training in the area of carbohydrate counting.	D	1,3

The researcher evaluated different studies with a similar design and questionnaire structure to assist in guiding the types of questions to include in the questionnaire. In an Australian study comparing the practices of dietitians in the nutritional management of liver cirrhosis, both open-ended and close-ended questions were used. SurveyMonkey was used to distribute this survey (Nguyen 2015). Visser, Mackenzie & Marais (2012) conducted a cross-sectional descriptive survey on the job satisfaction of South African registered dietitians. This survey was conducted by email and post and the researchers found that a reminder email or letter to the potential respondents was beneficial in increasing the response rate by 6.3%. An overall response rate of 22.5% was obtained via email and post (Visser *et al* 2012).

Other studies were reviewed concerning sampling technique and study design. In a survey of South African dietitians to investigate their practices regarding chronic renal failure, a response rate of 26% was obtained from a sample size of 600. The survey was sent via postal mail, but all dietitians were encouraged to participate, regardless of whether or not they saw and counselled renal patients (Herselman, Esau, Steel, Allen & Lang 2005). A South African study by Martin, Labadarios, Marais & Wentzel-Viljoen (2008), which aimed to determine dietitians' perceptions about continuing professional development, had a 20% response rate. This study used postal and email methods and a low response rate via the postal method was expected

(Martin *et al* 2008). In a more recent unpublished dissertation by Joyner (2014), the researcher used a similar population of KZN dietitians and method to the current study, and had a response rate of 58%. The participants were contacted via email using an online survey resource. Biggs (2012) conducted a survey of dietitians in KZN about practices regarding malnutrition. This survey was emailed to the respondents and had a response rate of 83%. The current study used a similar methodology as Biggs (2012), as it demonstrated that distributing surveys via email could have a higher response rate than the postal method. A descriptive observational study on the opinion of South African dietitians on the treatment options for intestinal failure used a web-based survey tool to assist in managing and distributing the questionnaires. The questionnaire provided the opportunity to exit the questionnaire early if the respondent did not meet the criteria for the study. Although the sample size was small, it was able to identify a lack of training in the area of intestinal failure as an obstacle in the implementation of fistuloclysis (Du Toit, Boutall & Blaauw 2018).

The ADA, ISPAD, Diabetes UK and SEMDSA guidelines for the management of diabetes were used to develop the questionnaire (ADA 2019; SEMDSA 2017; Smart, Annan, Bruno, Higgins & Acerini 2014; Dyson *et al* 2011). The theme from these guidelines was that nutrition therapy should be individualised as much as possible, as well as obtaining glycaemic control through the promotion and support of healthy eating patterns. Therefore, the questions that were used in the questionnaire for the current study included the time spent with a patient, what preferred advice was given to the patient and if patients attended follow-up appointments. Questions regarding which dietary approach and which resources were most commonly used to support achieving glycaemic control, were also asked.

After reviewing the above information it was decided by the researcher to use an online questionaire containing a link to the survey as it would be cost-effective, have a varied response rate and the means to easily reach the selected study population. The study population were likely to have access to the internet and would not have difficulty accessing such a questionaire.

3.3.1.2 Questionnaire distribution

SurveyMonkey was used to distribute and manage the questionnaire. SurveyMonkey is an internet based survey programme that is useful in survey research (Ponto 2015). The link was attached to an email, which was distributed to the dietitians who were members of the ADSA in KZN. The KZN DOH uploaded the survey on their intranet website under the surveys section, where the DOH dietitians could access the survey. As the DOH dietitians were not

contacted personally, as with the ADSA (KZN) dietitians, permission was obtained from the Nutrition Directorate to contact the respective DOH hospitals where dietitians worked. These hospitals were contacted via email to alert them to the survey on the intranet. A letter of support was issued to the researcher from the Nutrition Directorate (Appendix B). An information sheet and consent letter (Appendix C) was attached to the email that accompanied the survey, explaining the purpose of the study, the length of time it would take to complete the study, incentive to complete the survey, proof of ethics approval as well as assurance of anonymity. A random prize draw of a deli hamper to the value of R500 was used as an incentive to encourage respondents to complete the questionnaire.

The survey link was made available for three months (26 November 2018 - 28 February 2019) for the ADSA KZN members. It was made available from the 20 December - 28 February 2019 for the DOH dietitians, as approval was granted from the DOH in December 2018. Emails reminding dietitians to participate were sent out to ADSA KZN members on 10 December 2018 and the 22 January 2019. Another reminder was sent out three weeks after the initial link was sent out by the ADSA KZN chairperson. Although the DOH dietitians were not sent individual reminders, a reminder to participate in the survey was sent to the respective DOH hospitals, where dietitians worked.

Sixty-nine out of a sample size of 100 DOH dietitians and 173 ADSA members participated in the study, resulting in a response rate of 25%. However, it should be noted that some of the dietitians in DOH were members of ADSA at the time, but it was not known how many. The dietitians could not have participated twice as only one email address per link is allowed, unless the dietitian had two email addresses. According to Shih & Fan (2008), a response rate can be dependent on factors including population type and whether or not follow-up reminders are sent (Shih & Fan 2008). There was a similarity with the current study as follow-up reminders could only be sent to the dietitians that were members of ADSA.

3.4 Reduction of bias

Measures were put in place to minimise bias that could have been created by the participant not completing the questionnaire. The site did not allow the participant to move onto the next section without completing the questions that required answers. A message would display to state that the question that was skipped required an answer. However, participants were allowed to leave the questionnaire at any time to opt out.

3.5 Field testing of the questionnaire

An expert panel reviewed the questionnaire. This expert panel consisted of four dietitians with a special interest in diabetes and carbohydrate counting, working in the private, public and academic sectors. The expert panel assessed the questionnaire for appropriateness and comprehensiveness to meet the objectives. The questionnaire was revised according to their recommendations. The supervisor and a statistician assured the content of the questionnaire by ensuring that the questions answered the research objectives of the study, that there was a logical flow with the questions without any leading, ambiguous or confusing questions. Consistency was ensured by providing subjects with clear and detailed instructions when completing the questionnaire and preventing questions from being skipped.

3.6 Pilot study

Eleven dietitians in provinces other than KZN were invited to participate in the pilot study. These dietitians worked in both public and private sectors. The aim of the pilot study was to correct any errors within the questionnaire, to calculate the time needed for completion of the questionnaire and to make sure that the questions were easy to understand and not ambiguous. The pilot study was sent out via email with a link to the SurveyMonkey questionnaire. The participants were given an opportunity to review the information and consent form. An additional comment section was added at the end of the questionnaire for comments regarding flow, ambiguity and errors found in the questionnaire. Final adjustments were made to the questionnaire once the results of the pilot study had been analysed. The following changes were made to the questionnaire:

- The wording of Section E 1.1 was changed to reduce or prevent confusion.
- Spelling errors were corrected.
- Section A, Question 4 was altered to include a general Masters as an option rather than a Masters specific to dietetics.
- Section A, Question 5 was altered to include a ‘both’ option.
- Addition of ‘other’ boxes for additional answers.

3.7 Data analysis and quality control

Data from the questionnaires was exported into a Microsoft Excel spreadsheet directly from SurveyMonkey. The data exported from SurveyMonkey was coded and checked for errors by the researcher. The data was cross-checked by a research assistant before being analysed by

the statistician. Data was analysed by the statistician using the Statistical Package for Social Sciences (SPSS) version 26.0. The following statistical techniques were used to analyse the data: descriptive statistics, Chi-square/Goodness-of-fit test, Binomial test, One-sample t-test, Independent samples t-test, ANOVA, Pearson's/Spearman's Correlation and Chi-square test of independence. A p-value of <0.05 was regarded as statistically significant. A description of the statistical methods used are described in Table 3.3.

Table 3.3: Description of statistical techniques used to analyse data

Statistical technique	Description
Descriptive statistics	Descriptive statistics included means and standard deviations, where applicable. Frequencies were represented in tables or graphs.
Chi-Square/Goodness-of-fit test	This is an univariate test. It was used on categorical variables to test whether any of the response options were selected significantly more/less often that the others. Under the null hypothesis, it was assumed that all responses were equally selected.
Binomial test	This was applied to test whether a significant proportion of the respondents selected one of a possible two responses. This can be extended when data with more than two response options are split into two distinct groups.
One-sample t-test	This tested whether a mean score was significantly different from a scalar value.
Independent samples t-test	This test compared two independent groups of cases.
ANOVA	This tested for several independent samples that compares two or more groups of cases in one variable.
Pearson's/Spearman's Correlation	These correlations measured how variables or rank orders were related. Pearson's correlation coefficient is a measure of linear association. Spearman's was used for ordinal variables (rank orders).
Chi-square test of independence	This was used on cross-tabulations to see whether a significant relationship existed between the two variables represented in the cross-tabulation. When conditions were not met, the Fisher's exact test was used.

3.8 Ethical considerations

Ethical clearance was obtained from the Humanities and Social Science Ethics Committee of the University KwaZulu-Natal (Reference number HSS/1612/018M) (Appendix D). Approval was obtained from the KZN Department of Health via the NHIR to conduct the study on Dietitians employed by the Department of Health (Appendix E). Permission was also obtained from ADSA (KZN) to conduct the study using their members (Appendix F). The dietitians were informed via a consent letter (Appendix C) attached to the email that by opening the link to the survey, they were giving consent, however, they could opt out of the survey at any time.

CHAPTER 4
RESULTS

This chapter presents and describes the results of the study.

4.1 Demographic characteristics of the sample

Sixty-nine dietitians participated in the study. Although some of them did not complete certain questions, their responses were still analysed for those questions that they did complete.

The demographic characteristics of the dietitians are presented in Table 4.1.

Table 4.1: Demographic characteristics of the dietitians (n=69)

Characteristic	Category	n (%)
Age (years) (n=69)	20-25	9 (13.0)
	26-35	33 (47.8)
	36-45	21 (30.4)
	46-55	4 (5.8)
	56-65	2 (2.9)
University attended (n=69)	North-West University	2 (2.9)
	University of Cape Town	2 (2.9)
	University of KwaZulu-Natal	54 (78.3)
	University of Stellenbosch	6 (8.7)
	University of Pretoria	1 (1.4)
	University of the Western Cape	2 (2.9)
	Other	2 (2.9)
Highest qualification (n=68)	BSc Diet (Honours)	9 (13.0)
	BSc Diet	5 (7.2)
	PGDip Diet	43 (62.3)
	MSc Diet	10 (14.5)
	PhD	1 (1.4)
Sector of employment (n=69)	Private	38 (55.1)
	Public	25 (36.2)
	Both private and public	6 (8.7)
Area of employment (n=69)	Rural	4 (5.8)
	Semi-rural	11 (15.9)
	Urban	54 (78.3)
Number of years registered with the Health Professions Council of South Africa (n=69)	1-10 years	42 (60.9)
	11-20 years	18 (26.1)
	21-30 years	6 (8.7)
	>31 years	3 (4.3)

Just under 50% of the dietitians were 26-35 years of age. The majority (78.3%; n=54) indicated that they had attended the University of KwaZulu-Natal and 62.3% (n=43) indicated that the Post Graduate Diploma in Dietetics was their highest qualification. Two dietitians indicated that they studied at Universities outside of South Africa. One studied at Kings College London and another studied at a university in the USA. Fifty-five percent (n=38) indicated that they worked in the private sector, while 36.2% (n=25) worked in the public sector and 8.7% (n=6) worked in both the public and private sectors. More than 78% (n=54) of the dietitians worked in an urban area, while 15.9% (n=11) and 5.8% (n=4) worked in semi-rural and rural areas, respectively. Sixty percent (n=42) of the dietitians were registered with the Health Professions Council of South Africa (HPCSA) for 1-10 years, with the mean being 10.9 years.

4.2 Diabetes management and practice

Results on diabetes management and practice are presented in Table 4.2. A Chi-square goodness-of-fit test was applied to the information regarding diabetes management practices to assess whether one response was selected significantly more than others were.

