

Perceptual systems of the self-management of students living with diabetes mellitus: an IQA approach

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PREFACE

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ABSTRACT

The main purpose of this investigative study was to gain knowledge surrounding the perceptions of students' self-management living with diabetes mellitus (DM) in a tertiary institute.

DM is a chronic and metabolic disease that is defined by elevated blood glucose levels over a long period of time. One in ten people are living with DM and since 1980, the number of DM patients increased from 108 million to 425 million in 2017. When DM is uncontrolled the consequences could lead to polyuria, weight loss, polyphagia, overeating and blurred vision.

The general research objective of this study was to make use of the Interactive Qualitative Analysis (IQA) to construct and describe a cognitive mind map of the perceptions of self-management of students living with DM on the NWU Potchefstroom campus. Self-management has been defined as "an ability and process that individuals use in conscious attempts to gain control of his or her disease".

DM care responsibilities increase when one enters the life stage of "after high school". Tertiary education could raise concerns for adolescents who are not prepared for new independence and challenges, especially students with DM.

An analysis of the participants' mind map representing students living with DM on the NWU Potchefstroom campus, reveals eight main components (affinities) namely, **Social awareness and acceptance**, **Food available on campus**, **Keeping insulin cool**, **Independent lifestyle**, **Adjusting by cooking**, **Hurdles in the academic environment**, **Causes of changing blood sugar** and **Adapting to effects of changing blood sugar**. Participants completed an Affinity Relationship Table (ART) to add richness and in-depth descriptions of the meaning of the affinities.

The final perceptual system is an informative representation of the self-management of students living with DM. The system reflects barriers towards compliance with self-management of students living with DM. The system produced four recognisable loops or cycles namely **The Ignorance loop**, **The Revision loop**, **The Developing loop** and **The Self-management Loop**. These loops created pathways through the system for the students to find a way to better self-management living with DM.

The pathway leads from the primary driver, Social awareness and acceptance, to the primary outcome, Adapting to effects of changing blood sugar. In this pathway, the four feedback loops were present and had to have connections with each other to complete the way for the primary driver to the primary outcome. The connections where feedback loops overlapped played an

important role as they support the potential for the student to move out of the one feedback loop to the other or for the student to get stuck in a negative cycle in the loop and have the potential of slipping back to previous loops.

This study was the first to be done on the perception of students' self-management living with DM on the NWU Potchefstroom campus and provide new and previously unknown information in the format of a perceptual system and model to probably benefit students living with DM.

Key words: Interactive Qualitative Analysis, IQA, Self-management, Diabetes Mellitus, Students, University, Systems Influence Diagram, Self-management of diabetes mellitus.

LIST OF ABBREVIATIONS

2-h OGTT	Two-hour oral glucose tolerance test
A1C	Haemoglobin A1C
ADA	American Diabetes Association
ART	Affinity Relationship Table
BMI	Body mass index
DM	Diabetes mellitus
FPG	Fasting plasma glucose test
HREC	North West University Health Research Ethics Committee
IDF	International Diabetes Federation
IFG	Impaired fasting glycaemia
IGT	Impaired glucose tolerance
IQA	Interactive Qualitative Analysis
IRD	Interrelationship Diagram
MUSA	Medicine Usage in South Africa
NWU	North-West University
SCC	Student Campus Council
SID	System Influence Diagram
T1DM	Type 1 diabetes mellitus
T2DM	Type 2 diabetes mellitus
TQM	Total Quality Management
WHO	World Health Organization

LIST OF DEFINITIONS

Affinity	““Map pieces” of a system or systems” (Northcutt & McCoy, 2015:5). “Categories of meaning or common themes of a system” (Northcutt & McCoy, 2015: 16). “Common themes or sets of textual references that have an underlying common meaning or theme, synonymous to factors or topics” (Northcutt & McCoy, 2015:16).
Affinity Relationship Table	“Affinity Relationship Table (ART) records the nature of the relationships between all possible pairs of affinities as determined by the respondents (simple ART). The detailed ART can also capture a statement of the reasoning of the cause-and-effect relationships between the affinities” (Northcutt & McCoy, 2004:152).
Affinity Write-Up	“The IQA Affinity Write-up is a composite story of the group as a whole. The researcher is tasked with organizing the multiple interviews so that they tell the story of the group. The researcher seeks to identify what “does the affinity mean?”, “what are the sub components?” and “what is the range of meaning?” for each affinity and is presented in the words of the participant themselves” (Northcutt & McCoy, 2015:26).
Atherosclerosis	The growth and formation of plaques inside the arterial lumen with simultaneous loss of vascular elasticity (Head <i>et al.</i> , 2017:1).
Axial coding	“Axial coding seeks to name, reorganize, clarify, and refine the affinities” (Northcutt & McCoy, 2016:16). Axial codes are specific examples of discourse that illustrate or allude to an affinity” (Northcutt & McCoy, 2015:25).
Cluttered SID	“A Cluttered SID is one that contains all relationships identified by the respondents” (Northcutt & McCoy, 2015:27). “The first version of the SID contains all of the links identified by the participants in the protocol leading to the IRD and is saturated. The Cluttered SID, while being comprehensive and rich, can be very difficult to interpret, even for a modest number of affinities that are highly

interlocked or embedded within the system” (Northcutt & McCoy, 2015:31).

Constituency	“Constituency is a term reflecting both an interest (perceptual or phenomenological distance) and power over the phenomenon, which is at the centre of the problem. A constituency is anyone who has something to say about the phenomenon and anyone who can do something about the phenomenon” (Northcutt & McCoy, 2015:9).
Diabetes Mellitus	A chronic and metabolic disease that is categorized by high levels of blood glucose that leads to damage to the heart, blood vessels, eyes, kidneys and nerves over a period of time (World Health Organization, 2020).
Diabetic Ketoacidosis	“A serious condition that can lead to diabetic coma (passing out for a long time) or even death” (American Diabetes Association, 2020).
Focus groups	The term “IQA focus groups” identifies the affinities of a system or systems that will ultimately represent the group’s experience with the phenomenon. The focus group identifies the “states,” or the relationships between each of the affinities. Affinities defined by the group are then used to develop a protocol for interviews” (Northcutt & McCoy, 2015:5). “IQA focus groups is a group of people who share some common experience, work or live within some common structure, or have a similar background” (Northcutt & McCoy, 2015:14).
Glycogenolysis	The process of degradation of glycogen for the use as an energy source in the skeletal muscle and liver (Patino & Mohiuddin, 2019).
Gluconeogenesis	A composite metabolic process that includes multiple enzymatic steps that is regulated by innumerable factors that include substrate concentrations, the redox state, activation and inhibition of specific enzyme steps and hormonal modulation (ADA 2015:3996).
Interrelationship Diagram	Interrelationship Diagram (IRD) “The SID is a picture drawn using a set of rules for rationalization on a summary of the theoretical codes called an Interrelationship Diagram (IRD) produced by the

respondents". "The relationships are transferred to an Affinity Relationship Table (ART) and then processed through another protocol called an Interrelationship Diagram" (Northcutt & McCoy, 2015:27).

IQA

"Interactive Qualitative Analysis is a systems approach to qualitative research with systematic, protocol driven procedures. IQA identifies relationships among self-identified components of an issue and have the ability to draw a system of influence" (Northcutt & McCoy, 2015:1).

"The purpose of IQA is to draw a picture of the system (SID) that represents the perceptual terrain or the mind-map of an individual or group with respect to a phenomenon represented by the issue statement" (Northcutt & McCoy, 2015:27).

Issue Statement

"The Issue Statement is the question the researcher asks to get the audience (participants of focus group) to speak about the phenomenon. It is quite simple and is always a variation of Tell me about the phenomenon, but it must be presented in terms that are real to a given constituency" (Northcutt & McCoy, 2015:10).

Nephropathy

A diagnosis referring to a "specific pathologic structural and functional changes seen in the kidneys of patients with DM" resulting from effects that DM has on the kidney (Umanath & Lewis, 2018:884).

Neuropathy

A heterogeneous group of conditions that affects different parts of the human nervous system and has diverse clinical manifestations. Diabetic neuropathy is also the predominant chronic complications of DM (Pop-Busui *et al.*, 2017:136).

Pareto Principle

"Something like 20% of the variables in a system will account for 80% of the total variation in outcomes" (Northcutt & McCoy, 2004:156).

"A minority of the relationships in any system will account for a majority of the variation within the system" (Northcutt & McCoy, 2015:32).

Phenomenon	“The phenomenon is an abstract idea (but a simple name) capable of producing a system with elements and relationships that not only describe the phenomenon, but how it works” Northcutt & McCoy, 2015:9).
IQA report	“IQA report name and describe the elements (affinities) of the system, explain the relationships among the element of a system and compare system. The report is split into two phases (1) Results and Analysis and (2) Interpretation and Implications” (Northcutt & McCoy, 2015:23).
Research Design	“IQA Research Design provides a series of tools to help articulate problems of interest, to identify constituencies that have an interest in the problem, and to state research questions that are implied by the problem statement” (Northcutt & McCoy, 2015:5).
Research Questions	“There are three universal Research Questions (in IQA). If only one constituency is involved two, and only two, research questions can be answered from a systems point of view namely What are the elements (components) of the system? Secondly, how are these elements (components) related to each other?” (Northcutt & McCoy, 2015:10).
Results / Analysis	“IQA Results / Analysis provides the researcher the opportunity to describe the phenomenon in the participant's voice and to present the data free of commentary, interpretation or opinion by the researcher. Through a rigorous use of protocols, transcripts are coded and systems are drawn. The story of each constituency group is told by aggregating axial codes of each affinity to tell the story of the group as a whole. The system is built one relationship at a time by aggregating theoretical codes to tell the story of the group as a whole. The resulting report is an Axial Write-up, Theoretical Write-up and presentation of the SID” (Northcutt & McCoy, 2015:23).
Retinopathy	A complication that affects the eyes of patients with DM and it is causes damage to the blood vessels of the retina through high

levels of blood glucose that can ultimately lead to loss of vision (Kempen *et al.*, 2004:554).

Systems (IQA)	“Systems have two components: elements and relationships among the elements. The elements, for the purposes of this approach to qualitative research, categories of meaning. Understanding a system means to identify the elements of the system, described the relationships among the elements and understand how the elements and relationships dynamically interact to result in different states of the system” (Northcutt & McCoy, 2015:5).
System Influence Diagram	Systems Influence Diagram (SID) “Using a set of protocols or rules stemming from IQA systems theory, a system is drawn that represents a “mind-map” of the group’s reality”. “The SID is a picture drawn using a set of rules for rationalization on a summary of the theoretical codes called an Interrelationship Diagram (IRD) produced by the respondents” (Northcutt & McCoy, 2015:27).
Theoretical coding	“Theoretical Coding refers to ascertaining the perceived cause and-effect relationships (influences) among all the affinities in a system. In the interview setting, this is accomplished by facilitating a systematic process of building hypotheses linking each possible pair of affinities” (Northcutt & McCoy, 2004:149).
T1DM	A selective destruction of the beta cells and insulin deficiency to a severe or absolute level (Nolte Kennedy, 2012:743).
T2DM	A resistance by the tissue to the action of insulin and a relative deficiency in secretion of insulin (Nolte Kennedy, 2012:744).
Uncluttered SID	“The Uncluttered SID is the final version of the system in which redundant links are removed. The Uncluttered SID is the simplest possible representation consistent with all the relationships contained in the IRD” (Northcutt & McCoy, 2015:27, 32).

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CHAPTER 1 INTRODUCTION

1.1 Introduction

Globally, diabetes mellitus (DM) is responsible for a significant cause in mortality, morbidity and health-system costs (International Diabetes Federation, IDF, 2019a). The IDF estimates that there are more than 463 million people worldwide that have DM and that almost 79% of DM-related patients in the world are prevalent in low and middle-income countries (IDF, 2019a). DM requires consistent medical care and a consistent increase of knowledge on the disease to avoid acute complications and to make sure the risk of long-term complications is at a minimum (American Diabetes Association, ADA, 2003:33).

According to the World Health Organization (WHO) (2016) “diabetes is a chronic disease that occurs either when the pancreas does not produce enough insulin or when the body cannot effectively use the insulin it produces”. The WHO (2016) asserts that DM can lead to complications in the body that could cause premature death. The ADA (2014:S81) and the WHO (2016) stated that long-term complications caused by DM include retinopathy that can lead to probable blindness, nephropathy that can lead to kidney failure, peripheral neuropathy that has the risk of developing into foot ulcers, a loss of limbs and Charcot joints and lastly autonomic neuropathy that causes genitourinary, cardiovascular and gastrointestinal symptoms and impotence. Cardiovascular diseases include: atherosclerosis, inadequate blood flow and cerebrovascular disease. Hypertension and lipoprotein metabolism irregularities are common in DM patients (ADA, 2014:S81). DM is a disease that affects people from all ranges of life and all ages. The focus of this study will be on students.

Roisman *et al.* (2004:130) showed that adolescents and young adults develop their sense of self to gain autonomy in all areas of life and to broaden their focus from normal tasks of a childhood to tasks of an adult. Family involvement during the development of childhood into adolescence is very important for optimal DM management (ADA, 2003:46). When taking these factors into consideration, tertiary education could raise worries for adolescents who are not ready to be independent and who face new challenges (Wdowik *et al.*, 2001:17), for example students living with DM. A study done by Shalom (1991:278) showed that there is anger, sadness and frustration in college students living with DM. Wdowik *et al.* (1997:561) used focus groups and interviews to find that college students face barriers such as implementing self-care, effective time management, dealing with stress, having frequent hypoglycaemic reactions, problems with eating healthy and insufficient finances. Additional stressors such as managing DM, a lack of support from peers, denying their situation and rebellion also have an impact.

Self-care is an undertaking of an individual's interest of their own health and well-being, taking the responsibility of their health into their own hands (Ali, 2011:2). Self-management is a process where an individual takes responsibility for their health as part of self-care (Clark *et al.*, 1991:4). It is important for people living with DM to implement self-management actions to successfully manage their condition (Casey *et al.*, 2011).

This study will focus on the perceptual systems of self-management that students living with DM at a university level implement by using the Interactive Qualitative Analysis (IQA) method (Northcutt & McCoy, 2004).

1.2 Background to study

Self-management has been a term used since the 1960's (Lorig *et al.*, 2003:1). Creer *et al.* (1976:226) first described self-management as an act of active participation in treatment by a patient. According to Alderson (1999:289) the term "self-management" refers to an interdisciplinary group education that is constructed on values of adult education, personalised treatment and case management theory. Also, self-management has been defined as "an ability and process that individuals use in conscious attempts to gain control of his or her disease" (Richard & Shea, 2011:257).

WHO (2018) found that there are three sets of tasks associated with self-management. These include managing medicine usage and diet; maintaining, changing and creating behavioural roles in one's life; and dealing with the emotional factors of living with a chronic disease. This was supported by Garcia-Perez *et al.* (2013:189) when the researcher stated that self-management of a chronic illness requires lifelong engagement in treatment-related behaviours such as taking medication or partaking in physical activity. In chronic diseases, a patient should be active in applying their knowledge in the continuous process of self-management (Holman & Lorig, 2004:240). Shrivastav *et al.* (2013:17) concluded that there is an immense need to dedicate self-care behaviours in multiple domains for the patients toward self-management to prevent DM-related morbidity and mortality.

DM is described as high blood glucose which is associated with low or no insulin secretion and either a concurrent impairment of insulin action or no concurrent impairment of insulin action (Nolte Kennedy, 2012:743). DM "is a general term for heterogeneous disturbances of metabolism for which the main finding is chronic hyperglycaemia" (Kerner & Brückel, 2014:384).

Type 1 DM (T1DM), as stated by Nolte Kennedy (2012:743), is the selective destruction of the β -cells in the pancreas and it is an insulin deficiency at a severe or absolute level. Atkinson *et al.* (2014:69) said that T1DM is precipitated by an immune-associated destruction of pancreatic β -

cells. Type 2 DM (T2DM) is the resistance of the tissue to the action of insulin and a relative deficiency in the secretion of insulin (Nolte Kennedy, 2012:744).

DM is referred to as the epidemic of the century, with figures such as 10.9% of adults diagnosed with DM in the Middle East and North Africa (Kharroubi & Darwish, 2015:850). Kharroubi and Darwish (2015:850) also specified that the Western Pacific region has the highest prevalence of DM among adults at 37.5% of the adult population.

According to the IDF (2019a) there are 463 million adults, between the ages of 20 and 79 years globally living with DM. The IDF (2019a) estimates that by 2045 the number of people living with DM in the world will have increased to 700 million. In the United States of America, 28.9 million adults were living with DM in 2014 (University Health System, 2020).

The treatment of DM consists of monitoring blood glucose levels, in combination with medication, exercise and diet (Toobert *et al.*, 2000:943). Uncontrolled DM could lead to polyuria (the excess passage of urine, 2.5 litres per day) (Rudd Bosch *et al.*, 2015:1), weight loss, polyphagia (excessive eating or appetite, especially as a symptom of disease) (Lakhani & Lakhani, 2015:433), and blurred vision (ADA, 2014:S81). There is a slim chance of growth impairment and susceptibility to some infections (ADA, 2014:S81). In addition, there are acute, life threatening, consequences that could arise from uncontrolled DM. These are ketoacidosis, which occurs when the body of a diabetic produces high levels of ketones (Cameron *et al.*, 2014:1555), or Hyperosmolar Hyperglycaemic Nonketotic Syndrome, a disease seen more often in older people with DM that is not controlled properly, and normally it arises from being infected or as an illness (ADA, 2013:S67; WHO, 2016:2).

Balfe (2009:2367) stated that diabetic adolescents attending a university are faced with challenges that could make it difficult to maintain self-management. Factors contributing to self-management of DM involve family, peer groups and health care professionals (Casey *et al.*, 2011). The public assumes that university students are at high-risk in their environment (Balfe, 2007:137). Balfe (2009:2370) also stated that people living with DM sees the university as a hazardous environment where students could break the rules, “lose control”, and where students tend to seek a situation leading to an adrenaline rush.

Wdowik *et al.* (2001:21) found that students with a positive attitude and good intents may struggle with self-care if barriers or negative feelings exist. Bayliss *et al.* (2003:19), confirms that barriers to self-care could be exercise, taking medication and the misunderstanding of chronic diseases by society, parents or teachers. This was confirmed by Jerant *et al.* (2005:304) showing that depression, weight control, struggling with daily physical activity, tiredness, poor communication

with their healthcare providers, an absence of support from family, pain, and financial problems are barriers to active self-management.

In a study done by Nagelkerk *et al.* (2006:156), it was found that perceived barriers to DM self-management were a lack of knowledge, limited social support, time constraints, frustration, feelings of helplessness and disease progression. Self-management of a chronic condition is critical to developing models to improve the process and results of chronic illness care (Jerant, *et al.*, 2005:306).

1.3 Problem statement

DM is a serious health issue in the world and in South Africa. Of the 7.53 billion people in the world, 463 million were living with DM in 2019 (IDF, 2019a). The IDF (2019a) stated that there were 1 826 100 cases of DM in South Africa in 2017. The IDF (2019a) also stated that 5.4% of South Africans between the ages of 21 and 79 years have DM.

According to Lehohla (2017:20), the epidemic of DM in South Africa is worsening. Lehohla (2017:20) stated that DM was the second biggest reason for deaths in South Africa in 2016. In 2015, 57 318 people died from DM in South Africa (IDF, 2015).

Several barriers have been identified that prevent individuals living with DM from changing their lifestyle. These barriers include patients not regarding the disease as serious (Jansink *et al.*, 2012:417), the overall behaviour shown by the patients (Wermeling *et al.*, 2014:97), a decrease in the well-being of patients (Vermunt *et al.*, 2012:79), asymptomatic diseases, cost increases, the cultural backgrounds of patients (Brown *et al.*, 2002:344), self-satisfaction of a patients' own behaviour (Nagelkerk *et al.*, 2006:153), lack of success in treatment, physical impairments, a lack of time (Dutton *et al.*, 2005:2109) and interference with work (Hansen *et al.*, 2011:484).

The focus of this study will be the perceptions of self-management that students living with DM have. The methodology that was used in the study was the Interactive Qualitative Analysis (IQA). Qualitative studies enable the researcher to gain new information regarding the research question. All the information volunteered by the participants will be based on their experiences (Bargate, 2014:11).

The phenomenon that the researcher investigated was the self-management of students living with DM on campus.

1.4 Research questions

The following research questions were formulated from the information and findings mentioned in section 1.1 and section 1.2.

- What is DM?
- What is self-management?
- What are the components of self-management that relate to DM?
- What are the definitions of optimal self-management and sub-optimal self-management?
- What are the barriers to self-management for students living with DM?
- What are students' perceptions of taking care of their self-management of DM on the NWU Potchefstroom campus?
- How do the different elements of perceptions of these students compare with each other?

The research aims and objectives will be discussed in the next section.

1.5 Research aim and research objectives

1.5.1 Research aim

The aim of the study was to explore the perceptions of students living with DM regarding their self-management and to develop a mind map thereof.

To achieve the above aim, the following research objectives have been formulated. The objectives consist of general and specific objectives of the study.

1.5.2 General research objective

The general research objective of this study was to use the IQA to construct and describe a cognitive mind map of students on the NWU Potchefstroom campus living with DM regarding their perceptual systems of their self-management.

1.5.3 Specific research objectives

The specific research objectives for the study were divided into two parts, namely a literature review and an empirical investigation.

1.5.3.1 Literature review

The following research objectives were formulated for the literature review:

- To conceptualise and contextualise self-management, DM and other related and applicable terms.
- To describe and investigate the self-management of students living with DM in a tertiary institute.

1.5.3.2 Empirical investigation

The specific research objectives for the empirical investigation were as follows (Northcutt & McCoy, 2004:66):

- To determine the components of the students' perceptual system of their self-management while living with DM at a tertiary institute.
- To determine the relation between the components of the before mentioned perceptual system.

1.6 Research methodology

1.6.1 Study setting

The researcher conducted the study at the NWU Potchefstroom campus. The NWU Potchefstroom campus had a student population of 48 667 registered students in total in 2016 (NWU, 2017a). The researcher used 13 participants of the 21 788 contact students (NWU, 2017a) as participants for the study to investigate their perceptions of self-management of DM on the campus.

Only one of the three campuses of the NWU was included in this study. A campus tends to have specific practices related to the culture on the campus. It is the first time that a study of this nature was undertaken, hence this study could be repeated on the other two campuses in the future and the results can be compared. For a qualitative study of this nature it is advisable that study participants and the investigator are able to communicate. For participants to express themselves fully, they should be able to talk in their mother tongue. As this researcher received no funds to employ translators, the Potchefstroom Campus offered the best chance to engage participants with a similar mother tongue than the investigator.

1.6.2 Target population

The target population for the study was registered full-time contact students living with either T1DM or T2DM at the NWU Potchefstroom Campus.

1.6.2.1 Inclusion criteria

In this study, the study population was defined by inclusion and exclusion criteria.

The inclusion criteria were:

- Full time contact students on NWU Potchefstroom campus registered for 2019;
- Students diagnosed with DM for longer than a year; and
- Students studying at the NWU Potchefstroom campus for longer than 6 months.

1.6.2.2 Exclusion criteria

The exclusion criterium for this study was:

- Students older than 26 years (NWU, 2017b:16).

1.6.3 Study design

In this study, the IQA method consisted of three stages which formed part of the IQA research flow (Northcutt & McCoy, 2004:44). These stages include the IQA research process, the IQA focus group and reporting and discussion. The IQA stages that were followed can be seen in Chapter 3 (Figure 3-1).

- Stage 1 of the IQA research process: IQA Research design.

The first stage of the IQA research flow is the IQA research design, which is a structural component of the IQA research flow. This was the researchers' initial step to conceptualise the study.

The IQA research design (see Figure 1.1.) provides a series of tools to help articulate the problem to the researcher. It helps to identify constituencies to take part in the focus group, and to state a research question which is applicable to the problem statement. A process of recursion was used to develop the research design and each step was repeated until the researcher was satisfied with the answers to the question that has been asked (Northcutt & McCoy, 2004:61):

- Problem: The problem reflects an observation or a concern that the researcher finds interesting. The problem seeks “how” and “why” answers.
- Constituencies: Members of a constituency are people who have information on the phenomenon or can change the phenomenon.
- Comparisons: The comparisons between constituencies produce research questions.

- Phenomenon: The phenomenon is an idea that can produce a system with elements and relationships. The elements and relationships describe the phenomenon and how it works.
- Issue statement: The issue statement is a meaningful, but simple question that must have a meaning towards each constituency. The issue statement is the question that gets the participants to talk about the phenomenon.
- Research question: There are two universal research questions associated within the IQA:
 1. What are the elements that make up the phenomenon?
 2. How do these elements relate in a system of influence?

There is a specific flow to the IQA research design that has been discussed. It is a cycle that takes place and once the cycle is completed, without any uncertainties, the next stage of the IQA research flow can commence. The IQA research design (Northcutt & McCoy, 2004:57) is depicted in Figure 1-1:

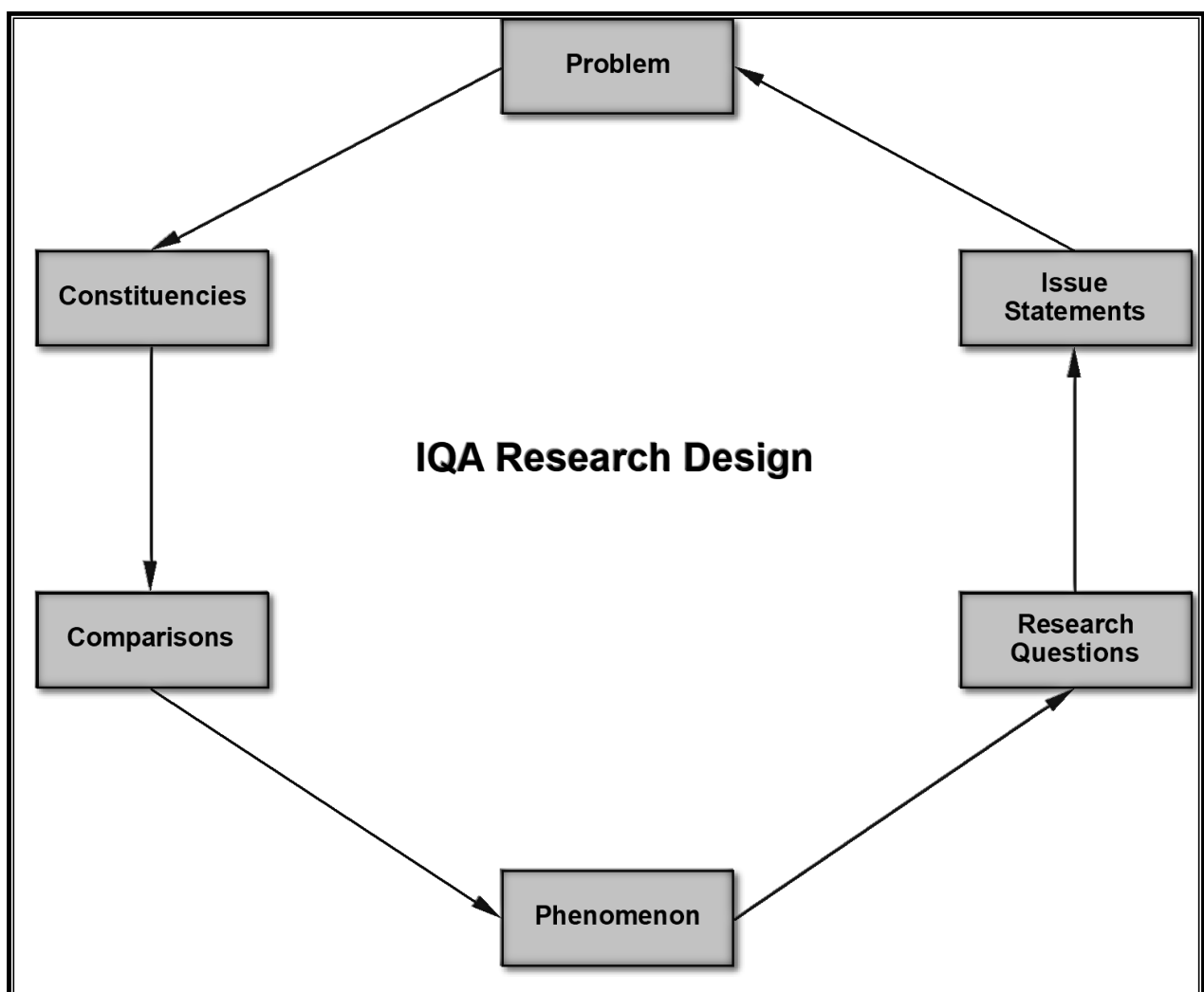


Figure 1-1: IQA Research flow

The flow of the IQA research design is described and elaborated on in Table 1.1 which is the IQA research design protocol. Table 1.1 demonstrates how the researcher personally applied stage 1 of the IQA research design protocol. All the steps in the IQA research design flow were set out in a broad perspective to formulate the issue statement that can be seen in Chapter 4 (Table 4-1) that was used in the focus group. The focus group forms stage 2.

Table 1-1: Implementation of the research design protocol

Problem	
Scenario	
DM is raised blood sugar which is related to low or no insulin secretion and either a concurrent impairment of insulin action or no concurrent impairment of insulin action (Nolte Kennedy, 2012:743). DM “is a general term for heterogeneous disturbances of metabolism for which the main finding is chronic hyperglycaemia” (Kerner <i>et al.</i>, 2014:384). “Self-management has been defined as an ability and process that individuals use in conscious attempts to gain control of his or her disease” (Richard & Shea, 2011:261). According to Haas and Maryniuk (2014:144), DM self-management is vital in the care of patients with DM and to those at risk of developing the disease. The importance lies in the prevention and delay of the complications of diabetes. Not everybody knows what it is like to have a chronic disease. Subsequently, most people do not know what a person has to go through daily to live a “normal” life. In South Africa, diabetes is accountable for 5.4% of deaths (Lehohla, 2017:20). According to Lehohla, DM is second on the list of causes of death in South Africa. It is therefore important to focus on diabetes in South Africa.	
Role of the researcher	Purpose of the study
○ Academic research ○ Graduate Student	○ Academic research ○ Dissertation ○ General understanding of a problem
Readers/Users of the study results	
○ Dietitians will be able to create a menu specifically for diabetic students to choose from in the cafeterias. ○ Lecturers could read the article and work out a way with their faculty to accommodate the students in the classes. ○ Pharmacists could read it to enhance their knowledge of diabetes patients and how to help them with self-management. ○ The researcher can use it for further studies and to enhance their knowledge on the problem. ○ Students in the field of medicine can read it for more information on the disease.	

○ Students with diabetes can use it to learn more on the self-management of their disease.
Problem question
○ What are the factors that influence the self-management of students living with DM in a university environment?
Domain
○ Students with T1DM or T2DM on the NWU Potchefstroom campus.
Potential causes of the problem or success
○ Pain for the student with DM to inject themselves with insulin. ○ Uncomfortable in public places to inject themselves with insulin. ○ They forget to adhere to medication usage. ○ Too busy to eat healthy per their disease and to even eat at all. ○ Too busy to exercise through the day. ○ Not enough healthy food on campus ○ Pharmacist did not inform him/her on self-management of their diabetes. ○ Lecturers are not informed of the students with diabetes and how to accommodate them in class. ○ The lifestyle of some diabetic students is not up to standard for a diabetic student. ○ The new timetable does not provide time for eating lunch. ○ The timetables are too busy and cause stressors. Students cannot cope or make time to eat or use their insulin.

The next stage of the IQA research flow was to recruit participants and to host the focus group.

- Stage 2 of the IQA research process: IQA Focus group.

The second stage to the IQA process is the IQA focus group. According to Northcutt & McCoy (2004:87), a typical IQA focus group should consist of between 12 and 20 members and the members of the focus group should have the following characteristics:

- They are information-rich, possesses knowledge of and experience with the issue;
- They can reflect on the question and transfer those thoughts into words;
- They have the time and inclination to participate in the study;
- They are homogenous with respect to important dimensions of distance and power (the influence the participants have on their disease and how they can influence the outcome of their disease);
- They can respect and practice group dynamics, *id est* they are neither overpowering nor too timid to speak (Northcutt & McCoy, 2004:90).

The focus group was then used to identify components, called affinities, of a system that represented the group's experience with the phenomenon. It is the purpose of an IQA study to "determine how a focus group represent their experiences in a system of cause and effect" (Human Vogel & Van Petegem, 2008:458).

- Stage 3 of the IQA process: Reporting and discussion

The last stage of this IQA process was to report and discuss the data. The result of the IQA study was a mind map of the system and the process that produced the system. The mind map has been designed to assist with the reporting process. The purpose of the IQA process was to name and describe the affinities of the system, to explain the relationships between the affinities of the system as well as the system dynamics (Northcutt & McCoy, 2004:50). Each affinity was identified and discussed in detail. These affinities were described by means of a System Influence Diagram (SID) by the participants. Also, a report on the relationships was done where the readers are guided through the system. The relative influence of each affinity on others was explained to the reader in the own words of the participants.

1.7 Data collection tool

The researcher made use of the IQA method as a data collection tool. The purpose of an IQA study is to find elements of meaning, called affinities, and define the perceived cause-and-effect relationship among the affinities to create a system called a mind map (Northcutt & McCoy, 2004:199). Northcutt & McCoy (2004:42) described the IQA study as a visual representation of a phenomenon that is prepared according to rigorous and replicable rules of achieving complexity, simplicity, comprehensiveness and interpretability.

The IQA is a qualitative data gathering tool and an analysis process that is dependent on facilitated group processes and will yield comparable results to other settings (Northcutt & McCoy, 2004:43, 50-51). The IQA approach implies that through the systemic facilitation of group processes and by means of the systematic representation of the discourse created by the group, the collection and interpretation of qualitative data can be approached from a systems point of view (Northcutt & McCoy, 2004:56). The purpose of the IQA study is to allow a group to create its own "mind map" of the phenomenon.

The purpose of the focus group is to construct a social reality for the researcher to gain data on the phenomenon (Northcutt & McCoy, 2004:16). The focus group identified the affinities of their perceptual system regarding their self-management of DM on the NWU Potchefstroom campus through a process of inductive coding as well as axial coding (Northcutt & McCoy, 2004:47). The affinities are the building blocks for the mind maps.

1.7.1 Trustworthiness and credibility of the data collection tool

The data analysis used in an IQA study is, as far as possible, uncontaminated with any subjective interpretation by the researcher. The IQA methodology is designed so that the results represent the constituencies' (students) perceptual model and not a representation of the researcher's interpretation of the patterns in the data (Human-Vogel & Van Petegem, 2008:456). "In the IQA study, issues of subjectivity and validity are fewer, because the participants code the data" (Human-Vogel & Van Petegem, 2008:456).

IQA develops the theory of the study into a comprehensive and transparent set of protocols for research design, observation, analysis and interpretation. The construction, interpretation, and comparison of recursive systems of meaning or mind maps are articulated in detail in this method (Northcutt & McCoy, 2004:27).

1.7.2 Recruitment of participants

Recruitment materials were developed and distributed through various channels to reach the students on campus to obtain participants for the focus group. These included:

- The NWU Potchefstroom Student Counselling and Development facility;
- A pharmacy located close to the NWU Potchefstroom campus that gets frequent visits by students;
- Distribution of flyers to B.Pharm students of the NWU Potchefstroom campus;
- The use of eFundi, a communication platform used by all registered students and lecturers;
- Placing flyers in consultation rooms of physicians and specialists in Potchefstroom;
- Posters were set up around the NWU Potchefstroom campus on all available notification boards as well as the 28 hostels on the campus;
- The researcher went to the hostels on the NWU Potchefstroom campus to attend their meetings and present the study and recruit possible participants;
- The researcher communicated to the hostels to continue to promote the study in hostel meetings.

1.7.3 Process of obtaining informed consent

The potential participants received the informed consent form electronically from the researcher when they contacted the researcher if they were interested to participate in the study. The potential participant then decided if they want to participate in the study by informing the researcher of their decision. The participants met an independent person at the location of the

focus group where the independent person was available and answered any other questions from the participants regarding the study. The independent person then oversaw in private the signing of the informed consent forms in her presence before the onset of the focus group.

1.7.4 Data gathering: Conducting the focus group

The focus group process is discussed in more detail in Chapter 3. In Chapter 3 the researcher described all the steps that were followed to run the focus group to obtain the data that was used in this study.

1.7.5 Data analysis

1.7.5 Data analyses

An audit trail is created with the IQA method where every step and decision in the analysis is accounted for (Human-Vogel & Van Petegem, 2008:456). The participants conducted their own theoretical coding of the components of the phenomenon (Northcutt & McCoy, 2004:87). The system was built by taking one relationship at a time and aggregating theoretical codes to tell the story of the group as whole.

The analysis should be free from any personal interpretation of the researcher (Northcutt & McCoy, 2004:199). The facts generated from the participants were used and credit will be given by the researcher (Northcutt & McCoy, 2004:199). The flow of the data analysis was as follows:

- System elements (describe each affinity).
 - Composite the descriptions of affinities.
 - Describe each affinity as from the point of views given by the focus group.
- System relationships (describe each relationship).
 - Composite the theoretical descriptions.
 - Draw the cluttered system of influence diagram one affinity at a time while each relationship gets described.
 - System influence diagram.
 - Present an uncluttered diagram of the “maps”.

1.8 Ethical considerations

1.8.1 Ethical approval

An ethical application was submitted to the HREC of the NWU Potchefstroom campus. The researcher obtained ethical approval for the study from HREC on 19 November 2018 with the ethics number being NWU-00124-17-A1.

Other factors that were taken into consideration are discussed in Chapter 3.

1.8.2 Reimbursement of study participants

There was a token of appreciation in the form of R150 cash handed to each participant after they participated in the focus group.

1.8.3 Data management

During data collection and coding, the data gathered were kept on several systems to ensure that it was safe and secure. At all times, the electronic data was stored and backed-up, secured with a password known only to the researcher. The hardcopies of the data were kept in the office of the researcher. It was locked in a cupboard with keys kept by the researcher.

The audio recordings of the IQA focus group were transcribed with the deletion of all names. After the researcher controlled the correctness of the transcription, the recording of the IQA focus group was deleted. The recording of the IQA focus group was removed from the audio recording device to a password-protected computer, directly after the completion of the focus group. All the documentation of the focus group (after it was processed), including the transcription of the recording, was stored in the assigned space allocated by the research entity Medicine Usage in South Africa (MUSA).

The study is presented in this dissertation. The data will be kept safe at the offices of MUSA. Hardcopies of the data will be shredded by MUSA and the electronic data will be formatted from all the personal drives used by the researcher in the presence of a research assistant of MUSA after a period of seven years.

Only the researcher and the two promoters had access to the data during the study.

The detailed information regarding the IQA methodology will be discussed in Chapter 3.

1.9 Division of chapters

The chapters for this dissertation will be divided as follow:

1.9.1 Chapter 1: Research protocol

In Chapter 1, the researcher presented the background to the study, the rationale of the study, the research objectives and outlined the study.

1.9.2 Chapter 2: Literature review

In the literature review, the researcher focussed on the history of DM, the effects of DM on a person, self-management of DM, the results of a lack of self-management of DM and DM in students. The background, definitions, examples, impact, consequences, ways to improve self-management, as well as other topics, were discussed.

1.9.3 Chapter 3: Methodology

The researcher presents the IQA research method in Chapter 3. The process that was followed has been prescribed by Northcutt and McCoy in their textbook from 2004: Interactive Qualitative Analysis: A system method for qualitative research. The two authors developed the IQA methodology and are considered the founders of the IQA methodology. Every aspect of the IQA methodology is described in the aforementioned book. The book was used as a guideline for the methodology of this study. The methodology is described in more detail in Chapter 3.

1.9.4 Chapter 4: Results and discussion of the system's elements and the system's relationships

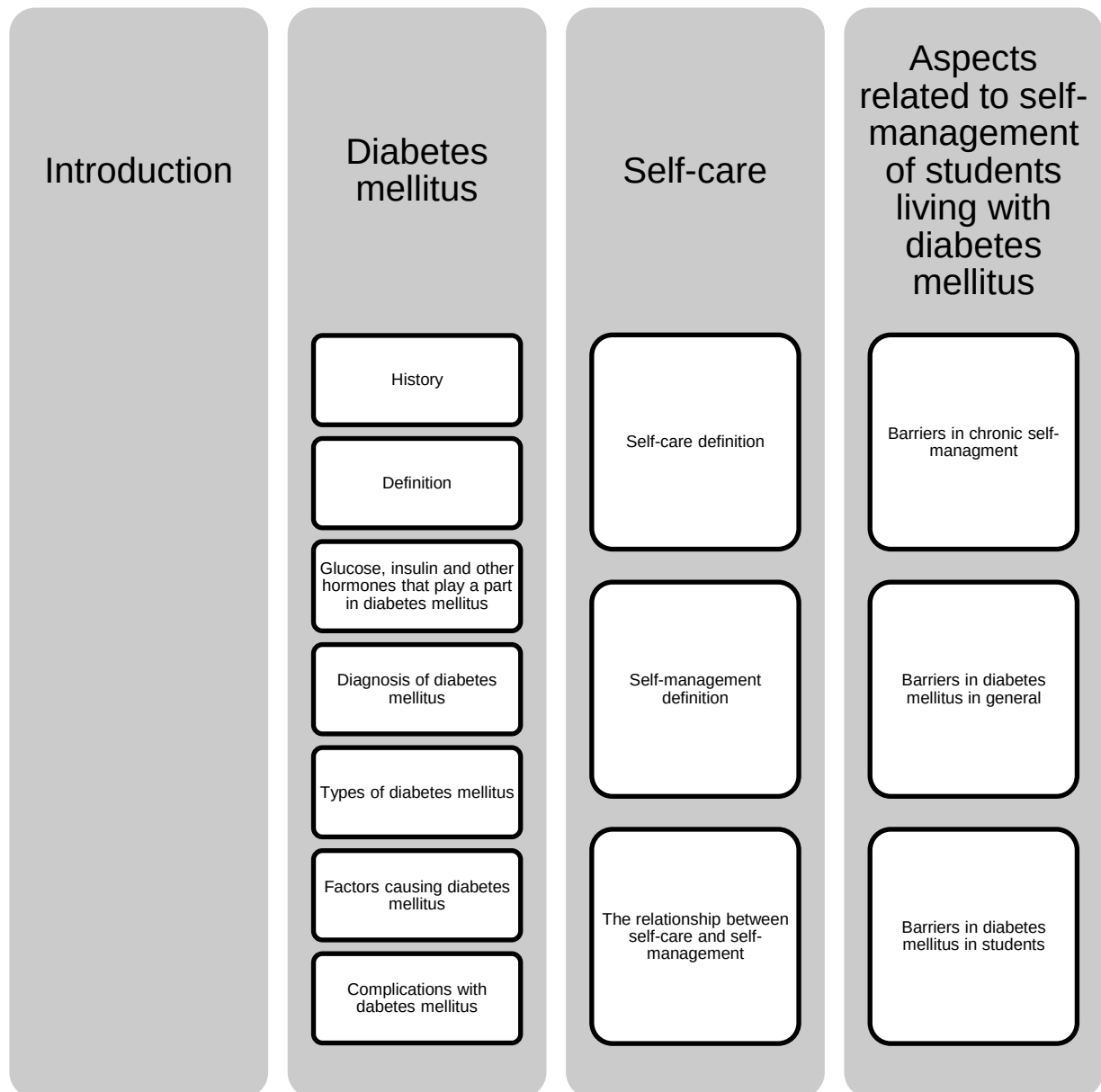
In this chapter, only the results of the systems affinities and the relationships of these affinities are discussed. The argumentation that comes later, is omitted in this chapter to add to the credibility of the data, as all data and facts are cleared of the researcher's interpretations and opinions. The reader can now draw their own conclusions without the bias of the researcher (Northcutt & McCoy, 2004:300).