Table 4.2: Information regarding diabetes management and practice

Management and practice	Responses	n (%)	p-value*
Is dietary advice given to patients with type 1 diabetes mellitus (T1DM)? (n=62)	Yes	53 (76.8)	**< 0.05**
	No	9 (13.0)	
Type of diabetes that most patients present with (n=62)	Type 1	3 (4.3)	**<0.05**
	Type 2	59 (85.5)	
Age group of most patients with diabetes (n=62)	0-10 years	1 (1.4)	**<0.05**
	11-20 years	1 (1.4)	
	31-50 years	28 (40.6)	
	51-65 years	30 (43.5)	
	>65 years	2 (2.9)	
Average time spent with a patient who presents for the first time with a new diagnosis of T1DM (n=62)	15-<30 minutes	3 (4.3)	0.001
	30-<45 minutes	14 (20.3	
	45 minutes - 1 hour	21 (30.4)	
	>1 hour	24 (34.8)	
Average frequency of follow-up visits for patients with T1DM (n=62)	At least once a month	16 (23.2)	0.126
	At least once every 2 months	11 (15.9)	
	At least once every 6 months	11 (15.9)	
	At least once a year	6 (8.7)	
	Less often than once a year	18 (26.1)	
Methods used to review/follow-up patients (n=62)[#]	Face-to-face	60 (87.0)	**<0.05**
	Skype	0 (0)	
	Email	16 (23.2)	
	Phone	12 (17.4)	
	WhatsApp	2 (2.9)	

* Chi-square goodness-of-fit test; p values in bold are statistically significant
[#] Participants could select more than one option

Although the majority (76.8%; n=53) of the dietitians indicated that they gave dietary management advice to patients with T1DM, a significant 85.5% (n=59) indicated that most of their patients presented with type 2 diabetes mellitus (T2DM) ($p<0.05$). A significant number

of patients with diabetes were between 51-65 years old (43.5%; n=30) and 31-50 years old (40.6%; n=28) ($p<0.05$). A significant number of initial appointments at diagnosis were at least 45 minutes long (30.4% n=21) ($p=0.001$) and a significant number of initial appointments (34.8%; n=24) ($p=0.001$) were > 1 hour in duration. Although not statistically significant, 23.2% (n=16) of patients were seen for a follow-up appointment at least once a month and 26.1% (n=18) were seen less often than once a year. A significant majority of dietitians (87%; n=60) used face-to-face methods for follow-up consultations ($p<0.05$). Only 23.2% (n=16) used email and 17.4% (n=12) used the phone. Interestingly, none of them used Skype for follow-up consultations.

4.3 Dietary management practices

Results on approaches to dietary management practices used or recommended when treating patients with T1DM are presented in Table 4.3. Respondents were asked to rate their level of agreement regarding their use of a set of dietary management practices, using the six-point Likert agreement scale where Strongly disagree =1; Disagree=2; Slightly disagree=3; Slightly agree=4; Agree=5; Strongly agree=6. The average agreement score was tested against the central score of 3.5 to test for significant agreement or disagreement using the one-sample t-test.

Table 4.3: Approaches to dietary management used or recommended when treating patients with type 1 diabetes mellitus (n=58)

	Strongly disagree	**Disagree**	**Slightly disagree**	**Slightly agree**	**Agree**	**Strongly agree**	**Mean agreement score**	**p-value***
	n (%)							
Glycaemic index	2(2.9)	3(4.3)	3(4.3)	12(17.4)	28(40.6)	10(14.5)	4.57	**<0.05**
Portion control using the healthy eating plate.	0(0)	3(4.3)	1(1.4)	3(4.3)	27(39.1)	24(34.8)	5.17	**<0.05**
Carbohydrate counting using scales and weighing items.	4(5.8)	16(23.2)	11(15.9)	15(21.7)	10(14.5)	2(2.9)	3.29	0.239
Carbohydrate counting using nutritional labels.	1(1.4)	6(8.7)	5(7.2)	17(24.6)	25(36.2)	4(5.8)	4.22	**<0.05**
Carbohydrate counting using household measures.	0(0)	3(4.3)	4(5.8)	11(15.9)	30(43.5)	10(14.5)	4.69	**<0.05**
Carbohydrate awareness i.e. making patients aware of which foods contain carbohydrate.	0(0)	0(0)	0(0)	1(1.4)	15(21.7)	42(60.9)	5.71	**<0.05**

*****One-sample t-test; p values in bold are statistically significant

A significant result, with a mean score of greater or less than 3.5 implies significant agreement/disagreement, respectively. There was significant agreement that dietitians used or recommended the following approaches when treating T1DM: glycaemic index, portion control using the healthy eating plate, carbohydrate counting using nutritional labels, carbohydrate counting using household measures, carbohydrate awareness i.e. making patients aware of which foods contain carbohydrate ($p<0.05$ in each case). There was neither significant agreement nor disagreement that carbohydrate counting using scales and weighing items was used by the dietitians in treating T1DM (Table 4.3). When asked if there were any other approaches used to those listed, the following were reported: 'I find that low carb works well', 'It depends on the individual patients education level, compliance etc.', 'restricted processed grains and focusing on whole foods like beans and veg for carbs' and 'The above answers are very dependent on the environment/setting in which one works'.

Additional statistical analysis from the independent samples t-test found that there was a significant difference in the use or recommendation of 'carbohydrate counting using scales and weighing items,' depending on whether the dietitian worked in the private or public sector ($p=0.018$). Specifically, those who worked in the private sector used or recommended this method significantly more than those who only worked in the public sector. There was a significant difference in the use or recommendation of 'carbohydrate counting using nutritional labels,' depending on whether the dietitian worked in the private or public sector ($p=0.015$). Specifically, those who worked in the private sector used or recommended this method significantly more than those who only worked in the public sector.

Respondents were asked to indicate their level of agreement regarding the factors that influenced their choice of dietary management approach. The same Likert agreement scale was used.

Results of factors that determined the choice of dietary management are presented in Table 4.4.

Table 4.4: Factors that determine the choice of dietary management approach (n=58)

	Strongly disagree	**Disagree**	**Slightly disagree**	**Slightly agree**	**Agree**	**Strongly agree**	**Mean agreement score**	**p-value***
	n (%)							
Time constraints	1 (1.4)	5 (7.2)	6 (8.7)	17 (24.6)	12 (17.4)	17 (24.6)	4.47	**<0.05**
Literacy level of patient	0 (0)	0 (0)	5 (7.2)	5 (7.2)	15 (21.7)	33 (47.8)	5.31	**<0.05**
Resources available	0 (0)	6 (8.7)	6 (8.7)	5 (7.2)	17 (24.6)	24 (34.8)	4.81	**<0.05**
Language barrier	4 (5.8)	8 (11.6)	3 (4.3)	9 (13.0)	12 (17.4)	22 (31.9)	4.43	**<0.05**

*One-sample t-test; p values in bold are statistically significant

Results from a one-sample t-test showed that there was a strong significant agreement that time constraints, the literacy level of the patient, available resources and language barriers all played a role in determining the choice of dietary management approach by dietitians ($p<0.05$ in each case). When asked if there were any additional factors to those listed, factors mentioned were: 'a mentally unstable person/addiction issues', research and experience, patients' understanding and ability to complement carbohydrate counting.

Respondents were asked to state which resources they used to assist patients in the dietary management of T1DM. A binomial test was used to test if a significant proportion used a specific resource. Results of the analysis regarding the use of resources used to assist patients in the dietary management of T1DM are presented in Table 4.5.

Table 4.5: Resources used to assist patients in the dietary management of type 1 diabetes mellitus

Category	Frequency of use (% frequency)[#]	p-value*
Healthy eating plate	49 (71.0)	**<0.05**
Exchange lists	29 (42.0)	1.000
Household measures	51 (73.9)	**<0.05**
Food models	31 (44.9)	0.694
Pictorial guide	27 (39.1)	0.694
Other	6 (8.7)	

*Binomial test; p values in bold are statistically significant
[#] Participants could select more than one option

A significant number of dietitians indicated that they used the 'healthy eating plate' (71%; n=49) ($p<0.05$) and 'household measures' (73.9%; n=51) ($p<0.05$) to assist patients in the dietary management of T1DM. Other resources mentioned included actual food products with their labels, food photos, practical weighing in clinic with real food samples, individualised meal plans that are used in state hospitals, pictures of food items and an individualised eating plan that contains a selection of quantified starch and protein choices, practical application exercise and the block system for carbohydrate counting.

Respondents were also asked to indicate their level of agreement with two statements regarding dietary management practices using the six-point Likert scale as before. The one-sample t-test was again used to test for significant agreement or disagreement. Results are presented in Table 4.6.

Table 4.6: Statements regarding dietary management practices

	Strongly disagree	Disagree	Slightly disagree	Slightly agree	Agree	Strongly agree	Mean agreement score	p-value*
	n (%)							
I teach my patients to read the total carbohydrate content from labels on food products.	4 (5.8)	6 (8.7)	3 (4.3)	16 (23.2)	22 (31.9)	7 (10.1)	4.16	0.001
I teach my patients to use an insulin to carbohydrate ratio.	8 (11.6)	7 (10.1)	6 (8.7)	15 (21.7)	19 (27.5)	3 (4.3)	3.67	0.390

*One-sample t-test; p values in bold are statistically significant

There was significant agreement that dietitians taught their patients to read the total carbohydrate content of food from nutrition labels on food products (p=0.001).

4.4 Training regarding carbohydrate counting

Respondents were asked whether or not they had additional diabetes management training and if they answered 'yes', they were asked to specify what training it was. The results of additional diabetes management training are presented in Table 4.7.

Table 4.7: Additional diabetes management training

	Responses	n (%)
Additional diabetes training received	Yes	27 (39.1)
	No	42 (60.9)
Training received		
	CDE	16 (23.2)
	DESSA	6 (8.7%)
	Other	5 (7.2%)

The majority of the dietitians (60.9%; n=42) indicated that they had not received additional diabetes management training (Table 4.7). Those that stated that they had received additional training, received training through the Certified Diabetes Educator Course (CDE) (23.2%;

n=16) and Diabetes Education Society of South Africa (DESSA) (8.7%; n=6) (Table 4.7). Other training received (7.2%; n=5) included: Masters Module, Continuing Professional Development (CPD) events, Paediatric Nutrition Workshop by Dietitians at Work, Certified Product Trainer with Medtronic, ISPAD, Science School for Health Care Professionals (HCPs) 2018, Diabetic Conversation tool kit by Lily diabetes, Informal training and self-learning, Diabetic Conversation tool kit by Lily diabetes and Optifast (Table 4.7).

Respondents were asked to indicate their level of agreement with statements about training regarding carbohydrate counting using the six-point Likert scale. The one-sample t-test was used to test for significant agreement or disagreement. Results from statements on training regarding carbohydrate counting are presented in Table 4.8. Dietitians significantly disagreed with the statement that they received adequate training on carbohydrate counting in their undergraduate degree [M=2.65, SD=1.518, t (56) =-4.233, $p<0.05$] and that their undergraduate training adequately prepared them for educating a patient with T1DM [M=3.04, SD=1.239, t (56)-2.834, p=0.006]. Dietitians significantly disagreed with the statement that they had received specialised training in the dietary management of diabetes [M=2.81, SD =1.586, t (56) =-3.299, p=0.002]. They strongly agreed that they required further training or education in the use of carbohydrate counting as a dietary management approach to manage patients with T1DM [M=4.88, SD=1.151, t (56)= 9.036, $p<0.05$]. Dietitians strongly agreed that they would attend a teaching/training session on the use of carbohydrate counting, if it was available to them [M=5.40, SD=0.842, t (56) =17.064, $p<0.05$]. They strongly agreed that they would find it useful to use an online resource/tool when teaching carbohydrate counting to their patients/clients (e.g. mobile application, web-based calorie counting tool) [M=5.09, SD=1.090, t (56) =10.995, $p<0.05$] (Table 4.8).

Table 4.8: Training regarding carbohydrate counting

	Strongly disagree	Disagree	Slightly disagree	Slightly agree	Agree	Strongly agree	Mean agreement score	p-value*
	n (%)							
I received adequate training on carbohydrate counting as an undergraduate student in my degree.	16 (23.2)	17 (24.6)	6 (8.7)	9 (13.0)	7 (10.1)	2 (2.9)	2.65	**<0.05**
My undergraduate training adequately prepared me for educating a patient with type 1 diabetes mellitus.	7 (10.1)	14 (20.3)	12 (17.4)	19 (27.5)	4 (5.8)	1 (1.4)	3.04	0.006
I am well equipped to teach patients to carbohydrate count.	4 (5.8)	9 (13.0)	10 (14.5)	16 (23.2)	16 (23.2)	2 (2.9)	3.65	0.401
I require further training or education in the use of carbohydrate counting as a dietary management approach, to manage patients with type 1 diabetes mellitus.	0 (0)	3 (4.3)	4 (5.8)	11 (15.9)	18 (26.1)	21 (30.4)	4.88	**<0.05**
I would attend a teaching/ training session on the use of carbohydrate counting if it was available to me.	0 (0)	1 (1.4)	1 (1.4)	4 (5.8)	19 (27.5)	32 (46.4)	5.40	**<0.05**
I would find it useful to use an online resource/tool when teaching carbohydrate counting to my patients/clients (e.g. mobile application, web-based calorie counting tool).	0 (0)	2 (2.9)	4 (5.8)	7 (10.1)	18 (26.1)	26 (37.7)	5.09	**<0.05**
I have had specialised training in the dietary management of diabetes.	13 (18.8)	18 (26.1)	7 (10.1)	11 (15.9)	2 (2.9)	6 (8.7)	2.81	0.002

*One-sample t-test; p values in bold are statistically significant

Respondents were asked to indicate whether or not they used a specific guideline in the dietary management of diabetes. A binomial test was used to test if a significant proportion chose one guideline over another. Results on which guidelines were used by dietitians in the management of diabetes mellitus are presented in Table 4.9.

Table 4.9: Guidelines used by dietitians in the management of diabetes mellitus

Category	Response	n (%)	p-value*
American Diabetes Association (ADA)	Yes	40 (58.0)	0.003
	No	17 (24.6))	
NICE (National Institute for Clinical Excellence)	Yes	15 (21.7)	**<0.05**
	No	42 (60.9)	
SEMDSA (Society for Endocrinology, Metabolism and Diabetes of South Africa)	Yes	33 (47.8)	0.289
	No	24 (34.8)	
International Society for Paediatric and Adolescent Diabetes (ISPAD)	Yes	4 (5.8)	**<0.05**
	No	53 (76.8)	
International Diabetes Federation (IDF)	Yes	16 (23.2)	0.001
	No	41 (59.4)	
European Association for the Study of Diabetes (EASD)	Yes	3 (4.3)	**<0.05**
	No	54 (78.3)	
Other	Yes	5 (7.2)	
	No	52 (75.4)	

*Binomial test; p values in bold are statistically significant

Approximately 58% (n=40) of the dietitians used the American Diabetes Association (ADA) guidelines as a resource (p=0.003), while a significant number (60.9%; n=42) indicated that they did not use the NICE (National Institute for Clinical Excellence) guidelines. The other guidelines that were not used by dietitians included the International Society for Paediatric and Adolescent Diabetes (ISPAD) guidelines (76.8%; n=53) (p<0.05), International Diabetes Federation (IDF) (59.4%; n=41) (p=0.001) and the European Association for the Study of Diabetes (EASD) (78.3%; n=54) (p<0.05). Other guidelines used, included the Canadian Clinical Practice Guidelines (n=1), Canadian Diabetes Journal and the KZN Department of Health Guidelines (n=1).

Respondents were asked to indicate their level of agreement with statements about which factors would increase the use of carbohydrate counting using the six-point Likert scale. The one-sample

t-test was used to test for significant agreement or disagreement. Results on which measures would increase the use of carbohydrate counting amongst dietitians are presented in Table 4.10.

Table 4.10: Measures that would increase the use of carbohydrate counting by dietitians

	Strongly disagree	**Disagree**	**Slightly disagree**	**Slightly agree**	**Agree**	**Strongly agree**	**Mean agreement score**	**p-value***
	n (%)							
More online resources.	0 (0)	2 (2.9)	3 (4.3)	10 (14.5)	29 (42.0)	13 (18.8)	4.84	**<0.05**
More training.	0 (0)	1 (1.4)	0 (0)	9 (13.0)	19 (27.5)	28 (40.6)	5.28	**<0.05**
Availability of interpreters.	3 (4.3)	8 (11.6)	4 (5.8)	12 (17.4)	21 (30.4)	9 (13.0)	4.18	0.001
Access to more blood glucose test strips.	2 (2.9)	6 (8.7)	3 (4.3)	12 (17.4)	21 (30.4)	13 (18.8)	4.46	**<0.05**
Access to technology e.g. bolus advisors, blood glucose meters, mobile applications, continuous glucose monitoring.	1 (1.4)	2 (2.9)	4 (5.8)	12 (17.4)	20 (29.0)	18 (26.1)	4.79	**<0.05**

*One-sample t-test; p values in bold are statistically significant

Dietitians significantly agreed that the following would help them to make more use of carbohydrate counting: more online resources [M=4.84, SD=0.960, t (56)=10.558, p<0.05], more training [M=5.28, SD=0.861, t (56)=15.615, p<0.05], availability of interpreters [M=4.18, SD=1.453, t (56)=3.509, p=0.001], access to more blood glucose test strips [M=4.46, SD= 1.377, t (56)=5.243, p<0.05], access to technology e.g. bolus advisors, blood glucose meters, mobile applications, continuous glucose monitoring [M=4.79, SD= 1.176, t (56)=8.277, p<0.05]. There were no significant differences when comparing whether the dietitians had additional training in diabetes and which dietary management approach they used.

4.5 Barriers to using carbohydrate counting in the dietary management of diabetes

Respondents were asked to indicate their level of agreement regarding the barriers to using carbohydrate counting in the dietary management of diabetes, using the six-point Likert scale. The one-sample t-test was used to test for significant agreement or disagreement. Results of barriers to the use of carbohydrate counting amongst dietitians are presented in Table 4.11.

Table 4.11: Barriers to the use of carbohydrate counting by dietitians

	Strongly disagree	Disagree	Slightly disagree	Slightly agree	Agree	Strongly agree	Mean agreement score	p-value*
	n (%)							
Lack of financial resources.	0 (0)	11 (15.9)	7 (10.1)	11 (15.9)	19 (27.5)	9 (13.0)	4.14	0.001
Lack of training or knowledge of dietitians.	0 (0)	6 (8.7)	5 (7.2)	11 (15.9)	25 (36.2)	10 (14.5)	4.49	**<0.05**
Dietitians lack experience in the practice of carbohydrate counting.	0 (0)	5 (7.2)	8 (11.6)	7 (10.1)	22 (31.9)	15 (21.7)	4.60	**<0.05**
Dietitians lack the confidence to use carbohydrate counting.	2 (2.9)	3 (4.3)	5 (7.2)	15 (21.7)	21 (30.4)	11 (15.9)	4.46	**<0.05**
Patient illiteracy.	2 (2.9)	2 (2.9)	4 (5.8)	13 (18.8)	16 (23.2)	20 (29.0)	4.74	**<0.05**
Lack of time.	0 (0)	5 (7.2)	9 (13.0)	17 (24.6)	15 (21.7)	11 (15.9)	4.32	**<0.05**
Lack of blood glucose records.	1 (1.4)	2 (2.9)	4 (5.8)	12 (17.4)	24 (34.8)	14 (20.3)	4.72	**<0.05**
Lack of patient motivation.	1 (1.4)	3 (4.3)	5 (7.2)	13 (18.8)	18 (26.1)	17 (24.6)	4.67	**<0.05**

*One-sample t-test; p values in bold are statistically significant

Dietitians significantly agreed that the following were barriers to their use of carbohydrate counting in the management of diabetes: lack of financial resources [M=4.14, SD=1.369, t(56)=3.533, p=0.001], lack of training or knowledge of dietitians [M=4.49, SD=1.197, t (56)=6.252, p<0.05], a lack of experience in the practice of carbohydrate counting [M=4.6, SD=1.266, t (56)=6.540, p<0.05], a lack of confidence to use carbohydrate counting [M=4.46, SD=1.255, t (56)=5.754, p<0.05], patient illiteracy [M=4.74, SD=1.303, t (56)=7.167, p<0.05], a lack of time [M=4.32, SD= 1.212, t (56)=5.080, p<0.05], a lack of blood glucose records [M=4.72, SD=1.130, t (56)= 8.146, p<0.05], lack of patient motivation [M=4.67, SD=1.244, t (56)=7.080, p<0.05].

Factor analysis with varimax rotation was applied to the items describing barriers to carbohydrate counting in order to identify groupings of items. The value of Kaiser-Meyer-Olkin Measure of Sampling Adequacy (KMO) (0.686) and the significant Bartlett's test indicated that the data was adequate for reliable factor extraction. Two factors were extracted from the eight items and accounted for 61.728% of the variance in the data. The two factors were: general barriers and dietitian-specific barriers. General barriers accounted for 43.848% of the variance (Reliability* = 0.763) and dietitian-specific barriers accounted for 17.879% of the variance (Reliability* = 0.830). Based on this, the results are reliable measures. The factors were grouped as follows: general barriers to carbohydrate counting and dietitian-specific barriers to carbohydrate counting. The general barriers included lack of financial resources, patient illiteracy, lack of time, lack of blood glucose records and lack of patient motivation. The dietitian-specific barriers were lack of training or knowledge of dietitians, lack of experience in the practice of carbohydrate counting, lack of confidence to use carbohydrate counting. There was a significant agreement for both general ($p \leq 0.05$) and dietitian-specific barriers ($p \leq 0.05$) that these barriers existed. There was no significant difference amongst those working in private, public or both sectors with regards to barriers to carbohydrate counting. * Reliability was measured using Cronbach's alpha.

4.6 Dietitian's perceptions regarding carbohydrate counting

Respondents were asked to indicate their level of agreement with statements regarding perceptions about carbohydrate counting using the six-point Likert scale. The one-sample t-test was again used to test for significant agreement or disagreement.

Results from statements about dietitian's perceptions on carbohydrate counting are presented in Table 4.12.

Table 4.12: Dietitian's perceptions regarding carbohydrate counting

	Strongly disagree	Disagree	Slightly disagree	Slightly Agree	Agree	Strongly agree	Mean agreement score	p-value*
	n (%)							
Carbohydrate counting is useful as a dietary management approach.	0 (0)	2 (2.9)	2 (2.9)	9 (13.0)	30 (43.5)	14 (20.3)	5.02	**<0.05**
I believe that carbohydrate counting is an essential part of the dietary management of type 1 diabetes mellitus.	2 (2.9)	1 (1.4)	2 (2.9)	8 (11.6)	34 (49.3)	10 (14.5)	4.91	**<0.05**
I believe that carbohydrate counting is a difficult concept for patients with type 1 diabetes to understand.	0 (0)	4 (5.8)	12 (17.4)	18 (26.1)	15 (21.7)	6 (8.7)	4.07	0.001
Teaching patients how to carbohydrate count is time consuming.	0 (0)	2 (2.9)	2 (2.9)	17 (24.6)	21 (30.4)	13 (18.8)	4.73	**<0.05**
Carbohydrate counting can only be taught alongside intensive insulin therapy or multiple daily injections.	2 (2.9)	9 (13.0)	11 (15.9)	10 (14.5)	14 (20.3)	9 (13.0)	3.95	0.025
I believe all patients with diabetes can be taught some form of carbohydrate counting.	1 (1.4)	2 (2.9)	1 (1.4)	8 (11.6)	26 (37.7)	17 (24.6)	4.96	**<0.05**
I believe that there is a strong evidence base for teaching carbohydrate counting to patients with type 1 diabetes.	0 (0)	1 (1.4)	1 (1.4)	18 (26.1)	23 (33.3)	12 (17.4)	4.79	**<0.05**

*One-sample t-test; p values in bold are statistically significant

Dietitian's agreed that carbohydrate counting was useful as a dietary management approach [M=5.02, SD=0.751, t (55) =15.134, p<0.05] and that it was an essential part of the dietary management of T1DM [M=4.91, SD=0.793, t (55) =13.319, p<0.05]. Dietitian's also agreed that carbohydrate counting was a difficult concept for patients with T1DM to understand [M=4.07, SD=1.173, t (55) =3.645, p=0.001] and that teaching patients how to carbohydrate count was time consuming [M=4.73, SD=0.981, t (55) =9.394, p<0.05]. There was significant agreement among the dietitians that carbohydrate counting could only be taught alongside intensive insulin therapy or multiple daily injections [M=3. 95, SD=1.445, t (55) =2.312, p=0.025] and that all patients with diabetes could be taught some form of carbohydrate counting [M=4.96, SD=1.078, t (55) =10.164, p<0.05]. Dietitian's believed that there was a strong evidence base for teaching carbohydrate counting to patients with T1DM [M=4.79, SD=0.929, t (55) =10.361, p<0.05].

Respondents were asked to rate the effectiveness of dietary management methods. The Likert scale of effectiveness was used with 1= not at all effective to 5=extremely effective. The average effectiveness score was tested against the central score of 3 to test for significant effectiveness using the one-sample t-test. Results of the effectiveness of different methods in the dietary management of diabetes is presented in Table 4.13.

Table 4.13: Effectiveness of different methods in the dietary management of diabetes (n=56)

	Mean effectiveness score	**p-value***
Glycaemic index.	3.16	0.192
Portion control using the healthy eating plate.	3.98	**<0.05**
Counting carbohydrates using exchange lists.	3.36	0.012
Carbohydrate counting using scales and weighing items.	2.80	0.161
Carbohydrate counting using nutritional labels.	3.38	0.002
Carbohydrate counting using household measures.	4.00	**<0.05**
Carbohydrate awareness.	4.39	**<0.05**

*One-sample t-test; p values in bold are statistically significant

Carbohydrate awareness ($p<0.05$) and carbohydrate counting using household measures ($p<0.05$) were thought to be significantly effective in the dietary management of diabetes. Portion control using the healthy eating plate $p<0.05$), carbohydrate counting using nutritional labels ($p=0.002$) and carbohydrate counting using exchange lists ($p=0.012$), were less effective methods, however, still statistically significant. The glycaemic index ($p=0.192$), carbohydrate counting using scales and weighing items ($p=0.161$) were not thought to be significantly effective. A Friedman's test showed that the carbohydrate awareness method was regarded as an extremely effective method in the dietary management of diabetes. The results of the effectiveness of different dietary methods in the management of diabetes are depicted in Figure 4.1.