1.9.5 Chapter 5: Analysis, interpretation and implementations

The implications of the study were presented in Chapter 5 to provide an opportunity for the researcher to analyse and interpret the data and draw conclusions based on the data. The composite system, highlighted feedback loops, and exercising the model was described by the researcher.

In the section on the predictions, interventions and practical interventions, the researcher consulted the literature to find possible solutions regarding problems that the researcher identified, other research results, theories of thought and other sources to support and inform the findings (Northcutt & McCoy, 2004:302). The chapter ended with limitations of the study and recommendations to further studies and a conclusion to the study.

CHAPTER 2 LITERATURE REVIEW



In this chapter the researcher looks at the objectives of the study as set out in Chapter 1. The general research objective of this study was to use the Interactive Qualitative Analysis (IQA) to construct and describe a cognitive mind map of students on the Potchefstroom campus of the North-West University who are living with diabetes mellitus (DM) regarding their perceptual systems of their self-management. As mentioned in Chapter 1, the IQA has a literature review and an empirical investigation. The literature review will be done in this chapter to complete the first part of the objective. The following research objectives were formulated for the literature review:

- To conceptualise and contextualise self-management, DM and other related and applicable terms.
- To describe and investigate the self-management of students living with DM in a tertiary institute.

2.1 Introduction

DM is currently referred to as the epidemic of the century (IDF 2015a). DM statistics significantly increased from 108 million people, living with T1DM and T2DM, in 1980, to nearly 425 million people in 2017 (IDF, 2019a; WHO, 2018). Statistics indicate that the prevalence is high with 463 million people between 20 to 79 years living with DM in 2019. However, in 2013 the reported worldwide cases of DM in children aged 0 to 14 years was approximately 500 000 (IDF, 2019a). Globally, 1 in 433 youths under 20 years are affected by DM (Pettitt *et al.*, 2014:407). As the DM statistics are significantly rising, it is estimated that DM will increase to 629 million adults globally by 2045. For children, an estimated 79 000 new cases per year is forecasted. Statistics from IDF (2019b) indicated that more than 1 106 500 children were living with DM in 2017. Additionally, 352 million people living with T2DM worldwide are at risk for developing T1DM (IDF, 2019b). Globally about 727 billion US dollars were spent on DM (T1DM and T2DM) in 2017 (Ogurtsova *et al.*, 2017:45; WHO, 2016b; Zhou *et al.*, 2016:1513), and DM was responsible for an estimate of 4.2 million deaths in 2019 (IDF, 2019b).

DM is ranked seventh on the World Health Organisation's death statistics. High blood glucose (DM) attributed to almost half of the deaths of people before the age of 70 years in 2016 (WHO, 2018). In addition, DM is also responsible for *inter alia* complications leading to blindness, renal failure, heart attacks, strokes and loss of lower limbs. When comparing first world countries and developing countries, it is evident that DM is more prevalent among middle- and low-income countries (developing countries). For example, in the Middle East and North Africa (developing countries), the DM prevalence was the highest amongst all countries in 2013 with 34.6 million (10.9%) of adults living with DM between the ages of 20 and 79 years (Kharroubi & Darwish, 2015:850); 30.3 million adults lived with DM in the United States (a developed country) in 2015 (University Health System, 2014); and by 2017, 15.9 million people lived with DM in Africa (IDF, 2015a; IDF, 2017).

In 2017 Africa had a population of 516 million people of which 3.1% of adults between 18 and 99 lived with DM; and out of 19.6 million children between the ages of 0 and 18, 50 600 were diagnosed with T1DM (this accounts for 0.258% of children in Africa). In the same year Africa spent 3.4 billion US dollars on DM, with 312 000 recorded deaths due to DM complications (IDF, 2017). In South Africa, 1 826 100 out of 33 762 000 adults (5.4%) were diagnosed with DM in

2019 (IDF, 2019a). The DM epidemic is worsening in South Africa with an increase in DM diagnoses and more deaths as a result of DM complications recorded between 1997 and 2015 (Lehohla, 2017:20). DM is the second highest cause of deaths in South Africa where 25 070 deaths out of 460 236 deaths were related to DM in 2015) (this accounts for 5.4% of the population in 2015) (the population of South Africa was 55 390 000 (IDF, 2015; Lehohla, 2017:20).

2.2 Diabetes Mellitus

2.2.1 History

The concept of DM was first evident in Egyptian manuscripts dating back to 1500 B.C., where they characterised DM as “too great emptying of urine” DM. Between 400-500 A.D., Indian physicians were intrigued by the fact that individuals’ urine attracted ants and they further researched this phenomenon and came about the concept of ‘madhumeha’, meaning ‘honey urine’ (Lakhtakia, 2013:368). Later in 1869, Paul Langerhans claimed the notion of the ‘islets of Langerhans’ (Lakhtakia, 2013:368; Levy, 2011:1). He postulated that the function of the islets of Langerhans, found inside the pancreas, had a clinical effect on the development and diagnosis of DM. In 1889, Von Mering and Minkowski discovered that dogs which had their pancreases removed developed DM. This particular theory was verified in 1921 by Frederick Banting and Charles Best when they observed that the blood glucose levels of such dogs decreased as a result of insulin injections (ADA, 2014, Lakhtakia, 2013:368, Levy, 2011:2). The above-mentioned discoveries led many physicians from 1920 till present to further explore the concept of DM (ADA, 2014, Levy, 2011:2).

2.2.2 Definition

Today DM can be described as a chronic disease relating to chronic elevated blood glucose levels (also known as hyperglycaemia) which is associated with either defective insulin secretion or an impairment of insulin action, or both (ADA, 2004:5; Kerner & Brückel, 2014:384; Nolte Kennedy, 2012:743; WHO, 2019b). The concept of DM embodies two major forms of DM, namely Type 1 and Type 2. T1DM is identified as the body’s failure to produce insulin and is mainly diagnosed in children and young adults (0 to 18 years old). On the other hand, a body with T2DM does produce insulin, but does not use the insulin; this is known as insulin resistance. Both T1DM and T2DM lead to complications in the body, such as failure of several organs and tissues (ADA, 2019; IDF, 2019a). Centers for Disease Control and Prevention (CDC) (2016) confirmed in their study conducted in the United States that various complications caused by DM occur over a period of time. They focused predominantly on complications such as heart problems and stroke, high blood pressure, loss of vision and problems related to the eyes, renal problems, nervous

system disease, the loss of limbs due to amputations, diseases of the teeth, complications during pregnancy and other difficulties (CDCP, 2016). Lastly, disturbances in the metabolism of carbohydrates, fat and protein are factors contributing to hyperglycaemia (de Munter *et al.*, 2007:1386). It is an immense challenge to deduce DM to a single definition and therefore the various components or factors relating to DM needs to be explored.

2.2.3 Glucose, insulin and other hormones that play a part in DM

2.2.3.1 Glucose

Glucose plays a prominent role in DM. According to Wang & Jia (2018:1), glucose can be defined as the main source of energy utilised by human activities. Normally, glucose levels are between 3.9 - 6.1 mmol/L fasting and reaches between 7.8 - 8.3 mmol/L following meals. Blood glucose levels plays an essential role as it is utilised in determining the possibility of DM, treatment of DM, and follow-ups of DM. When blood glucose levels exceed 7 mmol/L for a fasting patient or are higher than 11.1 mmol/L, it can indicate the dysfunctionality of insulin produced by the body (ADA, 2018a:S15).

2.2.3.1.1 Glucose metabolism

Glucose is a molecule obtained from the metabolism of carbohydrates that is found in food substances. Of all the carbohydrate molecules, glucose is the most prominently used and stored molecule (Szablewski, 2011; Wang & Jia, 2018:1). Its main functions are to supply energy and transportation in the body. The carbohydrates found in food are responsible for 70% of the body's energy. After the metabolism of the carbohydrates into glucose (as seen in Figure 2-1), the glucose is absorbed into the blood circulation, where it is oxidized (combined chemically with oxygen) in the blood and used by the body's organs, tissues and cells. The remaining glucose, not used by the body, is then stored as glycogen in the liver and muscles.

The glycogen stored in the muscles is used as reserved energy at any given time, as needed by the body. Whereas, the glucose absorbed in the intestines are transported to the liver where it is synthesised into liver glycogen for storing (Wang & Jia, 2018:2). The function of liver glycogen is to keep a balance with glucose homeostasis, controlled by many neurohumoral factors. For a healthy adult, liver glycogen is more or less 100 gram that is used up within 24 hours of fasting. When fasting during a sleeping period, 50% of the before-mentioned liver glycogen, is decomposed (Adeva-Andany *et al.*, 2016:95; Petit *et al.*, 2015:275).

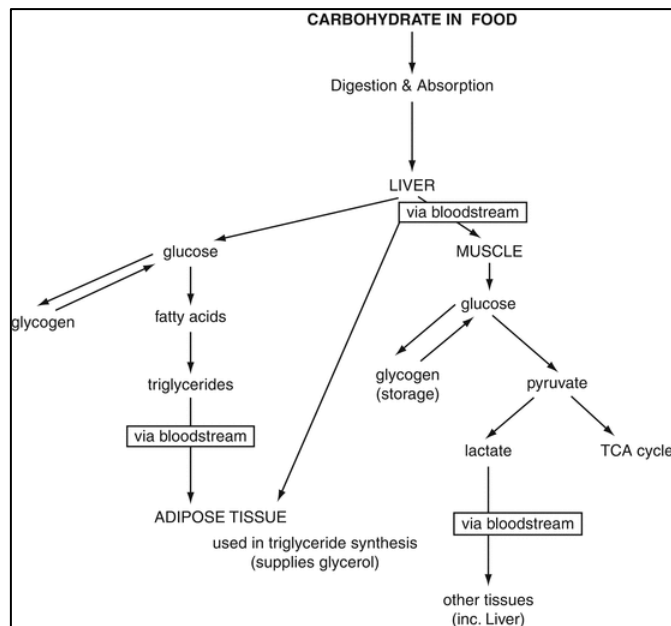


Figure 1-1: Carbohydrate metabolism (Chen, 2012)¹

The main sources of blood glucose are, foods that account for 60% – 70% of the body's energy, glycogen decomposition, and gluconeogenesis (a pathway used by the body to create glucose from other molecules called particles, and an important pathway that allows the body to store needed energy for the brain in the form of glucose) during a period of fasting. The blood glucose that the body receives is utilised for:

- Energy supply when it is oxidatively decomposed;
- The synthesis for glycogen in the liver, muscle and other tissues;
- Transformed into different kinds of carbohydrates and derivatives;
- Converted to non-sugar substances, such as fat, non-essential amino acids, etc.;
- Excreted in the urine when the concentration of blood glucose is extremely high and surpasses the renal glucose threshold (Wang & Jia, 2018:2).

Blood glucose, in the body, is consistently maintained at an average level. This is called glucose homeostasis (Röder et al., 2016:1). This process is vital for the usage of glucose by numerous organs and tissues, such as the tissue in the brain, bone marrow, red-blood cells and nerve cells (Adeva-Andany *et al.*, 2016:95; Mergenthaler *et al.*, 2013:297). Glucose homeostasis is the process that controls the balance of blood glucose production and release (Mergenthaler *et al.*,

¹ Approval for the use of Figure 2-1 can be found in Annexure B.

2013:588; Röder *et al.*, 2016:1). The glucose in the blood needs to be absorbed for metabolism and several functional activities, when required.

The transport of glucose from the blood to various cells and tissues happens through facilitated diffusion (Huang & Czech, 2007:245). When the blood glucose levels become too low (for example when a DM patient injects too much insulin), conditions are not suitable to transport glucose across cell membranes into various tissues, whereas with high blood glucose levels (when a DM patient does not inject insulin or the insulin is ineffective), excess glucose is distributed into the urine via the kidneys (Wang & Jia, 2018:2). The brain uses a substantial amount of energy, however, it stores diminutive number of glycogens (energy reserves) (Murray & Rosenbloom, 2018:244).

In hypoglycaemic conditions (a condition caused by a very low level of blood glucose), an individual's brain is depleted from blood glucose and can thus fall into coma, have convulsions, and irreversible damage to tissue (Mukherjee *et al.*, 2011:86). This process happens in a DM patient in the absence of insulin or ineffective insulin, and the body cannot produce glucose from the glycogen stores. Blood glucose homeostasis, in the body, is closely regulated by hormones, the liver and nerves where the main hormones that play a role in the process are, insulin, glucagon, adrenaline, cortisol, growth hormones, and others (Wang & Jia, 2018:2).

2.2.3.2 Insulin

In the following section, the researcher describes the processes of a normal human body, living without DM and introduces the effects that a lack of insulin has in these circumstances. This will highlight the importance of insulin in the body. Without insulin or working insulin, the body will not function properly.

Insulin's purpose in the body is to lower the blood glucose production in the body, when in a state of hyperglycaemia. Insulin has three mechanisms to lower the blood glucose levels in inhibiting the glycogenolysis (biochemical breakdown of glycogen to glucose) and gluconeogenesis, also to increase the uptake of glucose and use of blood glucose in the muscles, liver and adipose tissue (Wang & Jia, 2018:4). Insulin can move glucose from the blood into the liver cells by increasing the formation of transmembrane glucose gradient via a process called intracellular glucose phosphorylation (Within a cell, glucose 6-phosphate is produced by phosphorylation of glucose on the sixth carbon) (Wang & Jia, 2018:4). This process helps with hepatic glycogen production and hinders gluconeogenesis, this helps to lower hepatic glucose output. All these effects start when the body is in a hyperglycaemic state (Nolte Kennedy, 2012:745).

2.2.3.2.1 Insulin secretion

The secretion of insulin is a cardinal process for the normal person (Fu *et al.*, 2013:28). Glucose is not the only factor in secretion of insulin, but it is a primary factor (Fu *et al.*, 2013:29). The process of insulin secretion starts in the β -cells (in the pancreas) and for insulin to be secreted, β -cells in the pancreas needs to be activated by certain factors, such as glucose (increased levels of glucose in the body), where insulin is then released into the bloodstream from the pancreas (Newsholme *et al.*, 2014:R106; Nolte Kennedy, 2012:745; Watkins *et al.*, 2008:23).

The first function of the β -cells is the synthesis of insulin via proinsulin and the second function of the β -cells is to use its developed mechanism to secrete insulin in response to glucose (Watkins *et al.*, 2008:23). The proinsulin has a connecting peptide called the C-peptide that gets stored in the β -cells. When C-peptides are found in the blood circulation and it is an indication of active β -cells (Krentz, 2002:3; Watkins *et al.*, 2008:23). This is an important factor in patients receiving insulin therapy as these patients have no measure of endogenous β -cell activity (Watkins *et al.*, 2008:23).

2.2.3.2.2 Effects of insulin

The mechanism of action and the many effects of insulin have been well established over the years (Dimitriadis *et al.*, 2011:S52). Uncertainty remains about the main metabolic process that insulin uses to control blood glucose levels. What could well be said is that insulin has a major effect on the metabolism of carbohydrates, fats and proteins, which influences the liver, muscle and adipose tissue (also called fat) and has been well documented (Dimitriadis *et al.*, 2011:S52; Nolte Kennedy, 2012:747; Sen *et al.*, 2016:4) These effects of insulin on the various metabolisms all play a role in the metabolism of glucose in muscles and adipose tissue (or fat), the synthesis of protein in muscle, lipid metabolism in adipose tissue, the glucose/fatty acid cycle, blood flow, and the sensitivity of glucose utilisation to insulin (insulin can be defined as an anabolic hormone).

- Effects on muscle

The insulin that is secreted in the body influences muscles in the body via the metabolism of carbohydrates (as seen in Figure 2-1). Carbohydrate metabolism is affected by insulin by increasing the rate of glucose transportation across cell membranes in muscles and adipose tissue. In a DM patient, insulin cannot transport glucose into the muscles or adipose tissue, reducing the storage of glucose in states of hypoglycaemia. Other effects of insulin on muscle includes the higher rate that glycolysis takes place in muscle and adipose tissue; insulin increases synthesis of glycogen in muscles, the liver and adipose tissue while also lowering the breakdown of glycogen in muscle and the liver; and it stops the rate of glycogen breakdown into glucose

(glycogenolysis) and generating of glucose (gluconeogenesis effects) in the liver (Dimitriadis *et al.*, 2011:S52). As described (in section 2.2.3.2.2.), the effects of insulin do not directly affect major tissues such as the brain and intestine, but it can hamper the indirect effects of glucose when it gets utilised in these tissues, by mobilising the fuels taken from adipose tissue.

- Effects on adipose tissue

Insulin affects the metabolism of lipids by decreasing the rate at which lipolysis (the process by which fats are broken down in our bodies) takes place in the adipose tissue. This causes a reduction in the level of plasma fatty acids and the rate of fatty acid oxidation in the liver and muscle. It stimulates the synthesis of fatty acid and triacylglycerol in tissues and increases the rate at which very-low-density lipoproteins form in the liver, absorption of triglyceride from the blood into the muscle and adipose tissue and cholesterol synthesis in the liver (Dimitriadis *et al.*, 2011:S53). When a DM patient does not have the effects of insulin in their body, fat does not get metabolised and this can lead to higher levels of fat in the blood, leading to potential hyperlipidaemia.

- Effects on amino acids

The metabolism of proteins is affected by insulin with an increase in the rate of transport of certain amino acids (the building blocks of proteins and enzymes) into the specific tissues and the rate of protein synthesis in adipose tissue, liver, muscle and other tissue. Insulin also decreases the rate at which protein is degraded in muscle and urea is formed (Aliu, *et al.*, 2018:471; Dimitriadis *et al.*, 2011:S53). The lack of insulin, or effective working insulin, reduces the transport of amino acids into muscle, adipose tissue, liver and other tissue, reducing the ability to regenerate cells. These circumstances increase the degradation of muscle, lowering the power and muscle mass in the body of the patient living with DM.

The importance of glucose and glucose metabolism in the human body has been described in section 2.2.3.1. In a healthy human, insulin plays a role in glucose metabolism in adipose tissue and muscle. For instance, insulin only stimulates the transport of glucose in the muscle and adipose tissue and not in the liver or other cells (Dimitriadis *et al.*, 2011:S53; Nolte Kennedy, 2012:747; Sen *et al.*, 2016:4). The transport of glucose for metabolism is a vital step that needs to happen, because it controls the rate at which glucose gets used. Insulin increases the rate at which glucose is being transported into the muscle and adipose tissue by stimulating the receptors that transport the glucose into the cells. Skeletal muscles play a vital role in glucose metabolism, and insulin is required to complete the action (Corcoran *et al.*, 2007:662).

The skeletal muscle, as one of the primary stores of glycogen, gets affected by insulin by the increase of glycolysis (the process of breaking down glucose) that transpires and the transportation of glucose into the cells. These effects are of significant importance, because when the uptake of glycogen in the skeletal muscle is depleted, the glucose taken up is converted into lactate which increases the usage of glucose. Lactate produced and released by the skeletal muscles and adipose tissue, is transported to the liver where it is converted to glycogen. (Dimitriadis *et al.*, 2011:S53; Nolte Kennedy, 2012:747; Sen *et al.*, 2016:4). This process acts as a gluconeogenic forerunner when the uptake of the skeletal muscles' glycogen is complete, and it also acts as a "temporal buffer" for glucose. The pathway followed, is a way to "smooth out" the increase of blood glucose levels and maintain a consistent blood glucose level after consuming of carbohydrates. The effects of insulin on skeletal muscle are an important process in order to maintain a normal blood glucose level. When a DM patient does not have insulin or effective insulin, extra glucose is not available when the patient reaches a hypoglycaemic state.

Protein synthesis in the muscle is also affected by insulin. For a normal concentration of protein in muscles, a balance between synthesis and degradation needs to take place. The effect created by insulin, turns the normal effects around so that synthesis of protein is increased and the degradation of protein is decreased (Dimitriadis *et al.*, 2011:S54; Nolte Kennedy, 2012:747; Sen *et al.*, 2016:4). This helps the anabolic (building) process of skeletal muscle in the human body. In a DM patient there will be an increase in protein degradation and a decrease in protein synthesis.

The building process brought about by insulin happens when the amino acids are not released from the muscles but are rather kept in the muscles and are being incorporated into the protein that is visible in the muscle. Still the body needs to maintain anabolic conditions and normal plasma concentrations of amino acids. Diets rich amino acids will benefit the equilibrium of amino acid plasma concentrations. If the diet is not standard, insulin will still be active at its task (to inhibit gluconeogenesis in the liver via the use of amino acids) and by this, the plasma concentration of amino acids will not decrease and amino acids can still build muscle along with protein (Dimitriadis *et al.*, 2011:S55; Nolte Kennedy, 2012:747; Sen *et al.*, 2016:4).

Adipose tissue is more than just an extra source of energy (Fryan, 2002:1201; Nascimento *et al.*, 2009:453; Samra, 2000:441). Adipocytes (a specialised cell for the storage of fat), secrete a variety of hormones and cytokines, which influences the energy homeostasis and the sensitivity of the tissues to insulin (Dyke, 2009:399; Scherer, 2006:1537). Furthermore, the process in fat storage as well as mobilisation is controlled in a highly coordinated manner (McQuaid, 2011:54). There is a minute-to-minute process of control and a rapid shift in metabolic flux, for example

during the shift in a fasting period to a postprandial period (during or relating to the period after dinner or lunch) (McQuaid, 2011:49).

The function of the adipose tissue in buffering the flux and level of fatty acids in the blood circulation in the period after eating is important. It is perceived as similar to the buffering of the level of flux of glucose by the muscle and the liver in the period after eating (Dyke, 2009:399). The effect that the adipose tissue provides in the buffering action, is to control the release of non-esterified fatty acids (any fatty acid that is free, instead of being esterified with glycerol to form a glyceride or other fat) into the blood circulation depending on the conditions of fasting or eating through a change in the actions of the enzyme hormone-sensitive lipase. Plus, adipose tissue increases the tempo of triacylglycerol clearance via a change in the activity of breaking down the lipoproteins (Dyke, 2009:399; Scherer, 2006:1537). Adipose tissue can do this action, primarily because of the effects of insulin (Dimitriadis *et al.*, 2011:S55; Dyke, 2009:399; Scherer, 2006:1357). In DM patients the action of the adipose tissue is thus inhibited.

As described above, insulin has innumerable effects on the human body, this includes one final important effect, referring to the effect on blood flow (Dimitriadis *et al.*, 2011:S55). The effect that insulin performs on the blood flow, is aimed at the vascular endothelium “(the tissue which forms a single layer of cells lining various organs and cavities of the body, especially the blood vessels, heart, and lymphatic vessels)” and the increase of blood flow of the muscle and adipose tissue by causing vasodilatation and capillary recruitment (Zheng & Liu, 2015:298). The increase of blood flow and tissue glucose uptake, via insulin, are strongly fixed processes and a vital determinant of tissue sensitivity to insulin. The effects that insulin has on the blood flow are facilitated by increased endothelium-derived nitric oxide (NO) (Wasserman *et al.*, 2018:1142). The exposure of endothelial cells to high levels of non-esterified fatty acids inhibits endothelial function and insulin-mediated NO production. This leads to a decrease in blood flow to the tissue (Ghosh *et al.*, 2017:10). This process occurs at the same time as the decrease in insulin-mediated glucose uptake and metabolism in muscle that was seen after the exposure of fatty acids. As a result, the dysregulation of fatty acid metabolism leads to impaired vascular reactivity and endothelial function, resulting in insulin resistance (cause of type 2 DM) (Dimitriadis *et al.*, 2011:S58).

2.2.3.3 Other factors influencing blood glucose

DM is a complex system. In the normal human body, homeostatic levels of glucose need to be maintained, in other words glucose needs to be lowered when in hyperglycaemic state and needs to be increased when the body is in hypoglycaemic state. Insulin, as discussed in section 2.2.3.2., is a glucose lowering hormone (hypoglycaemic hormone). Other hormones, previously mentioned

in section 2.2.3.1.1., such as adrenaline, growth hormone, glucagon and cortisol all have a blood glucose increasing effect (hyperglycaemic hormones) (Fredheim *et al.*, 2018:1761; Wang & Jia, 2018:4).

When the body reaches hyperglycaemia, the synthesis of glycogen from glucose is increased and stored (glycogenesis) (Wang & Jia, 2018:4). In hypoglycaemic states, the glycogen is broken down to glucose and released into the blood to increase the blood glucose levels (gluconeogenesis) (Hatting *et al.*, 2018:22; Wang & Jia, 2018:4). In certain situations, like strenuous exercise, hepatic glycogen tends to get depleted when the endogenous (having an internal cause or origin) glucoses' need abruptly increases. On the other hand, during starvation, glucose intake or absorption is highly inadequate (Muranen *et al.*, 2017:13989; Wang & Jia, 2018:5). In the event of starvation, the liver can synthesize glycogen by using non-sugar substances like a part of glycogenic amino acids, glycerol, pyruvate and lactic acid via gluconeogenesis, which contributes to keeping the glycogen in the liver to satisfactory levels. In circumstances where a large amount of sugar is consumed, amounts beyond the capacity of the body, glucose can be transformed into fat that gets stored (Kumar *et al.*, 2015:252; Wang & Jia, 2018:5).

2.2.4 Diagnosis of DM

In the past, DM diagnosis was based on the plasma glucose alone by either fasting plasma glucose or 2-hour oral glucose tolerance test (ADA, 2010:S11). The criteria for diabetes diagnosis are based on four abnormalities. The criteria are:

- A haemoglobin A1C (A1C) (a blood test that reflects your average blood glucose levels over the past 3 months) value higher or equal to 48 mmol/mol;
- A fasting plasma glucose value higher or equal to 7 mmol/L;
- Two-hour plasma glucose higher or equal to 11.1 mmol/L; or
- Patients with symptoms of hyperglycaemia and a random glucose measurement greater or equal to 11.1 mmol/L (ADA, 2018a:S15).

Certain recommendations are made for testing an asymptomatic (showing no symptoms) patient, as well as testing for T2DM in adults and children and testing T1DM in patients (ADA, 2010:S14). Testing patients for future risks of T2DM and to detect T2DM, it is recommended that patients get tested when they are overweight or obese (with a body mass index (BMI) $\geq 25\text{kg/m}^2$) or have one or more of the risk factors. T2DM has a long asymptomatic period and substantial risk markers and thus needs to be diagnosed as soon as possible. DM can be identified by a large scale of clinical features which can range from a low risk individual that has glucose testing, a high-risk

individual that gets tested for the idea that he/she has DM all the way to a symptomatic patient (ADA, 2010:S14).

Early diagnoses of DM meet important criteria for early detection, although early identification of DM has not yet been proven to be definitely effective. The diagnoses of T2DM, often, goes undiagnosed or is only diagnosed after complications appear. There is a long period of no symptoms before the diagnosis of T2DM is made (ADA, 2010:S14; Engelgau *et al.*, 2000:1564). For adults with asymptomatic and undiagnosed DM, the ADA has the following recommendations for adults in need of testing:

- Being physically inactive;
- Having a first-degree relative with DM;
- Any members originating from high-risk ethnic populations (e.g., African American, Latino, Native American, Asian American, Pacific Islander);
- Any members originating from high-risk ethnic populations (e.g., African American, Latino, Native American, Asian American, Pacific Islander);
- A woman who delivered a child weighing >4kg or were diagnosed with gestational DM;
- Hypertension (high-blood pressure) ($\geq 140/90$ mmHg) or on therapy for hypertension;
- High-density lipoprotein cholesterol level < 35 mg/dL (0.9 mmol/L) and/or a triglyceride level > 250 mg/dL (2.82 mmol/L);
- Women with polycystic ovary syndrome;
- A1C $\geq 5.7\%$, impaired glucose tolerance or on impaired fasting glycaemia on previous testing;
- Other clinical conditions associated with insulin resistance (e.g., severe obesity); and
- History of cardiovascular disease (ADA, 2010:S14).

If none of the risk factors are present, patients older than 45 years should consider getting tested regularly as age is a significant factor in T2DM (ADA, 2010:S14). Either A1C, fasting plasma glucose test (FPG) or two-hour oral glucose tolerance test (2-h OGTT) can be considered as appropriate measures for testing of DM. The 2-h OGTT is used to identify people who have a risk of developing DM or cardio vascular diseases by testing for impaired fasting glycemia (IFG) and impaired glucose tolerance (IGT) (ADA 2010:S14; Gabir *et al.*, 2000:1110).

In children (6 to 12 years), the frequency of T2DM has increased considerably since 2000, especially in minority groups (Hamman *et al.*, 2014:3339). It still appears seldom in the general paediatric population (0 to 18 years) (Pettitt *et al.*, 2014:405). As with adults, children and youth (15 to 24 years) are also recommended to get tested if there is a possibility of T2DM risks (ADA,

2000:385). T2DM generally arises from risk factors (ADA, 2010:S15). Children can also be tested with these risk factors:

- Overweight (BMI >85th percentile for age and sex, weight for height >85th percentile, or weight >120% of ideal for height);
- Family history of T2DM in a first- or second-degree relative;
- Any high-risk race/ethnicity (Native American, African American, Latino, Asian American, Pacific Islander);
- Signs of insulin resistance or conditions associated with insulin resistance (acanthosis nigricans, hypertension, dyslipidaemia, polycystic ovary syndrome, or small for gestational age birth weight); and
- Maternal history of diabetes or GDM during the child's gestation (ADA, 2010:S15).

With T1DM, acute symptoms of DM and distinctly raised blood glucose levels are prominent. Most people get diagnosed after the onset of hyperglycaemia (ADA, 2010:S15). Studies have shown that the detection of islet autoantibodies can identify an individual at an early stage to develop T1DM (ADA, 2010:S15). Generally, these tests are done for high-risk individuals with prior brief hyperglycaemia or with a family history of T1DM (ADA, 2010:S15). T2DM generally arises from risk factors as previously mentioned.

As seen, DM has a lot of risk factors that could lead to an individual developing DM. In the next section, the researcher will discuss the factors that can lead to developing DM from these risk factors.

2.2.5 Factors causing DM

2.2.5.1 T1DM

Commonly, T1DM is seen as an immune-associated destruction of the insulin-producing pancreatic β -cells (Bluestone *et al.*, 2010:1294; Todd, 2010:458). In the present times, T1DM cannot be referred to as a disease only found in children and adolescents (Leslie, 2010:331). The general indicators for diagnosis of T1DM, in children, adolescents and to a minor degree adults, are polydipsia (excessive thirst or excess drinking); polyphagia (excessive hunger or increased appetite); and polyuria (excessive or an abnormally large production or passage of urine) (Atkinson *et al.*, 2014:69). The epidemiology of T1DM, efficiency of existing therapies, understanding how the disorder develops and the preventing or curing of the disease, are still unanswered questions in this disease (Atkinson *et al.*, 2014:69; Bluestone *et al.*, 2010:1938; Chiang *et al.*, 2014:2043).

T1DM is one of the most common diseases in children (although it can be diagnosed at any age) (Gale, 2005:1435; Wherrett *et al.*, 2018:S234). With most of the research stating that the pathogenesis of T1DM begins with an auto-immune destruction of the β -cells. This observation is based on the occurrence of continuing inflammatory infiltrate that affects the pancreatic islets at systematic onset of T1DM (Howson *et al.*, 2011:2645). Another view formulated by researchers dictates that patients with a long-standing disease could face a situation where a pancreas is lacking insulin-producing cells and the β -cells that remain are unable of regeneration. Although both of these theories have been discussed, there is research showing that in infants and children, having no or few β -cells, signs of regeneration were spotted (Green *et al.*, 2018:11; Gregg *et al.*, 2012:3202; Keenan *et al.*, 2010:2853). With all the studies that have been done, it is suggested that a succession of functional defects in the bone marrow and thymus, immune system and β -cells collectively plays a role in the pathophysiology of T1DM (Atkinson *et al.*, 2011:1376; Lehuen *et al.*, 2010:502; Roep & Peakman, 2011:746).

2.2.5.2 T2DM

T2DM develops largely due to lifestyle factors and genetics (Ripsin *et al.*, 2009:29). Lifestyle factors that contribute to the development of T2DM consist of a lack of physical activity, cigarette smoking, sedentary lifestyle and consumption of big amounts of alcohol (Zheng *et al.*, 2018:92). One of the biggest contributors for T2DM is obesity, accounting for 65% to 80% of all cases (IDF, 2019c). This statistic stretches back to the time between 1960 to 2000, where an increased rate of childhood obesity, contributed to the childhood and adolescent DM crisis of the 21st century (Barlow *et al.*, 2007:S166).

Genetics has been found to contribute to T2DM being passed down in generations (Rother, 2007:1499). If relatives have T2DM, especially from mothers and fathers, the risk to develop T2DM is substantial. Monozygotic twins have a 100% chance of developing T2DM and about 25% of current diagnosed patients have a family history of T2DM. A substantial amount of genes have been found to play a role in the genetic inheritance of obesity and T2DM (Walley *et al.*, 2006:R125).

Moreover, medical conditions also play a role in the risk of developing T2DM. Such conditions include obesity, hypertension, elevated cholesterol and metabolic syndrome (also referred to as Syndrome X and Reaven's syndrome) (Alberti *et al.*, 2005:1060; Schuster, 2010:259). Added, and less common diseases, include, thyrotoxicosis, pheochromocytoma, cancer, Cushing's syndrome, acromegaly, chronic pancreatitis and drugs (Olokoba *et al.*, 2012:270). Lastly, high-fat diets, less active lifestyles and aging, are important risk factors that contribute to the development of T2DM (Kolb & Martin, 2017:132; Lovejoy, 2002:435).

T2DM is characterised by its insulin insensitivity because of insulin resistance, decreasing insulin production and lastly, pancreatic β -cell failure (Lin *et al.*, 2012:65) that ultimately leads to reduced glucose transport into the muscle cells, liver and fat cells (adipose tissue). This leads to the increased breakdown of fat which causes high blood glucose. The resulting effect is that the glucagon and hepatic glucose levels that increase during fasting are not repressed when eating (Olokoba *et al.*, 2012:270). Insufficient levels of insulin and an increase in insulin resistance results in hyperglycaemia.

A large number of patients with T2DM are overweight, with central visceral adiposity (Olokoba *et al.*, 2012:270). Adipose tissue plays a vital role in T2DM because of this fact. The main theory used in explaining this relation is the portal/visceral hypothesis that plays a key role in higher levels of non-esterified fatty acid concentrations. Another theory states the ectopic fat storage syndrome that states the removing of triglycerides in muscle, liver and pancreatic cells (Olokoba *et al.*, 2012:270). The before-mentioned hypotheses constitute the interaction between insulin resistance and β -cell dysfunction in T2DM, as well as the effects between the obesogenic environment and the risk of DM in the future (Holst *et al.*, 2009:133).

From here on T1DM and T2DM will be referred to as DM as a general term for purposes of this study.

2.2.6 Complications associated with DM

On a long-term basis, there are complications with DM such as retinopathy with possible blindness, nephropathy that can cause kidney failure, peripheral neuropathy with risk of foot ulcers, Charcot joints and loss of limbs and lastly autonomic neuropathy that may lead to genitourinary, gastrointestinal and cardiovascular symptoms and sexual dysfunction (ADA, 2004:S5; ADA, 2014:S81; WHO, 2016).

2.2.6.1 Retinopathy

Diabetic retinopathy is a complication that affects the eyes of patients with DM. It is damage caused to the blood vessels of the retina through high levels of blood glucose. It can lead to blindness (Kempner *et al.*, 2004:554). In 2015, diabetic retinopathy ranked seventh on the global chart for causes of blindness (Flaxman *et al.*, 2017:1227). The progression of vision loss is affiliated with the duration of DM, hyperglycaemia and hypertension. Vision loss caused by DM retinopathy could be prevented by controlling serum glucose and blood pressure (Lee *et al.*, 2015:1; Zhang *et al.*, 2001:1278).

2.2.6.2 Nephropathy

Nephropathy is defined as damage to the kidney. This damage is normally a result of high levels of blood glucose associated with DM and the damage can lead to kidney failure (Bech *et al.*, 2014:1388). Diabetic nephropathy was the leading cause of chronic dialysis since 1998 and diabetic nephropathy accounts for a large proportion of chronic kidney disease cases (Haneda *et al.*, 2015:242). Diabetic nephropathy affects 40% of patients with DM and diabetic nephropathy increases the risk of death, mostly from cardiovascular causes (ADA, 2005:164).

2.2.6.3 Neuropathy

Neuropathy is primarily caused by high levels of glucose in DM (Said, 2013:579). Neuropathy is a heterogeneous (diverse in character or content) group of conditions that influences different parts of the nervous system and can manifest as diverse clinical manifestations, *id est* weakness, numbness and pain, usually in the hands and feet (ADA, 2017a:136). Neuropathy, as one of the major complications in DM, has a significant effect on the morbidity and mortality in patients (Pasnoor, 2013:425). The most common problems faced with neuropathy include, numbness, tingling, pain and weakness that effect the nerves that start in the distal extremities (muscle, bone, limb, etc. situated farthest from the centre of the body) (Callaghan *et al.*, 2012:532). These effects come from a nerve that was damaged by the effects of DM that impair blood supply to the nerves and can lead to the loss of limbs (Juster-Switlyk & Smith, 2016:4; Razmaria, 2015:1)

2.2.6.4 Cardiovascular symptoms

Cardiovascular diseases such as endothelial dysfunction (occurs because of damage to the vascular endothelium, the thin layer of cells that lines blood vessels), oxidation, inflammation and vascular remodelling are all related to atherogenesis, caused by DM (Fisher, 2004:336; Rajendran *et al.*, 2013:1067). DM patients are at risk for cardiovascular disorders namely stroke, congestive heart failure, cardiomyopathy, peripheral arterial disease and coronary heart disease and these complications are all major causes of morbidity and deaths (ADA, 2014:S81).

T1DM and T2DM cannot be cured but could be managed by monitoring blood glucose levels and by trying to keep the level between 4.4 mmol/L and 7.2 mmol/L, in combination with medication, exercise and diet (Balfe, 2009b:128; Toobert *et al.*, 2000:943; Warren, 2004:3). It is important for people living with DM to implement self-management actions to successfully manage their condition (Casey *et al.* 2011).

The researcher will now explain how an individual living with DM needs to apply self-care and, in more detail, self-management towards their disease.

2.3 Self-care and self-management

Certain barriers to self-care and self-management exist. It seems that people living with DM find it difficult to exercise regularly and to take medication. Other problems are the misunderstanding of chronic diseases by society, depression, weight control issues, fatigue, poor communication with physicians, lack of support from family or teachers, pain and financial problems (Bayliss *et al.*, 2003:19; Jerant *et al.*, 2005:304).

It is important for the reader to understand that self-management is a section under self-care (Loh, 2018:2). Thus, the researcher will firstly discuss self-care as a factor in controlling chronic diseases and afterwards look at self-management in controlling chronic diseases, especially DM, to persist in completing the objectives of the study.

2.3.1 Self-care definition

The definitions used in describing self-care grew more over time (Omisakin & Ncama, 2011:1734). It starts off as an individual's responsibilities for healthy lifestyle behaviours that are required for human development and functioning, and the activities required to cope with health conditions (Omisakin & Ncama, 2011:1734). Self-care was defined by Rutter (2015:57) as behaviour started or done by individuals on their own behalf to promote a safe life and health.

Definitions addressed to self-care include non-professional-care, "utilisation of all non-health professional resources, *id est* the individual himself or herself, members of the family, neighbours and other lay persons, for any health related activity be it promotive, preventative, curative or rehabilitative" (WHO, 1984:248) and "Self-care ... is the primary health resource in the health care system. Included are informal health activities and health-related decision-making by individuals, families, neighbours, comprising self-medication, self-treatment, social support during illness, first aid, etc. Another term, lay care, describes all health care given by lay people to one another in both natural and organised settings" (WHO, 1987:96). Self-care rests on a wide-ranging idea that comprises of hygiene (general and personal), lifestyle (sporting activities, relaxation, etc.); environmental factors (living conditions, social behaviours, etc.); socioeconomic factors (level of income, cultural beliefs, etc.) and self-medication (WHO, 1998:2).

Akinsola (2001:163) stated that self-care emphasises that individuals utilise their recourses, such as their personal attributes like skills, determination, knowledge, courage, optimism and positive attitudes to increase poor health. The UK Department of Health added to self-care the care for slight illnesses and long-term conditions; the actions that individuals and caregivers take upon themselves, their children and their families to keep active and uphold good psychological and physical health; attain social and psychological needs; uphold health and well-being after an acute

illness or discharge from hospital; and avoid accidents or illness (WHO, 2015). Behaviours related to self-care include lifestyle (*id est* diet and exercise); management of therapy (*id est* concordance); making use of services efficiently and being able to comprehend symptoms and problems and attending to them properly (Jin *et al.*, 2008:270).

The working definition for self-care is defined as the capability of an individual, relatives and societies to encourage health, avoid disease, and uphold health and to manage disease and disability including or excluding the care of a health-care provider (WHO, 2009:1). The extent of self-care, according to this definition, consists of disease prevention and control; rehabilitation including palliative care; providing care to dependent persons; self-medication; seeking hospital/specialist/primary care if necessary; and health promotion (WHO, 2013).

There is an immense need to direct self-care behaviours in multiple domains for patients living with DM to move towards self-management to prevent diabetes-related morbidity and mortality (Shrivastava *et al.*, 2013:17).

2.3.2 Self-management

The term self-management has taken different meanings in different fields, for example, in business, education and psychology, self-management refers to procedures, expertise and plans by which an individual can successfully influence their own actions toward the accomplishment of aims and this include setting goals, making decisions, staying focused, planning ahead, making schedules, tracking tasks, evaluation of oneself, self-interventions and self-developments (Omisakin, 2011:1734).

When self-management is brought into the field of computer science for example it means to take control of a process to make a pre-programmed computer system that in the future manage their own operation with no human involvement. For a workplace, self-management refers to making decisions where the personnel agree on choices rather than the supervisor telling personnel what, how and where to do it, as in the traditional way (Omisakin, 2011:1734).

When looking at self-management in healthcare, the term refers to the ability of an individual to manage the treatment, physical symptoms and psychosocial consequences and the changes in lifestyle characteristics similar to living with a chronic disease (Barlow *et al.*, 2002:366).

Self-management can be viewed as a learning process and an outcome in all facets named so far. For a learning process, self-management programmes comprise of participating in education intended to bring about detailed outcomes; preparing individuals to manage their health conditions daily; the practise of certain behaviours and developing skills and abilities needed to

lessen the physical and emotional effects of an illness, including or excluding the help of a healthcare team (McGowan, 2005).

Efficient self-management includes the skill to monitor your condition and to achieve the behavioural, emotional and cognitive responses needed to continue a fitting quality of life. The term self-management is important in the field of health- and social care. Self-management is related to models of coping with difficulties in self-reliance, self-help and family- and community reliance (Newbould *et al.*, 2006:249).