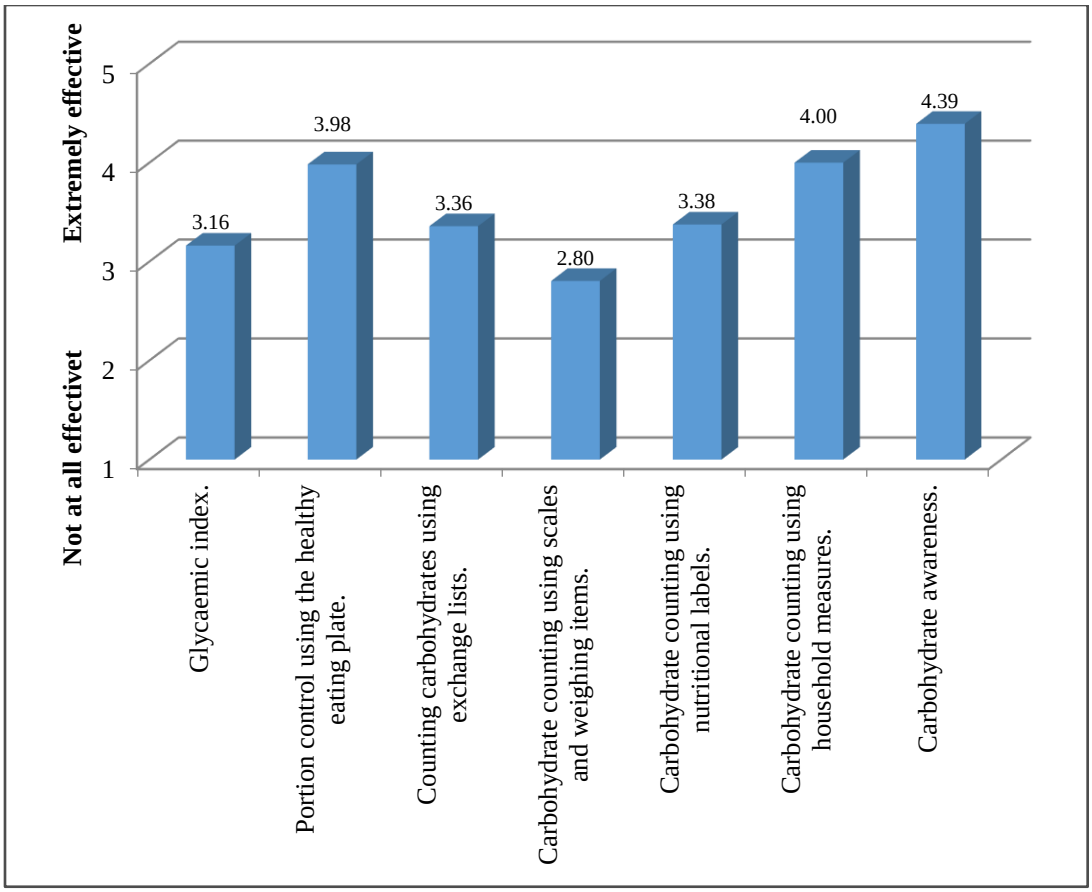

Figure 4.1: Effectiveness of different dietary methods used in the management of diabetes

Respondents were asked to indicate their level of agreement with opinions regarding dietary management methods using the six-point Likert scale. The one-sample t-test was used to test for significant agreement or disagreement.

Opinions on dietary management methods amongst dietitians are presented in Table 4.14.

Table 4.14: Opinions about dietary management methods

	Strongly disagree	Disagree	Slightly disagree	Slightly agree	Agree	Strongly agree	Mean agreement score	p-value*
	n (%)							
Carbohydrate counting is not possible without frequent blood glucose readings.	1 (1.4)	6 (8.7)	7 (10.1)	19 (27.5)	19 (27.5)	3 (4.3)	0.571	**<0.05**
Good glycaemic control is an excellent indicator of whether carbohydrate counting is effective.	1 (1.4)	1 (1.4)	4 (5.8)	11 (15.9)	35 (50.7)	3 (4.3)	1.107	**<0.05**
It is essential to know the amount of activity done before and after consuming carbohydrate to be able to carbohydrate count accurately.	1 (1.4)	3 (4.3)	4 (5.8)	16 (23.2)	23 (33.3)	8 (11.6)	0.982	**<0.05**
A detailed diet history is essential when teaching a patient to carbohydrate count.	0 (0)	1 (1.4)	0 (0)	4 (5.8)	23 (33.3)	27 (39.1)	1.875	**<0.05**

*One-sample t-test; p values in bold are statistically significant

Dietitian's agreed that carbohydrate counting was not possible without frequent blood glucose readings [M=4.07, SD=1.142, t (55) =3.74, p<0.05] and that good glycaemic control was an excellent indicator of whether carbohydrate counting was effective or not [M=4.61, SD=0.928, t (55) =8.929, p<0.05]. There was also a significant agreement that it is essential to know the amount of activity done before and after consuming carbohydrate to be able to carbohydrate count accurately [M=4.48, SD=1.112, t (55) =6.611, p<0.05] and that a detailed diet history is essential when teaching a patient to carbohydrate count [M=5.38, SD=0.776, t (55) =18.080, p<0.05].

4.7 Other significant findings

- There was a significant negative correlation between the number of years registered with the HPCSA and the perceived barrier of 'lack of blood glucose records' ($r= -0.320$; $p=0.015$). A longer time registered with the HPCSA was associated with greater disagreement that this was a barrier.
- There was a significant relationship between the sector in which the dietitians worked and the use of exchange lists for dietary management ($p=0.003$). Significantly, more of those who worked in the private sector used this resource, while a significant number who worked in the public sector did not use it.
- The literacy levels of patients was seen to be a significant factor when determining which dietary management approach was used among dietitians in both the private and public sector, as well as the dietitians that only worked in the public sector ($p=0.034$).
- When comparing the age of the dietitian to their opinions about carbohydrate counting, it was found that the there was a significant negative correlation with those that were younger and the opinion that carbohydrate counting was a difficult concept for patients with T1DM to understand ($r=-0.367$; $p=0.005$).
- There was a significant positive correlation between the older dietitians and the effectiveness of carbohydrate counting as a dietary management approach ($r=0.264$; $p=0.049$).
- There was a significant negative correlation between the age of the dietitian and the opinion that 'carbohydrate counting is not possible without frequent blood glucose readings' ($r= -0.399$; $p=0.002$).
- A significant negative correlation existed between the number of years registered with the HPCSA and the dietitian's agreement that 'I believe that carbohydrate counting is a difficult concept for patients with type 1 diabetes to understand' ($r= -0.459$; $p\leq0.05$).
- A positive correlation existed between the number of years registered with the HPCSA and the dietitian's agreement regarding the effectiveness of carbohydrate counting using household measures, as a dietary management method ($r =0.284$; $p=0.034$).

- A significant negative correlation existed between the number of years registered with the HPCSA and the dietitian's agreement that carbohydrate counting was not possible without frequent blood glucose readings (r= -0.393; p=0.003).

4.8 Summary of main findings

A large proportion of the dietitians were between the ages of 26-35 years, with the largest proportion having obtained their qualifications from the University of KwaZulu-Natal. More than half of the dietitians' worked in the private sector and the mean number of years registered with the HPCSA was 10.6 years. The majority of patients seen by the dietitians had T2DM and were between the 51-65 years old. Face-to-face consultations was the most popular method used for follow-up consultations. All dietary management methods were significantly used, except 'carbohydrate counting using scales and weighing items.' Time constraints, the literacy level of the patient, available resources and language barriers were all significant factors that played a role in determining which dietary management approach dietitians used. The most popular resources used to assist patients in the dietary management of T1DM were the 'healthy eating plate' and 'household measures'. Dietitians disagreed that they received adequate training on carbohydrate counting in their undergraduate degree and they strongly agreed that further training on the use of carbohydrate counting, as a dietary management approach, was required. There was strong agreement that an online resource/tool (e.g. mobile application, web-based calorie counting tool) would be useful when teaching carbohydrate counting to their patients/clients. Dietitians stated that they followed the ADA and SEMDSA guidelines to stay up to date on diabetes guidelines. There were numerous barriers to the use of carbohydrate counting in the management of diabetes. These included patient illiteracy, a lack of blood glucose records and a lack of patient motivation. Dietitian's agreed that carbohydrate counting was useful as a dietary management approach and that it was an essential part of the dietary management of T1DM. There was significant agreement among the dietitians that carbohydrate counting could only be taught alongside intensive insulin therapy or multiple daily injections, and that all patients with diabetes could be taught a degree of carbohydrate counting pertaining to one of the levels described in the literature

CHAPTER 5
DISCUSSION

This study aimed to determine the practices and perceptions of registered dietitians regarding the use of carbohydrate counting and the barriers associated with it in the dietary management of type 1 diabetes mellitus. It also aimed to determine if there is a need for further training on carbohydrate counting amongst dietitians in KZN. This chapter discusses the results presented in Chapter 4. Due to the uniqueness of this study, there were very few studies available to compare the findings to, thus, references to other similar studies are limited.

5.1 Demographic characteristics of the sample

Most of the dietitians had been registered with the HPCSA for approximately 10 years and this was in line with the largest group of the dietitians falling into the age range of 26-45 years. The majority of the respondents obtained their degree in dietetics from the University of KwaZulu-Natal (UKZN) and 62.3% stated that their highest qualification was the Post Graduate Diploma in Dietetics, which is only offered at UKZN. This result was expected as the study was conducted in KZN. Over half of the respondents worked in the private sector and 78% indicated that they worked in an urban area. This result could suggest that more dietitians work in the private sector. However, a possible reason for this could be that dietitians working in the private sector were individually sent the link to the survey via the Association for Dietetics South Africa (ADSA) and the dietitians working in the Department of Health (DOH) answered the survey via a link on the DOH website. It also possible that dietitians who work in the private sector manage more patients with T1DM as they are usually seen as outpatients, while the DOH dietitians tend to see a greater variety of patients without focusing on diabetics only.

In a study by Du Toit *et al* (2018), which investigated the opinions of South African dietitians on the treatment of fistuloclysis as a treatment option for intestinal failure, half of the dietitians indicated that they worked in the public sector and half in the private sector. The study by Du Toit *et al* (2018) is comparable in methodology to the current study, as the self-administered questionnaires were completed using SurveyMonkey and the questionnaire was sent to the dietitians via a link by a third party. Joyner (2014) conducted a study on the attitudes of dietitians in the province of KZN toward a low carbohydrate, high fat diet and prescription thereof. The

majority of the participating dietitians were between the ages of 20-29 years with a mean age of 31.3 years. In keeping with the current study which was also conducted in KZN, the study by Joyner (2014) found that the Post Graduate Diploma in Dietetics was the highest qualification held by most of the dietitians and just under 60% of the respondents worked in the public sector with the remainder (40.9%) working in the private sector (Joyner 2014).

5.2 Diabetes management and practice

Most of the patients seen by the dietitians in the current study had T2DM and were in the age range of 31-65 years. This was expected as the International Diabetes Federation (IDF) Atlas (2017) reports that the majority of people with diabetes have T2DM and are 20-64 years old (IDF Atlas 2017, p44). Type 1 diabetes mellitus (T1DM) is the most common form of diabetes in children and was historically associated with children, while T2DM is generally associated with adults (ADA 2019). Newly diagnosed diabetics with T1DM are usually seen by specialist doctors and would likely only be seen by the dietitians in those units. This would have limited the number of respondents that specifically saw patients with T1DM. The majority of patients were seen face-to-face and the average time spent was between 30 minutes to > 1 hour. Twenty six percent of the respondents indicated that their patients attended follow-up visits ‘less often than once a year’ and 23% indicated that patients attended follow-up visits ‘at least once a month.’ The Society for Endocrinology, Metabolism and Diabetes of South Africa (SEMDSA) 2017) recommends 3-4 visits within the first 3-6 months of diagnosis.

Ongoing follow-up and support are key to the patient’s success and this could be in the form of face-to-face visits, peer support, phone coaching or through social media platforms (Maryniuk, Evert & Rizzotto 2019, p481). Eighty-seven percent of respondents indicated that they used face-to-face methods to review patients, while 23.2% used email and 2.9% used WhatsApp. Skype consultations were not used at all by the dietitians as a means of follow-up. The reasons for this could be due to the lack of access to technology as well as patients being uncomfortable with the use of technology. Some of the additional reasons for the low use of phone and email for follow-up consultations could be due to the lack of access to technology by both patients and dietitians, and the lack of access to a work phone and the cost of the use of the phone. There is a paucity of evidence regarding the use of Skype and the risks and benefits it poses for health care professionals

and their patients. Further studies are therefore warranted to understand the potential role that Skype consultations could play in telemedicine (Armfield, Gray & Smith 2012). It is recommended that dietitians should consider other modes of follow-up as a potential way to deliver a service and should increase their knowledge and competency in the area of telemedicine (Dalton 2008).

5.3 Dietary management practices

The GI was one of the main dietary approaches used to manage diabetes in the current study. This could be due to the fact the there are numerous foods which have been endorsed by the Glycaemic Index Foundation of South Africa (GIFSA). The logo appears on the label of specific foods indicating the GI of the product and how frequently the food can be consumed. This can be used by diabetics to guide their food choices. Dietitians could be using the GIFSA logos on food labels to teach and guide their diabetic patients in terms of food choices. There was a significant use of carbohydrate counting using nutritional labels in the private sector and foods with the GIFSA logos could be a part of that group of foods. Another possible reason for the wide use of the GI could be that the GI concept has been described in the literature since the 1980s. Although it is a controversial dietary management method, dietitians are instrumental in assisting patients to understand and apply the concept to their diabetes management (Grant & Wolever 2011). A group of South African dietitians (n=36) attending a Masters class agreed that there are proven beneficial effects of a low GI diet versus a high GI diet, in the prevention and treatment of T2DM (Vorster 2005). However, there is conflicting evidence on the effectiveness of the GI as a meal planning approach (Franz, Powers, Leontos, Holzmeister, Kulkarni, Monk, Wedel & Gradwell 2010). In a South African study, investigating the dietary management practices of dietitians for T2DM in public hospitals in the Limpopo province, information on nutrition education materials was collected (Ceronio & Mbhenyane 2017). Results from 21 different hospitals highlighted that ‘General guidelines and a foods allowed/avoided list’ were the most common education materials used. Only two dietitians responded that they used a ‘glycaemic index’ sheet (Ceronio & Mbhenyane 2017).

In the current study portion control using the healthy eating plate was used more than the GI, counting carbohydrates using exchange lists, carbohydrate counting using scales and weighing items and carbohydrate counting using nutritional labels. The plate model is a type of eating pattern

that has been found to be an effective and useful method of controlling carbohydrate intake in diabetics. It is a simplified way of teaching patients without using lists of foods and confusing calculations but still takes healthy eating into consideration (Maryniuk *et al* 2019, p481; Maryniuk 2017). According to Maryniuk *et al* (2019, p481), if individuals require guidelines that are more specific, then issuing individual guidelines per meal could be implemented.

Additional reasons for the dietitian's preference for the use of the plate model and 'household measures' could be that these resources are more readily available in both the private and public sector as they are 'low cost' and they are also simple to explain and understand. Bowen *et al* (2016) concluded from their study of patients with T2DM, that the use of carbohydrate counting or a modified plate method by certified diabetes educators to educate patients, both improved glycaemic control. Bowen *et al* (2016) showed that the modified plate model might be better accepted as opposed to carbohydrate counting in patients with varied numeracy skills. However, further research is required to make a direct comparison of these two approaches (Bowen *et al* 2016). It was found that dietitians used nutritional labels, carbohydrate awareness and household measures as their main approach to carbohydrate counting. Although respondents agreed that they taught their patients to read the total carbohydrate content from nutritional labels of food products, it was unclear which dietary management method they used alongside this approach. According to Smart *et al* (2009), there is no clear evidence as to which method of estimation is better.

There was a strong agreement amongst the dietitians that patient's literacy levels was a factor that played a role in determining the choice of dietary approach used. According to a study assessing health literacy and numeracy of patients in diabetes care, it was found that the lack of these skills are not always obvious to the educator. Assessment of these areas is key in improving the education experience for both patient and provider, while also improving clinical outcomes (White, Wolff, Cavanaugh & Rothman 2010). Assessment of literacy and numeracy should possibly be included in the dietitian's initial assessment of the patient. Maryniuk (2017) stated that only 30% of people with diabetes from a 2014 survey said that they felt 'totally confident' in their ability to eat as per recommendations. This highlights the important role that dietitians have in educating and empowering patients in the dietary management of diabetes. Because diabetes care mostly takes place in the form of self-management, it is the approach to diabetes care that empowers and equips the patient to manage their diabetes on their own (Bowen, Cavanaugh, Wolff, Davis, Gregory,

Shintani, Eden, Wallston, Elasy & Rothman 2016). Other factors that determined the choice of dietary management approach were resources available and time constraints. Resources available could include resources such as food models, books, food labels, blood glucometers, test strips as well as additional dietetics staff. It is evident from the results that dietitians spend between 30 minutes to > 1 hour with newly diagnosed diabetic cases. This could present a time constraint depending on how many other patients need to be seen.

From the dietitian's responses to statements regarding dietary management practices, it appears that only a few dietitians taught their patients to use an insulin to carbohydrate ratio, which is deemed a nutrition teaching priority in the management of T1DM (Maryniuk *et al* 2019, p478). The reasons for this were not explored, however, there are a few possible reasons for this. One of them being that dietitians do not currently have prescribing rights and therefore require a doctor or diabetes nurse to adjust the insulin amount alongside their teaching. Another reason may be in keeping with the fact that dietitians indicated that patient's literacy, resources available and time constraints were factors that determined their choice of dietary management method. Insulin adjustment according to carbohydrate intake requires advanced skill, which may be difficult for a wider range of patients to understand (Bowen *et al* 2016). Education regarding adjusting insulin to carbohydrate intake for people living with T1DM, is strongly recommended by Diabetes UK. Another recommendation is that patients who are on a fixed insulin regime should aim for consistent intake of carbohydrate (Dyson *et al* 2018).

It was found that dietitians that worked in the private sector made use of exchange lists more than those in the public sector did. The lack of use of exchange lists in the public sector could be linked to patient literacy levels, as patients in the public sector are more likely to have lower literacy levels. They are also a more diverse population, so language barriers could also play a role in the lack of use of exchange lists.

5.4 Training regarding carbohydrate counting

It is clear that the respondents felt that they did not receive adequate training on carbohydrate counting in their undergraduate degree. They also indicated that further training on carbohydrate counting would be useful. Given that carbohydrate counting can be used in the management of both T1DM and T2DM, it may be useful for universities to add it to their curriculum on the dietary

management of diabetes. Respondents significantly agreed that: 'I would attend a teaching/ training session on the use of carbohydrate counting if it was available to me.' This result motivates towards training on the use of carbohydrate counting to be made available to dietitians. Other dietitians, who have specialised in the field of diabetes or received additional training in the area of carbohydrate counting, could deliver this training. Dietitians had a positive attitude towards carbohydrate counting despite the lack of training and there was a willingness amongst dietitians to learn more about carbohydrate counting. Very few indicated that they had specialised training in diabetes management, which also suggests that there is a need for further training in diabetes management. The dietitians indicated that more training and online resources were measures that would increase their use of carbohydrate counting.

There are no South African guidelines available on the dietary management of T1DM. In this study the American Diabetes Association (ADA) guidelines was the main resource used by the dietitians. The SEMDSA guidelines mostly focus on T2DM and does not address carbohydrate counting. Guidelines that specifically include T1DM and the dietary management thereof, include ISPAD, EASD and NICE. However, these guidelines were also not used by the dietitians who participated in the current study. This indicates that there is a need for guidelines on the dietary management of diabetes specific to South Africa, as the population in South Africa differs to that of the USA. There are also differences in terms of income and the availability of resources and patient literacy levels (IDF Atlas 2017, p45). According to Ceronio & Mbhenyane (2017), when Limpopo dietitians were asked which scientific sources were used to compile nutrition education guidelines for patients with T2DM, none of the sources used in the current study were mentioned. This study highlighted the need for standardisation of dietitian's practices in the province of Limpopo as well as highlighting the need for updated South African guidelines for diabetes management. It was also found that there was a need for dietitians in the province of Limpopo to attend continuing professional development opportunities on diabetes management (Ceronio & Mbhenyane 2017).

5.5 Barriers to the use of carbohydrate counting in the dietary management of diabetes

In this study, the dietitians indicated that the following were the main barriers to the use of carbohydrate counting: patient illiteracy, lack of blood glucose records and a lack of patient motivation. Similar barriers were identified in a study, which aimed to identify barriers to initiating

insulin therapy in poorly controlled patients with T2DM, on oral glucose lowering agents. Medical officers (n=46) working at community health centres in Cape Town were individually interviewed and barriers pertaining to doctors, patients and the system were identified. Doctor's barriers included lack of knowledge, lack of experience with and use of guidelines related to insulin therapy, language barriers between doctors and patients and fear of hypoglycaemia. System barriers included lack of time, lack of dietitian availability, lack of good quality blood glucometers and inadequate insulin supply and a lack of clinical guidelines available. Although this study focused on doctors and clinicians, it is evident that there is a need for further guidelines on the use of insulin and the dietary management of T1DM and T2DM (Haque, Navsa, Emerson, Dennison & Levitt 2005). A single site randomised control trial in the USA (n=193), which examined the influence that patient literacy had on the effectiveness of a diabetes management programme for T2DM, found that an intensive one-on-one diabetes management programme was more beneficial to those who had low literacy, than those with higher literacy levels (Rothman, DeWalt, Malone, Bryant, Shintani, Crigler, Weinberger & Pignone 2004). Low literacy was found to be common amongst patients with diabetes and could be associated with poor knowledge of the condition (Rothman *et al* 2004).

Effective communication between health care professionals and patients was seen as a predictor of better diabetes care and outcomes, according to a study that investigated barriers to diabetes management (Nam, Chesla, Stotts, Kroon & Janson 2011). When reviewing the literature, similar barriers existed for health care professionals concerning the management of diabetes. Whilst a lack of blood glucose records was seen as a barrier in the current study, this could also be associated with the barrier of a lack of quality glucometers (Haque *et al* 2005). Low health literacy can often be confused with a lack of patient motivation and this could be addressed by providing better support for patients through patient-centered education (Fransen, Beune, Baim-Lance, Bruessing & Essink-Bot 2015). This therefore reiterates the need for further training for dietitians in the area of diabetes self-management education (DSME).

Two groups of barriers were identified and these were described as general and dietitian specific. According to factor analysis, these barriers all existed in combination with barriers around the use of carbohydrate counting amongst dietitians. The literacy level of the patient had the highest agreement rating for factors determining the choice of dietary management approach amongst the

general barriers and the dietitian specific barrier that showed significant agreement, was the fact that there was a lack of training and knowledge amongst dietitians. These results are in line with the study hypotheses that barriers that would prevent the use of carbohydrate counting in the dietary management of T1DM were a lack of training, experience, resources, time and support.

In terms of other significant findings, respondents that had been registered with the HPCSA for a longer period did not feel that a lack of blood glucose records was a barrier to carbohydrate counting and they did not believe that 'carbohydrate counting was not possible without frequent blood glucose testing.' It is possible that dietitians who have been registered for a longer period have more experience with the management of T1DM, and are therefore more flexible in their approach to T1DM. The dietitians that have been practicing for longer could therefore feel that a lack of blood glucose records is not a barrier to teaching patients to carbohydrate count. The ADA (2018) recommends that those using intensive insulin regimes should test their blood glucose levels before meals, snacks, and bedtime, prior to exercise and driving, if they feel symptoms of hypoglycaemia, and after treating hypoglycaemia. This may equate to 6-10 times per day. The integration of blood glucose monitoring into the management of diabetes can be a useful tool for guiding medical nutrition therapy (MNT) (ADA 2018). There is an agreement in the literature that a lack of blood glucose records is a perceived barrier to carbohydrate counting (Chiesa *et al* 2005). These beliefs and perceptions from the current study, however, could be specific to patients with T2DM, as it was reported that the majority of patients seen had T2DM.

5.6 Dietitian's perceptions regarding carbohydrate counting

Dietitian's agreed that carbohydrate counting was a useful dietary management approach and that it was an essential part of the dietary management of T1DM. Just under half of the dietitians significantly agreed that carbohydrate counting was an essential part of the dietary management of T1DM. However, carbohydrate awareness i.e. making patients aware of which foods contain carbohydrate, GI and carbohydrate counting using household measures, were the three most used dietary management methods. The research highlighted that the dietitians could have had different understandings or perceptions regarding the term 'Carbohydrate counting' and in turn, this could have influenced the way the dietitians answered the questions pertaining to carbohydrate counting and ,their perceptions. For some dietitians the term 'Carbohydrate counting' could have encompassed many of the dietary management methods discussed. According to the literature,

carbohydrate counting can be used for T1DM, T2DM as well as gestational diabetics, as long as they are using insulin. According to education and nutritional recommendations for patients with T1DM, patients should not solely focus on insulin adjustment but also healthy eating and dietary quality and routines around meal times, to improve postprandial glycaemic control (Bell, Smart, Steil, Brand-Miller, King & Wolpert 2015).

Dietitian's also agreed that carbohydrate counting was a difficult concept for patients with T1DM to understand and that teaching patients how to carbohydrate count was time consuming. Dietitians that were registered for a longer period with the HPCSA, disagreed with the opinion more than the younger dietitians that carbohydrate counting was a difficult concept for patients with T1DM to understand.

The reason for this could be that dietitians who have been practicing longer have had more experience with managing patients with T1DM. This may assist them in adapting their teaching methods according to the patient's level of understanding. It is also possible that the dietitians registered for a longer time have a better understanding of the concept of carbohydrate counting. Diabetes educators and providers are known to tailor recommendations and guidelines to the individual needs of their patients. Part of this process includes assessing and addressing the patient's numeracy skills and level of health literacy, to provide the best diabetes care (White *et al* 2010). According to a study conducted by White *et al* (2010), patients with a grade nine level of numeracy skills struggled to calculate the total carbohydrate content in a container of chips. Even identifying the correct dosages on an insulin syringe proved difficult for some participants with low numeracy skills (White *et al* 2010). Because level two and level three carbohydrate counting entails more advanced carbohydrate counting skills, such as reading nutritional labels, estimating portion sizes and weighing foods (Gillespie *et al* 1998), this reinforces the perception that carbohydrate counting is a difficult concept to understand. Literacy levels and numeracy skills could therefore also play a role in the time taken for patients to be taught how to carbohydrate count. This is because patients with lower literacy and numeracy skills require more intensive, longer counselling sessions in order for them to grasp concepts such as the estimation of portion sizes and reading nutritional labels correctly.