The development of self-management programmes can be ascribed to (Omisakin, 2011:1734):

- The development of policy-makers' interest in self-care and lay-led self-management tactics to living with a chronic disease;
- The growing numbers of people looking to control their own tactics to living with a chronic disease with or without the assistance of other professionals and medical practitioners;
- An increase in awareness of the necessity to address chronic diseases and engage in self-management and alternative approaches to lessen the anguish and other cost that is imposed;
- The belief that endorsing self-management and assisting individuals to manage potentially incapacitating conditions better can have the potential to help them improve their quality of life; and
- The development of demographic and epidemiological transition with the development of new attitudes towards health care delivery, which have been the foremost drivers of self-management in health care.

Self-management is a term used since the 1960's (Lorig *et al.*, 2003:1). Self-management was first described as an act of active participation in treatment by a patient (Creer *et al.*, 1976:226). The term self-management refers to the ability of an individual to manage their treatment, symptoms, physical and psychosocial consequences and lifestyle changes to accommodate living with a chronic disease (Laranjo *et al.*, 2015:106; Richard & Shea, 2011:261; Shen *et al.*, 2013:628).

It is important for an individual to be able to take care of himself/herself. It seems that the personal strengths of people living with chronic disease, that are important, can be grouped into three categories (Kristjansdottir *et al.*, 2018:789):

- Internal strengths;
- External strengths; and
- Self-management strategies.

Kristjansdottir *et al.* (2018:789), categorised personal qualities and positive emotions as internal strengths. Internal strengths include:

- Optimism (Cal *et al.*, 2015:3);
- Knowledgeable and gaining insight (Kristjansdottir *et al.*, 2018:789);
- Being determined (Kristjansdottir *et al.*, 2018:789);
- Sense of meaning in life (Bellier-Teichmann & Pomini, 2015:106);
- Acceptance (Cal *et al.*, 2015:2);
- Being courageous (Kristjansdottir *et al.*, 2018:789);
- Positive emotions (e.g. gratitude, hope) (Ho *et al.*, 2010:659);
- Living kind and caring (Kristjansdottir *et al.*, 2018:789);
- Self-esteem (Lee *et al.*, 2013:274); and
- Self-efficacy (Rutter, 2012:338)

External strengths are described as having supportive relationships and gaining support from healthcare providers (Dingley & Roux, 2014:34; Kristjansdottir *et al.*, 2018:791). The relationships between an individual and their family and friends are central towards emotional and practical support. These relationships have a big influence for people living with DM to engage in positive health behaviour. Family and friends are valued when they are vigilant to the changes that are caused by the disease, understand their restrictions, recognise their health issues and respect their circumstances (Kristjansdottir *et al.*, 2018:791; Rosland *et al.*, 2010:26). Peers are an easy way to share thoughts and experiences with, instead of their family and friends. It feels worthwhile talking to people that went through the same experiences as themselves. There is a feel of fellowship and less emotional states of loneliness when they are with people who live with the same chronic illness. Another important factor with external strengths is the trustworthiness of their healthcare providers (Birkhäuser *et al.*, 2017:8; Kristjansdottir *et al.*, 2018:791). Other valuable factors are surroundings that support a healthy lifestyle (for example being able to train at work or to join other individuals in a training programme); living in a welcoming and safe neighbourhood and having financial security.

External strengths include:

- A supportive family (Bellier-Teichmann & Pomini, 2015:104);
- Neighbourhood and institutions (Kristjansdottir *et al.*, 2018:791); and
- Stable socioeconomic status (Kristjansdottir *et al.*, 2018:791).

Lee *et al.* and Zautra *et al.* (2013:275; 2010) stated that using the strengths in the face of chronic illness encourages flexibility and a successful adaption to difficulty.

Internal and external factors are helpful when it comes to self-management, when the need to practice the self-management strategies takes place, these internal and external factors can contribute to positive outcomes. Looking at every conceivable influencing factor, both expected and unexpected, and coming to terms with the circumstances, not just a single end result is called a strategy (Kristjansdottir *et al.*, 2018:791). A plan focuses on “here are the steps”, whereas a strategy focuses on “here are the best steps.” Strategy looks at the reasons why, whereas the plan focuses on how.

Self-management strategies have their strength in promoting health and well-being (Kristjansdottir *et al.*, 2018:791). Several strategies exist including to exercise, getting enough sleep, reducing stress and being active. Further strategies included taking things slowly, planning and prioritising, to set objectives and adjust these objectives and work towards the outcomes of these objectives (Grady & Gough, 2014:e25; Kristjansdottir *et al.*, 2018:792). Distraction, reflective writing, breathing exercises and visualisation are among the strategies to manage symptoms. Strategies to cope with stress include looking for knowledge and help when required, different methods for managing tough thoughts, making use of humour and looking for individuals with the same experience and concerns to share with and learn from (Kristjansdottir *et al.*, 2018:792; Peters *et al.*, 2014:3; Vaala *et al.*, 2018:138).

Chronic diseases are a central healthcare problem worldwide (Miller *et al.*, 2015:154). Persons with a disease and their healthcare providers play an important role in paying consistent attention to the disease and making lifestyle changes demanded by a chronic disease. Chronic diseases are typically incurable and are characterised by exacerbations and remissions that require constant management throughout a lifetime (Miller *et al.*, 2015:154). Healthcare providers, families and the patients all play an important role in the managing of the treatments, symptoms and lifestyle modifications associated with a chronic disease in daily life, which can make the management of the disease quite complex for the patient.

Patients and families can contribute to better outcomes of the chronic disease when they work together to manage the difficulty of the disease characteristics and restructure a suitable lifestyle (Unger & Buelow, 2009:94). Because chronic diseases are very common and due to the high costs associated therewith, there has been a strong need to develop interventions aimed at chronic disease self-management. Many such interventions exist and are structured to prepare patients to manage diseases to improve their outcomes (Barlow *et al.*, 2002:369).

In the setting of chronic illnesses, self-management involves tasks needed to be undertaken to live well with their condition (Akinsola, 2001:163). Some of these tasks tend to be challenging as people need to learn about their conditions, their medications, manage their symptoms and

emotions and make recommended lifestyle changes (Lorig & Holman, 2003:1). Finding one's own strengths or health assets is a crucial process in learning how to live well with a chronic disease. Strengths are part of general resistance resources, an essential element of salutogenesis (a medical term that focusses on factors that support human health and well-being, rather than on factors that cause diseases), directing the individual's power to heal (Lorig & Holman, 2003:2; Rotegård, *et al.*, 2010:519; Schulman-Green *et al.*, 2012:140).

2.3.3 The relationship between self-care and self-management

There has been no clear difference found in the literature amongst the notions of self-care and self-management (Richard & Shea, 2011:261). Self-care includes the capability of caring for oneself and to perform activities required to achieve, maintain or promote optimum health (Richard & Shea, 2011:261). Wilkinson & Whitehead (2009:1145) added that self-care can be seen as a range between total independence in managing health to total dependence in medical care. Self-care is influenced by the situation and culture of a person; self-care involves the capability of an individual to make a choice and take action under the individual's control; and the individual characteristics influences self-care in a wide variety (Abdulrehman *et al.*, 2016:9; Gobeil-Lavoie *et al.*, 2019:4). Self-care also includes interventions by nurses that promotes supportive and educational activities to encourage the capability of an individual or a family to take charge of an individual's healthcare requirements (Cebeci & Senol, 2008:416).

Self-management on the other hand is the ability of an individual, together with family, the community and healthcare providers to manage treatments, changes in lifestyle, symptoms and the outcomes related to psychosocial, cultural and spiritual factors of chronic diseases (Wilkinson & Whitehead, 2009:1145). Dineen-Griffin *et al.* (2019:7) added that self-management is a skill and a procedure an individual use in conscious attempts to obtain control of their disease and not to let the disease control them. In a wide range, self-management can be applied to health promotion activities and activities associated with acute or chronic illness (Jerant *et al.*, 2005:305; Lorig & Holman, 2003:2; Wilde & Garvin, 2007:340). Self-management involves monitoring of perceived health and implementing strategies to manage treatments and medication, symptoms, safety and other consequences of chronic disease (Thorne *et al.*, 2003:1349).

DM self-management is an important component to DM care as it is the individual's responsibility to take care of their health as part of self-care (Clark *et al.*, 1991:4; Shen *et al.*, 2013:628).

2.3.4 Theoretical interventions for health self-management

Several theories of health behaviours have been adopted over the years for health wellness (Riley *et al.*, 2011:55). These theories will be discussed as background literature to the different methods that are used to improve self-management in chronic diseases.

2.3.4.1 Social cognitive theory

Albert Bandura was the main founder in the works of social cognitive theory. The social cognitive theory is mainly regarded as the variety of motivators of human behaviours and specifically with the role of social aspects in forming individuals' actions (Bandura, 2001a:4; Bandura, 2001b:266). The social cognitive theory is based on the individuals' behaviours that are controlled by several critical human abilities namely:

- Symbolizing capability: an individuals' capability to trust in symbolic representations to understand their environment;
- Self-regulation: the capability to set goals and evaluate progression towards these goals;
- Self-reflection: the capability to critically observe one's standards and values;
- Vicarious capability: the capability to learn through observing behaviours of others and consequences of these behaviours (Bandura, 2001b:266).

Social cognitive theory reasons the significance of cognitive processes and promotion of human action in intentionally choosing to respond to environmental impetuses, instead of blindly responding to them following a set of internal rules (Mamykina *et al.*, 2015:407). Bandura explained that: "People gain understanding of causal relationships and expand their knowledge by operating symbolically on the wealth of information derived from personal and vicarious experiences. They generate solutions to problems, evaluate their likely outcomes, and pick suitable options without having to go through a laborious behavioural search" (Bandura, 2001b:267). Self-efficacy has a significant role in the frame of social cognitive theory and is focused on an individual's belief in their own capabilities to exercise authority over their degree of functioning and actions that have an effect on their lives.

2.3.4.2 Self-determination theory

The founders of the self-determination theory are Richard Ryan and Edward Deci. This theory's focus is on the inner resources for regulating individuals' behaviour (Ryan *et al.*, 1997:708). The main concept of the self-determination theory is human motivation. It highlights the degree to which behaviours are relatively self-directed (the degree to which behaviours start from in oneself)

regarding relatively controlled behaviour (the degree to which behaviours are forced or coerced by intrapsychic or interpersonal forces) (Ryan *et al.*, 1997:708).

The self-determination theory identifies three psychological desires that act as the operating factors for self-motivation in individuals. These are:

- The desire for competence is the perception of self as owning the ability and knowledge to achieve the task at hand;
- The desire for relatedness is encouraging social engagement with others; and
- The desire for autonomy is the perception of self as an operating force supporting one's choices and actions (Deci *et al.*, 1999:659).

When these three desires are met with satisfactory social and environmental circumstances, the self-determination theory suggests that the intrinsic motivation will flourish. In addition, when the needs are suppressed, intrinsic motivation is often dissatisfactory (Mymakina *et al.*, 2015:407). Introducing external rewards depending on the task performances has a disadvantageous impact on intrinsic motivation according to the self-determination theory (Patrick & Williams, 2012:20).

Self-regulation forms part of both the social cognitive theory and self-determination theory. In the social cognitive theory, self-regulation is seen as an individuals' ability to work to pursue personal objectives and to evaluate their growth towards these objectives. According to the self-determination theory, self-regulation refers to an individual's ability to process and internalise extrinsic motivation influences and to utilise these influences to drive behaviours (Mamykina *et al.*, 2015:408).

The principles founded by applying the self-determination theory have focused on the development of individuals' intrinsic motivation for example when considering adherence to blood pressure monitoring and taking medication (Patrick & Williams, 2012:20), and in encouraging an individual's sense of independence by assisting him to concentrate on his own reasons to enhance his levels of physical activity and exercise (Riiser *et al.*, 2014:4).

2.3.4.3 Theory of planned behaviour

The theory of planned behaviour focuses on the association between the intentions and behaviours and the dissimilar factors that can lead to individuals continuing in their intents and accomplishing desired behaviours or failing to do so (Ajzen, 1991:181). The theory of planned behaviour has three different factors contributing to the pathway between intention and action. These are

- The intent to act is the degree to which an individual favour a certain behaviour;

- The subjective norm is perceived social pressures to engage or not to engage in a behaviour; and
- Perceived behavioural control is an individual's perception concerning the ease or difficulty of engaging in a behaviour grounded on their earlier experience (Ajzen, 1991:188).

The notion formed by “perceived behaviour control” is the same as the concept of self-efficacy that resides within the social cognitive theory that highlights the individual's level of accomplished set goals (Mamykina *et al.*, 2015:408). The theory of planned behaviour explicitly addresses voluntary behaviours where individuals can decide to participate in the behaviour or not.

The treatment of past behaviours and habit plays a role in the context of theory of planned behaviour. Past behaviours or records of past behaviours have indirect effects on the future behaviours of an individual and the behaviours have an impact on the development of intents and perceptions of control and to the formation of habits (Sommer, 2011:96). When habits can be measured reliably, it could play a vital role in influencing future behaviours. Theory of planned behaviour has inspired numerous behavioural changes in the past that explicitly focus on the notion of assisting individuals to conceive intentions to improve their health behaviours, increase awareness of the social norms regarding these behaviours and to help improve the level of perceived behaviour control (Sommer, 2011:97).

2.3.4.4 Transtheoretical model

The transtheoretical model of behaviour change reasons that behaviour change is a process that describes an individual's development along different steps or changes (Prochaska & Velicer, 1997:38). These stages of the transtheoretical model include:

- Precontemplation where individuals do not see a necessity to change and have no intent of changing their behaviours;
- Contemplation where individuals identify limits of their existing behaviours and start to explore other possibilities;
- Preparation where individuals develop intents to act and take small steps in the direction of this action;
- Action where individuals apply exact steps in the direction of adopting what they see as healthier behaviours;
- Maintenance where individuals have continued in their new behaviours for 6 months and continue working on preventing a relapse; and

- Termination where new behaviours become profoundly rooted into individuals' routine practices and longstanding habits are not presented as temptations anymore (Prochaska & Velicer, 1997:39).

There is a multitude of reasons why individuals do not change their behaviours and these reasons differ depending on the stage of change the individual find himself in (Prochaska & Prochaska, 2011:209). For example, individuals in the precontemplation stage cannot alter their behaviours, because frequently they do not notice their present behaviours as a problem and therefore have no reason or yearning for change. On the opposite end individuals in the preparation stage may want to alter their behaviours but have little knowledge as to what and how to change. Thus, behavioural interventions to encourage change should be aligned to an individual's current state of willingness (Mamykina *et al.*, 2015:408). For example, health professionals could concentrate on increasing mindfulness in individuals in the precontemplation stage and on addressing explicit information requirements for individuals in preparation stage.

2.3.4.5 Problem-solving perspectives

The model of problem-solving has ascended as a well-articulated and powerful framework for conceptualising DM self-management. The problem-solving model was proposed to account for how an individual can recognise and deal with external barriers to adopt desired self-management behaviours (Hill-Briggs, 2003:188). Problem-solving in the framework of DM self-management is included as one of the most vital self-management behaviours (American Association of Diabetes Educators, 2019). There is proof in the lead of improvements to individuals' glycaemic control and psychosocial outcomes for DM self-management because of an increase in the amount of behavioural and interventions into the problem-solving model (Fitzpatrick *et al.*, 2013:154).

2.3.5 Self-management of DM

Self-management of health in patients with chronic diseases has increased tremendously (Schulman-Green *et al.*, 2012:138). A lot has changed over the years regarding self-management, for example, novel technologies offer a unique chance to record and observe data that relates to health and wellness (Mamykina *et al.*, 2015:406). Glucose monitoring has been made easier with devices that generate high accuracy readings using reduced amounts of blood drop volumes. This feature lowers the pain related with day-to-day testing of patients' blood glucose and empowers regular testing (Gonzales *et al.*, 2019:809; Mamykina *et al.*, 2015:406).

As the mortality rates associated with DM increases, DM prevalence looks to double by 2030 (Rowley *et al.*, 2017:7). Galaviz *et al.* (2018:14) stated that adjustments in lifestyle, like eating healthy, exercising daily and monitoring of blood-glucose levels, can delay the progression of DM.

The WHO (2018) adds that a person living with DM should partake in a lifestyle that is healthy, includes a healthy diet, the monitoring and maintenance of glucose levels and adherence to medicine usage. DM treatment also consists of losing weight, monitoring of carbohydrate intake, correct intake of fibre, restricting cholesterol, avoiding saturated fats, trans fats and sodium (Forouhi *et al.*, 2018a:1). Lastly, patients with DM require further tactics to address individual, family and social practices to improve DM self-management (Miller & DiMatteo, 2013:425).

There are seven sets of tasks associated with self-management (Shrivastava *et al.*, 2013:2). These tasks include a healthy diet, being physically active, monitoring of blood glucose, medication compliance, good problem-solving skills, healthy coping skills and risk-reduction behaviours (Adu *et al.*, 2019:7; Mikhael *et al.*, 2019:4). A patient living with a chronic disease should be active in applying their knowledge in the continuous process of self-management (Mikhael *et al.*, 2019:16). All seven factors have proven positive correlation with good glycaemic control, a decrease in complications and improvement in quality of life (Adu *et al.*, 2019:7; Mikhael *et al.*, 2019:16).

2.3.5.1 Nutrition therapy

Patients with DM must include healthy eating and follow a fitting meal plan to their lifestyle, but unfortunately there is no one-size-fits all eating pattern for patients living with DM and thus the nutrition should be individualised (ADA, 2018a:S41). Nutrition therapy in DM plays an important role in overall DM management. A person living with DM must be actively involved in his education, self-management and treatment planning with the healthcare team. This includes a collaborative development of an individualised eating plan (Evert *et al.* 2014:S133; Inzucchi *et al.*, 2015:147). A person living with DM should be advised to go to a registered dietician to get knowledgeable and skilful provided medical nutrition therapy. Medical nutrition therapy provided by a registered dietician has been related with lowering A1C values of 1.0-1.9% for people living with T1DM (Franz *et al.*, 2017:1676; Rossi *et al.*, 2010:109; Scavone *et al.*, 2010:479) and 0.3-2.0% for people living with T2DM (Coppell *et al.*, 2010:240; Franz *et al.*, 2017:1676).

There are goals and standards set for nutrition therapy for adults with DM (ADA, 2018a:S41):

- “To promote and support healthful eating patterns, emphasising a variety of nutrient-dense foods in appropriate portion sizes, to improve overall health and:
 - Achieve and maintain body weight goals;
 - Attain individualised glycaemic, blood pressure, and lipid goals;
 - Delay or prevent the complications of DM”.

- “To address individual nutrition needs based on personal and cultural preferences, health literacy and numeracy, access to healthful foods, willingness and ability to make behavioural changes, and barriers to change”;
- “To maintain the pleasure of eating by providing non-judgmental messages about food choices”;
- “To provide an individual with DM the practical tools for developing healthy eating patterns rather than focusing on individual macronutrients, micronutrients, or single foods”.

Role playing factors in diet include decisions in motivation, cravings, quality of diets, costs, healthy recipes, quantity and portion size, and daily food intake (Laranjo *et al.*, 2015:107). High consumption of calories has played a big role in the development of DM, but diet quality has self-determining effects (Hu, 2011:1250). The quality of fats and carbohydrates play a vital role in the development of DM, independent of the BMI and other related risk factors to DM (Hu, 2011:1250). Consuming higher glycaemic loads and trans fats in a diet credits a high risk for DM, where the consumption of cereal fibre and polyunsaturated fats are associated with a lower risk for DM (de Munter *et al.*, 2007:1393).

Studies have shown that there is no perfect percentage of calories from carbohydrates, proteins and fats which can be applied to all people living with DM (ADA, 2018a:S41). The spreading of macronutrients (carbohydrates (sugar), lipids (fats), and proteins) should therefore be based on an individualised assessment of a patient's existing eating patterns, likings and metabolic targets (ADA, 2018a:S41). Individual preferences for example, tradition, religion, culture, health beliefs, goals and economics should be brought into perspective, as well as metabolic goals, when determining an individual's best eating pattern (Evert *et al.*, 2014:S121; MacLeod *et al.*, 2017:1639).

It is very important that all the health care team members involved are knowledgeable on nutrition therapy principles for individuals with all types of DM and be encouraging of the implementation of the nutrition plan (ADA, 2018a:S41). It is important that the plan is based on healthy eating patterns that contain nutrient-dense foods with fewer of the emphasis on certain nutrients (Maryniuk, 2017:69). A diversity of eating patterns is suitable for the management of DM (MacLeod *et al.*, 2017:1639; Schwingshackl *et al.*, 2017:375): the Mediterranean (Boucher, 2017:75; Esposito *et al.*, 2009:902); dietary methods to stop high blood pressure (Campbell, 2017:79; Cespedes *et al.*, 2016:107; Ley *et al.*, 2014:2005) and plant-based diets (Pawlak, 2017:86; Rinaldi *et al.*, 2016:474) are examples of healthy eating patterns that had significant outcomes in research. That said, individualised meal planning should concentrate on individual preference, needs and goals. The DM plate method has been used to provide basic meal planning management (Bowen *et al.*, 2016:1376) as it gives a visual representation of how to regulate

calories by showing a smaller plate; control carbohydrates through restricting the carbohydrates to what fits in a quarter of the plate; and place emphasis on low-carbohydrate or non-starchy vegetables (ADA, 2018a:S41).

The next section will consist of the nutrients that play a part in DM.

2.3.5.1.1 Carbohydrates

There are no studies proving an exact amount of carbohydrates that should be consumed by people living with DM, but the monitoring of carbohydrate consumption and bearing in mind the blood glucose response to dietary carbohydrates are important in enhancing postprandial glucose control (Delahanty *et al.*, 2009:521). The results on glycaemic index and glycaemic load in people living with DM have been complex and studies showed mixed results. Some studies have found that the lowering of the glycaemic load of carbohydrates taken in, has proved a reduction in A1C (is testing blood for T2DM and prediabetes. It measures the average blood glucose or blood glucose level across a 3-month period) (Thomas & Elliot, 2009:9; Wheeler *et al.*, 2012:436). Further studies in glycaemia index and glycaemia load showed no influence on the A1C independent of any weight loss, but more mixed results were found on the results of fasting glucose levels and endogenous insulin levels.

A wide-range of definitions surrounds the concept of low-carbohydrate diets (Snorgaard *et al.*, 2017:6; Thomas & Elliot, 2009:9) that confuses the role that low-carbohydrate diets play in DM (Wheeler *et al.*, 2012:435). There are benefits surrounding low-carbohydrate diets, but the enhancements incline to be more on the short term and these effects are not preserved (Meng *et al.*, 2017:130; Snorgaard *et al.*, 2017:8; Tay *et al.*, 2015:781; van Wyk *et al.*, 2016:156). Very low-carbohydrate or ketogenic diets (less than 50 grams of carbohydrates daily) have little benefits. Thus, this approach is only feasible for short-term use, because it proves no long-term benefits nor harm to the patient (Goday *et al.*, 2016:4, Saslow *et al.*, 2017:305).

Attempts to change usual eating patterns are ineffective over the long-term, because individuals tend to revert to their usual macronutrient supply (MacLeod *et al.*, 2017:1642). For this the recommended path is to individualise meal plans according to the caloric goals with a macronutrient supply that is more consistent with one's normal intake to accompany a long-term maintenance of the diet. Individuals with DM are encouraged to lower their consumption of refined carbohydrates and added sugars and rather emphasise on consuming carbohydrates from whole grains, vegetables, legumes, dairy and fruits. Also, a lowering in the intake of sugar-sweetened beverages and processed "low-fat" or "non-fat" food products, containing large quantities of refined grains and added sugars (Katz *et al.*, 2014:515; Nansel *et al.*, 2016:83).

People living with DM that are used to taking insulin with their meals should be educated on the need to pair insulin administration with the consumption of carbohydrates. Regular counselling is necessary to people whose meal schedules or carbohydrate consumption is variable. Counselling should be given to assist them to comprehend the intricate association related to carbohydrate intake and insulin needs. Education on the use of insulin-to-carbohydrate ratios for meal planning can help with effective adjusting insulin dosing from meal to meal to help and improve glycaemic control (Bell *et al.*, 2015:1011; Laurenzi *et al.*, 2011:824; MacLeod *et al.*, 2017:1642; Rossi *et al.*, 2010:111). Individuals who normally consume more meals containing higher amounts of protein and fat may need to make mealtime insulin dose alterations to compensate for the delayed postprandial (after a meal) glycaemic excursions (Bell *et al.*, 2015:1009; Bell *et al.*, 2016:1633; Paterson *et al.*, 2016:596). Individuals whose insulin is on a set daily schedule, meal planning ought to consist of a fairly set carbohydrate intake pattern with relation to time and quantity (Evert *et al.*, 2014:S124). In contrast to individuals with different meal plans, a simpler DM meal plan should be considered with attention given to portion control and healthy food choices for elder individuals, individuals with cognitive dysfunction and to individuals with concerns over health literacy and numeracy (Evert *et al.*, 2014:S124; Laurenzi *et al.*, 2011:825; Rossi *et al.*, 2010:109). The other alternative is to use the modified plate method, which uses measuring cups to help with portion measurements, to assist with carbohydrate counting for some individuals to control glycaemia (Bowen *et al.*, 2016:1371).

2.3.5.1.2 Proteins

Protein intake in individuals living with DM without DM kidney disease has had no significant evidence to suggest improvement in health. Research is still inconclusive on the perfect quantity of dietary protein required to optimise either glycaemic control or cardiovascular disease risk (Wheeler *et al.*, 2012:439). Based on this information protein intake should be individualised based on existing eating patterns. There is evidence from research showing success in the management of T2DM with meal plans containing a little more protein that may contribute to increased satiety (Ley *et al.*, 2014:2007). Individuals living with T2DM may benefit from protein intake through the increase of insulin response to dietary carbohydrates (Layman *et al.*, 2008:1572S). Thus, carbohydrate sources that contain high levels of protein should not be used to treat or prevent hypoglycaemia (a condition that arises when an individual's blood glucose level drops too low), because of the potential simultaneous increase in endogenous insulin.

2.3.5.1.3 Fats

The quantity of dietary fat that an individual living with DM can consume is still being debated (Liu *et al.*, 2017:64). The type of fats that is eaten is of greater importance than the quantity of fat. The

recommended percentage of total calories from saturated fats should be restricted (Estruch *et al.*, 2013:1281; Forouhi *et al.*, 2018:3; Wang *et al.*, 2016:1140).

Previous studies showed that patients living with T2DM had improved glycaemic control and improved blood lipids when consuming eating patterns rich in polyunsaturated and monounsaturated fats (Bloomfield *et al.*, 2016:495; Estruch *et al.*, 2013:1288; Sacks *et al.*, 2017:e15). Normally, trans fats should be avoided. Also, with the saturated fats being reduced in the diet, they should be substituted with unsaturated fats rather than refined carbohydrates (Sacks *et al.*, 2017:e5).

2.3.5.1.4 Sodium

People living with DM are recommended to lower their sodium intake to under 2300mg per day (Evert *et al.*, 2014:S126). Lowering sodium intake to 1500mg per day has positive effects on blood pressure (Eckel *et al.*, 2014:2966). In contrast, other studies have suggested caution when restricting sodium intake to 1500mg in people living with DM for the risk of cardiovascular events (Ekinci *et al.*, 2011:706; Thomas *et al.*, 2011:863). It is advised for sodium intake recommendations to be considered over availability, palatability, the difficulty of attaining low-sodium recommendations in a nutritional adequate diet and affordability (Maillot & Drewnowski, 2011:175).

2.3.5.2 Glycaemic control in DM self-management

Factors contributing to glycaemic control are the stress and discomfort related to it (Laranja *et al.*, 2015:107). The self-monitoring of glycaemic control is the cornerstone of the self-management of DM to ensure the patient achieves and maintains the correct glycaemic targets (Shivastava *et al.*, 2013:15). The primary objective of self-monitoring is to assess the overall glycaemic control and to take the necessary steps to achieve optimum levels, when required (Shivastava *et al.*, 2013:15). The action of self-monitoring provides the patient with information about current glycaemic status that allows for valuation of treatment and guiding modifications in diet, exercise and medication to reach optimal levels (Shivastava *et al.*, 2013:15).

2.3.5.3 Weight management

Managing of weight and weight loss in overweight and obese people living with T1DM and T2DM plays an important part in self-management (ADA, 2018a:S41). An intensive lifestyle intervention program should be implemented, and regular follow-ups should be done to accomplish noteworthy decreases in excess body weight and to improve clinical indicators. There is solid and reliable evidence that modest determined weight loss can delay the development of prediabetes

to T2DM (Balk *et al.*, 2015:446; MacLeod *et al.*, 2017:1639; Mudaliar *et al.*, 2016:2) and can benefit the management of T2DM (ADA, 2018a:S41).

Previous studies have shown that the decrease in calorie interventions reduces the A1C of 0.3% to 2.0% in adults with T2DM and improves medication doses and quality of life (MacLeod *et al.*, 2017:1649). To persist with weight loss can be challenging (Franz *et al.*, 2015:1449), but in the long-term such persistence has enduring benefits. Keeping with a weight loss program for five years has been linked to consistent enhancements in A1C and lipid levels ((Franz *et al.*, 2015:1449). For many individuals with T2DM that are obese, weight loss of more than 5% is required to produce useful results for glycaemic control, blood pressure and lipids where weight loss of more than 7% is optimal (Franz *et al.*, 2015:1449).

Meal plans that are mostly prescribed for rigorous lifestyle management for weight loss can vary regarding the types of food the plan restrict, for example high-fat versus high-carbohydrate foods, and the focus should rather be on nutrient dense foods, for example legumes, low-fat dairy, lean meats, fruits, seeds, whole grains, vegetables and nuts (Fox *et al.*, 2015:926). The focus of meal planning should be on the health status and preferences of the patients living with DM.

2.3.5.4 Physical activity recommendations

Physical activity is defined to include all movement that increases the use of energy and physical activity is a vital part of DM management (ADA, 2018a:S43). Exercise in this context is a more specific form of physical activity, intended to enhance physical fitness and physical activity; exercise is important in the management of DM (Kennedy *et al.*, 2018:1; Lascar *et al.*, 2014:1; Shivastava *et al.*, 2013:15). Exercise has proved to “improve blood glucose control, reduce cardiovascular risk factors, contribute to weight loss, and improve well-being” (ADA, 2018a:S43). With higher intensity exercise, A1C levels have shown improvement along with fitness (Thrent *et al.*, 2013:4). Physical activity plays a cardinal role in T1DM, but the prevention of DM complications and the management of blood glucose is clearer in individuals living with T2DM than with T1DM (ADA, 2018a:S43). Structured exercise of at least eight weeks has proved in lowering A1C levels in T2DM, even if there are no significant changes in the BMI (Haghighi *et al.*, 2018:705). Exercise in T1DM has shown proven benefits for better muscle strength, improvement of sensitivity towards insulin and improved cardiovascular fitness (Chimen *et al.*, 2012:542; Colberg *et al.*, 2013:2067). Overweight patients living with DM, has showed an increase in mobility when exercising frequently (Rejeski *et al.*, 2012:1211).

A few recommendations regarding the physical activity of people living with DM are being set as standard (ADA, 2018a:S43). Children and adolescents that live with DM is advised to engage in

60 minutes or more of daily modest- to vigorous intensity aerobic activity, with strenuous muscle-strengthening and bone-strengthening activities no less than three times per week (Jansen *et al.*, 2011:18). Adults living with DM is suggested to do at least 150 minutes or more of modest- to vigorous intensity aerobic activity weekly, stretched over at best three times per week, with no more than two successive days without activity. Shorter periods, with a minimum of 75 minutes weekly vigorous-intensity or interval training may be adequate for younger and substantially fitter individuals (Little *et al.*, 2011:1559). Adults living with DM are advised to engage between two and three sessions weekly of resistance exercise on alternate days (Colberg *et al.*, 2010:e155). All adults, and particularly those living with T2DM, are advised to reduce the time they spent in daily inactive behaviour. Lengthy sitting should be interrupted every 30 minutes for blood glucose benefits, especially in adults living with T2DM (Dempsey *et al.*, 2016:969; Katzmarzyk *et al.*, 2009:1002). Flexibility- and balance exercise is recommended two to three times per week for older adults living with DM. Yoga and tai chi might be involved based on individual preferences to enhance balance, muscular strength, and flexibility.

2.3.5.5 Lifestyle changes as factor in self-management of DM

Patients with DM are seemingly not interested in changing their lifestyle (Linmans *et al.*, 2015:439). It seems that 47% of patients with DM are inactive and 70% of patients do not adhere to physical activity guidelines (Grandes *et al.*, 2008:172; Linmans *et al.*, 2015:439).

Several barriers have been identified that prohibits lifestyle changes in people living with DM (Brown *et al.*, 2002:344; Dutton *et al.*, 2005:2109; Hansen *et al.*, 2011:484; Jansink *et al.*, 2012:417; Nagelkerk *et al.*, 2006:153; Vermunt *et al.*, 2012:79; Wermeling *et al.*, 2014:97). These barriers include:

- Patients not regarding the disease as serious;
- The general behaviour shown by the patients;
- A decrease in the well-being of patients;
- Asymptomatic diseases;
- Cost increases;
- The cultural backgrounds of patients;
- Self-satisfaction of a patients' own behaviour;
- Lack of success in treatment;
- Physical impairments;
- A lack of time; and
- Interference with work.

2.3.6 Self-management of adolescents

Students, as the focus in this study, are defined in different terms across different studies. In this section the researcher will explore the different terms used in literature and form a term that will be used in the rest of the study.

2.3.6.1 Adolescents definitions

The term adolescence comes from the Latin *adolescere* which means “to grow up” (Sharma *et al.*, 2008:125). But to define the phase that stretches from childhood to adulthood has been a conundrum for years. At the beginning of the 20th century, G. Stanley Hall defined adolescence as the developing period extending from 14 to 24-year olds in his thesis on adolescence (Arnett, 2006:127). The WHO proposed 50 years ago that adolescence stretched from 10 to 20-year olds, although the period started with puberty, the endpoint was less well defined (WHO, 1964:28; WHO, 1977:10). The United Nations on the Rights of the Child defined a child to be between the ages of 0 to 18-years and later the United Nations defined adolescence as the period between 10 to 19-years (WHO, 2015:27). It is still met with surprise in different countries, cultures and context that 10-year-olds are still seen as children and not as adolescents, and that 19-year-olds are already referred to as adults (Sawyer *et al.*, 2018:223).

The term youth became popular about the time same the United Nations’ first International Youth Year, however, the term overlapped with adolescence. Youth is currently defined as a time between 15 and 24-years, but a Barcelona Statement from the accompanying world congress has defined youth as a social category; the congress proceeding were extraordinary because of the absence of age descriptions (World Congress of Youth, 1985). The latest released definitions of young adulthood and emerging adulthood ranges from 18 to 26-years. (Arnett, 2000:473; Bonnie *et al.*, 2015:25; Patton *et al.*, 2016:2499). With all these different variations it is notable that the term (youth) most used is a generic term for young people, but it does not have a definite definition (Sawyer *et al.*, 2018:223).

One of the challenges faced with all the different definitions, is that for developing years, specifically adolescence, a 16-year-old can be a child, adolescent and youth at the same time (Sawyer *et al.*, 2012:1632). Each term has a different meaning as a child is dependent, youth shows independence and adolescence suggests the idea of a growing individual who can take more responsibility but still requires more protection than an adult (Sawyer *et al.*, 2018:223). This viewpoint, on different definitions and terms summarises the degree to which the biological growth and social role changes that define adolescence have transformed over time (Sawyer *et al.*, 2018:223).

Sawyer *et al.* (2018:223) summarised key points on the terms to ultimately define the period of adolescence and that term will be used in this chapter as the age category for adolescents and students at the North-West University Potchefstroom campus:

- Adolescence covers elements of biological growth and vital social role changes, with the timing of these growth patterns changing over time and place;
- The way adolescence is conceptualised and defined affects the scope and focus of laws, policies and programmes proposed to defend and empower adolescents;
- The definition of adolescence ranging from 10 to 19 years of age dates from the mid-20th century, when patterns of adolescent growth and the timing of role changes were very dissimilar to current patterns in many places; and
- An extended and more comprehensive definition of adolescence ranging from 10 to 24 years of age aligns more closely with current patterns of adolescent growth and popular understandings of this life phase.

2.3.6.2 The transition of an adolescent to successful DM self-management

The adjustment to DM self-management is a challenging period for the majority of adolescents (Ingerski *et al.*, 2010:191). Some adolescents take up independence in their DM self-management responsibilities from ages as young as 9 or 10, with ages 11 to 13 showing most of the care being done by themselves (Dashiff *et al.*, 2006:230; Ingerski *et al.*, 2010:194). When an adolescent takes more responsibility for their own care, the A1C levels tend to rise and their blood glucose self-monitoring tends to go down (Rausch *et al.*, 2012:1223).

The tasks of self-management in childhood generally start with blood glucose self-monitoring and injecting insulin (Hanna & Decker, 2010:109). DM self-management is a complicated task with more than 600 different tasks to manage that includes the physical aspects of glycaemic control plus the emotional adjustments of having a chronic disease (Coffen, 2009:132). Wysocki *et al.* (2008:882) adds the importance of making decisions and having problem-solving skills in DM self-management. The perceptions that an adolescent have regarding their self-efficacy has been proven as a vital aspect in both DM self-management and glycaemic control (Berg *et al.*, 2011:334; Iannotti *et al.*, 2006:104). Parents and their relationship with the adolescent have a positive effect on adhering to DM care and metabolic control (Berg *et al.*, 2011:337). Dependence on parents tend to go down between the ages of 14 and 15, while problem-solving skills improve over the period of adolescence (Keough *et al.*, 2011:495). Risk factors associated with substandard adherence to care may consist of an increase in age, lower socio-economic status, high levels of family conflict, coping methods, single-family homes, poor family communication and poor social- and problem-solving skills (Wysocki, 2006:928). Different theories exist that

describe the self-management towards chronic illness and the risk- and protective factors that can improve the outcomes, but it is still a struggle for adolescents to attain successful self-management of their DM throughout these transitioning years (Grey *et al.*, 2009:415; Ryan & Sawin, 2009:223). Parents have recounted frustration and concern towards their adolescent's self-management of DM, but say that jogging the memory of their adolescent and allowing more independence, assists them during this time (Dashiff *et al.*, 2011:307).

Adolescents go through increased psychological distress that includes poor self-confidence relating to poor quality of life (Abolfotouh *et al.*, 2011:144), more parental conflict (Dashiff *et al.*, 2009:80; Ingerski *et al.*, 2010:195) and higher rates of depression and anxiety (Hoey, 2009:11; Insabella *et al.*, 2007:232). Some adolescents think that their parents are overbearing and controlling (Carroll & Marrero, 2006:247; Hoey, 2009:11; Leonard *et al.*, 2005:107) and then prefer their parents not to be involved (Hanna *et al.*, 2003:153) even though studies have shown certain benefits of parental support (Leonard *et al.*, 2005:118).

The main tasks for an adolescent to transition to independence is taking over care, facing conflict with parents and realising DM is tough (Babler & Strickland, 2015). The major tasks that an adolescent tend to reach for is to independently manage DM with the normalising task of taking on the burden of care. Key factors inherent in the task of achieving independence are (Babler & Strickland, 2015):

- "Fear of needles";
- "Forgetting to give insulin";
- "Making judgments on insulin dosing affects outcomes";
- "Feeling self-conscious or embarrassed about doing care in front of others";
- "Experiencing conflict with parents occurs more when they are frequently asking about blood sugars";
- "The rate of transition affects how the adolescent does (too soon, too slow)"; and
- "Feeling that diabetes is hard when adolescents just want to fit in with peers"

2.3.6.3 Adolescents facing university

Adolescents with DM attending a university are faced with challenges that could make it difficult to maintain self-management (Balfe, 2009a:2367). Factors that contribute to self-management of adolescents with DM involve family, peer groups and health care professionals (Casey *et al.*, 2011). Students living with DM view university as a hazardous environment where students could break the rules, "lose control", and where students tend to seek an adrenaline rush situation (Balfe, 2007:137; Balfe, 2009a:2370).

Adolescents and young adults develop their sense of self to gain autonomy in all areas of life and to broaden their focus from normal tasks of a childhood to tasks of an adult (Roisman *et al.*, 2004:130). Family involvement during the development of childhood into adolescence is very important for optimal DM management (ADA, 2003:46). With these factors in mind, college life could raise concerns for adolescents who are not prepared for new independence and challenges they face, especially students with DM (Wdowik *et al.*, 2001:17). Anger, sadness and frustration are common among college students with DM (Shalom, 1991:278).

DM care responsibilities increase with the transition from high school to after high school (Hanna *et al.*, 2013a:65). There is a difference between the risk behaviours and lifestyle characteristics among college students that result in patterns of a widespread series of factors: physical activity, glycaemic control, diet, stress, risky sexual activity, substance use and sleep (Laska *et al.*, 2009:385). Three categories of diabetic students that tend to engage in high-risk behaviours were identified: those with eating disorders, those who drank large amounts of alcohol and those who were not being monitored by a healthcare provider (Fedor *et al.*, 2017:319; Ramchandani *et al.*, 2000:665).

College students also face barriers such as implementing self-care, effective time management, dealing with stress and inadequate finances. Additional stressors such as DM management, social support, denial and rebellion also have an impact on students living with DM in a college or university environment. Finding a routine, an identity, benefits of a self-care routine, complications experienced accomplishing self-care routines through the first year in university, teaching oneself how to lay out self-care routines in university and the reluctance or incapability of students newly diagnosed with DM to routinise their self-care practices are also found to be barriers in implementing self-care (Balfe, 2009a:2370; Wdowik *et al.*, 1997:561).

2.3.6.4 Psychological factors associated with DM self-management among adolescents

The excess of short- and long-term physical health difficulties that relate to DM is crucial for young people. These difficulties play an important role for such young people to learn how to manage their DM effectively. The importance of the management lies in the fact that a reduction in A1C reduces the risk of complications (Lind *et al.*, 2013:2606). DM management for adolescent age groups are far more composite with a set of challenges that stretches over a variety of social, physiological and emotional changes which occurs amid childhood and adulthood, as well as peer pressure, puberty, identity formation, a desire to be 'normal' and often testing of boundaries set by healthcare professionals, caregivers and parents (Hilliard *et al.*, 2013:395). Interventions have been created to enable young people to better manage their condition (Martinez *et al.*, 2018:1750). Normally these interventions would take the form of educational programmes that

aim to teach specific DM management skills and becoming more independent with said tasks, namely counting carbohydrates and monitoring blood glucose, or psychosocial interventions intended to address self-care and emotional problems through a diversity of problem-solving and emotion-focused methods (Peytor & Ruben, 2007).

2.3.7 Sub-optimal DM self-management in general

Uncontrolled DM could lead to polyuria (the excess passage of urine, 2.5 litres per day), weight loss, polyphagia, overeating, and blurred vision (ADA, 2014:S81; Lakhani & Lakhani, 2015:433; Rudd Bosch *et al.*, 2015:1). There are also slim chances of growth impairment and susceptibility to some infections (ADA, 2014:S81). Acute, life threatening, consequences could arise from uncontrolled DM. These are ketoacidosis, which occurs when the body of a diabetic produces high levels of ketones (Cameron *et al.*, 2014:1555), or Hyperosmolar Hyperglycaemic Nonketotic Syndrome, a disease seen more frequently in older people with DM that is not controlled properly, and normally it arises from being infected or as an illness (ADA, 2013:S67; WHO, 2016:2).

2.4 Barriers to self-management in chronic diseases, DM in general and DM in students

In this section, the researcher looks at the barriers to self-management. First, the barriers to self-management in chronic illnesses are viewed, next the barriers to self-management in general for DM and lastly the barriers to self-management of students living with DM on campus. The researcher leads the reader through these different barriers by funnelling the barriers and providing the comparisons and differences in different themes of barriers in self-management over these three spectrums.

There are five main categories to the factors that influence self-management that will be looked at (Schulman-Green *et al.*, 2016:1472), namely:

- Health care system;
- Resources;
- Environmental characteristics;
- Health status; and
- Personal/lifestyle characteristics.

Eight sub-factors were identified by Peters & Laffel (2011:2479) to contribute to sub-optimal self-management of an emerging adult that will be combined into the five main categories of overall self-management: difference between paediatric and adult care, poor glycaemic control, losing the ability to follow-up on care, reproductive health issues, acute- and chronic complications, psychosocial issues and substance abuse.

2.4.1 Personal/lifestyle characteristics

Under each of the main categories, there are sub-categories influencing the self-management of people living with chronic illnesses. Personal/lifestyle characteristics are influenced by beliefs, motivation, knowledge, life patterns and psychological distress.

2.4.1.1 Knowledge

Knowledge regarding the disease processes, knowledge of the function of the medicine, and knowledge on the treatment plan of the illness, have all been factors contributing to poor self-management in general. Patients are generally unsure about how to self-manage their condition. Reports from patients are aimed towards not knowing why and how to manage their condition and thus the self-management efforts are insufficient (Griva *et al.*, 2013:23; Henriques *et al.*, 2012:3099; Lundberg & Thrakul, 2011:53; Ploughman *et al.*, 2012:13; Rasmussen *et al.*, 2011:1988; Wortz *et al.*, 2012:389;)

Some individuals have a common understanding of the causes, symptoms and complications regarding DM (Hewitt *et al.*, 2011:120). Specifically relating to T2DM, individuals accept that their DM is caused by them eating unhealthily, being overweight, no exercise and because of cultural and genetic factors (Low *et al.*, 2014:15; Reyes *et al.*, 2017:7). Being informed of their diagnosis, various emotions and feelings are present. Such feelings and emotions range from fear, denial, anger, depression and uncertainty towards the acceptance of DM.

When comorbidities are present, blood glucose control decreases. Other perceived barriers to diabetes self-management are a lack of knowledge, limited social support, time constraints, frustration, helplessness and disease progression (Nagelkerk *et al.*, 2006:156).

Factors that contribute to poor glycaemic control in students are related to self-monitoring of blood glucose, the time span since diagnosis, physical activity, total level of cholesterol and waist to hip ratio (Mamo *et al.*, 2019:6). Students who have been diagnosed in the past seven years or more have proven to have less control over their blood glucose. Students with daily physical activities of more than 30 minutes tend to have better glycaemic control than students with physical exercise of 30 minutes, 1 to 6 days of the week (Mamo *et al.*, 2019:6).

2.4.1.2 Beliefs

The beliefs regarding culture and traditions have affected individuals' lack of correspondence between their beliefs and self-management practices (Schulman-Green *et al.*, 2016:1478). Struggles towards self-management and diet were present when diet recommendations were not

in line with the cultural practices and values (de Brito-Ashurst *et al.*, 2011:93, Lundberg & Thrakul, 2012:552, Orzech *et al.*, 2013:63).

As a result of spiritual beliefs, some people reported that they struggled to come to terms with accepting their disease (Foster & Gaskins, 2009:1310; Roberto *et al.*, 2005:683). With some patients struggling to come to terms with their disease, others have pointed to prayer and spiritual beliefs as a way of control and confidence in self-management. The treatments and healthcare providers get selected via the spiritual beliefs surrounding the cause and cure of the illness (Lundberg & Thrakul, 2012:555; Zhang & Verhoef, 2002:1801).

Personal health beliefs are influencers and barriers to self-management. Especially when it comes to perceived control over the illness and the symptoms, self-management increased. Self-management increased in such a sense that increased perceptions of control over the illness lead to better self-management (Handley *et al.*, 2010:16). Both perceptions with positive and negative consequences of self-management tasks plays a role in the efforts by patients towards their self-management (Henriques *et al.*, 2012:389; Lin *et al.*, 2008:38; Lundberg & Thrakul, 2012:553).

Once individuals allege the positive consequences of their tasks related to their self-management or their negative consequences of not finishing their self-management tasks, they make more effort to self-manage. When a negative belief toward self-management comes up (treatment being time-consuming, inconvenient, hard work, complex, did little to control their chronic illness) the self-management is hindered (Griva *et al.*, 2013:14; Handley *et al.*, 2010:15; Henriques *et al.*, 2012:3103; Lundberg & Thrakul 2011:56; Lundberg & Thrakul 2012:554; Song *et al.*, 2010:216; Wortz *et al.*, 2012:.).

2.4.1.3 Psychological stress

Psychological stress has a noticeable influence on individuals' self-management. Multiple roles' pressure (example of working and being a mother) and stress plays a role in the barriers to self-management (Balfe, 2009a:2373; Mead *et al.*, 2010:73; Modeste & Majeke, 2010:166). Other psychological barriers that act as barriers in self-management are anxiety, fear and an impaired mood (Jo Wu *et al.*, 2008:21; Ploughman *et al.*, 2012:13; Wortz *et al.*, 2012:390; Wu *et al.*, 2011:2281). Nervousness acts as a facilitator for individuals as this makes them more attentive to monitoring their symptoms and performing additional self-management tasks (Riegel *et al.*, 2010:893). Barriers according to Grant & Steadman, (2016:243) include inadequate health system and communication interfaces, struggles to cope with DM and difficulty in implementing DM self-management inside social roles and settings.

Individuals living with DM who are controlling their blood glucose show more optimism and a positive attitude towards their quality of life (Kueh *et al.*, 2015:133). These individuals are prone to change in their lifestyle (Chong *et al.*, 2017:49). The individuals who control their DM, do so with the advice from their healthcare providers taking part in self-management (Powell *et al.*, 2015:227; Reyes *et al.*, 2017:7). The individuals take the advice of the healthcare providers and incorporate it into their self-management actions. The key for these individuals is to make one small change at a time (McDuffie *et al.*, 2001:150; Reyes *et al.*, 2017:7).

The diagnosis of DM force individuals to see an opportunity for a healthier lifestyle (ADA, 2017b:S34). Individuals who control their DM make the decision to focus on portion control and to exchange one food choice for another (Evert *et al.*, 2014:S124; Liu *et al.*, 2018:e424); positive attitudes are seen when individuals start to enjoy their new food choices and to look forward to exercising (Karimy, *et al.*, 2018:3; Reyes *et al.*, 2017:8). On the other hand, individuals with uncontrolled blood glucose reports to the lack of self-management of their DM and experience fear concerning eating and medication and the effects that these will have on their blood glucose (Mahabalshetti *et al.*, 2016:174).

Social isolation, stress, depression, anxiety and loss are mental health issues that individuals with DM see as barriers to effectively act on their self-management (Ducat *et al.*, 2015:337; Robinson *et al.*, 2018:S132).

2.4.1.4 Motivation

Persistence with self-management efforts are affected by the lack of motivation and self-discipline (Ofstedal *et al.*, 2010:2554; Song *et al.*, 2010:214). Motivation towards self-management is enhanced by the awareness of self-efficacy or personal control (Cooper *et al.*, 2010:1501; Handley *et al.*, 2010:16; Lundberg & Thrakul, 2012). One factor that plays a part in individuals' motivation is the stigma factor that they will rather take care of themselves to circumvent the stigma of requiring additional devices or being accommodated for, just to attain a "normal life" (Audulv *et al.*, 2009:290; Ploughman *et al.*, 2012:15).

Cravings are present for food that individuals living with DM should not consume, in both individuals with controlled and uncontrolled blood glucose (Reyes *et al.*, 2017:5; Yu *et al.*, 2013:1082). Controlled individuals are more in control of their self-management, controlling their cravings and rather deciding to take the healthy choice for example by choosing water instead of carbonated beverages (Reyes *et al.*, 2017:5).

Being physical active is important in controlled individuals and uncontrolled individuals (Hamasaki, 2016:248). Comorbidities are some of the reasons for not exercising as well a lack of

motivation (Lascar *et al.*, 2014:5; Medagama & Galgomuwa, 2018:4). Difficulties in exercise exist because of shortness of breath, musculoskeletal sprains or strains, pain and obesity (Reyes *et al.*, 2017:5).

2.4.1.5 Life patterns

Personal characteristics having an impact on the self-management of chronic illnesses include past self-management experiences, the capability to design a self-management routine and life transitions. Earlier self-management experiences where the self-management practices boosted health, positively affects existing behaviours and beliefs towards management of a chronic disease (Henriques *et al.*, 2012:390; Lin *et al.*, 2008:40; Riegel *et al.*, 2007:240). On the other hand, individuals who experienced adverse effects to their self-management or fears for additional harm are less susceptible to endure with their self-management (Griva *et al.*, 2013:21; Hwu & Yu, 2006:265). To facilitate self-management, individuals have proved to develop a daily self-management routine (Griva *et al.*, 2013:19; Hwu & Yu, 2006:266; Pascucci *et al.*, 2010:9; Song *et al.*, 2010:214).

All of the above-mentioned strategies enable individuals to engage and enhance their self-management behaviours. But, in contrast to having a routine, maintaining a demanding schedule complicates the capacity to develop and uphold routines (Handley *et al.*, 2010:16; Hwu & Yu 2006:266; Song *et al.*, 2010:216). Interruptions to a daily routine causes a disturbance and a challenge to an individual's self-management. These interruptions include travelling, vacation, holidays and weather (Pascucci *et al.*, 2010:9; Song *et al.*, 2010:214). To maintain routines, individuals want more creativity and flexibility when their situations change. Life-transitions have an effect on self-management (Balfe, 2009a:2370). Additional transitions mentioned are that of becoming a mother and having to start employment, as it requires an adjustment of one's self-management routines, and also becoming older (the reason being the increased potential of cognitive issues that could prevent self-management) (Rasmussen *et al.*, 2011:1985; Song *et al.*, 2010:214).

To set and overcome challenges is a difficulty for individuals living with DM (Klinkner *et al.*, 2017:309). Factors that contribute to the challenges are a lack of motivation, limited capacity of self-management and a constant difficulty to break accustomed habits and routines (Reyes *et al.*, 2017:6). Goals are set by individuals themselves and sometimes they want help from their healthcare providers (Wallace *et al.*, 2016:209). The two top goals are to lose weight and to lower their blood glucose (Boot *et al.*, 2013:335; Van Gaal & Scheen, 2015:1169). Not having the self-confidence and lacking the skill to achieve their goals act as barriers that make the tasks harder (Reyes *et al.*, 2017:6).

The difficulty for students managing DM in the university environment comes with the accountability and responsibility that rests on themselves. This decreases the accountability of the parents for all the aspects of daily living and is a big stressor related to the life of a student (Meyer *et al.*, 2017:62).

Becoming aware of routine changes is complex and not that simple to adapt to. Changes to routines are hard to cope with as a result of working long hours and not having time or energy to exercise or preparing a meal. More specific problems relating to routine changes are recurrent exposure to social situations or places that influence behaviour that does not correspond with DM self-management (Fritz, 2014:237).

Numerous students living with DM at university level have reported that they want to eat healthier (Hilger *et al.*, 2017:102). Most of the student population find it effortless to maintain a healthy diet, especially female students. Although many students find it easy to live healthy on campus, two barriers still arise, *id est*, lacking time to prepare healthy meals due to university obligations and lacking healthy meals at the university cafeteria. Students find themselves eating at the cafeteria as a result of poor cooking skills and lacking time to prepare healthy meals. A lack of motivation to eat healthy is seen among students and that they dislike eating healthy as the food choices are unpalatable. A lack of time cannot merely be ascribed to university commitments, but also to the importance of their hobbies and other interests. Factors that contribute to poor eating habits for other students are that they changed their diet since moving to university and have a side job. However, they also say that money is not a reason for eating unhealthily (Hilger *et al.*, 2017:102).

2.4.2 Health status

Some factors associated with an individual's health status influence self-management tasks, namely, severity of the illness, comorbidities, side-effects as a result of treatment, symptoms and cognitive functioning. Self-management tasks are influenced by any physical comorbidities added to the difficulty of their healthcare regimes and extra strain of their symptoms that restricts their self-management efforts (Brand *et al.* 2010:77; Griva *et al.*, 2013:26; Hwu & Yu 2006:267; McCarthy *et al.*, 2010:247; Ploughman *et al.*, 2012:16; Riegel *et al.*, 2010:893; Utz *et al.* 2006:200; Wortz *et al.*, 2012:389). More barriers to self-management include side-effects (especially pain and fatigue) and symptoms (Henriques *et al.*, 2012:3100; McCarthy *et al.*, 2010:247; Pascucci *et al.*, 2010:8, Wortz *et al.*, 2012:388; Wu *et al.*, 2011:2279). Remarkably, the lack of symptoms is identified as an aspect that reduces self-management efforts. This is because of the lack of apparent seriousness or lack of apparent benefit (Handley *et al.*, 2010:17). Cognitive weakening also features as a barrier to seeing signs and symptoms, for example to remember to implement self-management tasks or problem-solving (Jo Wu *et al.*, 2008:2283; McCarthy *et al.*, 2010:248).

Individuals find it harder to manage their diet when they have more than one condition due to advanced DM. The most common comorbidity conditions with DM is cardiovascular disease, renal disease, arthritis, being overweight and musculoskeletal pain (Bouhairie & McGill, 2016:393; Leitner *et al.*, 2017:489; Leon & Maddox, 2015:1247; Piva *et al.*, 2015:71; Sözen *et al.*, 2018:259). In certain situations, individuals are told to cut down on green vegetables when they are on Warfarin (a blood thinning medication), however, when they were first diagnosed with DM they were told to eat more vegetables (Reyes *et al.*, 2017:5; Violi *et al.*, 2016:e2900). Other individuals have to cut down on their protein and potassium due to advanced kidney disease and restrict the intake of salt due to high blood pressure or a history of stroke (Cupisti *et al.*, 2018:261; Ko *et al.*, 2017:81; Reyes *et al.*, 2017:5).

One of the major issues for individuals living with DM are the side-effects such as gastrointestinal including anorexia, nausea, abdominal discomfort and diarrhoea, that they experience when using their medication (Marín-Peñalver *et al.*, 2016:360). Another problem factor is remembering to take their medication on time (Alqarni *et al.*, 2019:69).

2.4.3 Resources

Financial resources, equipment and psychosocial support are resources that influence the self-management of individuals with chronic illnesses. The degree and value of personal resources might influence self-management.

2.4.3.1 Financial

Major barriers to self-management are limited financial resources, the lack of insurance and financial instability of individuals (Lundberg & Thrakul, 2011:55; Modeste & Majeke, 2010:166; Nagelkerk *et al.*, 2006:154). The choices made by some individuals to sustain their self-management are affected by the high prices of medication, healthy food, supplies and alternative therapies. Also, employment loss or trying to remain able to work are barriers to self-management. The lack of health insurance and the limited coverage of health insurance have a considerable impact on self-management due to some individuals' limited access to healthcare and associated problems in obtaining medication (Gee *et al.*, 2007:323; Mead *et al.*, 2010:71; Vest *et al.*, 2013:151). On the other hand, when there is financial support from family or friends, self-management improves due to the ability to purchase high-cost foods as prescribed for the individual (Orzech *et al.*, 2013:62).

Financial limitations are a major barrier to individuals with DM (Cambell *et al.*, 2017:80; Morris & Chasens: 2017:248). The limitations hampers individuals to the extent of obtaining adequate medication, purchasing healthy food and attending clinic visits (Cambell *et al.*, 2017:80).

Individuals with better control highlight that they work together with their healthcare providers to lower the cost of medication or to get financial assistance (Adu *et al.*, 2019:16; Cambell *et al.*, 2016:e5565; Cambell *et al.*, 2017:80).

2.4.3.2 Equipment

Devices that either assist or hinder self-management include the internet, electronic equipment and non-electronic equipment. The internet may assist in self-management by providing helpful information regarding illnesses and connecting individuals with certain illnesses to peer groups and other resources (Brand *et al.*, 2010:79; McCarthy *et al.*, 2010:248; Wellard, *et al.*, 2008:223). However, the internet is also described to hinder self-management by providing information regarding a disease that could either be frightening or unreliable (Vassilev *et al.*, 2014:728).

Electronic equipment and non-electronic equipment are described as both facilitators and barriers to self-management. The aforementioned equipment facilitates self-management by helping individuals to learn about their health condition, make self-management decisions and to adapt to their environment. (Ploughman *et al.*, 2012:13). This equipment also acts as barriers to self-management by the perceived inconvenience or the stigma surrounding the disease (Ploughman *et al.*, 2012:15).

2.4.3.3 Psychosocial

Psychosocial support shows positive and negative influences towards self-management of individuals. The support from partners and peers plays a big role as it promotes empowerment (Brand *et al.*, 2010:79; Gee *et al.*, 2007:326; Henriques *et al.*, 2012:3100; Hwu & Yu 2006:268). The acts of support by nearby family and friends towards self-management includes preparing healthy food, providing reminders about medication and accompanying the individual to medical appointments (Emlet *et al.*, 2011:107; Hwu & Yu 2006:265; Lundberg & Thrakul 2011:57; Lundberg & Thrakul, 2012:554; Winters *et al.*, 2006:279). Contrary to the support from family and peers, individuals also identified with negative or no support from peers and families and this acts as a barrier towards their self-management (Balfe, 2009a:2370; Orzech *et al.*, 2013:62).

Support groups and peer support were highlighted as an important facilitator to self-management, especially when the support comes from someone with the same disease to share information with and to connect to the community (Griva *et al.*, 2013:19; Lowe & McBride-Henry, 2012:24; Ploughman *et al.*, 2012:13; Rasmussen *et al.* 2011:1987; Utz *et al.*, 2006:200). Having no social support is seen as a barrier to the self-management of individuals with chronic illnesses (De Brito-Ashurst *et al.*, 2011:92; Riegel *et al.*, 2007:239).

Family caregiving responsibilities are seen as a challenge for individual DM self-management (Cosser *et al.*, 2018: 628; Dhada & Blackbeard, 2019:126). Some individuals choose to take on the role of the family caregiver and place the needs of others before their own. Self-management of these individuals gets neglected because of this choice (Reyes *et al.*, 2017:7).

Support from family members helps individuals living with DM to stay on track with their self-management (Pamungkas *et al.*, 2017:69). Family support are especially helpful when facing difficult times (Ahmed & Yeasmeen, 2016:106). The individuals benefit from talking to others and spending time with them. When in a family with more than one person with DM, individuals share information from healthcare providers regarding self-management among each other (Peters *et al.*, 2014:3; Reyes *et al.*, 2017:7; Vaala *et al.*, 2018:138). Such shared information enhances self-care and problem-solving capabilities. Family members also remind those family members with DM to take medication and test their blood glucose levels (Rintala *et al.*, 2013:89; Vaala *et al.*, 2018:138). Family members lend assistance regarding food consumption, either by telling family members with DM what they should or should not consume, by being a positive influence or encouraging them to purchase healthy foods during grocery shopping (Reyes *et al.*, 2017:7).

Friends provide a supporting role whilst shopping with a friend with DM, acting as a reminder of what they should buy and what they should ignore (Reyes *et al.*, 2017:7). They regularly check in on each other, especially in the case where one or both have no family, or where family is not available. Both family and peer support are indispensable in the lives of people living with DM (Baig *et al.*, 2015:90; Reyes *et al.*, 2017:7).

Making new friends is a stressful venture for people with DM (Meyer *et al.*, 2017:62). The difficulty lies in explaining DM to potential friends (Lehmkuhl *et al.*, 2009:213). Discussing the consequences of living with DM also acts as a stressor for these students. The routine of these students differs from their friends' routines and this makes them feel like outsiders, it interferes with their social activities, it wastes time and they cannot share in the same culinary experiences as their friends. The consequences of living with DM is the most upsetting to the students and the most common issue is that it takes time away from activities.

Students, who do not get proper support and involvement from their parents regarding self-management of DM, are at high risk of poor diabetes outcomes (Young *et al.*, 2014:553).

2.4.4 Environmental characteristics

The environmental factors that influences the self-management in individuals living with chronic diseases include home, work and community.

2.4.4.1 Home

One of the barriers to self-management of DM is living in a home environment with family members who have a different diet to the one required to maintain health in a chronic illness (Orzech *et al.*, 2013:60). The issue of keeping DM appropriate foods in the house often creates conflict between family members in such a situation (Orzech *et al.*, 2013:60). Another issue arises in homes with more than one family member living with a chronic illness as this creates conflict of demands, competition between members and a struggle to concentrate on self-management needs (Wu *et al.*, 2011:2280).

2.4.4.2 Work

The work environment often creates stress regarding self-management tasks due to time and schedule constraints. These barriers make it harder to perform tasks related to diet, exercise and medication (Dickson *et al.*, 2008:68; Lundberg & Thrakul, 2012:554; Oftedal *et al.*, 2010:2552). However, self-management is also facilitated by the support received by employers and co-workers and to have a sense of belonging at work (Dickson *et al.*, 2008:68; Oftedal *et al.*, 2010:2552).

Creating a balance between health care and meeting academic obligations pose a great challenge for students living with DM. The influencing factor in these students' academic performance is handling fatigue during periods of hypoglycaemia and hyperglycaemia. Academic stress affects the metabolic self-management (Hill *et al.*, 2013:240). The students attribute the fact that their A1C levels were raised since joining university to academic stress. Forgoing some aspects of some DM management tasks were actions taken by students to reach their academic goals. This caused unrest in some students as they knew the consequences of ignoring self-care. Other students felt it necessary at this stage of their life (Hill *et al.*, 2013:240).

2.4.4.3 Community

The lack of transportation to get to a gym or medical appointments is seen as barriers to self-management in the community. Other barriers include exposure to unhealthy food at restaurants and social environments; and the lack of knowledge in the community surrounding chronic illnesses (Cooper *et al.*, 2010:1505; Foster & Gaskins, 2009:1310; Lundberg & Thrace, 2012:552; Modesto & Magee 2010:166).

Challenges arise when modifying a diet to control DM on the one hand, and to keep family members satisfied on the other (Ahmed & Yeasmeen, 2016:106; Reyes *et al.*, 2017:4). The feeling of having to follow a different diet than others creates overall frustration as it is seen as

unfair (Reyes *et al.*, 2017:4). Following a diet that differs from others make the transition to a healthier diet harder and living in a home with unhealthy food worsens temptation (Marcy *et al.*, 2011:15; Reyes *et al.*, 2017:4). The changes in diet may lead to spending less time with family due to dietary restrictions. Lending assistance during family gatherings is another tempting affair, as the food available is not part of the “DM diet” and creates temptations to eat unhealthy (Reyes *et al.*, 2017:4).

There are a few factors creating barriers for students living with DM. These include the lack of guidance, barriers during intimacy and a fear of hypoglycaemia during sex (Pinhas-Hamiel *et al.*, 2017:4). A small group of students acknowledge having issues in their sexual life. They do take special precautions to prevent issues during sex, such as frequent blood glucose monitoring. Other students just avoid sex for fear of hypoglycaemia (Pinhas-Hamiel *et al.*, 2017:4)

Alcohol use, smoking and drug abuse pose a risk for students with DM in the transition to university. Involvement in these behaviours among students with DM is equivalent to students living without DM. Alcohol worsens glycaemic control and is a risk factor for severe hypoglycaemia. Cigarette smoking increases the risk for cardiovascular diseases and risks of microalbuminuria (a moderate increase in the level of urine albumin) (Peters & Laffel, 2011:2481).

Peer group relationships are a concern for students living with DM (Rasmussen *et al.*, 2011). Students must face dealing with peer pressure or discrimination against them from other students. This increase stress levels in students and affects their DM and emotions, such as anger and frustration.

2.4.5 Health system

Access to healthcare, navigating the healthcare system and ensuring continuity of care and relationship with healthcare providers, are seen as barriers for individual self-management tasks.

2.4.5.1 Access

The lack of access to healthcare services (specialists, nursing care, self-management programmes and alternative therapy) is an important factor relating to poor self-management in individuals (Brand *et al.*, 2010:79; Henriques *et al.*, 2012:3100; Lin *et al.*, 2008:38; Mead *et al.*, 2010:73; Ploughman *et al.*, 2012:13; Vest *et al.*, 2013:152). Self-management could be facilitated by access to informative resources that are not part of the healthcare system (information from radio, books or brochures) (Brand *et al.*, 2010:79; Lundberg & Thrakul, 2011:57; Lundberg & Thrakul, 2012:554).

Often students do not make changes in healthcare providers when moving to university. Some students do make the change and switch to a different healthcare professional at university. The difficulties for these students arise when they do not remember their appointments or do not make appointments due to schedule and travelling changes (Fedor *et al.*, 2017:316). Students with physicians in their hometowns often undertake long distance trips to obtain their medical supplies from their home pharmacy. The fact that healthcare professionals do not have the same experience with DM as the students is seen as yet another barrier by students with DM (Fedor *et al.*, 2017:316).

2.4.5.2 Navigation system/continuity of care

There are two challenges facing individuals living with chronic illness, namely navigating the healthcare system and continuity of care. These individuals are affected negatively in pursuing self-management tasks by long waiting times for appointments, unreturned phone messages or confusing communication with clinic staff (Brand *et al.*, 2010:79; Gordon *et al.*, 2007:412). Confusion is created when some individuals have more than one healthcare provider; they do not know which care provider to call (Brand *et al.*, 2010:80). Some individuals experience challenges in communication and obtaining prescriptions when they must see different healthcare providers (Gordon *et al.*, 2007:412). This is linked to their problems regarding the lack of continuity of care from the healthcare providers.

Managing DM in a student environment is hard because the rigor of a changing time schedule makes managing insulin a challenge. Stress caused by classes and the typical student parties makes management hard, even with several insulin shots and glucose checking. Due to alcohol being readily available in a university setup, it is especially hard if the student with DM is still uneducated about factors surrounding the illness. A lot of these students are uncomfortable testing and injecting in public. Thus, they don't always carry their insulin or a glucose monitor with them in all situations (Ravert *et al.*, 2015:262).

2.4.5.3 Relationships with providers

Self-management of individuals is enhanced by a positive patient-provider relationship. The relationship needs to be a place where problems relating to the student's healthcare are discussed, they want to feel supported, trust the provider and receive empathy (Brand *et al.*, 2010:80; Griva *et al.*, 2013:22; Henriques *et al.*, 2012:3102; Jo Wu *et al.*, 2008:20; Jowsey *et al.*, 2009:27; McCarthy *et al.*, 2010:249; Mead *et al.*, 2010:71; Oftedal *et al.*, 2010:2552; Ploughman *et al.*, 2012:13; Vest *et al.*, 2013:151; Wu *et al.*, 2011:2283). Better self-management is recorded in a co-operative approach where the patient and the healthcare provider (example dieticians,

physicians, pharmacists nurses etc.) are partners in self-management and solve any self-management problems as a team with communal goals (Cooper *et al.*, 2010:1507; Handley *et al.*, 2010:17; Lundberg & Thrakul 2012:555; Oftedal *et al.*, 2010:2552; Ploughman *et al.*, 2012:15; Utz *et al.*, 2006:197;).

Spending enough time with a healthcare provider is an important factor for individuals to understand changes in self-management, to ask questions or to get feedback on self-management (Vest *et al.*, 2013:150). To improve self-management, individuals want to feel confident with their healthcare provider's capability (Winters *et al.*, 2006:281; Wu *et al.*, 2011:2283). Good communication is an essential part of positive patient-healthcare provider relationships. When the language that the healthcare provider uses is too difficult to understand, the patient gets confused and is left wondering about given instructions (Gordon *et al.*, 2007:413; Jowsey *et al.*, 2009:26). The same problem arises when a healthcare provider talks too fast and gives too much information at once (Brand *et al.*, 2010:79; Costantini *et al.*, 2008:152; Gordon *et al.*, 2007:411).

Characteristics of a helpful healthcare provider include active listening to the patient's efforts towards improving their health, appreciating the patient's unique experience with his illness, making time to get to know the patient, having regular visits, giving practical advice and preventative guidance and recommending culturally sensitive self-management strategies (De Brito-Ashurst *et al.*, 2011:93; Henriques *et al.*, 2012:3101; McCarthy *et al.*, 2010:248; Mead *et al.*, 2010:74; Orzech *et al.*, 2013:57; Ploughman *et al.*, 2012:13; Wu *et al.*, 2011:2283).

The communication of an individual also plays a role in their self-management. Limited information from the individual or not being honest is identified as difficulties with communication towards healthcare providers (Lundberg & Thrakul, 2012:556). Language barriers act as barriers towards self-management (De Brito-Ashurst *et al.*, 2011:89; Griva *et al.*, 2013:22). Always looking for more information, making suggestions to their healthcare providers and sharing their own opinion about their own self-management regimen to the healthcare provider are also patient-related factors that increase self-management (Utz *et al.*, 2006:202).

The issue surrounding healthcare providers is viewed as a challenge when it comes to DM self-management, as individuals have trouble understanding and translating their advice on a balanced diet, being physically active and monitoring their blood glucose (Dickinson *et al.*, 2017:1979; Reyes *et al.*, 2017:6). Individuals do not know where to begin with the instructions from the doctor and start using their own ideas and impressions to adhere to DM (Reyes *et al.*, 2017:6). Other individuals know that some foods are bad for their diet, but still needed help to choose the correct food. Some individuals listen to the advice from the dietician, follow the

instructions and incorporate the instructions into their daily routine (Muchiri *et al.*, 2016:29; Sergeant & Dyson, 2018:1736). Integrating different approaches from different healthcare providers' advice is troubling to individuals (Reyes *et al.*, 2017:6)

Healthcare providers are also part of the support group, along with family and friends (Jones *et al.*, 2016:3; Powell *et al.*, 2015:224). Healthcare providers give guidance to address needs, facilitate problem solving and provide guidance during difficult times (Adu *et al.*, 2019:2; Reid *et al.*, 2018:124). Healthcare providers also pay attention when the individual is talking and giving answers to their questions (Freeman-Hildreth *et al.*, 2019:15). Dieticians and nurses form part of the healthcare support group as they motivate, provide specific diet advice, cookbooks and other instrumental help (Nyoni & Reid, 2019:5).

Negative feedback regarding healthcare providers involves comments about office hours visits and discussions around care plans (Bhojani *et al.*, 2014:9). Individuals state that they do not receive enough feedback or recommendations during office visits, and they switch healthcare providers in the hope of receiving better rapport and support (Reyes *et al.*, 2017:7).

Sometimes informal support from family and friends overlap the support from the formal healthcare provider (Reyes *et al.*, 2017:8). The information from the healthcare provider is shared with peers. This confuses some of the individuals if the information from the peers and the healthcare professionals do not match (Reyes *et al.*, 2017:8; Vaala *et al.*, 2018:138). Grant & Steadman (2016:243) suggest that an inadequate health system and communication interface, difficulty in coping with diabetes and difficulty in implementing diabetes self-management within social roles and contexts, are also barriers to DM self-management.

2.5 Summary

In Chapter 2, the researcher studied the literature review objective of the IQA methodology as mentioned in section 1.5.3.1. The following research objectives were met in Chapter 2:

- The conceptualisation and contextualisation of self-management, DM and other related and applicable terms; and
- Describing and investigating the self-management of students living with DM in a tertiary institute.

In broad terms the researcher gave a short description of the history of DM. From that he created a concept of what the definition of DM means in this study and touched on the various definitions over the years. DM is a complex disease and numerous factors contribute to DM. The hormones that play a role in DM were explained briefly to the reader for a better understanding of DM. The

criteria for DM diagnosis were discussed along with the two types of DM that will be used in the study. The factors that play a part in causing DM were mentioned along with all the complications surrounding living with DM. These descriptions were set for the reader to get an understanding of what people living with DM face every day, for the rest of their lives.

For the rest of the chapter, the researcher focused on the self-care and self-management of DM and for that part the researcher described the difference between self-care and self-management and how these two terms correlate with each other. Barriers facing people living with DM were discussed, after which the focus was on the barriers students face. The researcher only briefly touched on the barriers that were previously reported in research as to make sure that no assumptions were made in advance for the data that will be gathered from the participants of this study.

In Chapter 3, the researcher discusses the IQA methodology. The discussion will guide the reader into the complicated ways of the IQA by Northcutt and McCoy and how the data that will be discussed in Chapter 4 and Chapter 5 were attained for this study.

CHAPTER 3 METHODOLOGY

3.1 Introduction

In Chapter 2, the importance of DM, self-management of persons living with DM, complications that arise from sub-optimal self-management of DM and several barriers to self-management when living with DM were discussed.

In Chapter 3, the process of the Interactive Qualitative Analysis (IQA) will be discussed. It is a unique system that will be described. Because of the complexity of the IQA, this chapter will look at all the IQA processes.

In order to better understand the IQA processes, the researcher will use the first part of this chapter to discuss the theoretical aspects of the IQA. In the second part of this chapter, the researcher will demonstrate how the IQA was used and implemented in the study.

3.2 Background to IQA methodology

The aim of an IQA study is to identify elements of meaning or importance, called affinities, and define the perceived cause-and-effect relationship between the affinities to generating a system (called a mind map) (Northcutt & McCoy, 2004:199). Northcutt and McCoy (2004:42), the founders of the IQA, described the IQA study as a visual representation of a phenomenon that is prepared according to rigorous and replicable rules of achieving complexity, simplicity, comprehensiveness and interpretability.

The IQA is a qualitative data-gathering tool and an analysis process that is dependent on facilitated group processes and produce comparable results to other settings (Northcutt & McCoy, 2004:43, 50-51). The IQA approach implies that through the systemic facilitation of group processes and by means of the systematic representation of the discussions created by the group, the collection and clarification of qualitative data can be approached from a systems standpoint (Northcutt & McCoy, 2004:56). The aim of the IQA study is to allow a group to generate its own “mind map” of the phenomenon.

In this study the focus group was the creators of the mind map. The aim of the focus group was to construct a social reality for the researcher to gain data on the phenomenon (Northcutt & McCoy, 2004:16). The focus group identified the affinities of the participants’ perceptual system regarding their self-management of DM on the NWU Potchefstroom campus through a process of inductive coding as well as axial coding (Northcutt & McCoy, 2004:47).

3.3 Theoretical rationale and foundations of the IQA

3.3.1 The place of the IQA among the different viewpoints of two paradigms

A paradigm is a widely accepted example, belief or concept. The IQA has an important theoretical implication that strives to represent a balance between the ideological dimensions postpositivists and postmodernists (Northcutt & McCoy, 2004:15). The two paradigms are two different viewpoints that originate from different values and perceptions (Northcutt & McCoy, 2004:2). The position of the IQA is discussed in the next sections.

3.3.1.1 The believes and values related to IQA

The balance between the postpositivists and postmodernists' values and beliefs as applied to the IQA will be discussed individually according to Northcutt & McCoy in the following sections.

3.3.1.1.1 Relationship of knowledge and power

- The IQA presumes that knowledge and power are dependent; this states that the power will influence which knowledge is relevant and which is irrelevant. The IQA uses constituencies (anyone who has something to say about the phenomenon and anyone who can do something about the phenomenon) as an important component in the research design phase and uses comparison of mind maps (conceptual maps) among these constituencies. One of two criterion used for constituency selection, is the degree of power that a constituency has over the phenomenon that is being investigated (Northcutt & McCoy, 2004:16).

3.3.1.1.2 Relationship between the observer and the observed

- The IQA presumes that the observer and the observed are interdependent or dependent. Some qualitative studies, while trying to capture the meaning of a phenomenon from the "subject's" point of view, rely on methods of data collection and analysis that are essentially positivist and imply a separation between the subject of the research and the researcher. The IQA questions two common assumptions of some qualitative research that data collection is separate and distinct from analysis and that only the researcher is qualified to interpret the data (Northcutt & McCoy, 2004:16).

3.3.1.1.3 The object of research

- According to Northcutt and McCoy, the object of research IQA is reality regarding the phenomenon as perceived by the constituency. The IQA uses distance from the

phenomenon as the second criteria for the selection of constituencies. The IQA also uses a focus group process as a data collection tool so that the researcher can gain useful insights into a socially constructed reality that is reported by members of the group (Northcutt & McCoy, 2004:16).

3.3.1.1.4 Primary logical operation

- Both deduction and induction are essential in IQA to the examination of meaning according to Northcutt & McCoy (2004:16). The participants are requested to induce categories of meaning (which is induction). Then they define and refine the categories through induction and deduction. Finally, they examine, deductively, the relationships of influence between the categories. These three stages of data production/analysis correlate with the three formal classes of analysis of coding which are emergent, axial and theoretical.

3.3.1.1.5 Level of description

- The level of description is the extent to which a description is contextualised. To understand meaning, it must first be based on description and then that description must be highly contextualised or situated within a certain life experience (Northcutt & McCoy, 2004:17).
- In an IQA, decontextualized descriptions are useful and possible, if it is backed or grounded by highly contextualised descriptions and if the decontextualized descriptions are publicly available and responsible. An IQA makes a judgement between storytelling and research. It is in the hands of the researcher to help the reader understand what the story means in some larger context (Northcutt & McCoy, 2004:17).

3.3.1.1.6 Degree of abstraction

- The IQA is in favour of the theory, both from the standpoint of inducing theory and testing it as a result of IQA's stance already discussed – pro-decontextualization and induction and deduction (Northcutt & McCoy, 2004:17). The definition of the mind map of an individual or a group is “a set of relationships from which hypotheses can be deduced” (Cambell & Stanley, cited by Northcutt & McCoy, 2004:7). The IQA is a theory in perception or the mental model of an individual or a group with regard to a phenomenon, instead of a theory forced by earlier findings or a researcher's own hypothesising (Northcutt & McCoy, 2004:17).

3.3.1.1.7 Properties of rigor

The above-mentioned interactions of the three beliefs and three values' outcomes are Northcutt and McCoy's definition of rigour or the truth value of research (Northcutt & McCoy, 2004:17). The following terms are used as properties of trustworthiness:

- Internal validity: "the extent to which variations in an outcome (dependent) variable can be ascribed to a controlled variation in an independent variable" (Lincoln & Guba, 1985:290);
- External validity: "the approximate validity with which we infer that the presumed causal relationship can be generalised to and across alternate measures of the cause and effect and across different types of persons, settings and times" (Lincoln & Guba, 1985:291);
- Reliability: synonymous of the words "dependability, stability, consistency, predictability, accuracy" (Lincoln & Guba, 1985:292); and
- Objectivity: This is usually played off against subjectivity (Lincoln & Guba, 1985:294).

When applying the before mentioned conventional paradigmatic or positivistic paradigmatic criteria to the "naturalistic paradigm" or constructive paradigm and in the light of a postmodern thinking, Lincoln and Guba (1985:294) concluded that they are inappropriate. They decided to change the terms from "naturalist" terms to more conventional terms:

- Credibility substitutes internal validity;
- Transferability substitutes external validity;
- Dependability substitutes reliability; and
- Confirmability substitutes objectivity.

Reflexivity was added as a final property of qualitative or naturalistic inquiry. Lincoln and Guba (1985:327) suggested that the reflexive journal is kept as a tool to indicate the extent of the inquirer's favouritisms which may have influenced the outcomes.

Trustworthiness can be a way in which the qualitative researcher can ensure that confirmability, dependability, credibility and transferability are evident in the research. Trustworthiness also includes the provisions of credibility to the writing when the researcher informs the readers of the process used in the research (Given, 2008:895; Saldana, 2011:136). Credibility of a study could be established by citing the key writers in related works in the literature review, specifying the analytic methods that the researcher used, verifying data analysis with the participants themselves, describing how the data was triangulated and the researcher can provide evidence

by quoting participants directly by including field notes from the data obtained (Saldana, 2011:135).

The IQA positions itself right between the properties of objective, internally valid, externally valid and reliable side and the more conventional terms confirmable, creditable, transferable, dependable and reflexive. Northcutt and McCoy (2004:17) pointed out that they do not disagree with the terms used by Lincoln and Guba (1985:292) about rigour, but they contend that concepts such as validity and reliability are still useful concepts, with different descriptions. Internal validity is defined by the IQA as “the extent to which a System Influenced Diagram (mind map) is consistent with the individual hypothesis comprising it”. The IQA defines external validity as “the extent to which mind maps constructed by independent samples of the same constituency on the same phenomenon are similar” (Northcutt and McCoy, 2004:17).

Regarding reliability, Northcutt and McCoy (2004:1) stated that they presented the same issue statements (a description of the phenomenon to be analysed) to subsequent associates of doctoral candidates for several years and “the mind maps so far are distinguished more by their similarity than their difference in terms of both the elements and their relationships among elements”. According to Northcutt & McCoy, the principles support constructs such as credibility, transferability and dependability and highlights concepts of validity and reliability through publicly, assessable and accountable procedures.

3.3.1.1.8 Ontological and epistemological bases of the IQA

The elements that were previously mentioned described the research and setting of the IQA’s “ideology of research” and are not just a list, but are interactions between each other in meaningful ways. The elements of one’s belief system forms the ontological (showing the relations between the concepts and categories in a subject area or domain) base and they are:

- The relation of knowledge and power;
- The relation of the observer to the observed; and
- The object of research or the “thing” to be investigated.

"The ontological position of the IQA is consistent with a postmodern critical paradigm and acknowledges the power relations between the researcher and the participants; the participants and not the researcher are regarded as authorities on the *self-management of students living with DM* under investigation" (Van Biljon *et al.*, 2015:439) (words in italic are the researcher’s own addition).

This then forms the basis for the system of epistemological values of the preferences for “ways of knowing”. These three elements are:

- Level of abstraction;
- Level of description; and
- Primary logical operation.

Van Biljon *et al.* (2015:440) stated that “the epistemological basis of the IQA is social constructivist as it recognises that people know their world through the social construction of meaning. Both deduction and induction are considered necessary to the investigation of meaning and therefore participants are asked to induce meaning and then to define, refine and investigate the relationship of influences among the categories”.

3.3.2 Rigour and the nature of qualitative research

Rigour is formed as the seventh element when the beliefs and values from the previous section interact. The meaning of rigour is very personal and depends on the ontological and epistemological system of the researcher (Northcutt & McCoy, 2004:18)

There is a very specific position that the IQA takes regarding rigour. There are three questions that the activity of an IQA research answers regarding systems (Northcutt & McCoy, 2004:38). The IQA uses rigour that refers to procedures for data collection and analysis that:

- Are “public and non-idiosyncratic”;
- Are “replicable within reasonable bounds”; and
- “Do not depend on the nature of the elements themselves”.

This means that two different analysts can present with similar set of focus group data and will produce systems representations or mind maps that are topologically identical by adhering to the guidelines for rationalisation irrespective of the predispositions of the analyst or the meaning of the elements. Northcutt & McCoy (2004:38) concluded that rigour is achievable in qualitative analysis, it is relevant, and it is a good thing.