There was significant agreement among the dietitians that carbohydrate counting could only be taught alongside intensive insulin therapy or multiple daily injections and that all patients with diabetes could be taught some form of carbohydrate counting. Carbohydrate counting can be taught on three different levels according to Gillespie *et al* (1998), where the basic level of carbohydrate counting can be taught to patients with T1DM and T2DM. Carbohydrate awareness is also a basic concept that can be taught to all patients with diabetes and about 60% of dietitians agreed that they used this method. This reinforces the perception that all patients could be taught some form of carbohydrate counting. However, level three carbohydrate counting requires patients to be on an intensive insulin therapy regime (Gillespie *et al* 1998).

Dietitian's believed that there was a strong evidence base for teaching carbohydrate counting to patients with T1DM, however, the main guidelines used as stated previously were ADA and SEMDSA guidelines. Although the American Diabetes Association Guidelines (ADA 2019) recommend carbohydrate counting, the SEMDSA guidelines do not discuss carbohydrate counting in the context of T1DM. While dietitians believed there was strong evidence for teaching carbohydrate counting, it was evident that it was not put into practice because of the barriers identified and the need for further training on carbohydrate counting.

Dietitians identified carbohydrate awareness and carbohydrate counting using household measures as significantly effective methods used in the dietary management of diabetes. The most effective method described by dietitians was carbohydrate awareness. According to McArdle *et al* (2017), carbohydrate awareness needs to be further defined and described as a dietary approach for others in the profession to use, as dietitians reported using this method frequently (McArdle *et al* 2017). Dietitians perceived that good glycaemic control was an indication of whether carbohydrate counting was effective and they indicated that carbohydrate counting was not possible without frequent blood glucose readings. It is evident from the results that dietitians believed that carbohydrate awareness is an effective method in the dietary management of diabetes and it is widely used amongst dietitians in the province of KZN. This dietary method can possibly be correlated to level one carbohydrate counting (Gillespie *et al* 1998), which can be used without frequent blood glucose testing. Thus, it is apparent from the research and literature that a simple form of carbohydrate counting is possible without frequent blood glucose testing.

Dietitians also agreed that a detailed diet history is essential when teaching a patient to carbohydrate count. This has been confirmed in the literature, as a study assessing the validity of a diet history in type 2 diabetics (n=56), found that a diet history gave a good estimation of both the energy and macronutrient intake in individuals with T2DM. However, underreporting was noted in some instances (Martin, Tapsell, Denmeade & Batterham 2003). Dietitians that had been registered with the HPCSA for longer were more in agreement with the fact that carbohydrate counting using household measures was an effective method of dietary management. This may be because household measures are easier to understand than other methods. Dietitians registered with the HPCSA for longer also believed that carbohydrate counting was an effective dietary management approach, overall.

5.7 Response to hypotheses

The hypotheses set out at the beginning of this study were:

1. There is no one specific dietary management approach used by dietitians in KZN when educating patients with T1DM. This hypothesis is accepted.
2. There is a low use of carbohydrate counting in the dietary management of T1DM among dietitians in KZN. This hypothesis is rejected.
3. Dietitians in KZN perceive carbohydrate counting as a useful and effective method in the dietary management of T1DM; however, they are not able to put it into practice. This hypothesis is accepted.
4. The barriers that prevent the use of carbohydrate counting in the dietary management of T1DM are a lack of training, experience, resources, time and support. This hypothesis is accepted.
5. Dietitians in KZN see a need for further education/training in the area of carbohydrate counting. This hypothesis is accepted.

5.8 Summary

The study sample consisted of dietitians in the province of KZN employed in both the private and public health sectors, with the majority employed in the private sector. A large number of the dietitians obtained their qualifications from the University of KwaZulu-Natal. Patients with T2DM seemed to be more commonly seen than those with T1DM. Seeing patients face-to-face for

consultations was the most common consultation method used. Patients were not seen as frequently as recommended for follow-up visits. One of the study hypotheses was that there was a low use of carbohydrate counting amongst dietitians. This was rejected as it was found that dietitians in KZN did use carbohydrate counting as a dietary management method. However, dietitians used a variety of different dietary management methods and different ways of carbohydrate counting in practice. The dietary management methods used when treating patients with T1DM included the GI, carbohydrate counting using nutritional labels, carbohydrate awareness and carbohydrate counting using household measures. A significant number of dietitians used carbohydrate awareness i.e. making patients aware of which foods contain carbohydrate. Dietitians did not teach their patients to use a carbohydrate to insulin ratio; however, reasons for this were not explored. Portion control using the healthy eating plate was a popular resource amongst dietitians over and above the other dietary resources. Factors that determined which dietary management approach a dietitian used included patient literacy, resources available and time constraints. It was agreed that dietitians were not adequately trained on carbohydrate counting in their undergraduate degree and that further training and online resources would increase the use of carbohydrate counting amongst dietitians. Patient illiteracy was seen as a significant barrier to dietitians teaching their patients how to carbohydrate count. In relation to patient's illiteracy, dietitians agreed that carbohydrate counting was a difficult concept to teach patients and it was also time consuming. According to the results of this study, dietitians perceived that carbohydrate counting was both essential and useful in the dietary management of T1DM. Although dietitians did practice carbohydrate counting as a dietary management approach, significant barriers such as a lack of training and patient illiteracy existed.

CHAPTER 6
CONCLUSION AND RECOMMENDATIONS

This study aimed to determine the practices and perceptions of registered dietitians regarding the use of carbohydrate counting and the barriers associated with it in the dietary management of diabetes mellitus. It also aimed to determine if there is a need for further training on carbohydrate counting amongst dietitians in KZN. The objectives were i) To determine which dietary management approach is most commonly used by dietitians in KZN when educating patients with T1DM. ii) To determine if dietitians in KZN use carbohydrate counting in the dietary management of patients with T1DM. iii) To determine the perceptions of dietitians in KZN towards the use of carbohydrate counting in the dietary management of T1DM. iv) To determine the barriers which prevent dietitians in KZN from using carbohydrate counting in the dietary management of T1DM. v) To determine if dietitians in KZN see a need for further education/training in the area of carbohydrate counting. This chapter presents the study conclusions, limitations and recommendations.

6.1 Conclusions

Although dietitians in KZN stated that they used carbohydrate counting as a dietary management method, carbohydrate counting practices varied. There was no one specific carbohydrate counting practice that stood out significantly, however, it was evident that adjusting the insulin to carbohydrate ratio was not a common practice. The dietary management approaches followed by KZN dietitians in treating T1DM are not based on South African guidelines, as there are no South African guidelines specific to the dietary management of T1DM. There is therefore a need for South African guidelines on the dietary management of T1DM. Dietitians indicated that they received inadequate training on carbohydrate counting in their undergraduate degree and indicated that further training on the use of carbohydrate counting, as a dietary management approach was required. There was a willingness amongst dietitians in both the private and public sectors to receive more training on carbohydrate counting and to apply it to patient care. Although dietitians agreed that carbohydrate counting was a useful and essential method in the dietary management of T1DM, there were a number of barriers that prevented the use of this method. A large number of dietitians in KZN are treating patients with diabetes without additional training, inadequate undergraduate training and a lack of South African-based guidelines for the nutritional

management of T1DM. Dietitians' were in agreement that more online resources would be useful in supporting carbohydrate counting and they would consider making more use of the technology available. Dietitians agreed that carbohydrate counting could only be taught alongside intensive insulin therapy or multiple daily injections, and that all patients with diabetes could be taught some form of carbohydrate counting. This study showed that there are barriers to carbohydrate counting specific to dietitians. A lack of training, confidence and experience influenced whether or not the dietitians taught their patients to carbohydrate count. Dietary management practices need to be updated and dietitians need to continuously develop and improve their skills in managing diabetes. It is clear that KZN is a diverse population and that there is no 'one size fits all' approach for the dietary management of diabetes. Each person should be treated individually with evidence-based guidelines and carbohydrate counting should be considered when choosing a dietary management method.

6.2 Study limitations

6.2.1 Dietitians working in the Department of Health (DOH) could not be contacted in the same way as the members of the Association for Dietetics in South Africa (ADSA) (KZN). The ADSA (KZN) members each received an email link to the questionnaire. A link to the survey was uploaded to the DOH website and there was no way of alerting the DOH dietitians to the link. The sample size was therefore not a true representation of all the dietitians in the province of KZN and this prevented generalised conclusions from being made.

6.2.2 Due to the online nature of the survey method, there was a possibility that the participant who answered it was an unintended recipient of the survey.

6.2.3 It was also a possible that the participant looked up the answers to the survey or requested that someone else answer the questions for them.

6.2.4 All participants of the study took part voluntarily. The fact that the study relied on volunteers could have affected the size of the sample.

6.2.5 It was possible that by addressing T1DM specifically in the study, it may have limited the number of responses received.

6.2.6 All members of ADSA received reminders in the ADSA newsletter about the questionnaire; however, DOH dietitians did not receive a reminder, as they could not be contacted directly.

6.2.7 Only one link per DOH hospital computer was allowed to be answered. Therefore, if a hospital department had more than one dietitian to a computer, only one dietitian was able to answer the survey. This limited the number of responses from the DOH dietitians.

6.2.8 A number of dietitians exited the survey before it was complete for unknown reasons and this decreased the sample size of the study.

6.2.9 In the original questionnaire, the question regarding which dietary management method was used 'carbohydrate counting with exchange lists' was not added to SurveyMonkey, when transferring the questionnaire to its online format, for technical reasons. Therefore, information regarding this dietary management method could not be captured.

6.2.10 It was apparent from the research that the participants had different perceptions regarding the term 'Carbohydrate counting.' The questionnaire therefore should have had an additional question about the participants understanding of the term 'Carbohydrate counting.'

6.2.11 Due to a lack of research on the use of carbohydrate counting by dietitians in South Africa, there were no published South African studies to compare this study to.

6.3 Recommendations

6.3.1 There is a need for the development of South African specific dietary guidelines for the management of T1DM.

6.3.2 Definitions for carbohydrate awareness, frequent blood glucose testing, patient literacy and numeracy should be defined in future studies.

6.3.3 It is recommended that universities offering degrees in dietetics should include the topic of carbohydrate counting as part of the undergraduate curriculum on diabetes.

6.3.4 Further training should be provided to dietitians in the area of carbohydrate counting.

6.3.5 Dietitians should be made aware of the availability of different online resources to assist in carbohydrate counting. Online resources specific to the South African context should be developed to help dietitians to teach carbohydrate counting effectively.

6.4 Recommendations for further study

6.4.1 A larger study incorporating dietitians in South Africa should be conducted on this topic. Face-to-face interviews should be conducted to provide clarity on specific issues surrounding the topic and participants should be recruited from both private and public sectors. Future studies should focus on diabetes self-management education and dietitian's practices and perceptions regarding comparison of the plate model and carbohydrate counting.

6.4.2 A larger study investigating the use of carbohydrate counting in patients with T2DM on insulin is recommended, given the growing prevalence of T2DM, and the fact that most dietitians in the current study reported that the majority of patients seen had T2DM.

6.4.3 Further studies exploring the barriers or reasons for dietitians not using the carbohydrate to insulin ratio are also recommended, as well as which insulin regime is most prescribed for diabetics.

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APPENDIX A: QUESTIONNAIRE

Practices and perceptions of registered dietitians regarding the use of carbohydrate counting in the dietary management of type 1 diabetes mellitus

This is a research project for a Master of Science in Dietetics degree. The objectives of the study are as follows:

Objectives of the study

1. To determine which dietary management approach is most commonly used by dietitians when educating patients with type 1 diabetes mellitus.
2 To determine if dietitians in KwaZulu-Natal use carbohydrate counting in the dietary management of patients with type 1 diabetes mellitus.
3. To determine the perceptions of dietitians in KwaZulu-Natal towards the use of carbohydrate counting in the dietary management of type 1 diabetes mellitus.
4. To determine the barriers which influence or prevent dietitians in KwaZulu-Natal from using carbohydrate counting in the dietary management of type 1 diabetes mellitus.
5. To determine if dietitians in KwaZulu-Natal see a need for further education/training in the area of carbohydrate counting.

Please answer all questions honestly and tick the appropriate column/s or fill in where necessary.