The IQA allows the participants to identify both the elements and relationships between the elements themselves. Guidelines for realisation and guidelines for visual representations may produce three different versions for each system:

- Cluttered representations that are low in simplicity and high in complexity;
- Uncluttered representations that are low in complexity and high in simplicity; and

- Clean representation that is high in simplicity and the complexity is only presented in the background (Northcutt & McCoy, 2004:38).

3.3.3 Understanding systems

Systems in the IQA have two components. They are elements and relationships amongst the elements. These elements can be mathematical constructs, physical objects or categories of meaning (Northcutt & McCoy, 2004:27).

The following aspects are required to understand the systems (Northcutt & McCoy, 2004:28):

- Identifying the elements of the system;
- Describing the relationships among the elements;
- Understanding how the elements and the relationships dynamically interact to result in different states of the system which implies -
 - Interpretation of what is the nature of the system;
 - Intra-systemic inferences: what are the logical effects of changes of state of some element on another; and
 - Extra-systemic: analysis of the effects of outside influences on the system.

If only a single system exists, as in this study, then only two research questions are possible:

- What are the components of the system; and
- How are the components related to each other (Northcutt & McCoy, 2004:28).

The questions are in a specific sequence and need to be answered in this sequence.

IQA research is an activity that can answer at least one of the research questions. Once the elements are defined in the system, and once the nature of the relationships amongst the elements (arrows or direction) are clarified, systems vary mainly only in their structure, which is composed of two features, namely, branching and recursion.

Systems are organised or rationalised according to different sets of rules for the purposes of research. A topological zone is an area in a system where the elements can have the same characteristics of influence. Elements can also be called relative drivers and outcomes. The driver is an influencer or a relative cause and has more arrows going out than coming in and has a contradictory outcome (as seen in Figure 4-4).

There are typically four topological zones. Primary drivers have arrows out, but no arrows coming in (the influencer) and primary outcomes have arrows coming in and not going out (result).

Secondary drivers have arrows coming in and going out. The secondary drivers have relatively more arrows going out than coming in and again are a secondary outcome the converse (Northcutt & McCoy, 2004:32).

The topology of the system points to the pattern of relations between the elements of the system. If no link between the patterns is broken or changed then transformations to a system do not change their essential topological character.

3.3.4 Discussion of rationalisation

Rationalisation in the IQA refers to a set of rules that are not dependent on the nature of elements of the system and where the elements are initially arranged into topological zones and are then linked by the lowest quantity of relationships consistent with the data collected (Northcutt & McCoy, 2004:37). There are specific goals to rationalisation:

- Comprehensiveness: where all the elements related to the phenomenon are identified;
- Complexity: the system should represent a fair complexity of the phenomenon represented by the degree of interrelationships among elements;
- Parsimony or simplicity: the principle that all other things being equal, the simpler of two representations is better and that good systems are successful trade-offs between complexity and parsimony; and
- Visual interpretability: the final representation in the IQA is a diagram or a picture.

The rationalisation of the IQA does not disturb the basic topology of the model and does not degrade the essential nature of the system even though some of the representations can look different.

3.3.5 The IQA systems

The IQA systems are social systems and can be defined as systems where human interpretation of meaning is involved (Northcutt & McCoy, 2004:41). Social systems also compose of elements and relationships where the relationships are the relationships of perceived cause and effect or an influence amongst the elements. The IQA systems describe the elements and the relationships of the social system in a way that describes the patterns of influence among the elements. The final product of the IQA study gives a visual representation of a phenomenon arranged according to rigorous and replicable rules for attaining simplicity, complexity, interpretability and comprehensiveness (Northcutt & McCoy, 2004:41).

3.3.6 The research's IQA "footprint"

The responsibility of the researcher is threefold and can be compared to a person stepping on fresh virgin soil making footprints as he/she walks according to a metaphor used by Northcutt and McCoy (Northcutt & McCoy, 2004:44):

The responsibilities of the researcher as seen by Northcutt and McCoy are:

- To "interpret";
- To "ensure that the ground of interpretation provides as much epistemological traction as possible"; and
- "Tread softly".

When the initial question regarding the "problem" enters the mind of the researcher, the "tracks will start to become visible on the new parcel of land". The IQA provides a set of data collection and analysis protocols that are intended to minimize the erosion caused by the researcher. A framework is provided and then the participants have a great deal of freedom that is provided by the researcher in discussion with the knowledge of the participants. It is in the hands of the participants to perform the first steps of analysing when they organise their focus group discourse into categories of meaning, termed affinities, and the participants then take the second step to present their individual supposed relationships of influence amongst these affinities. This process minimizes the bias and influence of the researcher.

The responsibility rests on the researcher to design a process and create an environment that invites the group of participants (members of the same constituency) to create the most data while minimizing the effect of the process on the content of the data obtained (Bargate, 2004:12). The facilitator will teach the participants the process and guide them to produce and analyse their personal data with minimum influence from the researcher and facilitator (Northcutt & McCoy, 2004:44).

3.3.7 System elements as affinities

The IQA data-collection and analysis techniques were derived from the Total Quality Management (TQM) techniques (Northcutt & McCoy, 2004:81). The TQM was designed to capture knowledge from participants in an organisation to solve problems and to enhance industrial processes. The most important assumption from the TQM is that the people nearest to the job have the greatest idea of what is incorrect and what the solution to the problem is. This is important to the IQA. The techniques for data-collection in the IQA assist the participants nearest (distance) to the phenomenon of interest to describe and label their experience.

The IQA intends to reach an outcome to produce an individual theory of perception or a conceptual map in the case of an individual interview, or a collective conceptual map (composite) in the case of a focus group of all the participants. The conceptual map is a systems representation of how an individual or group understands the specific problem. The system comprises of affinities (or categories of meaning) within the perceived perceptual relationships of the group (Northcutt & McCoy, 2004:81).

3.3.8 Affinities compared to variables

Affinities are compared to the variables of quantitative studies to a certain degree (Northcutt & McCoy, 2004:82). Affinities and variables are both homogenous. Both terms are reflections of one thing or a construct and both have range. An affinity must have a range of meaning to be useful; as a variable must be in the limits of practicality; and there should be only one unit of analysis. “An affinity should be about people, apples, or alligators, but not people, apples, and alligators” (Northcutt & McCoy, 2004:82).

There are differences between affinities and variables as well. Affinities are “looser” than variables, but more “robust” and do not have many “problems” with the strict rules of operationalisation and measurability. Variables are limited by the need to be operationalised. Variables may be lesser signified, because they contain too little of the construct to be significant or contain too much of other constructs that they have little to do with the signified. Affinities are richer and more meaningful because they are created by the words and thoughts of the participants close to the phenomenon (Northcutt & McCoy, 2004:81).

Affinities also have the ability to represent dialectical unities when in a system consisting of relationships in contrast to variables that consist mostly of bipolar monotonic constructs (Northcutt & McCoy, 2004:83).

3.3.9 The IQA and theoretical coding

The IQA's purpose is to draw a representation of the system using the System Influences Diagram (SID) that embodies the perceptual terrain or the mind map of a group with respect to the phenomenon that was presented by the issue statement. The SID is a representation, drawn up by means of rules that are set for rationalisation, as a summary of the theoretical codes called Interrelationship Diagram (IRD) as formed by the participants. Theoretical coding is used to ascertain the perceived cause and effect relationship (influences) amongst all the affinities in a system (Northcutt & McCoy, 2004:14).

All the conceivable direct relationships between affinities are investigated by developing a hypothesis grounded in the data. The IQA provides the participants with a formal protocol to decide if there is a direct influence between each of the probable pairs of affinities in the system and if the participant determines the direction of the influence. An underlying structure is identified for the groups mind map and then gets drawn up in a SID (Northcutt & McCoy, 2004:27).

3.3.10 Relationships between affinities

Three different relationships are identified between any two affinities. Either A can have a direct influence on B; B can have a direct influence on A; or there can be no direct influence between A and B. The rules for hypothesising are summarised as follows (Northcutt & McCoy, 2004:21):

For any two affinities A and B there are either:

$A \rightarrow B$ (where A can influence B directly)

$A \leftarrow B$ (where B can influence A directly)

$A \leftrightarrow B$ (where there is no relationship)

For this the participants do not decide the strength of the relationship, but merely identify the presence as well as the direction of the relationship.

3.3.11 Pareto Principle and the Pareto Protocol

The Pareto Principle is essentially applied in the IQA and states that a small number of the relationships in any system will justify most of the variation within the system. The Pareto Principle is named after Wilfredo Pareto (1843-1913), a 19th century economist, who was the writer of the trivial many and the significant few in his analysis of productivity and economics. When used in a systems term, “20% of the variables in a system will account for 80% of the total variation of the outcome” (Northcutt & McCoy, 2004:330).

The Pareto rule of thumb gets used in the IQA to reach agreement and to analytically produce a statistical complex. The total number of votes for every relationship was calculated and the cumulated percentage for each relationship was calculated. These cumulative frequencies have two purposes:

- Determining the optimum amount of relationships compromising the composite system (the least amount of relationships presenting the highest amount of variation); and
- Helping to resolve unclear relationships that attract votes in either direction.

The Pareto Protocol with Min/Max criterion is used as a protocol to construct a composite Systems Influence Diagram from individuals' Affinity Relationship Tables (ARTs). The ARTs are used because individual participants may have defined relationships between the affinities in a system differently and may not agree about the direction of a relationship (Northcutt & McCoy 2004:331). In the ART, only one relationship can be used. The relationship with the maximum frequency was used in the SID assignments protocol. The other relationships have a significant impact on the system and will be reconciled according to the Pareto Protocol (Northcutt & McCoy, 2004:331).

In the next section, the researcher will give an overview of the IQA process that was followed in the study. A detailed version of the IQA methodology can be found in Chapter 4. Personal permission was granted by Dr Danny McCoy via email, to approve the use of the manuscript. The researcher describes the methodology of the study by giving a basic theoretical background for each phase of the research and the application of the methodology by the researcher.²

3.4 Methodology for this investigation

The IQA process that was used in this study only consisted of a single focus group to describe the perceptual systems of the self-management of students living with DM on campus. Every process that was mentioned in sections 3.4 - 3.4.12 has a specific protocol as well as a set of documents that were developed by Northcutt and McCoy. All these protocols were used by the researcher in this study.

The next sections will describe the research flow as used in this study.

3.4.1 IQA research flow

The IQA methodology as described by Northcutt and McCoy (2004) was slightly adapted to fit the study as follows:

- Phase 1: The IQA research design provided a series of tools to assist the researcher by articulating the problems of interest that were investigated, the identifying of constituencies that had an interest in the problem and proposed research questions from the problem statement;

² Footnote: If the reader is still interested in more information, the reader is referred to the aforementioned book of Northcutt and McCoy. The book gives detailed descriptions, explanations, motivations and applications of the IQA as methodology. The researcher made use of most of the resources in the different phases of the study. There was contact made with one of the authors, Dr Danny McCoy and he provided more recent and updated versions of the original tables and documents than those used in the original book. Permission was granted to the researcher to make full use of the unpublished material

- Phase 2: The focus group was used to identify affinities of the system that will present the experience of the group with the phenomenon;
- Phase 3: The IQA report was the final phase and gave the researcher the opportunity to describe the affinities and their relationships in the words of the respondents and to make predictions for the study or inference based on the properties of the system.

The flow of the study can be seen in Figure 3-1.

The IQA research flow

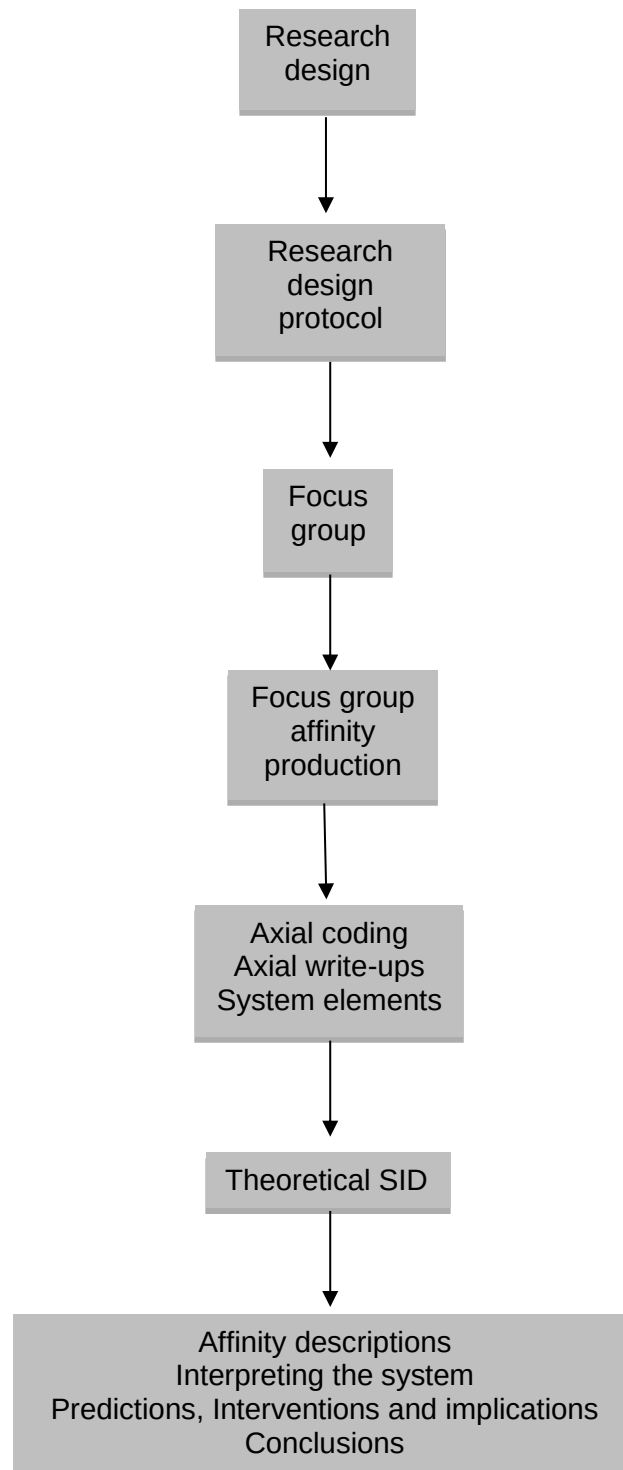


Figure 3-1: The IQA research flow

3.5 IQA phases

It is important to understand that the IQA methodology demands that the first phase be completed before the next phase of the methodology can continue. The first phase in the IQA methodology is the IQA research design. The first phase was done before the proposal was completed.

In this study, the IQA method consisted of three phases which formed part of the IQA research flow (Northcutt & McCoy, 2004:44). The following sections will focus on each phase in the IQA methodology.

The results of Phase 1 were already described in Chapter 1 (section 1.5.3), thus, the next section will only consist of a brief review of the IQA research flow used in this study.

3.5.1 Phase 1: IQA research design

The first phase of the IQA research flow was the IQA research design, which was a structural component of the IQA research flow. This was the researcher's initial step to conceptualise the study.

The IQA research design offers a series of tools to support and articulate the problem to the researcher. It helps to identify constituencies to take part in the focus group, and to state a research question which is applicable to the problem statement. A process of recursion (as seen in Figure 1-1) was used to develop the research design and each step was repeated until the researcher was satisfied with the answers to the question that has been asked (Northcutt & McCoy, 2004:61):

- **Problem:** The problem reflected an observation or a concern that the researcher found interesting. The problem seeks “how” and “why” answers.
- **Constituencies:** members of the constituency were someone who had something to say about the phenomenon or could do something about the phenomenon.
- **Comparisons:** The comparisons between constituencies generated research questions.
- **Phenomenon:** The phenomenon was an idea that could produce a system with elements and relationships. The elements and relationships could describe the phenomenon and how it works.
- **Issue statement:** The issue statement was a meaningful, but simple question that must have been meaningful to each constituency. The issue statement was the question that got the participants to speak about the phenomenon.
- **Research question:** There were three universal research questions associated within the IQA but only two was asked in this study. These questions were:

1. What are the elements that make up the phenomenon?
2. How do these elements relate in a system of influence?

The researcher continued with the cycle of recursive interaction between induction and deduction until the researcher was satisfied with the outcomes of the cycle (Table 1-1). Northcutt and McCoy (2004:61) called the recursive IQA design process a formalised version of what is known as critical thinking.

Before the researcher started with the initial proposal and administrative steps of the research process, he first followed the first stage of the IQA research flow to conceptualise this study.

The IQA research design, as seen in Figure 1-1, consists of six elements that will now be discussed in the following sections.

3.5.1.1 Problem

The IQA research started by dealing with the problem. The problem was a vague concern, a desire to know more about a phenomenon, an issue of interest that needed clarification in the mind of the researcher. There was no solution yet as the problem has not yet been completely identified (Northcutt & McCoy, 2015:46).

An intuitive thought process was used by the researcher in contemplating the problem (inductive) (Northcutt & McCoy, 2004:73).

The method used by the researcher was to follow the IQA research design protocol to identify the problem (Northcutt & McCoy, 2015:10). The following elements of the IQA research design protocol was used to develop a result:

- Scenario;
- The role of the researcher, purpose of the study and readers or users of the study results; and
- Problem question, domain and potential causes or successes regarding the problem.

3.5.1.2 Constituencies

The IQA research design process seeks to identify any possible comparisons of constituencies that understood the phenomenon as the comparisons developed the research question. The basic question in deciding which constituencies to compare was: "If you as researcher can talk to only one group, who will you talk to?" (Northcutt & McCoy, 2004:78). In this study only one group

was used and there was only one constituency. This was an explorative study towards the phenomenon and therefore there will be no comparisons.

The IQA methodology assists participants of a group close to a phenomenon to solve problems. The participants described and labelled their experiences of living close to the phenomenon. The participants articulated their perceived relationships among themselves before the mentioned experiences were used to produce a collective conceptual map. The collective conceptual map is “a systems representation of how an individual or a group understands a phenomenon”. The system has categories of meaning which are called affinities and the perceived casual relationships between the affinities (Northcutt & McCoy, 2004:81).

There were two questions the researcher had to ask to recruit a group of individuals who have a communal understanding of the problem (Northcutt & McCoy, 2004:46; Northcutt & McCoy 2015:9):

- How close (distance) is the constituency to the problem (has something to say about the phenomenon); and
- How much power does the constituency have over the phenomenon (can do something about the phenomenon).

3.5.1.3 Phenomenon

The phenomenon in this study was identified as “Self-management in students living with diabetes mellitus”. After finalising the phenomenon, the following sections are discussed:

- Constituency and phenomenon;
- Locations of events; and
- Range of time.

3.5.1.4 Compiling the research question

Research questions were presented in a specific order. The order was to first answer the first research question that identifies the elements and then identify the relationships between the elements (affinities). If the elements were not identified the second question could not be answered (Northcutt & McCoy, 2004:46). Only one constituency was identified and thus only two questions were answered from a systemic point of view:

- What are the elements that make up the phenomenon; and
- How do these elements relate in a system of influence?

The research questions, identified by using the research design, were:

- What are the perceptions of self-management of students living with DM on campus; and
- How do the components of these perceptions of self-management of students living with DM on campus relate?

3.5.1.5 Issue statement

The issue statement that was formulated was presented to the constituency in a term that they understand. The issue statement was the question the focus group facilitator asked to the students (participants) regarding the phenomenon at the outset of the focus group. Once the research question had been identified, the researcher had to formulate a question that would be asked to the constituencies (Northcutt & McCoy, 2015:10). The issue statement needed to be meaningful for each constituency and it needed to be fairly simple and was a variant of: "Tell me about the phenomenon".

3.5.1.6 The final answer

The IQA research design is a non-linear process that has a recursive nature. This design allows a successive refinement of each of the elements of the cycle (Northcutt & McCoy, 2004:46).

The research questions were tested for adequacy against two criteria (Northcutt & McCoy, 2004:46):

- If the student answers these research questions, what purpose will be served (what the problem statement is addressed by these questions); and
- Is the answer to the first question satisfactory to me (is the problem that we ought to be addressing)?

The IQA research design was completed when the answer for the second question was confirmed and affirmative. The cycle recurred in the early stages until the answer is yes.

The final answer for the research design protocol for the researcher was "What is your experience as a student living with DM on the NWU-Potchefstroom campus?"

The result of the first phase was then used in the IQA research design protocol. The IQA research design protocol was used in the focus group phase (Phase 2). In the following section the focus group phase will be discussed.

3.5.2 Phase 2: Focus group

The second phase of the IQA process was the IQA focus group. The focus group was formed by individuals who shared a common experience and lived in a common structure and had the same background regarding living with DM. They may have had different opinions and experiences with the system being studied but they shared a common perspective (Northcutt & McCoy, 2015:14). The main concept of IQA was to allow the participants of the constituency to define their meaning and the range of affinities of the phenomenon and to articulate how these affinities are linked in their perception of the phenomenon (as seen in Chapter 4) (Northcutt & McCoy, 2015:18).

The IQA focus group process was intended to identify affinities or themes pertaining to the phenomenon. The process is defined as dumping all the thoughts generated by the participants of the focus group by writing the thoughts on cards, clumping the thoughts on the cards in clusters of similarities and then naming the groups of thought in the group (Northcutt & McCoy, 2015:14).

The focus group was designed by the researcher in line with the guidelines given by Northcutt & McCoy (2004:85).

- The participants were information rich, having knowledge of and experience with the issue;
- The participants could reflect on the question and could transfer those views into words;
- The participants had the time and inclination to partake in the study;
- The participants were homogenous with respect to vital dimensions of distance and power; and
- They respected and practised group dynamics, i.e. they were neither overpowering nor too timid to speak (Northcutt & McCoy, 2004:90).

The focus group was then used to identify affinities of a system that presented the group's involvement with the phenomenon. It was the purpose of the IQA study to determine how a focus group represented their experiences in a system of cause and effect (Human Vogel & Van Petegem, 2008:458).

3.5.2.1 Icebreaker

The focus group started off by the facilitator providing an opportunity for the participants to know each other, and to serve as an ice breaker. Each participant, the facilitator, researcher and supervisor had an opportunity to introduce themselves and give a few facts about themselves. The protocol that was used in the focus group is set out in Chapter 4.

3.5.2.2 Warm-up exercises

The importance of the warm-up exercise was to clear the mind of all thoughts and to focus on the issue at hand. Guided imagery was done when the facilitator presented the issue to the group and gave them time to think about the topic by engaging themselves in the warm-up exercise (Northcutt & McCoy, 2004:89).

3.5.2.3 Silent nominal brainstorming

The facilitator invited the participants of the group to participate in a brainstorming session. The group process encourages maximum production of feelings, ideas and individual thoughts, but it also created a coherent group construction unlike the individual realities.

Each participant silently wrote down thoughts on an index card. The group got a short time to write down these thoughts in short phrases, diagrams or single words that came to mind on this issue statement. Each participant wrote down as many thoughts as possible (as seen in Chapter 4: Table 4-8) (Northcutt and McCoy, 2004:91).

The focus was on the brainstorming in silence and privacy of the participants. This reduced undue influence from the other group members and the facilitator. The silence prevented hierarchy in the group and one participant dominating the discussion. Each individual's thoughts were authentic (Northcutt and McCoy, 2004:91).

3.5.2.4 Clarification of meaning

After the silent brainstorming, each participant taped the cards in rows and columns where the group could view them. The facilitator guided the participants in the group discussion to clarify their understanding of each card.

The process continued as the facilitator read each of the cards, aloud, to the group. Each participant then reflected on their thoughts to achieve clarity and consensus on the meaning of each thought. When the cards got read out, the participant that wrote the card stayed anonymous in the group. Any participant in the group could now offer an opinion about the meaning of a thought.

The group could also add reflections and thoughts to the original word on the card. This process ensured that the thought on the cards reflect the individual's thought and the shared experience of the group.

3.5.2.5 Affinity grouping (Inductive coding)

The participants were asked to silently evaluate the cards and to start grouping them into comparable affinities. The participants silently grouped the cards and the cards could be moved a few times if a participant felt that a certain card belonged to another group. The cards were moved and categorised until the group felt that the categories have been set. Inductive coding is used in the IQA, because the term refers to the logical operation that is involved in the early stages of analysis. Inductive coding seeks to identify affinities.

3.5.2.6 Affinity naming and revision (Axial coding)

The facilitator then assisted the group in naming each of the affinities. The group could also divide the categories into subcategories and label each subcategory. This process categorised the data into themes called affinities.

The axial coding of the groups seeks to name, reorganise, clarify and refine the affinities. In inductive coding, the focus is on being inductive. The axial coding phase of the focus group cycles around from inductive to deductive. The affinities and their meanings narrowed down and reorganised through the participants. The main affinities could be reviewed and could be combined with another affinity or could be divided into subcategories.

The process of axial coding is achieved through group discussions and agreeing to a statement. The group discussed and defined the affinities till each affinity was defined accurately and agreed upon by each participant. Each affinity received a title that best defined the group and got put up as a header above the category of cards (example in Figure 3-2).

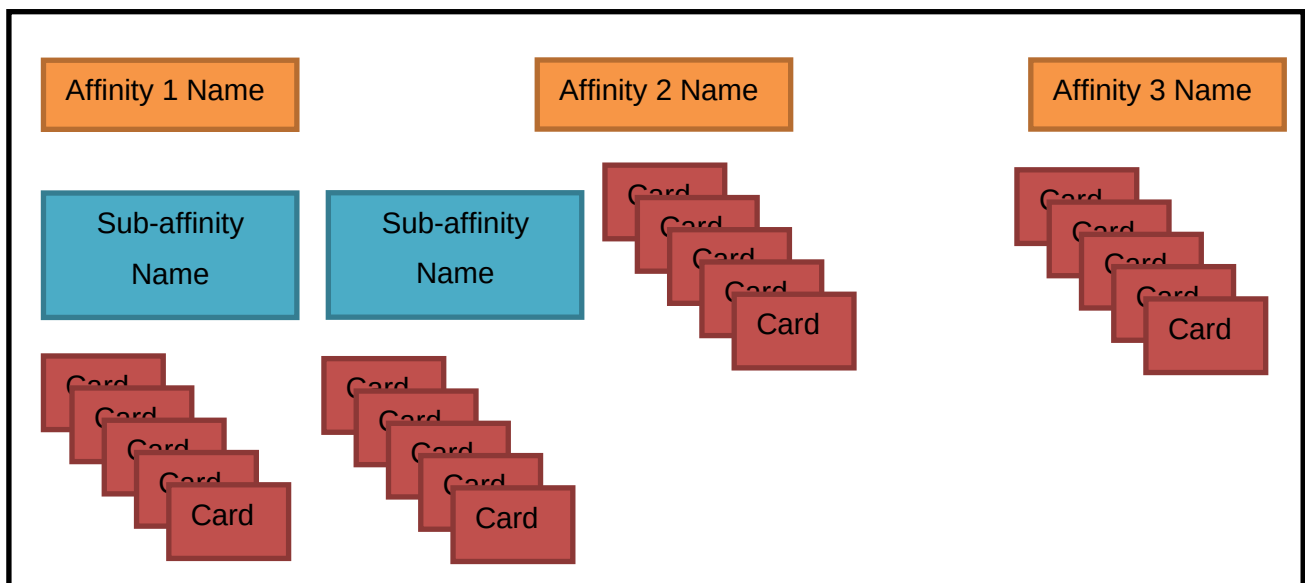


Figure 3-2: Example of affinity naming process for an IQA focus group (Northcutt & McCoy, 2015:17)

3.5.2.7 Ethical considerations

3.5.2.7.1 Anonymity

This qualitative study made use of a focus group. This means the researcher knew who the participants were and in the focus group all the participants saw each other and were involved in the sharing of their personal experiences. The participants were asked to refrain from giving away each other's information. All names were omitted in depicting of the data and thus anonymity was kept.

3.5.2.7.2 Confidentiality

In the focus group, each participant was informed that their current situation and information will be shared among the participants. When they signed the consent form, they agreed to keep the identities and information of the other participants confidential. In a focus group, the participants shared information about themselves and the experiences they had. Within the consent form the information that was required from the participants and the use of the information was stipulated. This helped them to understand that confidentiality is important. When the participant signed the document, they consented to the use of their information which they provided and to keeping another participant's information confidential.

3.5.2.7.3 Benefit-risk ratio analysis

For this study, **the benefits outweighed the risks**. The risk of harm was reasonable to the importance of the anticipated knowledge that was gained. **This study was regarded as medium risk**, since the research included participants that experienced potential risk, harm or discomfort. Appropriate steps were taken by the facilitator and researcher to minimise risk.

3.5.2.7.4 Anticipated risks and precautions

Precautions were taken when working with the participants to have few or no risks in the study. These are summarised as:

- It was time consuming for the participants, but the focus group was only held on one day, a Saturday;
- A four-hour period could have led to hunger, but there were diabetic friendly refreshments available;
- There needed to be order and concentration during the focus group, group rules were given at the start of focus group;
- Confidentiality and anonymity of the participants' information, written consent and verbal agreements were made for the participants to keep all identities confidential;
- Emotional aspects that could arise in the study, a psychological facility on campus was available at all times.

3.5.3 Phase 3: IQA Report

This is the final phase of the IQA process. The typical IQA report that was compiled for this study accomplished two goals:

- Naming and describing the elements of the system; and
- Explaining the relationships between the elements of the system.

There are two main parts in the last phase of the IQA. They are the results and analysis and interpretations and implications that will be discussed in the following sections.

3.5.4 Results and analysis

3.5.4.1 Composite System Influence Diagram (SID)

3.5.4.1.1 The Composite SID Assignment Protocol

According to IQA protocol, a picture of the system was drawn, namely the Systems Influence Diagram (SID) that represented the perceptual terrain or the mind-map of the group that correlated with the phenomenon represented in the issue statement (Northcutt & McCoy, 2004:251). Using the rules for rationalisation, a SID was drawn of the summary of the theoretical codes called an Interrelationship Diagram (IRD).

3.5.4.1.2 The Composite Cluttered SID

A composite cluttered SID was drawn up of the focus group and contained all the possible links between the affinities. The SID was comprehensive, rich and saturated with links. This form of the SID was hard to read because of all the links and the descriptive power of the system. The system got caught up in details of the relationships. The objective of the SID was to produce and represent a comprehensive and rich system but also to create a need for parsimony. To solve the richness-parsimony dialectic an uncluttered SID was developed that had all the redundant relations removed (Northcutt & McCoy, 2004: 329).

An uncluttered SID is the method to resolve the richness-parsimony dialectic system and remove all the redundant links. The cluttered SID is extremely rich in descriptive capability, but parsimony is an objective for the SID. The uncluttered SID is the simplest representation consistent with all the relationships containing in the IRD.

3.5.4.1.3 Pareto reconciled SID

Because the individuals might have defined relationships between affinities in the system differently, they also could have differed on the direction of the relationships (Northcutt & McCoy, 2015:33). The Pareto Protocol with Min/Max criterion provided a protocol to build a composite SID. After all the redundant relationships were removed, the Pareto Protocol was used to see if any conflicting directions of relationships needed to be added. The conflicting relationships occurred between affinities where the same affinity pair had equal relationships in both directions. Only one relationship could be used in the ART so the relationship with the highest frequency was used. The Pareto Protocol was reconciled with the other relationships as each relationship has a big impact on the system (Northcutt & McCoy, 2004:331).

The Pareto rule of thumb gets used in the IQA to reach consensus and to analytically produce a statistical composite. The number of “votes” for each relationship is calculated and the cumulated percentage for each relationship is calculated (Northcutt & McCoy, 2015:34). These cumulative frequencies have two purposes:

- Determining the ideal number of relationships compromising the composite system (the least number of relationships presenting the greatest amount of variation); and
- Helping to resolve unclear relationships that attract votes in either direction.

3.5.5 Interpretation and implication

This section contains the second part of the IQA report phase, as well as the final phase of the IQA process. The IQA study proceeded from the descriptions of the affinities given by the participants to the participants’ cause-and-effect relationships amongst affinities that were used to draw up a system to illustrate the relationships. The researcher described the composite system with a walk-through of the system drawn up; a description of the placement of the affinities; highlighted feedback loops; and exercised the model. The researcher went on to make further predictions and impose on interventions of the system and described practical implications where solutions were provided for identified problems. The researcher revisited the literature to search for results, theories of thought and other sources to inform the findings (Northcutt & McCoy, 2004:302). The researcher finished the chapter with conclusions and recommendations for further studies.

- Interpretation of the system

The interpretation was done for the constituency from the system named students’ perception on their self-management of DM.

- A walk-through of the system

There was a visual system accompanied by a brief tour of the system found in the study (Northcutt & McCoy, 2004:333). The uncluttered SID was used in the walk-through.

- General description of the system

A general description of the composite system of the individuals’ ART where the system is explained in terms of the position of each affinity and the relationships thereof in relation to the other affinities.

- Feedback loops, zooming and naming

The researcher looked for an opportunity to give different views on the system by highlighting and viewing the system from a close view and an afar view. The feedback loops gave the researcher a zoom in-view and a zoom out-view from the participants' and the researcher's view respectively. In the process of zooming, a name was given that substituted the names given for the individual components of such a loop (Northcutt & McCoy, 2004:335). These feedback loops were given names and the dynamics of the loop was explained and discussed. In the case of a negative feedback loop, a way to escape was discussed.

- Exercising the model

The researcher was enabled to see the given conditions of the drivers and could examine what the predicted result would be. Firstly, a prospective scenario was developed (forward scenario). Secondly, a retrospective scenario (backward scenario) was developed by assuming the conditions of the results, and then by examining the model to see what the conditions of the drivers would produce and could be. Thirdly, a scenario could be created in the case where external influences were created which were not mentioned and were not part of the system (Northcutt & McCoy 2004:301, 343).

- Practical implications of the model

Possible problems were identified, and the researcher provided solutions to the problems.

- Revisit the literature

The literature was used to investigate how other studies described the affinities identified in the focus group.

3.5.6 Selection of IQA as methodology for this study

The researcher wanted to investigate the perceptions of students living with DM regarding their self-management in a tertiary environment. The IQA as a qualitative method was selected in this study to get previously unknown data in South Africa from the participants. The IQA makes use of a unique investigation process. This process entails a research design and a data collection tool with emphasises on analytical and interpretational possibilities within a systematic process which led to the selection of this methodology for the research. Use of the IQA method with its various protocols and rigorous application creates a platform for this study to be explored in future studies.

Important theoretical aspects of the IQA as a methodology were discussed in this section for the reader to understand the basic concepts. In the following section the overview of the IQA methodology will be discussed as it was used in this study.

3.5.6.1 A retrospective and prospective review of the study

In the last section of the investigation of the study, the researcher employed a retrospective and prospective overview and formulated a summary and highlighted possible limitations for this study. Future directions through possible research problems were identified and the study was ended by the researcher's final conclusion.

In Chapter 4 the results of this study are presented by the researcher.

CHAPTER 4 RESULTS OF PERCEPTIONS OF THE SELF-MANAGEMENT OF STUDENTS LIVING WITH DIABETES MELLITUS

4.1 Introduction

In Chapter 3, the methodology was described. A broad explanation of each step followed during the IQA was set for the reader to get a clear understanding of the IQA methodology and to understand what the results indicate. This chapter will explain the results regarding the perceptions about self-management of students living with DM on campus to the reader in the form of a mind map. The first question raised in Chapter 1 (see section 1.5.3.1) was answered in the literature review in Chapter 2. The second question from Chapter 1 (see section 1.5.3.2), was the empirical investigation, namely, what are the components of the students' perceptual system of their self-management living with DM? The empirical investigation will be looked at in this chapter.

The affinities were constructed by the participants in the focus group. The researcher then recruited more individuals, presented them with the formulated affinities and asked them to draw up their own relationships in the ART for a wider and more detailed view of the phenomenon.

The affinities were developed as described by the participants in their own words. The IQA was designed to use only the perceptions of the participants on the phenomenon as described by them or their lived experience and reality. The group of participants were the best source for describing their lived experience (Northcutt & McCoy, 2004:314).

4.2 Research design protocol results: Phase 1

The IQA research design was developed by the researcher in Phase 1 of the IQA research flow (as seen in section 3.6.1). The IQA research design was completed before the start of the other phases of the IQA research flow, but the IQA research design is seen as a result and thus it is reported in Chapter 4. The researcher established the problem statement, identified the possible constituencies, formulated the phenomenon with the research questions and from this described the issue statement. The results for the IQA research design of this study can be found in Table 4-1. In this study there was only one constituency and thus no comparison was formed between different constituencies. The one constituency will now be discussed.

4.2.1 Problem statement

The problem statement was developed by the researcher using the method discussed in section 3.6.1 (Northcutt & McCoy, 2015:8; Northcutt & McCoy, 2016b). The problem statement can be seen in Table 4-1.

Table 4-1: IQA Research design protocol for students' perceptions of their self-management living with DM on campus: Problem statement

Problem	
Scenario	
DM is raised blood sugar which is related to low or no insulin secretion and either a concurrent impairment of insulin action or no concurrent impairment of insulin action (Nolte Kennedy, 2012:743). DM "is a general term for heterogeneous disturbances of metabolism for which the main finding is chronic hyperglycaemia" (Kerner <i>et al.</i>, 2014:384). "Self-management has been defined as an ability and process that individuals use in conscious attempts to gain control of his or her disease" (Richard & Shea, 2011:261). According to Haas and Maryniuk (2014:144), DM self-management is vital to the care of patients with DM and to those at risk of developing the disease. The importance lies in the prevention and delay of the complications of diabetes. Not everybody knows what it is like to have a chronic disease. Subsequently, most people do not know what a person has to endure daily to live a "normal" life. In South Africa, diabetes is accountable for 5.4% of deaths (Lehohla, 2017). According to Lehohla, DM is second on the list of causes of death in South Africa. It is therefore important to focus on diabetes in South Africa.	
Role of the researcher	Purpose of the study
○ Academic research ○ Graduate Student	○ Academic research ○ Dissertation ○ General understanding of a problem
Readers/Users of the study results	
○ Dieticians will be able to create a menu specifically for diabetic students to choose from in the cafeterias. ○ Lecturers could read the article and work out a way with their faculty to accommodate the students during class-time. ○ Pharmacists could read it to enhance their knowledge of diabetes patients and how to help them with self-management. ○ The researcher can use it for further studies and to enhance his knowledge on the problem. ○ Students in the field of medicine can read it for more information on the disease. ○ Students with diabetes can use it to learn more on the self-management of their disease.	

Problem question
○ What are the factors that influence the self-management of students living with DM in a University environment?
Domain
○ Students with T1DM or T2DM on the NWU Potchefstroom campus.
Potential causes of the Problem or Success
○ The student with DM experiences pain when injecting him/herself with insulin. ○ Feeling uncomfortable when having to inject him/her with insulin in public places. ○ Forgetfulness to adhere to medication usage. ○ Too busy to eat healthy per their disease and to even eat at all. ○ Too busy to exercise through the day. ○ Not enough healthy food on campus ○ Pharmacists do not inform him/her on self-management of their diabetes. ○ Lecturers are not informed of the students with diabetes and how to accommodate them during class. ○ The lifestyle of some diabetic students is not up to standard for a diabetic student. ○ The new timetable does not make time for lunch. ○ Full timetables and stress of following the timetable lead to students being unable to cope, take time to eat and take insulin.

4.2.1.1 Scenario

The first step in the IQA research design protocol, a scenario of the researcher's perceptions and knowledge of the "problem" of the probable self-management of students living with DM on campus was written down (Table 4-1).

4.2.1.2 The self-management of students, purpose of the study and readers/users of the study results

The purpose of the study was to conduct research and to complete a master's thesis to create a general understanding of the problem. The possible readers or users of the research can be seen in Table 4-1.

4.2.1.3 Problem question, domain and potential causes or successes regarding the problem

The question to articulate the problem was identified and the domain of where the study would take place was identified. The possible causes and successes were identified by the researcher and can be found in Table 4-1.

4.2.2 The identification of the constituency

The identification of a constituency was the next step. The identified constituency can be seen in Table 4-2. There was only one constituency used by the researcher in this study. The constituency was students living with T1DM or T2DM on the NWU Potchefstroom campus.

Table 4-2: Research design protocol for students' perceptions of their self-management living with DM on campus: Constituency

Constituency		
Constituency	Distance (close to far)	Power (High to low)
Individual		
Students living with DM on NWU-Potchefstroom campus.	Close	Medium

When selecting a constituency, the researcher needs to look at two questions before selecting the group (Northcutt & McCoy, 2004:46; Northcutt & McCoy, 2015:9):

- How close (distance) is the constituency to the problem (has something to say about the phenomenon); and
- How much power does this constituency have over the phenomenon (can do something about the phenomenon).

Only one constituency was selected as the one constituency can influence the phenomenon as experienced by an individual. The distance of the constituency is close, as the constituency has something to say about the phenomenon. The power that the constituency has is medium, as the student can influence his/her self-management in certain situations but does not always have the power to change other, out of their control.

4.2.3 Phenomenon

The phenomenon that was identified by the researcher and the results thereof can be seen in Table 4-3.

Table 4-3: Research design protocol for students' perceptions of their self-management living with DM on campus: Phenomenon

Phenomenon	
Constituency	Phenomenon
Students with T1DM or T2DM on campus.	Self-management in students with DM
Location of Events	

Individual	Intermediary	Authority
On the Potchefstroom campus of the North-West University, among the students.	Not applicable	Not applicable
Range of Time		
Individual	Intermediary	Authority
2019, on a Saturday at the onset of the third quarter in the calendar year.	Not applicable	Not applicable
Constituency	Research Questions	Issue Statement
Students with DM on the campus.	1. What are the perceptions of self-management of students living with DM on campus? 2. How do the components of these perceptions of self-management of students living with DM on campus relate?	What is your experience as a student daily?

4.2.3.1 Constituency and phenomenon

The researcher decided that the phenomenon to be investigated in the constituency will be “self-management of students living with DM on the NWU Potchefstroom campus”.

4.2.3.2 Location of events

The location decided by the researcher was the NWU Potchefstroom campus where full-time students spend most of their time.

4.2.3.3 Range of time

The range of time for the focus group in this study for the constituency was on a Saturday morning from 9:00 till 14:00.

4.2.3.4 Research questions

As one of the results from the IQA research design, the researcher took a single phenomenon and presented it to the constituency. The research questions that were developed by the researcher were:

- What are the perceptions of self-management of students living with diabetes mellitus on campus;

- How do the components of these perceptions of self-management of students living with diabetes mellitus on campus relate?

4.2.4 Issue statement

The issue statement is part of the results formulated according to the IQA research flow. The results of the issue statement and how it was formulated can be found in Table 4-4.

The issue statement was: What is your experience as a student living with DM on the NWU Potchefstroom campus.

4.2.5 Conclusion of the research design protocol

The final step of the research design protocol was to give a final answer on all the elements that make up the research design protocol. The conclusion or summary of the research design protocol can be found in Table 4-4.

Table 4-4: Research design protocol for perceptions of self-management of students with DM living on campus: Final answer

Final answer	
Problem:	What are the factors influencing the self-management of students living with DM in a university environment?
Constituency:	Students with T1DM or T2DM on campus.
Phenomenon:	Self-management of students living with DM on campus.
Research question	1. What are the perceptions of self-management of students living with DM on campus; 2. How do the components of these perceptions of self-management of students living with DM on campus relate.
Issue statement:	What is your experience as a student living with DM on the NWU Potchefstroom campus?

The last step to complete the IQA research design was to formulate the focus group warm-up exercise's design, which is described in the following section (also see Table 4-5 below).