SECTION A: DEMOGRAPHIC DATA

1. What is your age?

20-25 years	
26-35 years	
36-45 years	
46-55 years	
56-65 years	
> 65 years	

2. For how many years have you been registered with the HPCSA as a dietitian?
   _____

3. From which University did you obtain your dietetics qualification? (Select ONE option only)

Nelson Mandela Metropolitan University	
North West University	
Sefako Makgatho Health Sciences University	
University of Cape Town	
University of the Free State	
University of KwaZulu-Natal	
University of Limpopo	
University of Stellenbosch	
University of Pretoria	
University of the Western Cape	
Other: Please specify	

4. What is your highest dietetic qualification?

B.Sc Diet (Hons)	
B.Sc Diet	
PGDip Diet	
Masters	
PhD	
Other: Please specify	

5. In which sector do you work?

Private Sector	
Public Sector	
Both	

6. In which area do you work?

Rural	
Semi-rural	
Urban	

7. Have you received any additional training in diabetes management after qualifying as a dietitian?

YES	

NO	
If YES please state:	

SECTION B: DIABETES MANAGEMENT AND PRACTICE

1. Do you give dietary management advice to patients with type 1 diabetes?

Yes	
No	

2. With which type of diabetes do most of your patients present?

Type 1	
Type 2	

3.Into which age group do most of your patients with diabetes fall? (Select ONE option only)

0 -10 years	
11-20 years	
21-30 years	
31-50 years	
51-65 years	
>65 years	

4. How long do you spend on average with a patient who presents for the first time with a new diagnosis of type 1 diabetes mellitus?

<10 minutes	
10 -<15 min	
15 -<30min	
30 -<45 min	
45 min - 1 hour	
>1 hour	

5. How often, on average, do you see your patient with type 1 diabetes mellitus for follow-up visits?

At least once a month	
At least once every 2 months	
At least once every 6 months	
At least once a year	
Less often than once a year	

6. What methods do you use to review/follow up patients?

Face to face consultations	
Skype	
Email	
Phone	
Other:	

SECTION C: DIETARY MANAGEMENT PRACTICES

1. Indicate your agreement as to which of the following approaches to dietary management you would use/recommend when treating type 1 diabetes mellitus:

Approaches to dietary management	Strongly disagree	Disagree	Slightly Disagree	Slightly agree	Agree	Strongly agree
1.1 Glycaemic index.						
1.2 Portion control using the healthy eating plate.						
1.3 Carbohydrate counting using scales and weighing items.						
1.4 Carbohydrate counting using nutritional labels.						
1.5 Carbohydrate counting using household measures.						
1.6 Carbohydrate awareness i.e. making patients aware of which foods contain carbohydrate.						
Other: Please specify						

2. Indicate your agreement that the following factors determine your choice of dietary management approach:

	Strongly disagree	Disagree	Slightly disagree	Slightly agree	Agree	Strongly agree
2.1 Time constraints						
2.2 Literacy level of patient						
2.3 Resources available						
2.4 Language barrier						
Other: Please specify						

3. Which resources do you use to assist patients in the dietary management of type 1 diabetes mellitus? (Tick all that apply)

3.1 Healthy eating plate	
3.2 Exchange lists	
3.3 Household measures	
3.4 Food models	
3.5 Pictorial guide	
Other: Please specify	

4. Indicate your agreement with the following statements regarding dietary management practices:

	Strongly Disagree	Disagree	Slightly disagree	Slightly agree	Agree	Strongly agree
4.1 I teach my patients to read the total carbohydrate content from labels on food products.						
4.2 I teach my patients to use an insulin to carbohydrate ratio.						

SECTION D: TRAINING REGARDING CARBOHYDRATE COUNTING

1. Indicate your agreement with the following statements:

	Strongly disagree	Disagree	Slightly disagree	Slightly agree	Agree	Strongly agree
1.1 I received adequate training on carbohydrate counting as an undergraduate student in my degree.						
1.2 My undergraduate training adequately prepared me for educating a patient with type 1 diabetes mellitus.						
1.3 I am well equipped to teach patients to carbohydrate count.						
1.4 I require further training or education in the use of carbohydrate counting as a dietary management approach, to manage						

patients with type 1 diabetes mellitus.						
1.5 I would attend a teaching/ training session on the use of carbohydrate counting if it was available to me.						
1.6 I would find it useful to use an online resource/tool when teaching carbohydrate counting to my patients/clients (e.g. mobile application, web-based calorie counting tool).						
1.7 I have had specialised training in the dietary management of diabetes.						

2. Which guidelines do you, as a dietitian, follow or read to stay up to date in the area of diabetes and its dietary management? (Tick all that apply)

2.1 American Diabetes Association (ADA)	
2.2 NICE (National Institute for Clinical Excellence) guidelines	
2.3 SEMDSA (Society for Endocrinology, Metabolism and Diabetes of South Africa)	
2.4 International Society for Paediatric and Adolescent Diabetes (ISPAD)	
2.5 International Diabetes Federation (IDF)	
2.6 European Association for the Study of Diabetes (EASD)	
2.7 Other: Please specify	

3. Indicate your agreement that the following would help you to make more use of carbohydrate counting.

	Strongly disagree	Disagree	Slightly disagree	Slightly agree	Agree	Strongly agree
3.1 More online resources.						
3.2 More training.						
3.3 Availability of interpreters.						
3.4 Access to more blood glucose test strips.						

3.5 Access to technology e.g. bolus advisors, blood glucose meters, mobile applications, continuous glucose monitoring.						

SECTION E: BARRIERS TO CARBOHYDRATE COUNTING

1. Indicate your agreement that the following are barriers to using carbohydrate counting in the dietary management of diabetes mellitus in practice:

	Strongly disagree	Disagree	Slightly disagree	Slightly agree	Agree	Strongly agree
1.1 Lack of financial resources.						
1.2 Lack of training or knowledge of dietitians.						
1.3 Dietitians lack experience in the practice of carbohydrate counting.						
1.4 Dietitians lack the confidence to use carbohydrate counting.						
1.5 Patient illiteracy.						
1.6 Lack of time.						
1.7 Lack of blood glucose records.						
1.8 Lack of patient motivation.						

SECTION F: PERCEPTIONS REGARDING CARBOHYDRATE COUNTING

1. Indicate your agreement with the following statements:

	Strongly disagree	Disagree	Slightly disagree	Slightly agree	Agree	Strongly agree
1.1 Carbohydrate counting is useful as a dietary management approach.						
1.2 I believe that carbohydrate counting is an essential part of the dietary management of type 1 diabetes mellitus.						

1.3 I believe that carbohydrate counting is a difficult concept for patients with type 1 diabetes to understand.						
1.4 Teaching patients how to carbohydrate count is time consuming.						
1.5 Carbohydrate counting can only be taught alongside intensive insulin therapy or multiple daily injections.						
1.6 I believe all patients with diabetes can be taught some form of carbohydrate counting.						
1.7 I believe that there is a strong evidence base for teaching carbohydrate counting to patients with type 1 diabetes.						

2. Rate the effectiveness from 1 to 5 (where 1 = not at all effective and 5 = extremely effective) of the following methods in the dietary management of diabetes.

Dietary management methods	Not at all effective 1	2	3	4	Extremely effective 5
2.1 Glycaemic index.					
2.2 Portion control using the healthy eating plate.					
2.3 Counting carbohydrates using exchange lists.					
2.4 Carbohydrate counting using scales and weighing items.					
2.5 Carbohydrate counting using nutritional labels.					
2.6 Carbohydrate counting using household measures.					
2.7 Carbohydrate awareness.					

3. Indicate your agreement with the following statements:

IN MY OPINION…	Strongly disagree	Disagree	Slightly disagree	Slightly agree	Agree	Strongly agree
3.1 …Carbohydrate counting is not possible without frequent blood glucose readings.						
3.2 …Good glycaemic control is an excellent indicator of whether carbohydrate counting is effective.						
3.3 …It is essential to know the amount of activity done before and after consuming carbohydrate to be able to carbohydrate count accurately.						
3.4 …A detailed diet history is essential when teaching a patient to carbohydrate count.						

Thank you for your participation

APPENDIX B: LETTER OF SUPPORT FROM THE DEPARTMENT OF HEALTH

health
Department:
Health
PROVINCE OF KWAZULU-NATAL

DIRECTORATE:
MCWH & NUTRITION

300 Langalibalele Street
Natalia building Pietermaritzburg 3201
Private Bag x 9051, Pietermaritzburg 3200
Email: Tel: 033 395 2079/3162/2042 Fax: 033 342 5572 Email: Sthandiwe.njokwe@kznhealth.gov.za
www.kznhealth.gov.za

Date: 12 December 2018
Enquiries: Sthandiwe Monegi

Principal Investigator
To: Ms. Megan Dimitriades
No10 District Road 369
Lions River
3260

RE: SUPPORT FOR RESEARCH STUDY ON "DIETITIANS EMPLOYED IN THE DEPARTMENT OF HEALTH"

I have pleasure in informing you that I support your conduct of the research study entitled "***Practice and perceptions of registered dietitians regarding the use of carbohydrates counting in the dietary management of type 1 diabetes mellitus.***"

Please note the following:

1. Please ensure that you adhere to all the policies, procedures, protocols and guidelines of the Department of Health with regards to this research.
2. This research will only commence once this office has received confirmation from the Provincial Health Research Committee in the KZN Department of Health.
3. Please ensure this office is informed before you commence your research.
4. The District Office/Facility will not provide any resources for this research.
5. You will be expected to provide feedback on your findings to the District Office/Facility.

Sincerely

MS. M PHALANNDWA
ACTING DIRECTOR: MCWH & NUTRITION

Fighting Disease, Fighting Poverty, Giving Hope

APPENDIX C: INFORMATION SHEET AND CONSENT FORM FOR PARTICIPANTS

CONSENT FORM FOR STUDY PARTICIPANTS

INFORMATION SHEET AND CONSENT TO PARTICIPATE IN RESEARCH

Date: _____

My name is Megan Esme Dimitriades and I am currently doing my M.Sc in Dietetics through the University of KwaZulu-Natal. My supervisor is Dr K Pillay.

You are being invited to consider participating in a study, titled **Practices and perceptions of registered dietitians regarding the use of carbohydrate counting in the dietary management of type 1 diabetes mellitus.**

The aim of the study is to determine the practice and perceptions of dietitians in KwaZulu-Natal regarding the use of carbohydrate counting in the dietary management of diabetes. It also aims to determine whether there is a need for training in this dietary management practice.

The study is being conducted online in the form of a self-administered questionnaire via the web-based survey tool, SurveyMonkey. Participants will be required to complete a self-administered questionnaire on their practices and perceptions with regards to the use of carbohydrate counting in the dietary management of diabetes. Approximately 180 dietitians from KwaZulu-Natal are expected to participate in the study. The questionnaire consists of open and closed-ended questions and should take a maximum of 15 minutes to complete. The study is self-funded by the researcher.

In the event of any problems or concerns/questions, you may contact the researcher at 0608279587 or megan.wasserfall@gmail.com. The project supervisor can be contacted on 033-2605674 or pillayk@ukzn.ac.za.

The HUMANITIES & SOCIAL SCIENCES RESEARCH ETHICS ADMINISTRATION can be contacted as follows:

HUMANITIES & SOCIAL SCIENCES RESEARCH ETHICS ADMINISTRATION
Research Office, Westville Campus
Govan Mbeki Building

Private Bag X 54001
Durban
4000
KwaZulu-Natal, SOUTH AFRICA
Tel: 27 31 2604557- Fax: 27 31 2604609
Email: HSSREC@ukzn.ac.za

There are no risks associated with participation in the study. The questionnaire will be completed anonymously online and all the data from the study will remain confidential and will be used only for the purpose of this research project. The researcher will keep the original electronic copies of the completed questionnaires. Participation in the study is voluntary and participants may withdraw from the study at any time if they wish to do so, with no consequences. Participants of the study that complete the study will be entered into a random prize draw to win a Gourmet Greek deli hamper to the value of R500. A report from the study will be forwarded to Department of Health KZN Provincial Office as well as the Association for Dietetics in South Africa (KZN branch). It is hoped that that the study findings will be used to strengthen training in the area of carbohydrate counting and type 1 diabetes.

The study has been ethically reviewed and approved by the UKZN Humanities and Social Sciences Research Ethics Committee (approval number: HSS/1612/018M).

Consent:

I hereby confirm that I have been informed about the study titled: **Practices and perceptions of registered dietitians regarding the use of carbohydrate counting in the dietary management of type 1 diabetes mellitus.**

I understand the purpose and procedures of the study. I have been given an opportunity to answer questions about the study and have had answers to my satisfaction. Participation in this study is voluntary and opting out will have not have any negative consequences for me. The researcher will only have access to your email address and will not share this or any of your answers with any third party without your consent. I have been informed that I will be entered into a random prize draw to win a Gourmet Greek deli hamper to the value of R500, if I participate in this study. The survey will take approximately 15 minutes to complete and the answers will be saved via the web based tool Survey

Monkey.

By clicking on the link to the survey, you:

- Consent to participate in this study.
- Understand that choosing to stop the survey before you have finished will have no negative impact on you.
- Understand that you will be entered into a random prize draw to win a deli hamper to the value of R500.

By deciding not to click on the link, you:

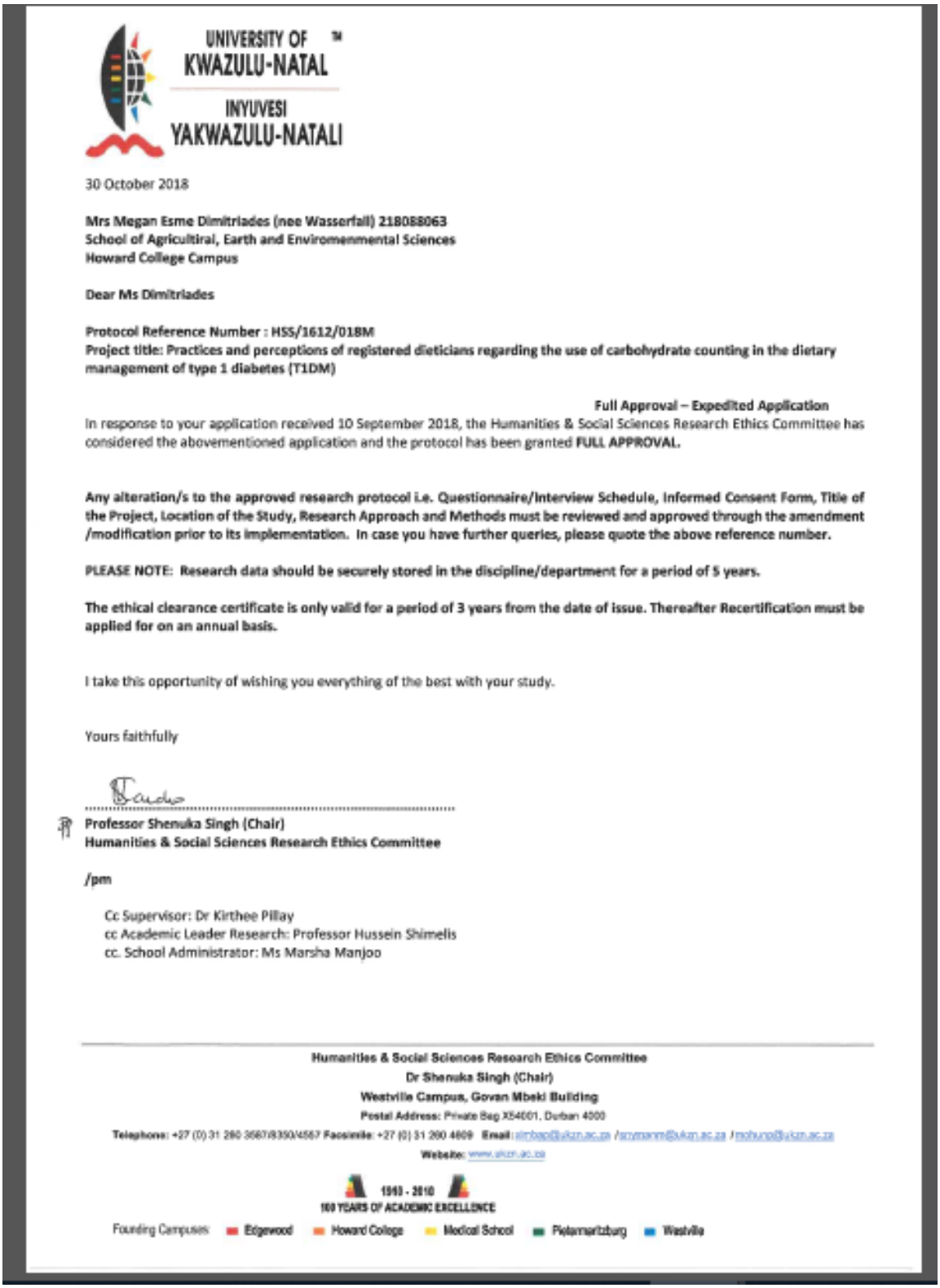
- Understand that opting out will have no negative impact on you.
- Understand that you will not be entered into the random prize draw for the deli hamper to the value of R500.

If I have any further questions/concerns or queries related to the study I understand that I may contact the research via telephone (0608 729 587) or email (megan.wasserfall@gmail.com).

If I have any questions or concerns about my rights as a study participant, or if I am concerned about an aspect of the study or the researcher or research supervisor, then I may contact:

Research Office, Westville Campus
Govan Mbeki Building
Private Bag X 5400
Durban
4000
KwaZulu-Natal, South Africa
Tel: +27 31 260 4557
Fax: +27 31 260 4609
Email: HSSREC@ukzn.ac.za

APPENDIX D: ETHICS APPROVAL LETTER FROM UKZN



UNIVERSITY OF KWAZULU-NATAL
INYUVESI YAKWAZULU-NATALI

30 October 2018

Mrs Megan Esme Dimitriades (nee Wasserfall) 218088063
School of Agricultiral, Earth and Enviromenmental Sciences
Howard College Campus

Dear Ms Dimitriades

Protocol Reference Number : HSS/1612/018M
Project title: Practices and perceptions of registered dieticians regarding the use of carbohydrate counting in the dietary management of type 1 diabetes (T1DM)

Full Approval – Expedited Application

In response to your application received 10 September 2018, the Humanities & Social Sciences Research Ethics Committee has considered the abovementioned application and the protocol has been granted **FULL APPROVAL.**

Any alteration/s to the approved research protocol i.e. Questionnaire/Interview Schedule, Informed Consent Form, Title of the Project, Location of the Study, Research Approach and Methods must be reviewed and approved through the amendment /modification prior to its implementation. In case you have further queries, please quote the above reference number.

PLEASE NOTE: Research data should be securely stored in the discipline/department for a period of 5 years.

The ethical clearance certificate is only valid for a period of 3 years from the date of issue. Thereafter Recertification must be applied for on an annual basis.

I take this opportunity of wishing you everything of the best with your study.

Yours faithfully

.....

Professor Shenuka Singh (Chair)
Humanities & Social Sciences Research Ethics Committee

/pm

Cc Supervisor: Dr Kirthee Pillay
cc Academic Leader Research: Professor Hussein Shimelis
cc. School Administrator: Ms Marsha Manjoo

Humanities & Social Sciences Research Ethics Committee
Dr Shenuka Singh (Chair)
Westville Campus, Govan Mbeki Building
Postal Address: Private Bag X54001, Durban 4000
Telephone: +27 (0) 31 260 3587/8350/4557 **Facsimile:** +27 (0) 31 260 4609 **Email:** simbap@ukzn.ac.za /snymanm@ukzn.ac.za /mohunp@ukzn.ac.za
Website: www.ukzn.ac.za

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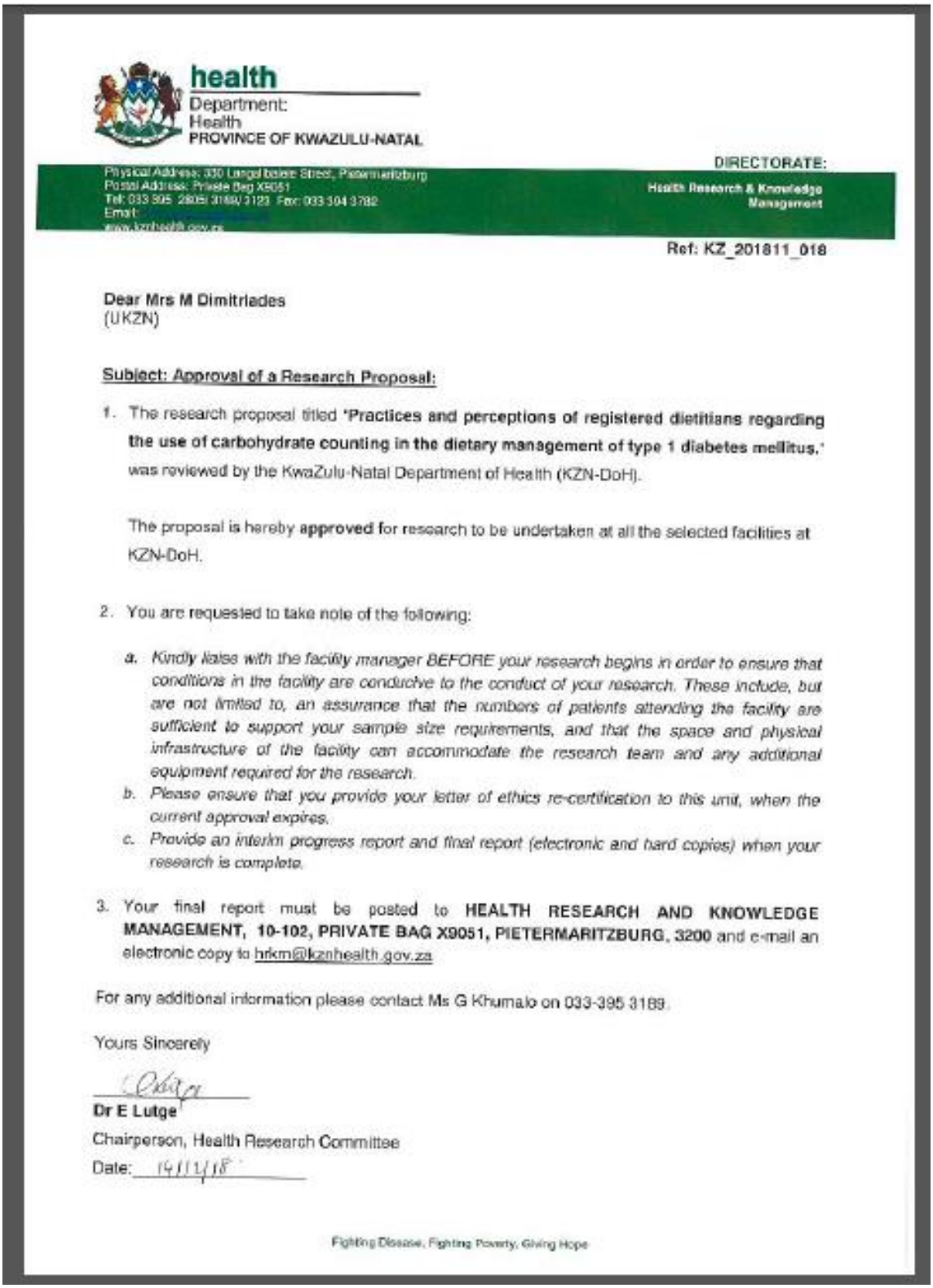
APPENDIX E: APPROVAL LETTER FROM THE DEPARTMENT OF HEALTH



health
Department:
Health
PROVINCE OF KWAZULU-NATAL

Physical Address: 330 Langalibalele Street, Pietermaritzburg
Postal Address: Private Bag X9051
Tel: 033 395 2808/ 3189/ 3123 Fax: 033 394 3782
Email:
www.kznhealth.gov.za

DIRECTORATE:
Health Research & Knowledge Management

Ref: KZ_201811_018

Dear Mrs M Dimitriades
(UKZN)

Subject: Approval of a Research Proposal:

1. The research proposal titled **'Practices and perceptions of registered dietitians regarding the use of carbohydrate counting in the dietary management of type 1 diabetes mellitus.'** was reviewed by the KwaZulu-Natal Department of Health (KZN-DoH).

   The proposal is hereby **approved** for research to be undertaken at all the selected facilities at KZN-DoH.

2. You are requested to take note of the following:

   a. *Kindly liaise with the facility manager BEFORE your research begins in order to ensure that conditions in the facility are conducive to the conduct of your research. These include, but are not limited to, an assurance that the numbers of patients attending the facility are sufficient to support your sample size requirements, and that the space and physical infrastructure of the facility can accommodate the research team and any additional equipment required for the research.*
   b. *Please ensure that you provide your letter of ethics re-certification to this unit, when the current approval expires.*
   c. *Provide an interim progress report and final report (electronic and hard copies) when your research is complete.*

3. Your final report must be posted to **HEALTH RESEARCH AND KNOWLEDGE MANAGEMENT, 10-102, PRIVATE BAG X9051, PIETERMARITZBURG, 3200** and e-mail an electronic copy to hrkm@kznhealth.gov.za

For any additional information please contact Ms G Khumalo on 033-395 3189.

Yours Sincerely

Dr E Lutge
Chairperson, Health Research Committee
Date: 14/11/18

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APPENDIX F: PERMISSION LETTER FROM THE ASSOCIATION FOR DIETETICS IN SOUTH AFRICA (KWAZULU-NATAL)

Physical IQ Sports Medical Centre

255 St Thomas Road

Musgrave

4001

1 August 2018

Dear Megan Wasserfall

RE: Permission to assist with data collection from KZN ADSA Members

As the ADSA KZN chairperson, I would like to inform you that as an ADSA member you have the member privilege to access the ADSA KZN members for input into your current research project on "Practices and perceptions of registered dietitians regarding the use of carbohydrate counting in the dietary management of type 1 diabetes mellitus".

I will facilitate the process by requesting members to fill in your survey on your behalf as we are not allowed to share members personal information to third parties.

Once you have your survey ready, please kindly inform me and I will initiate the request for assistance from our KZN members through our database. We will then also mention your survey at our next meeting which will be held on 13th September 2018. Should you wish to be there to present your request please do RVSP to attend.

If you require more National members to fill in your survey, please do let me know and I will ensure it is included in our ADSA mailer.

Kind Regards

Julie Perks

ADSA KZN Chairperson