Table 4-5: Focus group warm-up

Focus Group Warm-up Exercise

I would like you to think for a while about your daily lives as a student on campus.

In a few minutes, I am going to ask you to tell me about your experience as a student living with diabetes on campus.

So, let's begin.

- Please allow yourself to be as comfortable as possible.
- Put your thoughts from the day aside to allow your attention to focus on your experience as a student living with diabetes on campus.
- **Close your eyes to increase your state of relaxation and your ability to focus on your experience as a student living with diabetes on campus.**
- **Now imagine yourself on campus. See yourself in all of the places where you have to manage your diabetes. (Long pause.)**
- **Imagine yourself during your daily life on campus living with diabetes. (Long pause.)**
- **See all of the places, events and people around you on campus. (Long pause.)**
- **See yourself engaging in the activities of managing your diabetes. (Long pause.)**
- **Notice your surroundings. (Long pause.) Looking around you, take in the sights, the sounds that are associated with being on campus. (Long pause.)**
- **Allow all your senses to become aware of your environment.**
- **Focus on what it feels like to be totally absorbed on campus and your daily tasks. Be there in your mind. (Long pause.)**
- Review all your recollections up to this moment. (Pause.)
- Allow all these thoughts to remain calmly in your consciousness and ready to be revealed.

Thank you for allowing these valuable observations and recollections to come forward.

Allow yourself to gently come back to this time and place and when you are ready, open your eyes.

Good. Thank you.

And now, with all that you remember - and that is all that you just noticed - please write down your thoughts on these cards. Write one thought or experience per card. Feel free to record a word, a phrase, or a sentence to capture that thought. Write as many cards as come to mind. Do not censor yourself. There are no right or wrong answers.

Tell me about your experience as a student living with diabetes on campus.

4.3 Focus group: Phase 2

The IQA focus group process was intended to and was used by the researcher to identify affinities that the phenomenon, *id est* self-management of students living with DM on the NWU Potchefstroom campus, could produce.

4.3.1 Results of the focus group

Two focus groups were held for this study. The first focus group was held on 20 October 2018 and the second focus group was held on 24 August 2019. The reason for the decision to host two focus groups was that only three participants showed up for the focus group after the first recruitment attempt. We still conducted the focus group. On the second attempt the researcher broadened the recruitment methods and managed to attain ten interested participants, but because of the timing of the focus group (on a Saturday) not all the participants managed to attend. After conducting both focus groups the participants from the first focus group, along with the recruited participants who could not attend either focus group session, were asked to complete an ART (section 4.4) to accommodate them in times they were available to take part in the study. The extra ART's were developed to gain more depth in the affinities that were gathered from the second focus group.

4.3.1.1 Demographic data of the participants for the study

There were three participants in the first focus group, three participants in the second focus group and seven participants that did not take part in the focus groups and only completed the ART. Of the thirteen participants (n=13), four of the participants were male and nine of the participants were female. All the participants were full-time students on the campus, for longer than six months, and were between the ages of 18 and 26, which complied with the inclusion and exclusion criteria. Nine of the participants had T1DM and were diagnosed with T1DM for longer than a year. Two of the participants had T2DM and have been diagnosed for more than a year.

A more detailed demographic data sheet can be seen in Table 4-6.

Table 4-6: Demographic data of the participants included in the study

Participant	Gender	Age	Years spent on campus (needs to be more than 6 months)	T1DM or T2DM	Years diagnosed with DM (needs to be more than 1 year)
1	Female	21	3 years	T1DM	9 years
2	Male	20	2 years	T1DM	4 years
3	Female	19	2 years	T1DM	11 years
4	Female	24	6 years	T1DM	4 years
5	Female	21	4 years	T1DM	12 years
6	Female	23	5 years	T1DM	18 years
7	Female	22	4 years	T1DM	11 years
8	Male	21	3 years	T1DM	18 years
9	Male	24	6 years	T2DM	4 years
10	Female	25	2 years	T1DM	15 years
11	Male	28	9 years	T1DM	9 years
12	Female	19	1 year	T2DM	6 years
13	Female	23	5 years	T1DM	14 years

The focus group warm-up exercise was compiled by the facilitator as stated in the research design (using the final answer) and was presented to both focus groups as seen in Table 4-3. This was the product of the IQA research design phase.

The focus group then constructed the affinities according to the process that was discussed in section 3.5.2 in Chapter 3. More detail on the method that was used by the researcher can be seen in the added unpublished manuscript received from Northcutt and McCoy (Northcutt & McCoy, 2016).

The final results that were constructed by the focus group can be seen in Table 4-7. This is the final eight affinities and their descriptions in the words of the participants in the focus group. These affinities were formed when the participants in the second focus group wrote down their thoughts about the phenomenon and afterwards grouped these thoughts and gave them the names in the first column of Table 4-7 (name of the affinity). They then described each of the affinities as seen in Table 4-7, column 2 (definition of the affinity). Table 4-7 is a summary of Table 4-8 which depicts the sticky notes of the participants in the focus group.

Table 4-7: Descriptions of affinities of the focus group

Name of the affinity	Definition of the affinity
Food available on campus	There is not sufficient diabetic friendly food available on campus.
Keeping insulin cool	It is a “drag” to keep insulin cool for up to 14 hour stretches, every day or trying.
Causes of changing blood sugar	Almost everything contributes to blood sugar variation.
Adapting to the effects of changing blood sugar	You have to understand the causes and effects and learn to counter it.
Social awareness and acceptance	If society was better educated about diabetics, it would be much easier to manage my life.
Hurdles in academic environment	The academic community has to be more accommodating.
Adjusting by cooking	Learn, adjust, adapt in order to meet your personal health requirements (make it interesting).
Independent lifestyle	Accepting your condition and taking responsibility towards a healthy life.

In Table 4-8, the researcher laid out all the sticky notes as written by the participants in the focus group. Each colour gives a different affinity with the affinity name at the top, the definition as given by the participants and then all the sticky notes they wrote for the affinity.

Table 4-8: Affinity description in focus group

Food available on campus		
Adjustment to campus, take time	When it comes to diet	Food index
Insufficient diabetic friendly food on campus	Food at Student Centre, carb counting; no nutritional index	Accommodative foods on campus

Keeping insulin cool		
Insulin temperature? Keep cool	Insulin very expensive	Surroundings always reveal challenges
Insulin temperature	"Effort" to keep insulin with you	Need to plan

Causes of changing blood sugar			
Hypos (very low blood glucose) always occur at night	Fluctuating blood sugar levels	Inability to control stress – fluctuating sugar levels	Diet changing

Adapting to the effects of changing blood sugar		
Considered myself responsible	Swelling – Ketones	Emotional self-control
Hard to avoid stressful things	I can never be too happy not too sad	Learn to adapt
Control yourself not to snap	Problem with long eyesight seeing	Emotions – Blood sugar rises

Social awareness and acceptance			
Would like friends to ask "relevant" questions	Have the best support	Time for family to adjust	Need to know basis (Only some people know)
Assumptions	Don't test, you know	Sympathy from social group (friends)	Positive interventions with other diabetics
Keep social group small	Injecting in front of people? Not necessarily accepted socially		Act to keep friends comfortable
Responsibility to educate people	Unintelligent comments and questions of friends		Diabetic "emergencies"

Hurdles in the academic environment		
Always have a fear of DKA (Diabetic Ketoacidosis) (a life-threatening problem that affects people with diabetes)	Safe places	Hurdles with taking medication
Test – blood sugar test; stress	A letter to accommodate us in exam room	Letter for tests
Sick tests? High blood sugar? Acceptable/not?	Not want to test blood sugar during test	Time management – insulin/eating

Adjusting by cooking			
Wise choices "lekker" (nice)	"Cheat meals" be careful	Carry own Tupperware	Enjoy cooking
Spices in sauces	Gem squash	Cook own meal portion in fridge	Boring to have the same thing
Expensive to eat healthy for students	Starve vs. Cupcakes		Food index at Wimpy

Independent lifestyle		
Responsible for buying own food	Responsibility grow up "fast"	Very tempted
Keeping it down, 10% higher exam results		Lifestyle alone – nobody to check-up

4.4 Development of the System Influence Diagram of students' perceptions of their self-management living with DM on campus

In this study however, the researcher used the Detailed ART with the participants in the focus group and extra participants. The Detailed ART is used to capture the statement of the reasoning of the cause-and-effect relationships between the affinities (Northcutt & McCoy, 2004:152). The results for participant 1 can be seen in Table 4-9 as an example of how the Detailed ART was used in this study. All the participants from focus group 2 completed the Detailed ART and were supplied with the affinity names and definitions. The participants from focus group 1 and extra participants also received the same affinities and definitions to complete the Detailed ART. The purpose of the Detailed ART was to indicate the relationship between affinities. All of the affinities received arbitrary numbers for the processing of the data. The results for the other participants are kept with the researcher and are not displayed in the study, but can be obtained on request.

The information of all 13 participants was tallied and the product was the Combined Theoretical Frequency Table as seen in Table 4-10. The affinities at first were randomly ordered and numbered during the focus group activities and were then sorted to be added to Table 4-10.

Table 4-9: Example of a Detailed Affinity Relationship Table (ART) (participant 1)

Affinity Name			Possible Relationships
1.	Food available on campus		A > B
2.	Keeping insulin cool		A < B
3.	Causes of changing blood sugar		A <> B (No Relationship)
4.	Adapting to the effects of changing blood sugar		
5.	Social awareness and acceptance		
6.	Hurdles in the academic environment		
7.	Adjusting by cooking		
8.	Independent lifestyle		

Affinity Pair Relationship			Descriptions
1	<	2	It is important to keep effective (cool) insulin on hand because there needs to be injected for high carbohydrate food.
1	>	3	High carbohydrate foods cause an increase in blood sugar levels
1	<	4	You have to adapt to unhealthy foods that are available and according to that you have to take action
1	<	5	People are uninformed (management) and thus order/provide unhealthy/inappropriate foods
1	<>	6	No correlation, academic responsibilities are independent at the SS / campus foods
1	>	7	Make food at home because campus isn't adequate to get food from

Affinity Pair Relationship			Description
1	>	8	Make responsible choices regarding meals
2	>	3	It is important to keep insulin as effective as possible for stable BS levels
2	>	4	If insulin gets warm it is important to adjust and get new ones
2	<>	5	There is no correlation because even if people know insulin needs to stay cool, it is still my responsibility
2	>	6	Insulin must work effectively for use, especially during tests and academic responsibilities
2	<>	7	No correlation, effective insulin has nothing to do with responsible choices
2	<	8	It is my responsibility to keep my insulin cool
3	>	4	It is important to identify the causes of fluctuations in blood sugar and to be able to adapt accordingly
3	<>	5	The more people know about the causes doesn't necessarily mean that the causes will decrease or change
3	>	6	Causes such as stress influences academics in a negative way
3	>	7	Adjust to the causes through taking control and preparing food oneself (planning is key)
3	<	8	By accepting responsibility and striving towards health, causes can be minimised
4	<>	5	By adapting to causes it does not change the social awareness and visa versa
4	<	6	By adapting the hurdles in academic environment can decrease
4	>	7	One of the adjustments that needs to be made is cooking (and cooking healthy foods)
4	>	8	Responsibility is a tool that is used to overcome hurdles
5	>	6	If more people are informed it will bring change the academics and thus hurdles will be overcome
5	<>	7	What I choose to cook and if I cook is independent from social stigma
5	<>	8	Independence is independent from outsiders
6	<>	7	Academics are independent from cooking food
6	<>	8	Hurdles surrounding my academics is out of my control
7	<	8	Because I take responsibility for myself and my actions and life, I make healthy food for myself

The Theoretical Code Frequency of the affinity pairs of the Detailed ART's can be seen in Table 4-10.

Table 4-10: Combined Theoretical Code Frequency Table

Combined Theoretical Code Frequency Table					
Affinity Pair Relationship	Frequency	Affinity Pair Relationship	Frequency	Affinity Pair Relationship	Frequency
1 → 2	3	2 → 6	7	4 → 7	3
1 ← 2	2	2 ← 6	0	4 ← 7	9
1 → 3	13	2 → 7	1	4 → 8	5
1 ← 3	0	2 ← 7	0	4 ← 8	4
1 → 4	9	2 → 8	6	5 → 6	10
1 ← 4	2	2 ← 8	5	5 ← 6	2
1 → 5	4	3 → 4	10	5 → 7	6
1 ← 5	8	3 ← 4	1	5 ← 7	1
1 → 6	8	3 → 5	5	5 → 8	4
1 ← 6	2	3 → 6	5	5 ← 8	5
1 → 7	11	3 → 7	3	6 → 7	2
1 ← 7	2	3 → 8	3	6 ← 7	3
1 → 8	6	4 → 5	5	6 → 8	3
1 ← 8	4	4 ← 5	6	6 ← 8	5
2 → 3	10	4 → 6	5	7 → 8	4
2 ← 3	0	4 ← 6	6	7 ← 8	7
2 → 4	8				
2 ← 4	2				
2 → 5	5				
2 ← 5	6				
				Total	276

The original combined theoretical code frequency table had to be adjusted. Table 4-10 shows the adjusted version. All the highlighted frequencies had equal frequencies in the opposite direction. For the purpose of the Pareto Protocol the ties that were between several of the affinities had to be broken. The choices that were made by the researcher rested on observing the directions in which the other participants' relationships were directed and the direction that would suit the rest of the relationships better and the information that was provided in the detailed ART. With the help of Dr Danny McCoy, the tied frequencies were reviewed to form the corrected combined theoretical code frequency table (Table 4-10).

In the following section, the researcher will discuss the Pareto Protocol Analysis of the system of the detailed ART's.

4.5 Pareto Protocol analysis of the detailed ART's

In this section the researcher will be describing the Pareto Protocol in more detail for the reader to get a better understanding of the workings of the IQA methodology and how the researcher

came to the results. The Pareto principle states that in terms of a system, more or less 20% of the variables in a system accounts for more or less 80% of the total variation in the outcomes. The important application of the Pareto Principle is that a minority of the relationships (also called causes) in any system will account for most of the variation (also called effects) in the system. The Pareto Principle is used by the IQA methodology in process to attain consensus where there might be a disagreement among the respondents of the focus group and the detailed ART's about the nature of the given relationship (thus the direction of the relationship (as seen in Table 4-8) and to create a group composite (Northcutt & McCoy, 2016d). The precise count of each relationship code was used from the combined theoretical code frequency table (Table 4-11). The Pareto analysis consists of seven steps discussed below.

4.5.1 Step one of the Pareto Protocol: Building the Pareto table

The first step of the Pareto Protocol was to build the Pareto table (Northcutt & McCoy, 2016d). The combined theoretical code frequency table (Table 4-10) was used to gather the direction of the relationship and transfer them to the Pareto Protocol template (Table 4-11), organised according to the Pareto Protocol (Northcutt & McCoy, 2016d). A total of 46 possible relationships exist by means of 46 variations of the eight affinities when they are taken as pairs. A total of 276 votes were cast for the 46 possible relationships.

The frequencies of the affinities of the affinity pair relationships were ordered (Table 4-11) and the relationships were organised in descending order of frequency (column B in Table 4-11) and articulated as an increasing frequency (column C in Table 4-11). The cumulative frequencies were then expressed both as a percentage (column E in Table 4-11) of the 276 votes and the cumulative frequencies were also expressed based on the number of possible relations of 46 (column D in Table 4-11). Each of the relationships represents $1/46$ or more or less 2.17% of the probable number. Column F (Table 4-11) represents the power column that shows an index of the degree of optimisation of the system and shows the difference between cumulative percent (frequency) and cumulative percent (relation) (Northcutt & McCoy, 2016:d).

The cumulative frequencies are usually used for two purposes. The first use of the frequencies is for the optimal number of relationships that the composite system needs to consist of. For the sake of briefness or parsimony, the fewest number of relationships that offers the greatest amount of variation for the sake of comprehensiveness and richness need to be used. The second use of the frequencies is to resolve ambiguous relationships which attracted votes in both directions. A few ambiguous relationships were found in this study (directions of the relationship between pairs were equal). With the help of Dr D McCoy, the Pareto Protocol Tables were built.

Table 4-11: Pareto Protocol: Frequency ordered

Affinity Pair Relationship	Frequency Sorted (Descending)	Cumulative Frequency	Cumulative Percent (Relation)	Cumulative Percent (Frequency)	Power
Column A	Column B	Column C	Column D	Column E	Column F
1 > 3	13	13	1.8	4.7	2.9
1 > 7	11	24	3.6	8.7	5.1
2 > 3	10	34	5.4	12.3	7.0
3 > 4	10	44	7.1	15.9	8.8
3 < 7	10	54	8.9	19.6	10.6
5 > 6	10	64	10.7	23.2	12.5
1 > 4	9	73	12.5	26.4	13.9
4 < 7	9	82	14.3	29.7	15.4
1 < 5	8	90	16.1	32.6	16.5
1 > 6	8	98	17.9	35.5	17.7
2 > 4	8	106	19.6	38.4	18.8
3 < 8	8	114	21.4	41.3	19.9
2 > 6	7	121	23.2	43.8	20.6
7 < 8	7	128	25.0	46.4	21.4
1 > 8	6	134	26.8	48.6	21.8
2 > 8	6	140	28.6	50.7	22.2
4 < 5	6	146	30.4	52.9	22.5
4 < 6	6	152	32.1	55.1	22.9
5 > 7	6	158	33.9	57.2	23.3
2 < 5	6	164	35.7	59.4	23.7
3 < 5	6	170	37.5	61.6	24.1
3 < 6	6	176	39.3	63.8	24.5
2 > 5	5	181	41.1	65.6	24.5
2 < 8	5	186	42.9	67.4	24.5
3 > 5	5	191	44.6	69.2	24.6
3 > 6	5	196	46.4	71.0	24.6
4 > 5	5	201	48.2	72.8	24.6
4 > 6	5	206	50.0	74.6	24.6
4 > 8	5	211	51.8	76.4	24.7
6 < 8	5	216	53.6	78.3	24.7
5 < 8	5	221	55.4	80.1	24.7
1 > 5	4	225	57.1	81.5	24.4
1 < 8	4	229	58.9	83.0	24.0
4 < 8	4	233	60.7	84.4	23.7
5 > 8	4	237	62.5	85.9	23.4
7 > 8	4	241	64.3	87.3	23.0
1 > 2	3	244	66.1	88.4	22.3
3 > 7	3	247	67.9	89.5	21.6
3 > 8	3	250	69.6	90.6	20.9
4 > 7	3	253	71.4	91.7	20.2

6 < 7	3	256	73.2	92.8	19.5
6 > 8	3	259	75.0	93.8	18.8
1 < 2	2	261	76.8	94.6	17.8
1 < 4	2	263	78.6	95.3	16.7
1 < 6	2	265	80.4	96.0	15.7
1 < 7	2	267	82.1	96.7	14.6
2 < 4	2	269	83.9	97.5	13.5
5 < 6	2	271	85.7	98.2	12.5
6 > 7	2	273	87.5	98.9	11.4
3 < 4	1	274	89.3	99.3	10.0
5 < 7	1	275	91.1	99.6	8.6
2 > 7	1	276	92.9	100.0	7.1
1 < 3	0	276	94.6	100.0	5.4
2 < 3	0	276	96.4	100.0	3.6
2 < 6	0	276	98.2	100.0	1.8
2 < 7	0	276	100.0	100.0	0.0
Total Frequency	276	Equal Total Frequency	Equals 100%	Equals 100%	Power = E-D

4.5.2 Step two of the Pareto Protocol: Find an optimal cut-off point

The second step was to find the optimal cut-off point. A cut-off point was chosen that can answer the following prerequisites:

- Above the maximum or peak power of 95.3 (Marked in red in Table 4-11);
- Above 80% cumulative percent frequency points is chosen that is based on the min/max criterion (Northcutt & McCoy, 2004:158, 280) (marked in orange in table 4-11);
- At least one of each of the affinity pairs was incorporated; and
- All the frequencies of the same value were included.

The possible cut-off points were marked by highlighting the appropriate row in orange or 7.1, column F (Table 4-11).

4.5.2.1 The min/max criterion

The last two columns of the Pareto table (Table 4-11) are the keys to deciding which relationships will be selected for the system (Northcutt & McCoy, 2016d), and also which of these relationships will not be selected for the Combined Interrelationship Diagram (IRD) (Table 4-14 and Table 4-15). The conclusion of the cut-off point includes the optimisation of a trade-off amid the two criteria: The composite should account for maximum variation in the system (cumulative percent

based on frequency) and the minimising of the number of relationships in the interest of parsimony (cumulative percent based on relations).

4.5.2.2 Accounting for maximum variance: Frequency

In Figure 4-1 and in Table 4-11, it is seen that ten of the possible 46 (21.74%) relationships accounts for 35.5% of the variation in the system and that 50% (23 of the possible relationships) of the relationships accounts for 65.6% of the variance. Although these numbers are not close to the theoretical Pareto principle where 20% of the relationships are responsible for 80% of the variance, it is still acceptable.

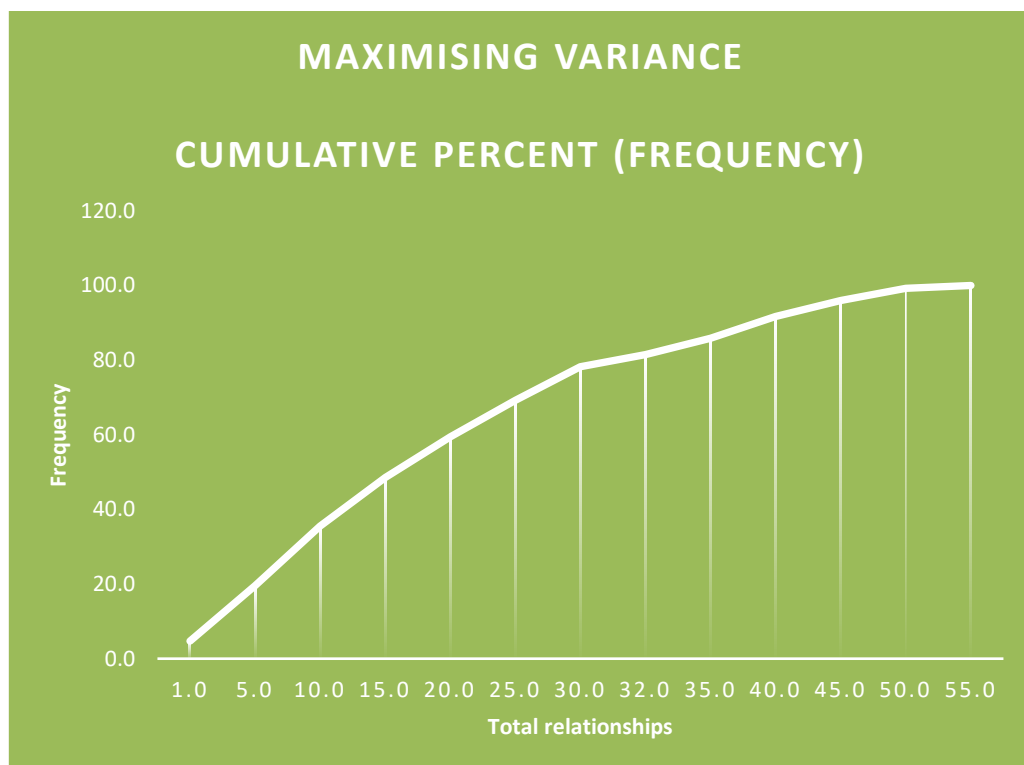


Figure 4-1: Variance accounted for each succeeding relationship

4.5.2.3 Accounting for minimizing the number of affinities: Power

As seen in Figure 4-2 and Table 4-11, power reached a maximum of 24.7 at 32 relationships, which accounts for 81.5% of variation in this system. This indicates that 32 relationships would have been a defensible choice for inclusion in the composite IRD since it is the optimal number regarding the min/max criterion.

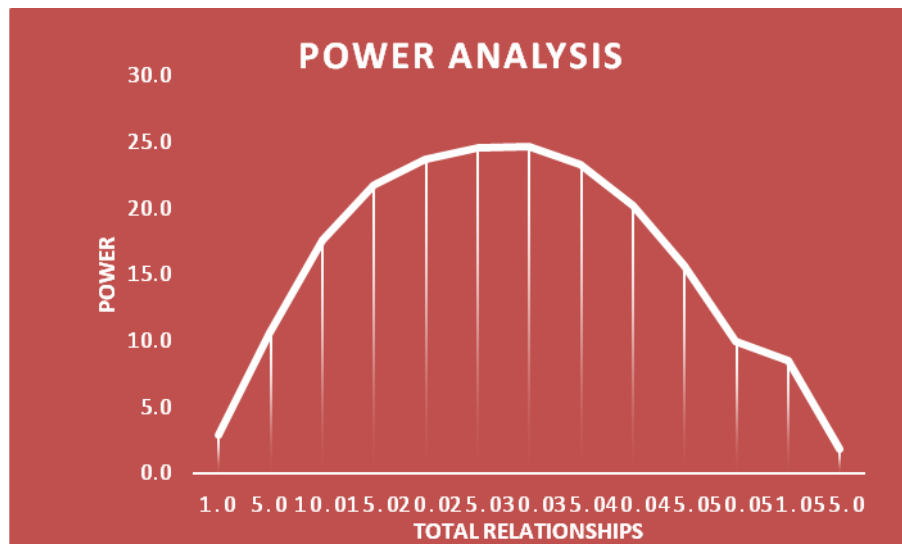


Figure 4-2: Power analysis of the system

A stacked line chart was completed using the cumulative percentage frequency along with power (Figure 4-3) (Northcutt & McCoy, 2016d). The power arc was examined for the peak of the curve. The researcher found that no distinctive peak could be identified but, row 53 was identified as the approximate arc.

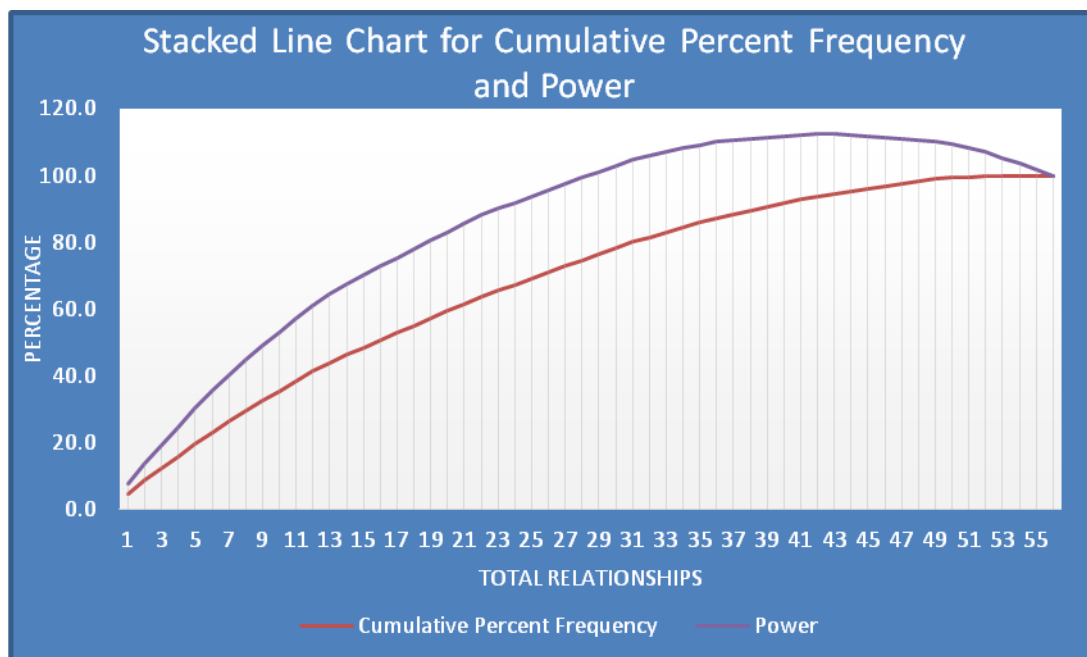


Figure 4-3: Stack line chart for cumulative percent frequency and power

Varying frequencies nearest to 85%, 90%, 95% and 100% were also marked in Table 4-11 for possible use. The researcher-built system was used for this research (Northcutt & McCoy, 2016d).

4.6 Third step of Pareto Protocol: Conflict management

The Pareto Protocol's third step was the management of the conflicting relationships for settlement of the systems influence diagram (SID). The Pareto protocol template was used (Northcutt & McCoy, 2016d).

Table 4-12: Pareto Protocol: Conflict management sheet

Affinity Pair Relationship	Frequency	Cut-off %	Affinity Pair Relationship	Frequency (Descending)
1 > 2	3	5	1 > 3	13
1 < 2	2	9	1 > 7	11
1 > 3	13	12	2 > 3	10
1 < 3	0	16	3 > 4	10
1 > 4	9	20	3 < 7	10
1 < 4	2	23	5 > 6	10
1 > 5	4	26	1 > 4	9
1 < 5	8	30	4 < 7	9
1 > 6	8	33	1 < 5	8
1 < 6	2	36	1 > 6	8
1 > 7	11	38	2 > 4	8
1 < 7	2	41	3 < 8	8
1 > 8	6	44	2 > 6	7
1 < 8	4	46	7 < 8	7
2 > 3	10	49	1 > 8	6
2 < 3	0	51	2 < 5	6
2 > 4	8	53	2 > 8	6
2 < 4	2	55	3 < 5	6
2 > 5	5	57	3 < 6	6
2 < 5	6	59	4 < 5	6
2 > 6	7	62	4 < 6	6
2 < 6	0	64	5 > 7	6
2 > 7	1	66	2 > 5	5
2 < 7	0	67	2 < 8	5
2 > 8	6	69	3 > 5	5
2 < 8	5	71	3 > 6	5
3 > 4	10	73	4 > 5	5
3 < 4	1	75	4 > 6	5
3 > 5	5	76	4 > 8	5
3 < 5	6	78	5 < 8	5
3 > 6	5	80	6 < 8	5
3 < 6	6	82	1 > 5	4
3 > 7	3	83	1 < 8	4
3 < 7	10	84	4 < 8	4
3 > 8	3	86	5 > 8	4
3 < 8	8	87	7 > 8	4
4 > 5	5	88	1 > 2	3

4 < 5	6	89	3 > 7	3
4 > 6	5	91	3 > 8	3
4 < 6	6	92	4 > 7	3
4 > 7	3	93	6 < 7	3
4 < 7	9	94	6 > 8	3
4 > 8	5	95	1 < 2	2
4 < 8	4	95	1 < 4	2
5 > 6	10	96	1 < 6	2
5 < 6	2	97	1 < 7	2
5 > 7	6	97	2 < 4	2
5 < 7	1	98	5 < 6	2
5 > 8	4	99	6 > 7	2
5 < 8	5	99	2 > 7	1
6 > 7	2	100	3 < 4	1
6 < 7	3	100	5 < 7	1
6 > 8	3	100	1 < 3	0
6 < 8	5	100	2 < 3	0
7 > 8	4	100	2 < 6	0
7 < 8	7	100	2 < 7	0

The affinity pairs that are situated in the white blocks are the pairs with the higher frequency and were used to build the uncluttered SID. The affinity pairs that are highlighted in the green blocks are pairs with the smaller frequency and were the conflicting pairs. They were used to reconcile the final system according to the protocol described in the unpublished manuscript provided to the researcher by Northcutt & McCoy (2016d).

4.7 Fourth step of Pareto Protocol: Build a Composite IRD

The SID assigned protocol was designed by using the white blocks in Table 4-12 and building the composite tentative SID assignments (Northcutt & McCoy, 2016d).

The SID assignment protocol consists of four tables and can be followed from Table 4-13 to Table 4-17 as the end result.

Table 4-13: SID Assignments Combined Protocol

Affinity Name	Possible Relationships
1. Food available on campus	$A \rightarrow B$
2. Keeping insulin cool	$A \leftarrow B$
3. Causes of changing blood sugar	$A \times B$ (No Relationship)
4. Adapting to the effects of changing blood sugar	
5. Social awareness and acceptance	
6. Hurdles in the academic environment	
7. Adjusting by cooking	
8. Independent lifestyle	

Affinity Relationship Table 100%										
Affinity Pair Relationship						Affinity Pair Relationship				
1	>	2				3	<	5		
1	>	3				3	<	6		
1	>	4				3	<	7		
1	<	5				3	<	8		
1	>	6				4	<	5		
1	>	7				4	<	6		
1	>	8				4	<	7		
2	>	3				4	>	8		
2	>	4				5	>	6		
2	<	5				5	>	7		
2	>	6				5	<	8		
2	>	7				6	<	7		
2	>	8				6	<	8		
3	>	4				7	<	8		

The next step in the protocol is the building of the composite interrelationship diagram (IRD)

Table 4-14: Combined Interrelationship Diagram

IRD											
	1	2	3	4	5	6	7	8	OUT	IN	Δ
1		↑	↑	↑	←	↑	↑	↑	6	1	5
2	←		↑	↑	←	↑	↑	↑	5	2	3
3	←	←		↑	←	←	←	←	1	6	-5
4	←	←	←		←	←	←	↑	1	6	-5
5	↑	↑	↑	↑		↑	↑	←	6	1	5
6	←	←	↑	↑	←		←	←	2	5	-3
7	←	←	↑	↑	←	↑		←	3	4	-1
8	←	←	↑	←	↑	↑	↑		4	3	1
Total									28	28	0

The information that was obtained from Table 4-13 was used to develop the sorted combined IRD table (Table 4-14).

Table 4-15: Combined Interrelationship Diagram (Sorted)

IRD – Sorted in Descending Order of Δ											
	1	2	3	4	5	6	7	8	OUT	IN	Δ
1		↑	↑	↑	←	↑	↑	↑	6	1	5
5	↑	↑	↑	↑		↑	↑	←	6	1	5
2	←		↑	↑	←	↑	↑	↑	5	2	3
8	←	←	↑	←	↑	↑	↑		4	3	1
7	←	←	↑	↑	←	↑		←	3	4	-1
6	←	←	↑	↑	←		←	←	2	5	-3
3	←	←		↑	←	←	←	←	1	6	-5
4	←	←	←		←	←	←	↑	1	6	-5

The outcome of the SID assignments protocol was the tentative SID Assignment (Table 4-16) to be used in the SID.

Table 4-16: Tentative SID Assignments

Tentative SID Assignments	
1	Primary Driver
5	Primary Driver
2	Secondary Driver
8	Secondary Driver
7	Secondary Outcome
6	Secondary Outcome
3	Primary Outcome
4	Primary Outcome

The tentative SID assignments show where the various affinities need to be placed in the SID. Primary drivers are placed on the left of the SID and the secondary drivers to the right of the primary drivers. The primary outcomes are placed on the right-hand side of the SID and the secondary outcomes to the left of the primary outcomes (Northcutt & McCoy, 2016a).

4.8 Fifth step of Pareto Protocol: Building the SID of students' perceptions of their self-management living with DM on campus

The standard protocol that was set up by Northcutt & McCoy (2016a) was followed along with the SID assignments in Table 4-16 to construct the cluttered SID (Figure 4-4) and the uncluttered SID (Figure 4-5).

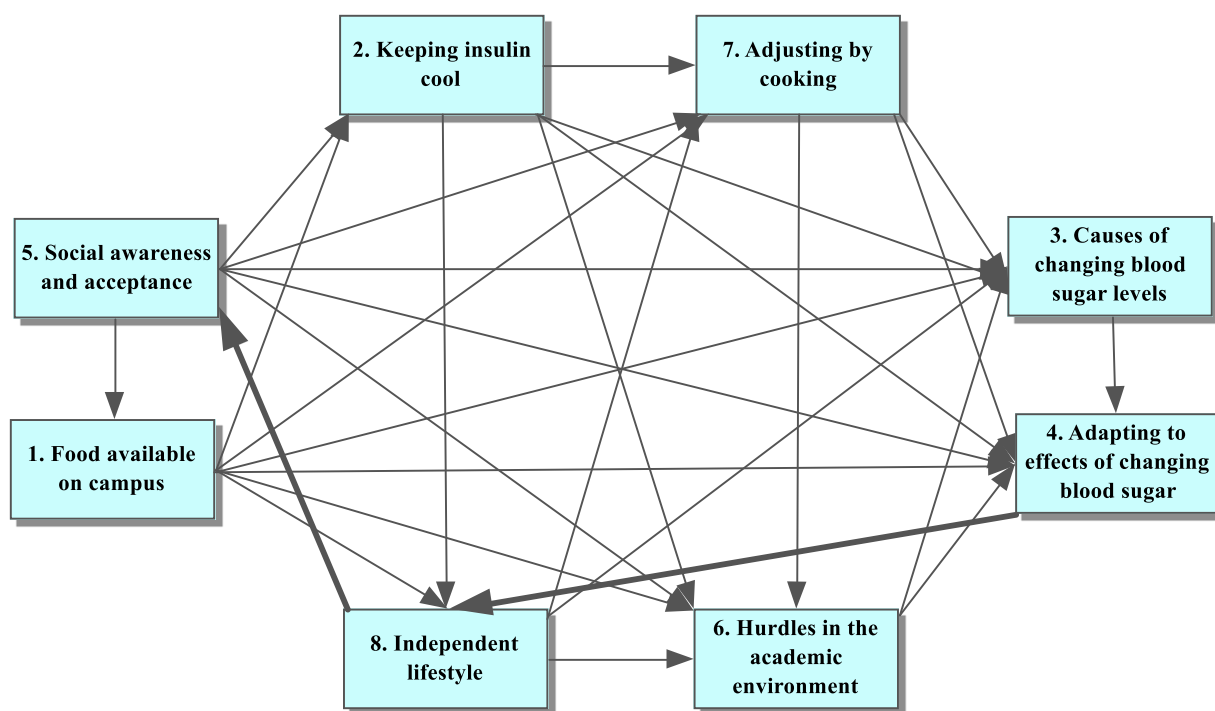


Figure 4-4: Cluttered SID of Students' perception of their self-management living with DM on campus

The cluttered SID as in Figure 4-4 consists of all the relationships that were described in the detailed ART's of the participants and is saturated with all the relationships as can be seen in Figure 4-7 (Northcutt & McCoy, 2004:329). The cluttered SID can be very difficult to interpret because of the level of saturation and richness. There are a lot of relationships and links in the system that makes it almost impossible to explain. Even though comprehensiveness and richness are sought in the cluttered SID, there is still a quest for caution.

The uncluttered SID (Figure 4-5) is the answer for all the redundant links that are removed according to the Pareto Protocol. The affinities are arranged to illustrate the system of the students' perceptions of their self-management living with DM on campus.

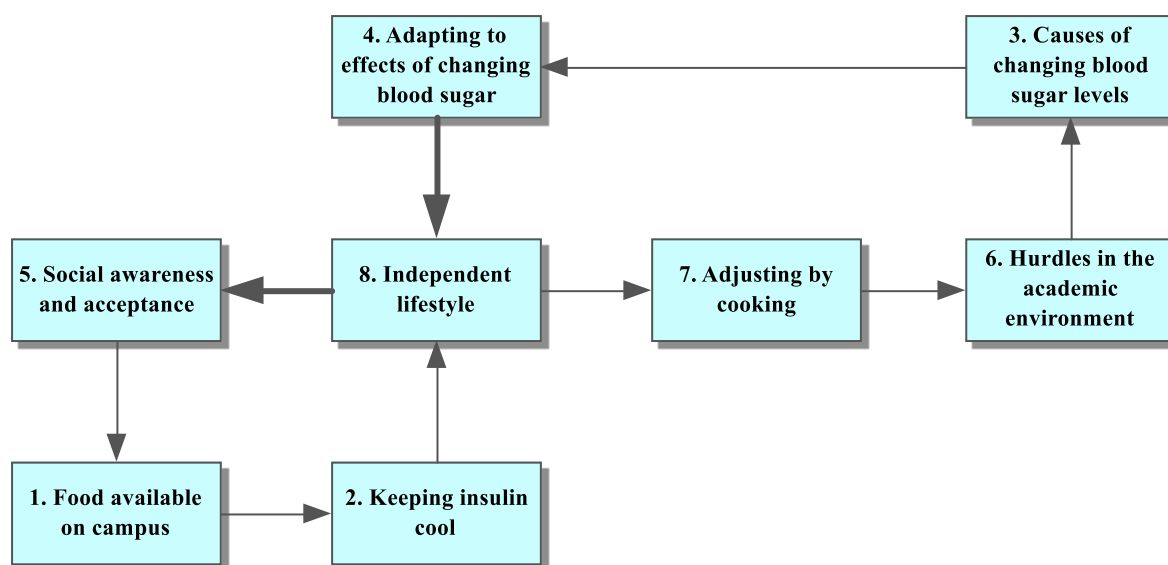


Figure 4-5: Uncluttered SID of students' perceptions of their self-management living with DM on campus

In the next step the reconciliation of the conflicts of the SID was done. Pareto Protocol principles were applied to the cluttered SID to examine and solve the conflicting relationships between the affinities of the system.

4.9 Sixth step of Pareto Protocol: The students' perceptions of their self-management living with DM on campus: Pareto reconciled system influence diagram (SID)

All the conflicts identified with the help of the Pareto Protocol were added back into the system by the researcher (Northcutt & McCoy, 2015:8; Northcutt & McCoy 2016a; Northcutt & McCoy, 2016d). The uncluttered SID (Figure 4-5) was examined for conflicting relationships (Northcutt & McCoy, 2004:331). Conflicting relationships occur when the same affinity pair has a significant number of relationships that move in both directions. Only the highest frequencies of the system's relationships are displayed in the uncluttered SID. By the means of the Pareto Protocol, the conflicting relationships not accounted for in the SID that might have a significant impact on the system are added back (reconciled) into the system (Northcutt & McCoy, 2016d).

The conflict 99% affinity relationship tables as well as the conflicting 100% ART's were constructed from the conflict management sheet (Table 4-12) and the information used to add the conflicts back into the cluttered SID (Figure 4-4). The protocol to reconcile the SID to the conflicting relationships, were followed and a 100% conflict reconciled SID and a 99% conflict reconciled SID was built.

Both the systems were investigated for the best representation of the system and it was decided that the 99% conflict reconciled SID was the better representation of the system for the Students' perception of their self-management living with DM on campus (Table 4-17).

Table 4-17: Conflict 99% Affinity Relationship Table

Conflict 99% Affinity Relationship Table						
Affinity Pair Relationship				Affinity Pair Relationship		
1	<	2		3	>	5
1		3		3	>	6
1	<	4		3	>	7
1	>	5		3	>	8
1	<	6		4	>	5
1	<	7		4	>	6
1	<	8		4	>	7
2		3		4	<	8
2	<	4		5	<	6
2	>	5		5	<	7
2		6		5	>	8
2		7		6	>	7
2	<	8		6	>	8
3	<	4		7	>	8

For the conflict 99% ART, four affinity pairs were not used in the reconciliation process.

Figure 4-6 gives a visual representation of the first step where the conflicting relationships were added back into the cluttered SID.

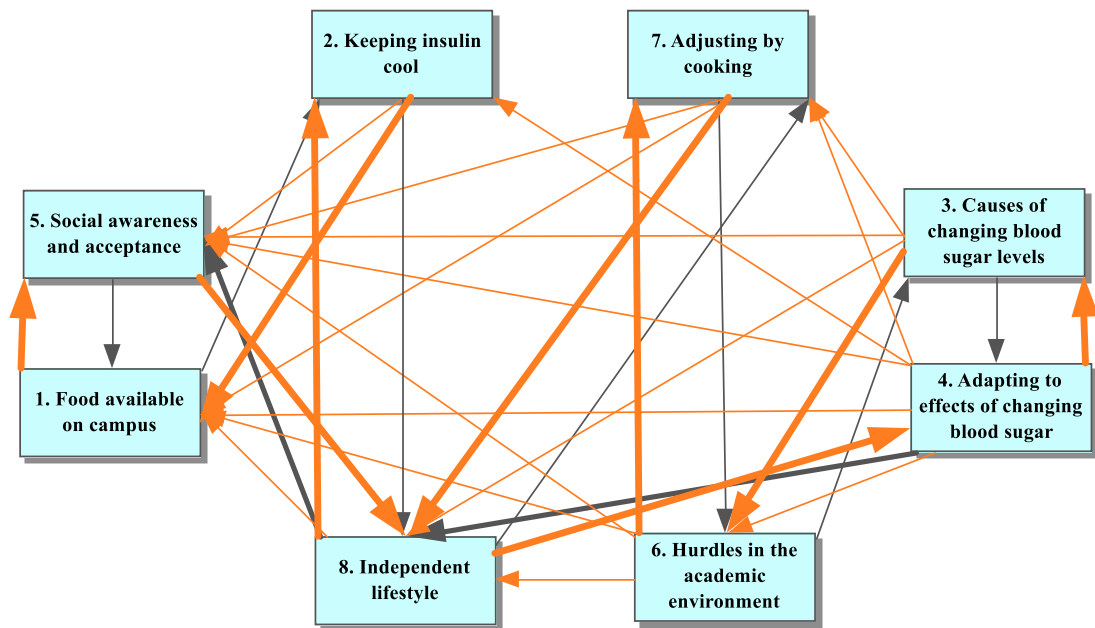


Figure 4-6: Conflicting 99% relationships of students' perceptions of their self-management living with DM on campus

The removal of the backward arrows process was conducted according to the Pareto Protocol and only four reconciled arrows in orange remained after the rebuilding of the Reconciled SID (Figure 4-7).

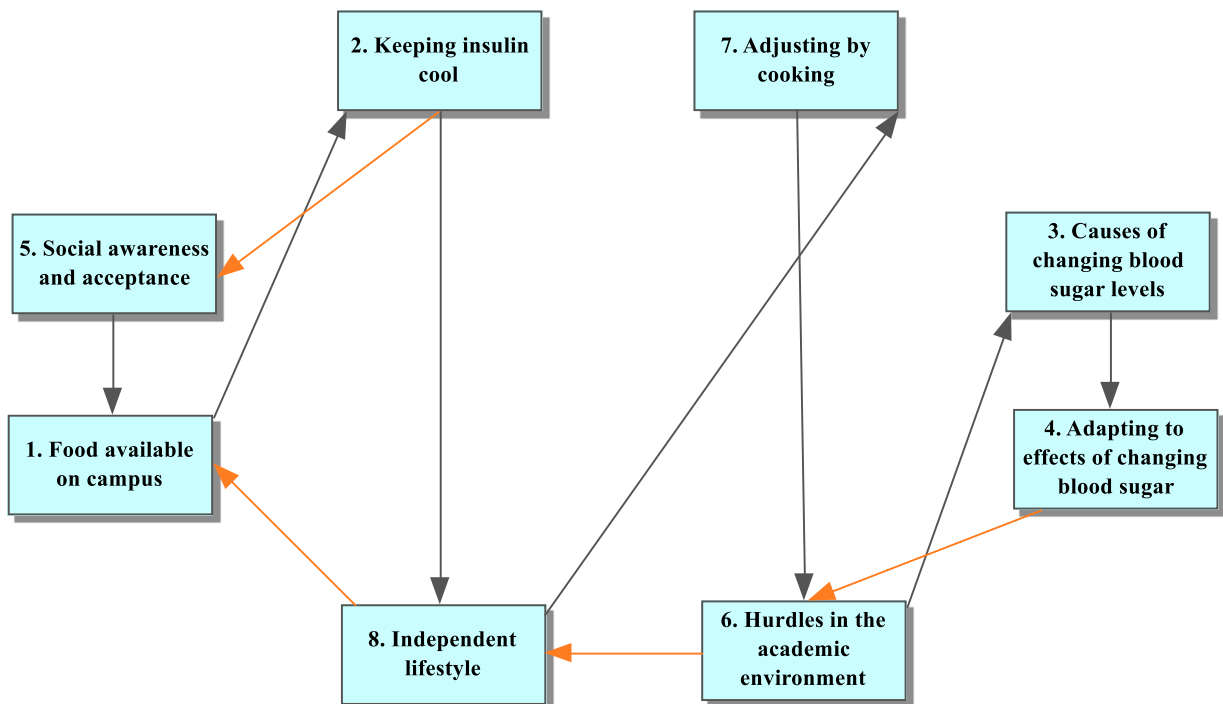


Figure 4-7: Final uncluttered reconciled SID of students' perceptions of their self-management living with DM on campus

The final step of the Pareto Protocol where the reconciled SID was rebuilt is discussed in the following section.

4.10 Seventh step of Pareto Protocol: Building the reconciled SID: The students' perceptions of their self-management living with DM on campus

The final system (Figure 4-8) was completed by rearranging the system elements according to the protocol for maximum communication where no lines between affinities crossed (Northcutt & McCoy, 2016a). The final SID of students' perceptions of their self-management living with DM on campus can be seen in Figure 4-8 and subsequently be discussed in Chapter 5.

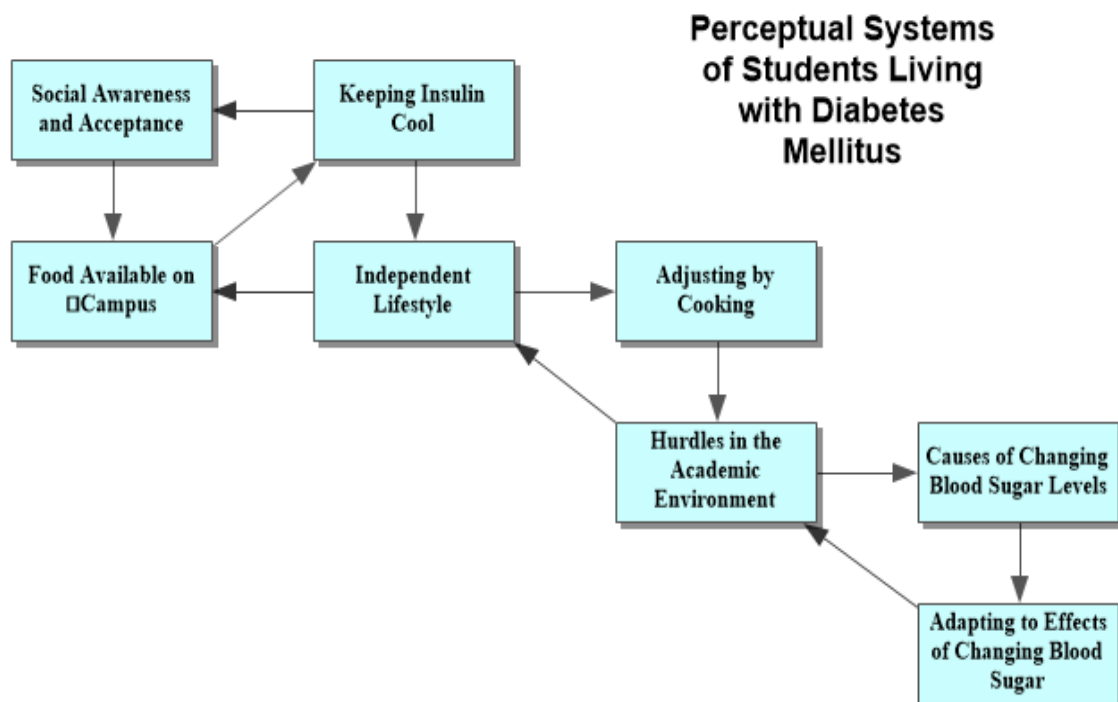


Figure 4-8: Final SID of students' perceptions of their self-management living with DM on campus

4.11 Theoretical write-up (composite theoretical descriptions)

In the next part of Chapter 4 the relationships between the affinities of the system, created by the focus group, are described. The quotes used is the direct words from the comments section of the ART, completed by all participants. Every possible relationship that resided between the

affinities is described in the words of the participants. This process is known as the theoretical write-up.

The cluttered SID (Figure 4-4) was used to provide a graphic representation to the reader. The IQA is designed to describe the phenomenon presented or for the lived reality of the focus group (Northcutt & McCoy, 2004:314).

The researcher combined the theoretical write-up with the affinity write-up, because the number of participants was too small to complete both write-ups in their separate protocol. The affinity write-up comprises of the first research question, namely “What are the components of the students’ perceptual system regarding their self-management of DM on the NWU Potchefstroom campus”. This question will now be answered.

All eight of the affinities are presented in the write-up in the exact order as their position in the system. This will be from the primary driver (Social awareness and acceptance) to the primary outcome (Adapting to effects of changing blood sugar). The reader will now be presented with the “write up” of the affinity that are presented and organized in a specific protocol throughout the write-up:

- The first sentence interprets the essence of the topic, is in **bold** and is the verbatim quote of a participant. The quote will again be part of the subsequent quotes.
- The second sentence interprets the section, is in the voice of the researcher and contains a noun or a phrase used as a noun that is *italicized*.
- The remainder of the section is enclosed in “quotes” and selected by the researcher as supporting material and in the voices of the students and presented in *Italics*.

4.11.1 Social awareness and acceptance

The affinities that are influenced by Social awareness and acceptance are shown in Figure 4-9.

Theoretical write up 1

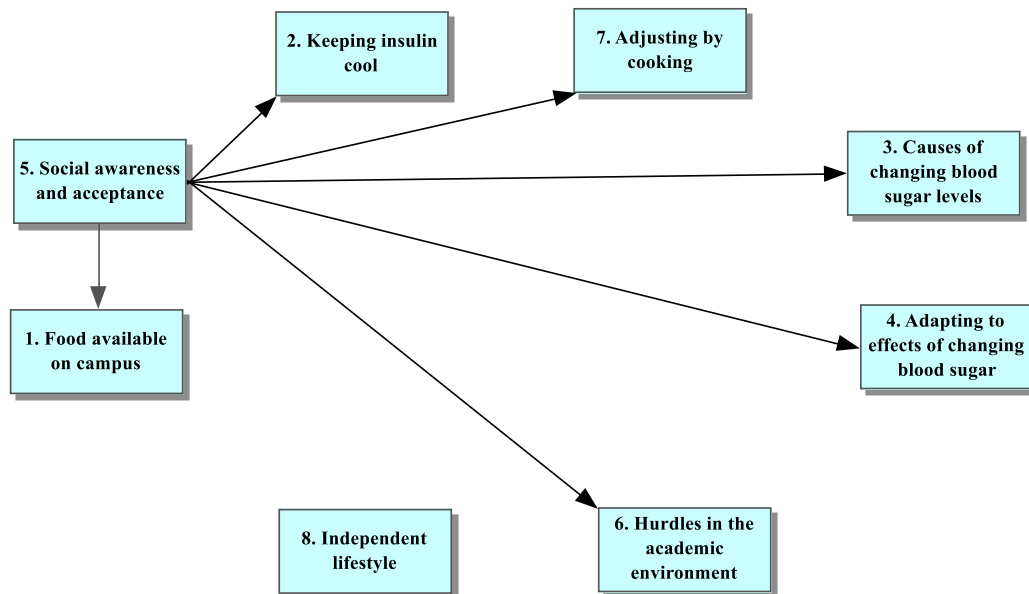


Figure 4-9: The affinities influenced by Social awareness and acceptance

4.11.1.1 Social awareness and acceptance influences Food available on campus

- **“With more social awareness there will be more food options available so less need for cooking.”**

A cafeteria management that is *informed* and *educated* about DM should result in more food options that *address* the nutritional needs of students living with DM.

“If people were more educated about diabetes, the food choices might be better on campus. People are uninformed (management) and thus order or provide unhealthy and inappropriate foods. Maybe the diabetic friendly food in the SS (student centre, cafeteria on campus) (in the future) should be reserved for diabetics only. The fact that people, even those who decide what food will be served or sold on campus, lack social awareness about diabetes it contributes to the lack of healthy, low-carb food options available on campus. If people were more aware of diabetes, then the food available on campus would change (through faculty and student movement).”

4.11.1.2 Social awareness and acceptance influences Keeping insulin cool

- **“If people were better educated, the importance of diabetics keeping insulin cool would not be a problem”.**

There is a *stigma* and a *struggle* surrounding the use of insulin and keeping insulin cool

“Always having to plan for cool storage makes you feel awkward and rejected by society due to lack of social group education. Having to carry a cooler bag all day and to plan ahead can be socially challenging as being spontaneous, going out with a group of friends is not always safe or you don’t have everything with you. If my blood sugar rises due to my insulin not being cool enough, I would have to adjust my insulin dosage in front of my friends. Keeping insulin cool has an effect on society’s perception of diabetes, e.g. others not understanding the struggle of keeping insulin cool.”

4.11.1.3 Social awareness and acceptance influences Adjusting by cooking

- **“With more social awareness there will be more food options available so less need for cooking.”**

The *need* for healthy food options *forces* the adjustment to cook for oneself.

“Because friends and family do not always understand my food requirements, I must cook as I do not eat take always which people don’t always understand, but I rather eat more expensive healthy food. When a group of friends wants to eat out it isn’t always easy to explain that I must eat a salad rather than a burger. You can’t just as easily eat out with friends or cheat all the time; you have to say no to friends otherwise you get tempted to be unhealthy. If social awareness of diabetes increased, more people and restaurants could adjust their cooking to accommodate people with diabetes.”

4.11.1.4 Social awareness and acceptance influences Hurdles in the academic environment

- **“Lecturers are not always aware of the needs of persons living with DM and therefore do not accommodate them.”**

There is the *need* to *educate* lecturers and personnel on DM and how to *manage* students with DM in the academic environment.

“Lecturers don’t always understand the situation and don’t always accommodate diabetics, it may be seen as an excuse as we don’t always ‘look’ sick. It is not acceptable to inject or test during

class. Since not everyone is aware of diabetes it creates a hustle when you suppose to administer your insulin because it feels uncomfortable. If my blood sugar drops during an exam most people wouldn't know how to react. This causes me to go out of class and miss information in order to check my blood glucose, due to stigma or not to disturb the class. People who are not well educated about diabetes add an extra hurdle because not everyone understands your struggles. If lecturers and those we study with know more about diabetes, the academic hurdle of being too sick due to diabetes to work efficiently could be avoided to a certain extent since understanding could lead to accommodation."

4.11.1.5 Social awareness and acceptance influences Causes of changing blood sugar

- **"Social settings for me are the main cause of fluctuations."**

Students living with DM may not *attend* to their needs due to their *experience* and *perceptions* of other peoples' opinions.

"The causes of changing blood sugar levels will directly influence your social awareness and acceptance due to fear of judgement and vice versa. I know what causes changes in my blood glucose, but society do not support diabetics to counter these changes in all environments. Hypos (very low blood glucose) or high blood sugar cause social difficulties, having to check and inject in front of people as well as causing people to ask insensitive questions. Social groups and environment can likely and mostly contribute to the blood sugar levels (like a party or an outing with friends). If my blood sugar is low and I start to shake and to feel faint, it will affect people around me. They wouldn't know what is happening."

4.11.1.6 Social awareness and acceptance influences Adapting to effects of changing blood sugar

- **"If social community were aware of what it means to be diabetic, they would understand the effects that go together with blood sugar levels."**

Students living with DM have to be *self-aware* and *aware* of others in terms of their own behaviour during blood sugar fluctuations

"If someone is emotional due to high blood sugar, then society would not necessarily understand what the cause of being emotional is. Social situations become stressful when your sugar level is high, causing irritability and forcing you to stop yourself from snapping. Social groups need to be aware that diabetes has an emotional impact on a person. Some people are judgmental on our lifestyle and how we do things to cope with our blood sugar level fluctuations. If I don't adapt to

the effects it has on me, people around me won't know what's wrong with me and won't know how to react."

4.11.2 Food available on campus

Theoretical write up 2

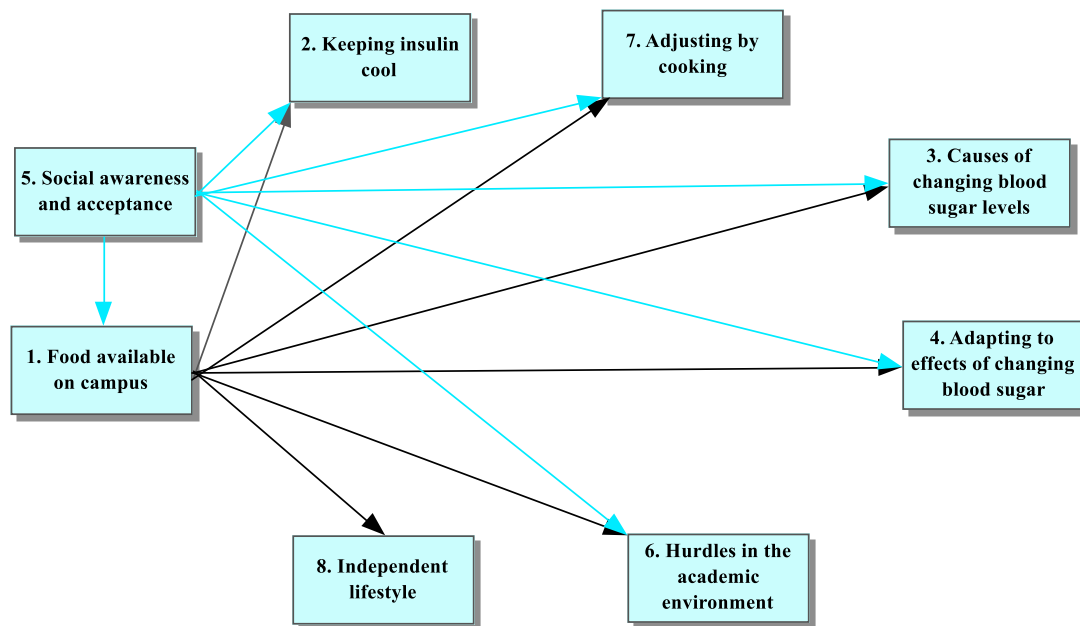


Figure 4-10: The affinities influenced by Food available on campus

4.11.2.1 Food available on campus influences Keeping insulin cool

- “Due to the food choices available on campus, (more) insulin is required during a meal.”

There is a *need* for healthier food choices on campus to allow for *better* control of blood glucose levels.

What you eat on campus (healthy or not) determines what your blood sugar will be, in turn affecting how much insulin you'll need (influencing how much you bring). If the insulin is not on its correct temperature (being cool), then regardless of the food available, it's not going to matter since there would be no blood sugar control."

4.11.2.2 Food available on campus influences Independent lifestyle

- **“Due to the lack of diabetic friendly foods on campus, you are forced to adapt and live an independent lifestyle.”**

A lack of healthy food has *forced* students living with DM to increase the *need* for an independent lifestyle.

“The food available on campus teaches one about self-control that not everything can be eaten so responsibility. This forces you to take care of yourself. The lack of proper food leads you to grow up, make your own solutions, take on the responsibility yourself. My health, my responsibility. I choose not to eat SS (student centre, cafeteria on campus) food, because I want to be healthy. Therefore, I am independent. Make responsible choices regarding meals. Even though the food on campus isn’t always suitable, you have to realize it is still your own responsibility.”

4.11.2.3 Food available on campus influences Adjusting by cooking

- **“Make food at home because campus isn’t adequate to get food from.”**

The students living with DM must *adjust* their daily lives to make up for the ignorance of the campus cafeterias on DM friendly food.

“After joining the NWU in my first year and seeing the impact that SS (student centre, cafeteria on campus) meals with unknown carbohydrate indexes have on my blood glucose level I decided that it is better and healthier for me to cook, although it is more time-consuming. You learn to make your own healthy food, carry it in your own Tupperware and it teaches you to say ‘no’ to unhealthy, rather making the wise choices. With no healthy food options, you learn to cook for yourself and carry food containers everywhere on the off chance you get hungry on campus. Due to the insufficient food on campus for us, it means one must adjust by cooking and create meals more suited for oneself. Because of the food on campus, it is sometimes necessary to cook your own meals. Insufficient food on campus forces one to cook and bring own suitable food to campus. If dining halls on campus prepares vegetables with sugar, I have to cook for myself.”

4.11.2.4 Food available on campus influences Hurdles in academic environment

- **“If the food on campus affects your blood sugar negatively, it will also affect your academic performance.”**

Changes in blood sugar, caused by *poor food options* to the students living with DM on campus, negatively *influences* the mood and the performance of a student living with DM.

“Just eating the wrong food on campus can impact you in class or during a test that takes place after a mealtime. I constantly have to eat on campus before a test and if it is unhealthy it messes everything up and it affects how I take the test e.g. high sugar causes me to be tired. If you are writing test in the afternoon and have been on campus the whole day and are very hungry, are you going to eat bad food and not be hungry or eat and have a high blood sugar, both factors that influence your academic performance? Insufficient diabetic food on campus can cause stress, causing a hurdle in the academic environment. When spending the whole day on campus after having high blood sugars throughout the day, one has the need for a good meal (healthy), which isn’t always available, this can be a hurdle in the academic environment since you have to wait precious time to go home and get or make a healthy meal.”

4.11.2.5 Food available on campus influences Causes of changing blood sugar

- **“The food available on campus affects the blood sugar level to spike creating a problem for diabetics.”**

The food available on campus seems to be the *cause* of changing blood sugar in the students living with DM in campus.

“Food is one of the main factors responsible for changes in blood sugar levels. Eating right controls changes and fluctuations much better. Your diet greatly affects your blood sugar, if the food you eat (on campus) doesn’t accommodate your condition, then your BS will reflect this. Food choices will affect blood sugar, better food choices better control. The food on campus (definitely) not diabetic friendly, causes dramatic spikes in blood sugar when one needs to eat on campus. Food available on campus isn’t always suitable for diabetics and can therefore cause blood sugar levels to change negatively. Unhealthy food will lead to higher blood sugar and fluctuations that can be difficult to control. The lack of healthy and fresh food options that are diabetic friendly may cause hypes (very high blood glucose) since HighGI (high glycaemic index), high sugar and carb meals are often what you have to eat. It could also cause hypes from injecting too much for a carby (carbohydrate) meal.

4.11.2.6 Food available on campus influences Adapting to effects of changing blood sugar

- **“Better food choices, less stress and fluctuations.”**

The effects that *uncontrolled* blood sugar has on a student with DM living on campus, is partly due to *non-friendly* DM food.

“The food available (on campus) requires that you have to adapt to your changing blood sugar. As already mentioned, the food on campus causes spikes in blood sugar, which in the long run can lead to complications and affect your academic performance. You need to adapt, and maybe bring your own food for example. Insufficient diabetic friendly food on campus makes it necessary to adapt to the effects of changing blood sugar. E.g. high blood sugar due to food makes you feel irritated, so you have to learn to cope with high blood sugar. Unhealthy food leads to bad glucose levels, causing emotional stress; long-term damage on eyesight and ketones. In my opinion, if you manage your food intake correctly, the adaption to the effects of changing blood sugar levels are much easier. If the food on campus, for example cause your blood sugar levels to rise, you will have to adapt to the effect it has on you. You need to learn to adapt to the available food and select the best options.”

4.11.3 Keeping insulin cool

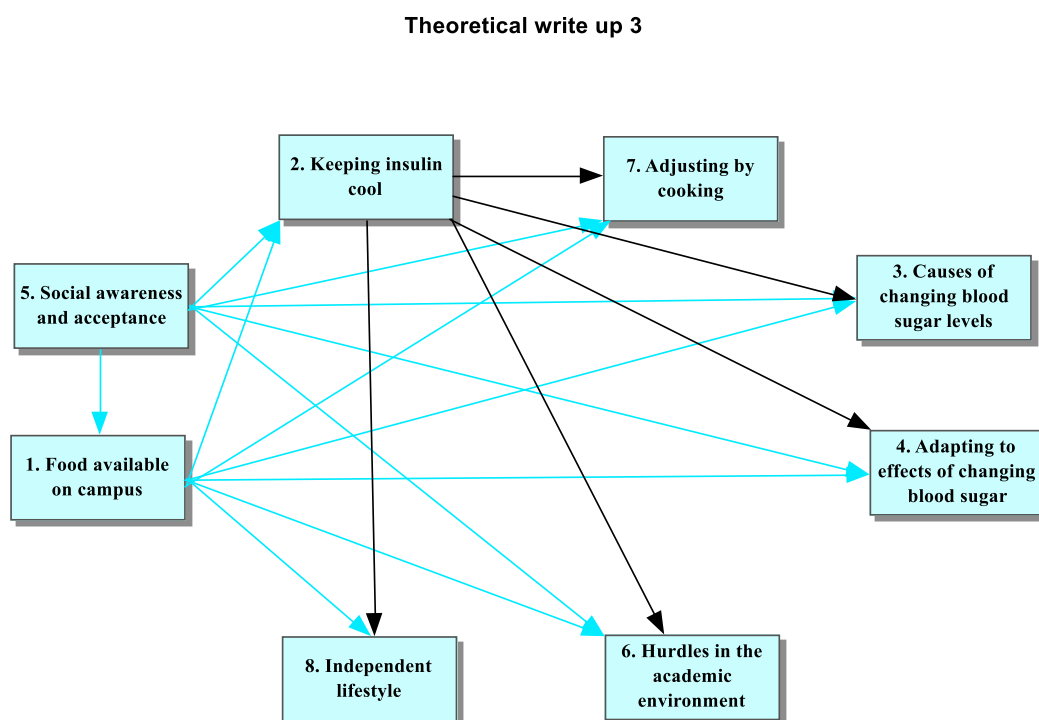


Figure 4-11: The affinities influenced by Keeping insulin cool

4.11.3.1 Keeping insulin cool influences Independent lifestyle

- **“If I don’t plan ahead on how much insulin I have to keep with me I have only myself to blame.”**

Keeping insulin cool is a *struggle* to a student living with DM, if he or she does not have a certain level of independence.

“Keeping insulin cool has an effect on independence, because having to keep insulin cool increases responsibility. It just teaches you to take the steps of responsibility and to be independent and check up on yourself.”

4.11.3.2 Keeping insulin cool influences Adjusting by cooking

- **“Adjusting by cooking is a person’s responsibility and same applies to keeping the insulin cool.”**

The *obligation* to keep insulin cool, *forces* the student living with DM to rather choose home cooked meals over those on campus.

“Adjusting by cooking that is more of self-discipline. If you want to eat on campus, you have to pack your own lunch box along with a cooler bag for the insulin.”

4.11.3.3 Keeping insulin cool influences Hurdles in the academic environment

- **“Insulin must work effectively for use, especially during tests and academic responsibilities.”**

Additional hurdles exist in the academic environment when the student living with DM has to keep insulin cool through the day.

“If insulin is not kept cool (stable) for long periods, it can influence academic performance by causing hypos (very low blood glucose) or hypers (very low or very high blood glucose) during a test and classes. I have hard days where my insulins cold chain broke despite my best efforts to keep it cool where I arrive for a test and realize that my BGL (blood glucose level) has spiked. Lecturers usually either allow you to go and get new insulin or ask you to finish writing with your hyper (very high blood glucose). In class, having to keep insulin with you all day and keeping it cold for a full day of class is not always easy especially in summer. Tests that lasts up to 3 hours needs planning according to where I am going to put my insulin etc. If my insulin is not cool enough, it will affect my academics, because I can’t concentrate very well then.”

4.11.3.4 Keeping insulin cool influences Causes of changing blood sugar

- **“If insulin isn’t kept cool your sugar will rise and become uncontrollable.”**

There is an *obligation* to keep insulin cool to ensure the effectiveness of the insulin when changes in blood glucose occur.

“If insulin can’t be kept cool, it can cause changes in blood glucose (BG) due to the changes in stability. If your insulin gets damaged by heat it will not be as effective, having an impact on your sugar levels. A fear of not having a cool place to store your insulin perhaps forces you to inject yourself with more insulin before class resulting in hypoglycaemia. It is hard to keep insulin cool on campus so that can cause a change in blood sugar, because then it is hard to inject insulin. I have a lot of classes and can’t always keep my insulin cool and that causes my blood sugar levels to rise.”

4.11.3.5 Keeping insulin cool influences Adapting to effects of changing blood sugar

- **“You have to be responsible and adopt by taking care of your insulin or else you’ll have to face the problems of your actions.”**

Keep insulin cool to make sure the *adaption* to changing blood sugar is easier to handle.

“When insulin isn’t cool and it loses its work ability, sugar rises and that leads to problems and challenges you need to learn to adapt to. If the above mentioned happens, I have to adapt to the effect it has on me, for example, low concentration levels. Frustrations of damaged insulin lead to high blood sugar levels, leading to emotional stress; pushing you to have emotional self-control. You have to be responsible and adopt by taking care of your insulin or else you’ll have to face the problems of your actions. Insulin is literally the medication that keeps me alive – it is stressful to think that heat can turn my insulin ineffective.”

4.11.4 Independent lifestyle

Theoretical write up 4

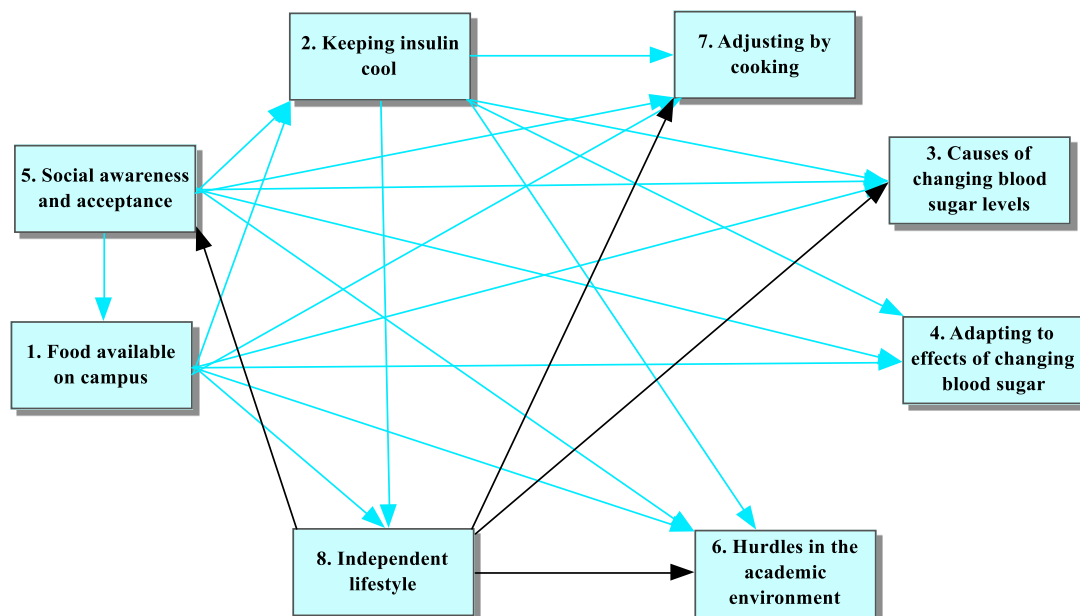


Figure 4-12: The affinities influenced by Independent lifestyle

4.11.4.1 Independent lifestyle influences Social awareness and acceptance

- “Since people are so poorly educated, I need to take responsibility for my own health.”

It is easier to *form* an independent lifestyle to *cope* with DM because society is ill informed on DM.

“I had to learn to be comfortable about my condition when it comes to other people and that it is nothing to be ashamed of. You learn to get on along easily, looking after yourself and not always relying on others as they will not always understand anyway.”

4.11.4.2 Independent lifestyle influences Adjusting by cooking

- “Because you have to grow up quickly you adapt how you prepare your food equally as fast.”

Adjusting by cooking is a *result* of forming an independent lifestyle in the ignorant community.

“I need to be healthy and therefore the need to change my cooking. I am responsible for buying my own food. Because I take responsibility for myself and my actions and life, I make healthy food for myself. Accepting your condition means better choices about 100% health and keeping everything thrill in your own bubble of being a diabetic. My condition is my own responsibility and I have to look for other alternatives sometimes, like cooking my own meals.”

4.11.4.3 Independent lifestyle influences Hurdles in the academic environment

- **“I need to look after myself to perform academically. If I do not look after myself, I cannot write test or concentrate in class.”**

The *lack* of knowledge surrounding DM, forces the student living with DM to *become* independent or lose out on academic performances as no-one else is aware.

“It is still my own responsibility to control my blood sugar even in an academic environment. You need to be in control and keep a strict watch on yourself to help limit academic hurdles caused by fluctuation in sugar levels.”

4.11.4.4 Independent lifestyle influences Causes of changing blood sugar

- **“You are independent and need to manage your disease and be aware of what affects your BG.”**

The more *independent* the student living with DM is, the *better control* there can be in managing changing blood glucose levels.

“By accepting responsibility and striving towards health, causes can be minimalized. If one could properly adapt to living independently, then causes like not knowing when to check your sugar wouldn’t occur. When one accepts that being a diabetic is not really a train smash then control the blood levels become easy. Sometimes it is so much responsibility, you never get a day off and everything you do causes blood sugar to change. I am not always 100% responsible when it comes to my blood sugar and that affects my blood sugar levels.”

4.11.5 Adjusting by cooking

Theoretical write up 5

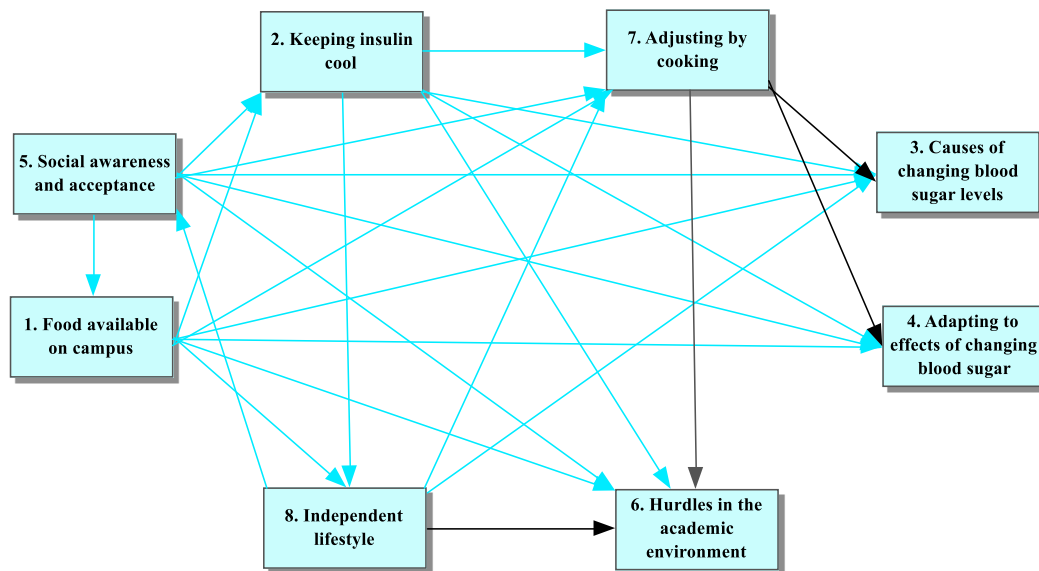


Figure 4-13: The affinities influenced by Adjusting by cooking

4.11.5.1 Adjusting by cooking influences Hurdles in the academic environment

- “Cooking is time consuming although I love and prefer cooking maybe cause the food is so much better.”

Sometimes academics get *less time* because more time is spent on cooking for oneself.

“If one decides to cook, then they can avoid hurdles like having high ketones during the school day. Cooking my own meals means controlled sugar levels and therefore better academic performance.”

4.11.5.2 Adjusting by cooking influences Causes of changing blood sugar

- “If I cook my own meals, I can control my blood sugar better”.

Cooking one’s own meals give more *assurance* of healthy living with DM than the uncontrolled blood sugar caused by foods with no index.

“The way you prepare your food and the type of food you eat directly affects your blood sugar levels. It is sometimes hard to cook 100% right because I am not well educated of what foods, other than sugars are bad for me, so my cooking can also be a reason for my blood sugar change. Not being prepared causes blood sugar to become unregulated, you don’t depend on fast food or friends. If one could start cooking more, then causes like BS (blood sugar) dropping (because of hunger) wouldn’t occur. Adjusting cooking has had positive effect on my BG levels. If you don’t take time to cook healthy meals, your sugar levels will be less stable. Meals that aren’t planned for and thus have incorrect amounts injected can influence sugar level.”

4.11.5.3 Adjusting by cooking influences Adapting to effects of changing blood sugar

- **“By cooking one’s own food, it is possible to better manage diabetes and prevent changing blood sugar levels”.**

By *adjusting* one’s lifestyle to cook for oneself, the student living with DM has *better control* and adapting skills to manage changing blood glucose.

“How you cook and prepare your food, affects the way you have to counter BSL (blood sugar levels) fluctuations. Cooking for yourself can impact the effects of decreased or increased BS (blood sugar) levels. Knowing that certain foods effect the blood sugar, it is important to cook healthy food since not all franchises accommodate diabetic people. Better cooking will help you achieve better blood sugars. If I cook my own meals. I won’t have to deal with the effects of changing blood sugar, because my blood sugar would be more controlled.”

4.11.6 Hurdles in the academic environment

Theoretical write up 6

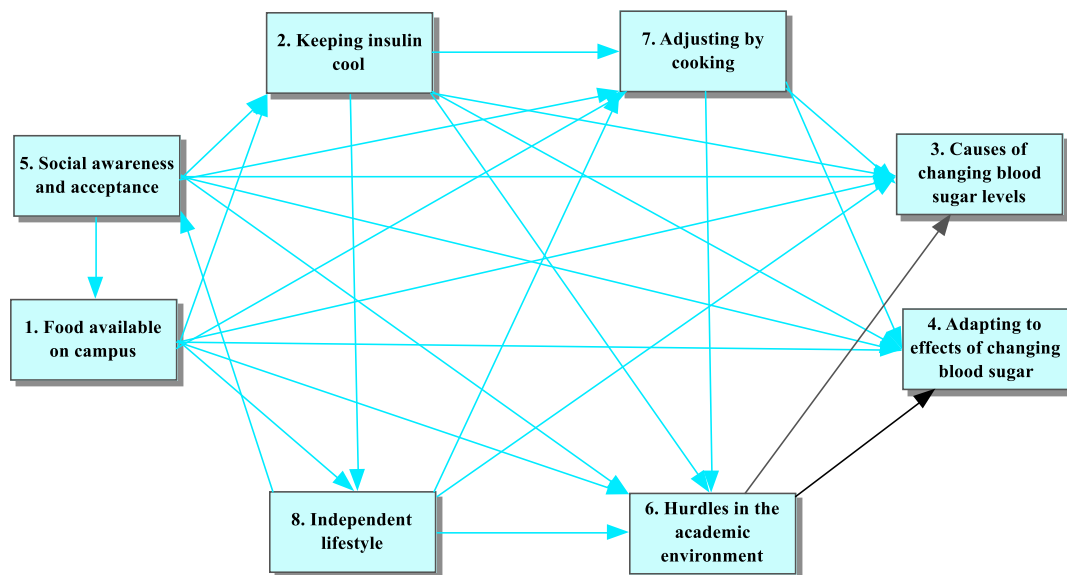


Figure 4-14: The affinities influenced by Hurdles in the academic environment

4.11.6.1 Hurdles in the academic environment influences Causes of changing blood sugar

- **“When experiencing stress in the academic environment, it directly influences your blood sugar levels.”**

The *difficulties* of academic environments and the *challenges* in these environments have significant effects on the *fluctuations* of blood sugar levels of students living with DM.

“Stress is hard to manage especially before tests. If factors like not being able to take insulin in public places weren’t an issue, then the causes like BS (blood sugar) being too high and its complications would stop considerably, e.g. not being able to eat or inject during a test is a cause of sugar being too high or low.”

4.11.6.2 Hurdles in the academic environment influences Adapting to effects of changing blood sugar

- “Hurdles in an academic environment like not being able to tend to your needs impact and can worsen the effects of changing blood sugar levels.”

The *barriers* in the academic environment *hinder* the student living with DM to adapt and act on the changing blood glucose levels.

“You always have to plan on how you will cope with a hypo (very low blood sugar) in a class or exam environment. With all these hurdles, it makes it harder to adapt to the changing of blood sugar. For me eating in class at specific times was not allowed. Because of the hurdles one is forced to adapt and to deal with reality that your sugar isn’t always perfect.”

4.11.7 Causes of changing blood sugar

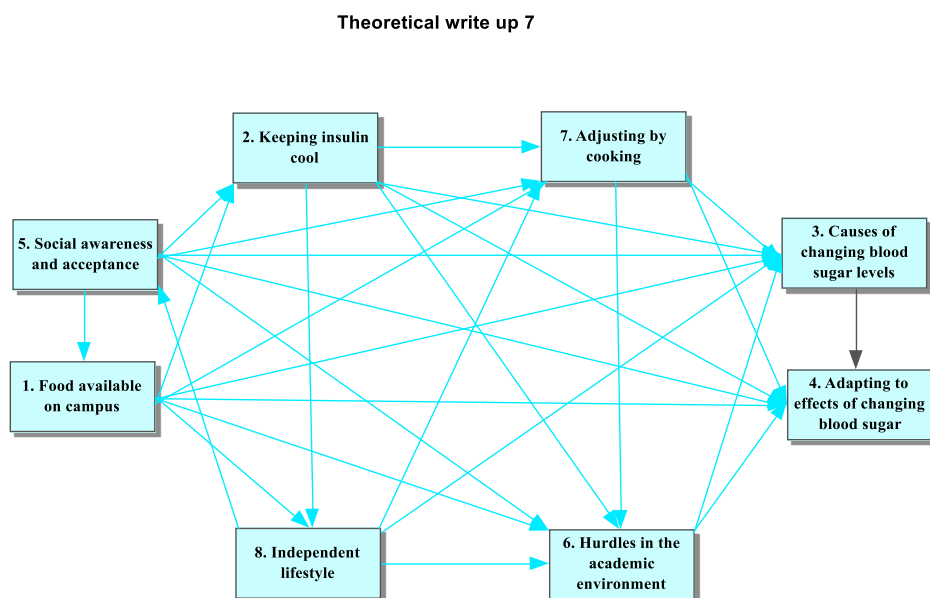


Figure 4-15: The affinities influenced by Causes of changing blood sugar

4.11.7.1 Causes of changing blood sugar influences Adapting to effects of changing blood sugar

- “You need to adapt by knowing what causes changes in blood glucose.”

When *changes* in blood glucose occur, it requires adequate and fast *adaptation*.

“The causes of change will force you to adapt quickly to the effects of change. For example, avoid SS (student centre, cafeteria on campus) food due to hyperglycaemia. It is important to identify the causes of fluctuations in blood sugar and to be able to adapt accordingly, e.g. understanding why hypos (very low blood sugar) occur at night helps one adapt to the effects of changing blood sugar, e.g. practicing emotional self-control. Knowing what causes changes in blood glucose, gives one information on how to counterattack the problems that arise with blood sugar changing. Your blood sugar will change, it will happen now and again, so you have to be able to adapt to change. If the cause of your blood sugar rising or dropping is within your control, then steps to counter the effects should be taken (NB: PREPARE!!!).”

4.11.8 Adapting to effects of changing blood sugar

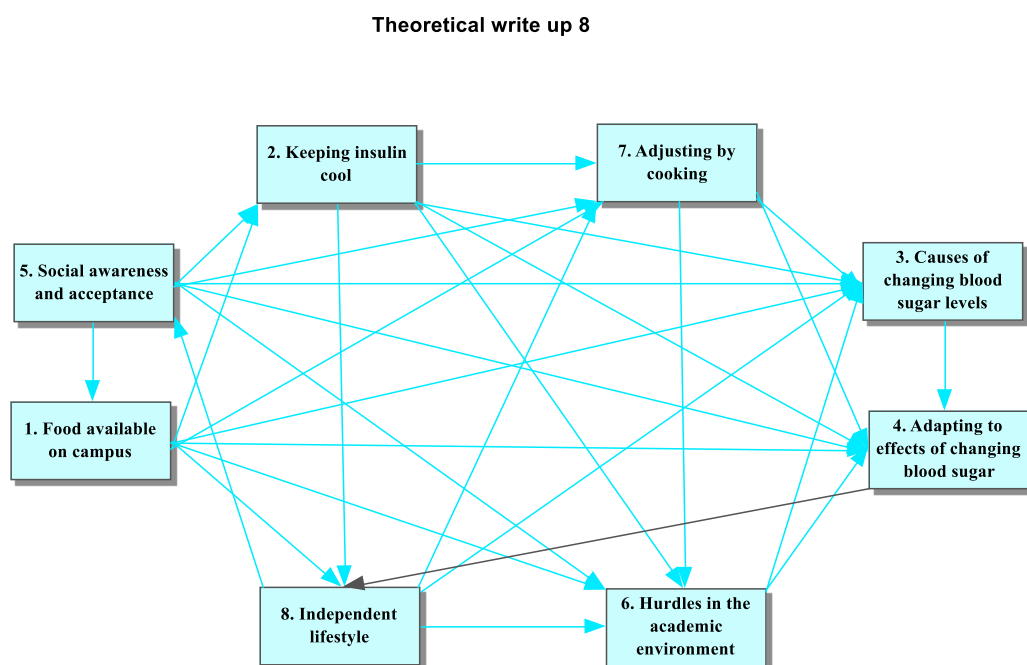


Figure 4-16: The affinities influenced by Adapting to effects of changing blood sugar

4.11.8.1 Adapting to effects of changing blood sugar influences Independent lifestyle

- **“By adapting to the effects of changing blood sugar and learning how to manage diabetes, an independent lifestyle can be achieved.”**

When a student living with DM can *adapt* to fluctuating blood glucose levels, a healthy independent lifestyle can be *lived*.

“You don’t always have someone to check upon you, so you have to deal with the effects yourself. Due to finding new ways to adapt to BSL (blood sugar level) fluctuations, it directly influences your lifestyle. You alone are responsible for the choices you make. The emotional challenges make you stronger, teaching you to accept the situation, accepting the condition and taking responsibility towards a healthy lifestyle leads to stable emotions.”

4.12 The conflicting relationships of the students’ perceptions of their self-management living with DM

In this section, the conflicting relationships that came to light for these participants are discussed.

In Chapter 3, the Pareto protocol was discussed, and more in-depth information can be found in section 4.5 as well as in Northcutt and McCoy (2016b) that was used. The Pareto protocol was used to determine the final composite system. This efficient method provides to determine the optimum number of relationships to be presented in the final system after the conflicts are discussed.

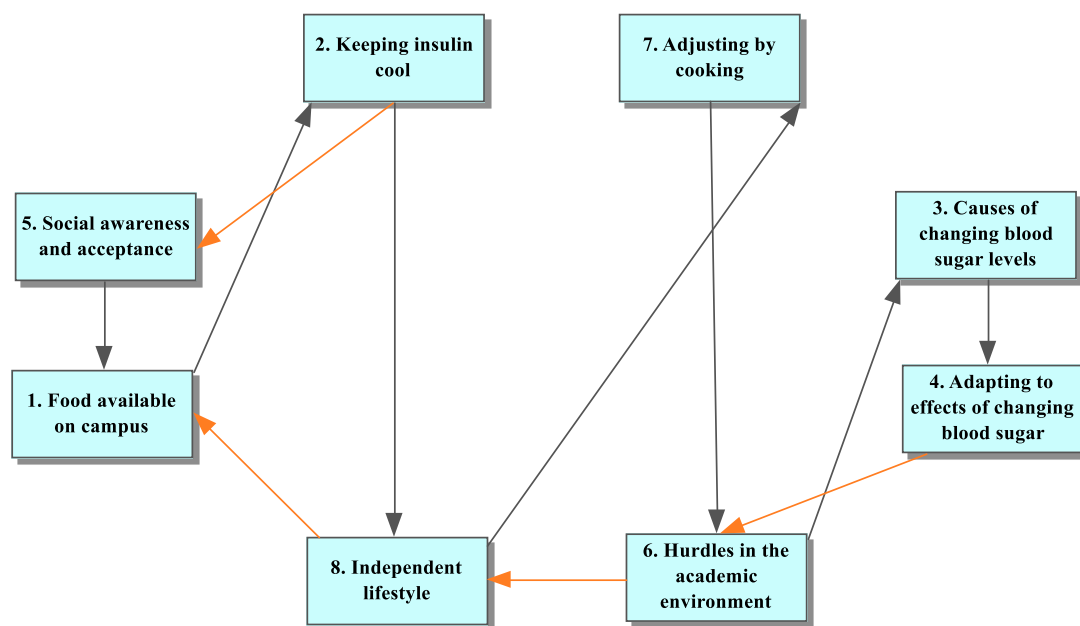


Figure 4-17: The conflicting relationship SID of students’ perceptions of their self-management living with DM on NWU Potchefstroom campus

4.12.1 Adapting to changing of blood sugar influences Hurdles in the academic environment

In certain situations, such as the classroom environment or during an exam or test, it is hard to adapt to changes of blood sugar. These negative effects that changing blood sugar levels have on the diabetic student's body, has an impact on academic performance and produces hurdles in the academic environment.

The aftermath of these changes

"The effect changing blood sugar has on me, definitely affects my academics negatively. Having hypos (very low blood glucose) or hypers (very high blood glucose) can create a number of problems and that can affect one's concentration and being in public space it becomes hard to moderate it. E.g. problems with sight causes hurdles in the academic environment."

The obstacle

"You need to learn to adapt to the hurdles in academics so that you can control blood sugar. It is not easy to adapt to changing BG during a test / exam / practical."

4.12.2 Hurdles in the academic environment influences Independent lifestyle

The hurdles in the academic environment forces one to adapt and teaches one to be independent. It teaches positive ways to manage one's DM in the academic environment or, on the other side, to feel trapped in the space of the academic environment.

Positive

"Being independent has taught me to just manage the sugar level and do what needs to be done academically."

Negative

"Being in an academic environment gives one little space to be free and be yourself."

Ill-informed academics

"Sometimes I am dependent on a doctor's letter to say that my BG was too high for me to function which has an effect on how independently I am function because I need medical doctors to back what I'm through since my lecturers don't always understand what a high BG does to my brain"

function. My department also requires a letter not just printed stats from my insulin pumps continuous glucose monitor.”

4.12.3 Independent lifestyle influences Food available on campus

Living independently goes hand in hand with better management of DM. When deciding what to eat, one decides independently on one's future and health.

Choosing health

“Part of being independent is know what to eat, so you decide that it is better to make your own food instead of buying. It is sometimes very tempting to buy macaroni casseroles at the ‘Voorhuis’ (cafeteria) or frozen yogurt at the SS when it is very hot so sometimes is the temptation too big. E.g. I have to plan to pack my own snacks where my mother used to do it.”

4.12.4 Keeping insulin cool influences Social awareness and acceptance

As society is not yet educated enough on DM, and because of the managing DM in public is not yet widely accepted, keeping insulin at hand has become a problem for students living with DM.

Adapting in public

“Always having to plan for cool storage makes you feel awkward and rejected by society due to lack of social group education.”

Judgement in public

“Keeping insulin cool has an effect on society's perception of diabetes, e.g. others not understanding the struggle of keeping insulin cool. If my blood sugar rises due to my insulin not being cool enough, I would have to adjust my insulin dosage in front of my friends. Having to carry a cooler bag all day and to plan ahead can be socially challenging as being spontaneous, going out with a group of friends is not always safe or you don't have everything with you.”

4.13 The final reconciled SID of students' perception of their self-management of DM

The final SID for the phenomenon can be seen in Figure 4.8. The system was compiled according to the guidelines of maximum communication power. The final SID was used in Chapter 5 for discussion purposes. Rigour was maintained through the use of the Pareto Protocol process, and through the work of the researcher, supervisor and Dr Danny McCoy (co-author of the Interactive Qualitative Analyses). The information from the focus group and other participants (working only on the ART) was used to formulate the systems representation or mind maps that were

topologically identical by adhering to the SID assignment protocol as the rules for rationalisation, regardless of the analyst's biases or the meaning of the elements (Northcutt & McCoy, 2004:338).

4.14 Summary and conclusion of the chapter

There were two research questions that needed to be answered. The questions are:

- First research question: What are the affinities of the system: The perceptions of self-management of students living with DM on campus;
- Second research question: What are the relationships between the affinities of the system: The perceptions of self-management of students living with DM on campus.

Both research questions were answered. The first research question was answered by the presentation of individual affinities and their descriptions. The second research question's answers were given with the relationships formed by the participants between each of the affinities. The affinities, with the summary of the affinities with definitions according to the IQA focus group protocol, and the relationships between affinities in the theoretical write-up, were described by means of narrative text, containing conclusions and meanings as were described in the participants' own words to prevent bias from the researcher.

CHAPTER 5 DISCUSSION AND INTERPRETATION OF THE SYSTEM: STUDENTS' PERCEPTUAL SYSTEM OF THEIR SELF-MANAGEMENT LIVING WITH DIABETES MELLITUS

5.1 Introduction

In Chapter 5 the researcher analyses and interprets the data from the focus group and draws conclusions from the data and results. The first section's focus is on the general description of the system and the students' perceptions of their self-management living with DM. The components of the system will be discussed.

The second section in Chapter 5 is a detailed description of each of the affinities and how these affinities interact with each other through relationships and influences in the system.

Thirdly, the researcher leads the reader through the system, explaining the position of the affinities in the system and the nature of the relationships and influences between the affinities. The system will be portrayed by visual aspects in the form of figures and tables for the reader to better see and understand the systems. Feedback loops are identified, named and observed and different views of the students' perceptions of their self-management living with DM system is observed starting from a distance and zooming in for a close-up view.

The fourth section in the chapter shows how the researcher exercises the system by giving assumptions of the drivers and the resulting outcomes. The researcher assumes the state of the outcome and predicts the state of the drivers that will produce the assumed outcome. The practical implications of the system's problems will be identified and the probable solutions to the problems will be given.

The last part of the chapter consists of the limitations of the study, the recommendations and future directions derived from this study.

5.2 General description of the system

5.2.1 The final visual representation of the system

In this section, the researcher looks at the system and each affinity that forms part of the system.

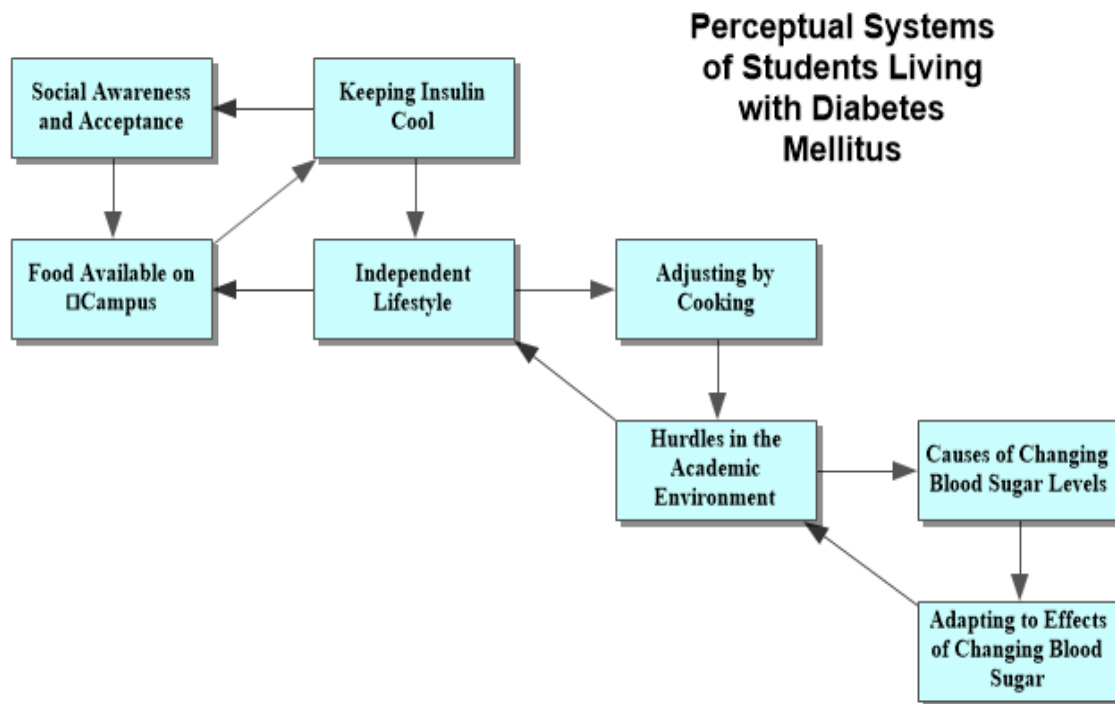


Figure 5-1: Positions and influences of affinities of the system: Students' perceptions of their self-management living with DM

5.2.2 Description of the system and affinities

The system is a representation of the results gathered from the theoretical coding coordinated through the relationships that the participants indicated for the affinities in the ART. The system has two components that make up the final representation, *id est*. the affinities and the relationships between the affinities. The affinities direct the system and influence each other (Burton, 2015:565).

The system is read from top left to the bottom right. The SID has three zones within itself. The first zone (top left) is the driver zone, the middle has both drivers and outcomes and lastly the third zone (bottom right) is the outcome zone. The system starts with Social awareness and acceptance as the primary driver and then moves to the Food available on campus, known as the second primary driver.

5.3 A tour through the system: Students' perceptions of their self-management of living with diabetes mellitus

5.3.1 Theoretical summary of the system

The system that was portrayed by the perceptions of students' self-management of living with DM can be seen in Figure 5-1. The system starts at Social awareness and acceptance and ends at Adapting to effects of changing blood sugar. The system can be utilised as a path where each of the affinities influences the next affinity. An affinity can be seen positively or negatively and can influence the experience of the next affinity (Northcutt & McCoy, 2004:333).

To understand the system, the reader must first return to the phenomenon that was part of the initial study: the perceptions of students' self-management living with DM. The primary drivers of the students' perceptions of their self-management living with DM, Social awareness and acceptance and Food available on campus, are placed in the top left corner. The Social awareness and acceptance and Food available on campus can either have a positive or a negative effect on the rest of the system. The secondary drivers, Keeping insulin cool and Independent lifestyle, is placed to the right of the primary drivers and in the middle of the system. The secondary outcomes, Adjusting by cooking and Hurdles in the academic environment, are placed in the bottom middle and top right of the system. The primary outcomes, Causes of changing blood sugar and Adapting to effects of changing blood sugar, are found at the bottom right of the system. These different SID assignments can be seen in Table 5-1 where the affinities are associated with their SID location.

Table 5-1: Assignment of affinities in topological zones (The affinities are numbered according to their SID assignments)

SID assignment		Affinities
1	Primary Driver	Social awareness and acceptance
2	Primary Driver	Food available on campus
3	Secondary Driver	Keeping insulin cool
4	Secondary Driver	Independent lifestyle
5	Secondary Outcome	Adjusting by cooking
6	Secondary Outcome	Hurdles in the academic environment
7	Primary Outcome	Causes of changing blood sugar
8	Primary Outcome	Adapting to the effects of changing blood sugar

The numbers that are used in Table 5-1 will be used for the rest of Chapter 5.

5.3.2 Different views of the reality of the system: Feedback loops, zooming and naming

A feedback loop in the general system is represented by a relationship from an affinity later in the system, back to an affinity earlier in the system (Northcutt & McCoy, 2004:30, 31). (Later means an affinity towards the outcome zones). Earlier means affinities towards the driver zones. Relationships between affinities that are recursive are known as feedback loops. According to Northcutt & McCoy (2004:30) “recursive relationships result when a relative outcome feeds back or influences the state of an element that is a relative driver”.

When the researcher zooms in and out of the system, the reader gets a better chance to view and understand the system. When zooming out the system provides progressively simpler views with less feedback loops, less branching and fewer affinities constructed (Northcutt & McCoy, 2004:335).

5.3.3 Normal view of the system: Students’ perceptions of their self-management living with DM

In Figure 5-2, the researcher looks at the system from a normal view and tries to find feedback loops that may exist in the system.

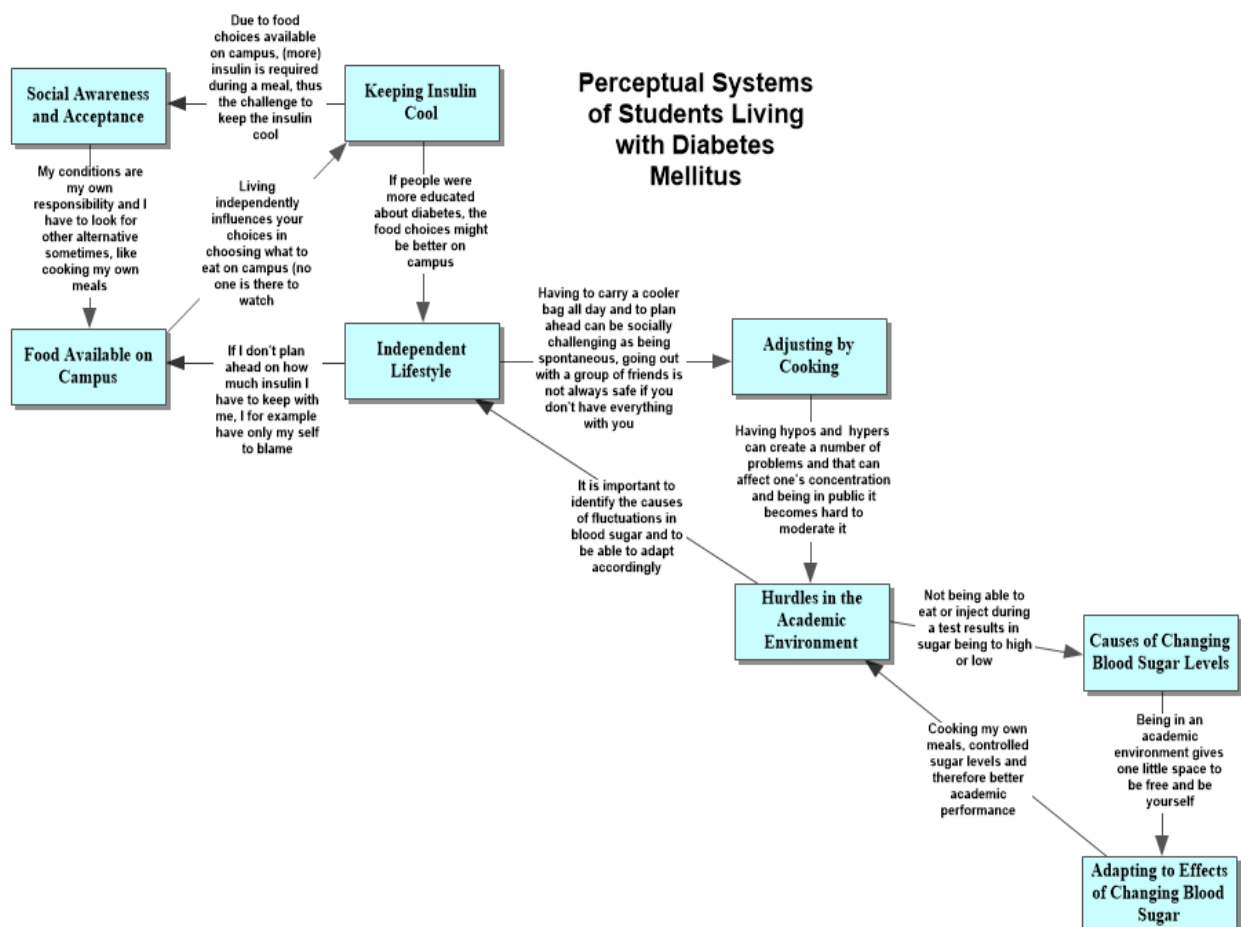


Figure 5-2 is the system from a normal view of the composite SID. The researcher found four interlocking feedback loops that exist in the system as seen in Figure 5-3. The researcher had to revisit the theoretical codes and descriptions of each of the affinities of the four feedback loops and the placement of the loops in the system and made the conclusion that these four loops can each be defined as a sub-system (Northcutt & McCoy, 2004:335). When applying this to the system the affinities of Social awareness and acceptance, Food available on campus and Keeping insulin cool (affinities 1, 2 and 3) could be replaced with a “super-affinity”. Food available on campus, Keeping insulin cool and Independent lifestyle (affinities 2, 3 and 4) could also be replaced with a “super-affinity”. Independent lifestyle, Adjusting by cooking and Hurdles in the academic environment (affinities 4, 5 and 6) and Hurdles in the academic environment, Causes of changing blood sugar and Adapting to effects of changing blood sugar (affinities 6, 7 and 8) are the last two groups to be replaced by super-affinities. These super-affinities can be seen in the intermediate view of the composite SID in Figure 5-3.

Perceptual Systems of Students Living with Diabetes Mellitus

```

graph TD
    1[1. Food Available on Campus] --> 2[2. Keeping Insulin Cool]
    1 --> 8[8. Independent Lifestyle]
    2 --> 5[5. Social Awareness and Acceptance]
    2 --> 8
    5 --> 1
    8 --> 7[7. Adjusting by Cooking]
    7 --> 6[6. Hurdles in the Academic Environment]
    6 --> 3[3. Causes of Changing Blood Sugar Levels]
    3 --> 4[4. Adapting to Effects of Changing Blood Sugar]
    4 --> 6
    6 --> 8
  
```

The diagram illustrates the Perceptual Systems of Students Living with Diabetes Mellitus, showing the relationships between eight key factors:

- 1. Food Available on Campus** (Red box)
- 2. Keeping Insulin Cool** (Red box)
- 3. Causes of Changing Blood Sugar Levels** (Pink box)
- 4. Adapting to Effects of Changing Blood Sugar** (Pink box)
- 5. Social Awareness and Acceptance** (Red box)
- 6. Hurdles in the Academic Environment** (Green box)
- 7. Adjusting by Cooking** (Green box)
- 8. Independent Lifestyle** (Blue box)

The flow of influence is as follows:

- 1. Food Available on Campus** influences **2. Keeping Insulin Cool** and **8. Independent Lifestyle**.
- 2. Keeping Insulin Cool** influences **5. Social Awareness and Acceptance** and **8. Independent Lifestyle**.
- 5. Social Awareness and Acceptance** influences **1. Food Available on Campus**.
- 8. Independent Lifestyle** influences **7. Adjusting by Cooking**.
- 7. Adjusting by Cooking** influences **6. Hurdles in the Academic Environment**.
- 6. Hurdles in the Academic Environment** influences **3. Causes of Changing Blood Sugar Levels** and **4. Adapting to Effects of Changing Blood Sugar**.
- 3. Causes of Changing Blood Sugar Levels** influences **4. Adapting to Effects of Changing Blood Sugar**.
- 4. Adapting to Effects of Changing Blood Sugar** influences **6. Hurdles in the Academic Environment**.

Figure 5-3: Intermediate view of the system: Students' perceptions of their self-management living with DM with new views

In the intermediate view (Figure 5-3) of the system (zoomed out), the four feedback loops were identified and each individual affinity were replaced by the four super-affinities (feedback loops). All four feedback loops can be seen in Figure 5-3. The loops are the Ignorance loop, Revision loop, Developing loop and Self-management loop. There are no branches between these super-affinities. These four super-affinities are interlocked at different places, namely Food available on campus; Keeping insulin cool; Independent lifestyle; and Hurdles in the academic environment. In the first loop on the top left side are the affinities Social awareness and acceptance, Food available on campus and Keeping insulin cool. Social awareness and acceptance directly influence Food available on campus, but Food available on campus indirectly influences Social awareness and acceptance through Keeping insulin cool. Independent of this feedback loop, Social awareness and acceptance, Food available on campus and Keeping insulin cool each have their own definition and are positioned in different levels in the topology of the system as either primary drivers or secondary drivers. In the feedback loop the affinities all influence each other and because of their interconnectedness, they have meaning as a dynamic set of affinities (Northcutt & McCoy, 2004:335).

In the bottom part in the top left-hand feedback loop are the affinities Food available on campus, Keeping insulin cool and Independent lifestyle. Independent lifestyle directly influences Food available on campus, but Food available on campus indirectly, through Keeping insulin cool, influences Independent lifestyle. Food available on campus, Keeping insulin cool and Independent lifestyle each have their own definition and are positioned in on different levels in the topology of the system as either primary drivers or secondary drivers. In the feedback loop the affinities all influence each other and because of their interconnectedness, they have meaning as a dynamic set of affinities (Northcutt & McCoy, 2004:335).

In the middle part of the system in the feedback loop is the affinities Independent lifestyle, Adjusting by cooking and Hurdles in the academic environment. Independent lifestyle directly influences Adjusting by cooking, but Adjusting by cooking indirectly, through Hurdles in the academic environment, influences Independent lifestyle. Independent lifestyle, Adjusting by cooking and Hurdles in the academic environment each have their own definition and are positioned in on different levels in the topology of the system as either secondary drivers or secondary outcomes. In the feedback loop the affinities all influence each other and because of their interconnectedness, they have meaning as a dynamic set of affinities (Northcutt & McCoy, 2004:335).

In the bottom right-hand side part of the system in the feedback loop is the Hurdles in the academic environment, Causes of changing blood sugar and Adapting to effects of changing blood sugar. Causes of changing blood sugar directly influences Adapting to effects of changing blood sugar, but Adapting to effects of changing blood sugar indirectly, through Hurdles in the academic environment, influences Causes of changing blood sugar. Hurdles in the academic environment, Causes of changing blood sugar and Adapting to effects of changing blood sugar each have their own definition and are positioned in on different levels in the topology of the system as either secondary outcomes or primary outcomes. In the feedback loop the affinities all influence each other and because of their interconnectedness, they have meaning as a dynamic set of affinities (Northcutt & McCoy, 2004:335).

The researcher reviewed the location of feedback loops in the topological zones of the system. The researcher's conclusion is that the affinities in the Ignorance loop involved the lack of knowledge that the community have on DM and the impact it has on students living with DM. The ignorance from the community plays a role in the way that the student must revise his/her self-management living with DM. This revision lies in the food that is available on campus and to keep insulin cool which transitions into the second loop. The Revision loop involves how the student living with DM must revise their decisions in the community to adhere to their self-management. This revision that the student does influences the skills they develop over years. The developing of these skills comes from their independence they learn from the Revision loop to the Developing loop. In the Developing loop the student living with DM must develop the skills to enhance their self-management by conforming to the standards set by the community. When the hurdles in the academic environment are adjusted to and adapted to, it influences the conforming to loop number four, the Self-management loop. The Self-management loop states the conforming of a student living with DM to adhere and enhance their self-management by adapting to the effects of changing blood sugar levels.

The first feedback loop has been named the "Ignorance loop", because of the ignorance of the community which forced a revision of the student, thus the second feedback loop has been named "Revision loop". Developing of skills is the result of the revision done by the student living with DM and the third feedback loop was named "Developing loop". The fourth feedback loop came from changes made by the students and leads to conforming to the hurdles they face and has been named the "Self-management loop".

5.3.5 Distant view (telephoto) of system: Students' perceptions of their self-management living with DM

The last view that can be seen of the system is where the four feedback loops were replaced by the four super affinities. These changes can be seen in Figure 5-4. There is a two-directional relationship between the "Ignorance loop" and the "Revision loop"; the "Revision loop" and the "Developing loop"; and the "Developing loop" and the "Self-management loop". The view in Figure 5-4 is the furthest this system can be zoomed out.

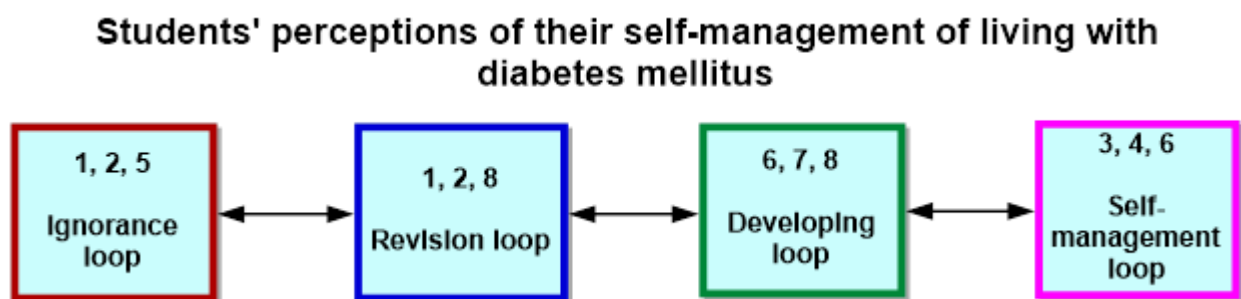


Figure 5-4: Distant view of system: Students' perceptions of their self-management living with DM

The four feedback loops are discussed in the following section.

5.3.6 Discussion of the feedback loops

In the following sections the researcher looks at scenarios in each feedback loop. In this section the participants are referred to as students. This does not include all students, just the students living with DM.

5.3.6.1 The Ignorance loop

The Ignorance loop consists of three affinities (Figure 5-3), namely Social awareness and acceptance, Food available on campus and Keeping insulin cool, as seen in (Figure 5-5).

The Ignorance loop is the focus of the system that is influenced by the lack of knowledge surrounding the community which, in return, has a big impact on the Social awareness and acceptance. In the students' perceptions of their self-management living with DM system, Social awareness and acceptance and Food available on campus plays a role as the primary drivers and Keeping insulin cool acts as the secondary driver.

The system shows the effects that the campus community have on their perceptions of their self-management as a student living with DM. The student wants to fulfil the primary outcome of the system, which is Adapting to effects of changing blood sugar in managing DM. The Ignorance loop gives an idea to the reader of how the student reacts to the community on campus and their lack of knowledge surrounding DM and how this influences their self-management tasks. The student's struggle is hardened by the ignorance that the campus shows towards DM. The student must focus on adapting to effects of changing blood sugar levels and find a way around the ignorance of the community.

Ignorance loop

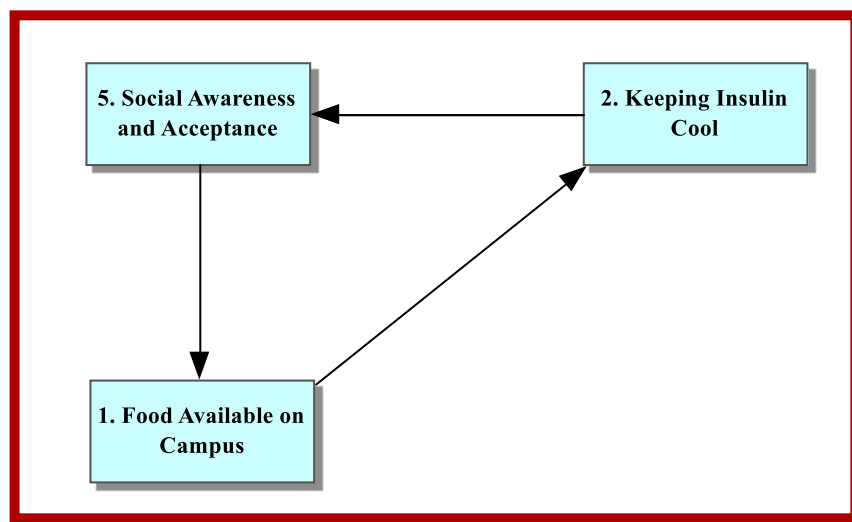


Figure 5-5: The Ignorance loop

In the following sections, the researcher will be discussing how each of the feedback loops influences each other in itself. Then the researcher will be discussing how these feedback loops influence each other.

5.3.6.1.1 Social awareness and acceptance' influence on Food available on campus

The social awareness of DM plays a big part in the daily lives of students living with DM. Because there is little awareness from the community regarding students living with DM, the community does not accommodate such students in its decisions on how to go through daily life. The lack of knowledge regarding the self-management tasks of an individual with DM influences the food that is available on campus in either the student centre (SS, cafeteria on campus) or at the five

designated cafeterias around campus. The food that is available on campus generally does not fit the nutritional requirements that a student living with DM should consume. It is either prepared in a way that is not suitable, such as deep-fried foods, too high in proteins or carbohydrates or contains ingredients that can lead to an increase in the blood glucose levels of students living with DM. Other factors are that the SS closes at 21:30 at night. Thus, if a student is either living in a hostel, with no food available, or must study till late at the library, the chances of finding something to eat in an emergency is very unlikely. The five cafeterias on campus (excluding the SS) have certain times that they are open to serve food, breakfast between 07:30 and 9:30, lunch between 10:00 and 14:00, and dinner at 16:00 till 18:30. These times restrict the students from constant access to the availability of food or drinks when they are in a hypoglycaemic state.

The other part influencing the Food available on campus in the Ignorance loop is the acceptance of DM. DM is currently the second highest cause of deaths in South Africa and still there is a stigma and a lack of knowledge regarding the disease. When it comes to the food available on campus, the cafeterias are unaware that the food they are serving does not accommodate students living with DM, and because of the lack of knowledge and stigma surrounding DM, the cafeterias only focus on the sugar in the food being unhealthy, rather than the types of food that can also, negatively, effect the blood glucose levels of the student living with DM. They find it hard to accept that sugar is not the biggest problem that students living with DM are facing when it comes to selecting their meals.

In the focus group, a participant stated that *“there are not diabetic friendly food available at all”*. But with that, the participant said, *“there is, but it is not sufficient”*. Certain participants’ ART’s were adamant regarding the awareness of DM and *“If people were more educated about diabetes, the food choices might be better on campus. Maybe the diabetic friendly food in the SS (in the future) should be reserved for diabetics only”*. It is like the administrators of the cafeterias are not always aware that students are struggling with their self-management of DM and *“if people were more aware of diabetic people, they would create more diabetic friendly food on campus”*.

Students living with DM have a big responsibility to manage their diet. And when their struggles get met with more struggles on campus, they need to take extra measures just to stick to their self-management. *“The SS isn’t accommodating to diabetics, but because I carb count... so sometimes... I stay close to campus, so the SS isn’t a problem for me I just walk home and I make food for myself, but then sometimes when I do eat at the SS and I eat something that isn’t diabetic friendly I have to inject for the amount of carbs that I take but then the problem comes in there isn’t a nutritional index they don’t tell you. So, then I don’t know. I am in the dark about how much insulin I have to inject. If you take up 1 unit too much... the thing is if you have a hyper (very high*

blood glucose) you don't feel it, but if you have a hypo (very low blood glucose) it takes me two, two and a half hours to feel better. So, then I can't focus in class."

5.3.6.1.2 Food available on campus has an influence on Keeping insulin cool

Insulin is a necessity in the lives of a DM patient. Classes on the NWU-Potchefstroom campus, for some students, start at 07:30 and only end at 17:30. Insulin needs to be kept below 32°C, or it loses its potency (Bahendeka *et al.*, 2019:347). Every student uses a different insulin pen and different vials and thus they work on different temperatures. Keeping insulin cool has its challenges and when it comes to the unhealthy food choices on campus and the effects it has on the students living with DM's blood glucose, insulin needs to work at an optimum level.

The times that these students spend on campus varies. Some of them live close to campus and do not have to spend lots of time on campus *"I don't have classes that long. For me it is mostly like five hours."* And when asked about where the participant lives and asking, *"you can just go home?"*: *"Yes, I live right here"*. For other students it is not that easy *"eight in the morning till late at four"*. Still some students do not have access to a shuttle service to take them home when they need to, or to take them to campus when they have to study. *"Yes, but I'm taking study time as well. I spend the entire day and night"* and that can be up to *"thirteen to fourteen"* hours. *"If my day starts at eight, I finish at nine, ten"*.

While these students are facing the hardship of dealing with their self-management on a campus, for hours in a day, that do not accommodate their dietary needs, they need to keep insulin with them to counter the effects of the food they consume on campus. *"Due to the food choices available on campus, (more) insulin is required during a meal, thus the challenge to keep the insulin cool"*. *"What you eat on campus (healthy or not) then determines how your BS will be, in turn affecting how much insulin you'll need (influencing how much you bring)"*.

When these students attend classes and are on campus the whole day due to not being able to go home, they have to face the heat on campus. And then *"the thing is also, let's say my insulin gets warm, then it is ineffective. Then it doesn't work. Then I have to get new ones"*.

5.3.6.1.3 Keeping insulin cool has an influence on Social awareness and acceptance

As been discussed, insulin needs to be available all the time for students living with DM. Insulin needs to be kept cool, especially in the summer days when temperatures in Potchefstroom can rise to an average of 32°C (Daemane *et al.*, 2010). This requires students to carry their insulin in cooler bags, which draws attention to them. Also, when they need to manage their blood glucose

levels, they need to inject themselves, sometimes in front of other people. Because of the lack of knowledge and awareness of DM, these students fall under a parade of criticism and judgement.

At first when they (other students) see your cooler bag *“you feel awkward and rejected by society due to lack of social group education”*. *“Keeping insulin cool has an effect on society’s perception of diabetes, e.g. others not understanding the struggle of keeping insulin cool”*. Being in public as a DM student and *“carrying insulin or medication adds to social awkwardness”* and when *“my blood sugar rises due to my insulin not being cool enough, I would have to adjust my insulin dosage in front of my friends”*.

5.3.6.1.4 The Ignorance loop as a negative feedback loop

The loops in the IQA methodology can be either vicious (negative) or it can be virtuous (positive) (Northcutt & McCoy, 2004:361). When the loop has a positive affinity, it makes the next affinity better and the outcome is better and positive. Sometimes the feedback loop can become negative and then a specific loop can “capture” the students and hold them captive and the loop continues to “spin” in the loop and there is no exit from the loop. This effect on the loop increases the negativity and results in a vicious cycle where every negative aspect of the affinity makes the following affinity more negative. Every cycle that follows will become more and more vicious and there seems to be no exit from this cycle and it keeps going until the loop implodes collapses and breaks. If the system breaks, the student may have an experience of poor self-management and a weak moment and refuse to or neglect their self-management. There are times when the loop can have a negative and a positive cycle. In this situation the student faces a barrier and it affects them negatively at first, but after the correct self-management technique is applied, the outcome can still be positive in the end.

To fix this negative loop, a student needs to identify the problem in each of the affinities and make the correct changes. The fix is mostly in one of the affinities preceding the loop or earlier in the loop. The fix sometimes can come from the student or it can come from an external source if the influence is towards the front or outcome of the system.

Next the researcher discusses a scenario that could arise for a student living with DM, to illustrate how a negative loop can occur. A student that lives on campus can have a meal on campus that is not (according to them) healthy for their disease, but because they need to eat they compromise and try and (without a nutritional index) determine how much insulin will be needed to cancel out the spike in blood glucose that will occur because of the meal. They may miscalculate and inject themselves with not enough insulin. The student rushes off to class and in class the student realizes that he did not inject enough insulin and feels a rise in blood glucose. The day is hot and

the insulin is not cool enough but the student does not want to leave class to go to his/her hostel for more effective insulin because the lecturer is not informed of his disease and arranged a surprise class test so he cannot leave (Hillson 2015:231). Because the student is in class and the student does not want to freak out the classmates around him/her the student cannot inject himself/herself with the less effective insulin. The student is now feeling the negative effects of hyperglycaemia, the student cannot concentrate on the test and the social awareness and lack of acceptance is restricting him from injecting insulin which would help. Even after class the student only has 10 minutes to get to his next class. The student might inject himself/herself with less effective insulin but because the student does not have enough time to get a proper meal, the student needs to grab something from the cafeteria not to go into a hypoglycaemic state, so the student eats unhealthy again, his/her blood sugar rises and the student still has not had time to go and find more effective insulin.

There are several solutions to prevent the feedback loop to spin out of control for the student. The start of the negative feedback loop is when the student had to eat on campus. The rest, from the miscalculation of the insulin, to the poor awareness and acceptance in the classroom (the community as well) worsens the situation. *"What you eat on campus (healthy or not) then determines how your blood sugar will be, in turn affecting how much insulin you'll need (influencing how much you bring)". "If the insulin is not on its correct temperature (being cool) then regardless of the food available, it's not gonna matter since there would be no blood sugar control."* If the meals were healthier or if the student decided to prepare his own meal the insulin's temperature would not need to be at optimal level (Hillson 2015:231), because it would not be needed. *"The SS (student centre, cafeteria on campus) isn't accommodating to diabetics but I carb count. I stay close to campus so the SS isn't a problem for me I just walk home and I make food for myself but then sometimes when I do eat at the SS and I eat something that isn't diabetic friendly I have to inject for the amount of carbs that I take but then the problem comes in there isn't a nutritional index they don't tell you. So, then I don't know. I am in the dark about how much insulin I have to inject. So, then I can't focus in class."* If the student prepared his/her own food or if a nutritional index is available, the student can inject the right amount of insulin. Even if the food was still a problem and the student prepared to have cool insulin, he could inject insulin that worked. Additionally, the community is unaware and uneducated on DM. If the community (the region in which a person resides in and spend most of their time) was better educated on the struggles of DM, the student could have gone out and injected himself and gone back into the classroom and continued to take the test without any problems. If the community and lecturers were educated and aware of students living with DM in their classrooms, special arrangements could have been made and the lecturer could be vigilant on their students and help them when they are in a tough situation because of their DM. *"I think when you are writing exams or*

something you have a letter you can present so when you are writing someone keeps on checking up are you still okay do you need to check you insulin cause when they see you falling asleep they can ask are you okay or when you stand up to go to your bag they understand you are taking out your insulin not taking out anything to check for answers.”

A positive situation would be where the student has good self-management, finds himself where Food available on campus is handled positively, the part of Keeping insulin cool has a positive outcome and the direction towards an Independent lifestyle in the revision loop is possible and the outcome can be reached. *“It just teaches you to take the steps of responsibility and to be independent and check up on yourself”. “Keeping insulin cool has an effect on independence – having to keep insulin cool increases responsibility.”* Keeping insulin cool plays an important role as it determines in which direction the process moves. The direction can either go back to the Social awareness and acceptance or it can move forward to Independent lifestyle in the Revision loop, a way closer to the outcome of Adapting to effects of changing blood sugar and better self-management of DM. If the student has a positive attitude towards the Food available on campus but does not have responsibility towards Keeping insulin cool through their academic day the student might find himself trapped inside the Ignorance loop and it becomes a negative cycle.

The effect and influence of Food available on campus on Keeping insulin cool that branches into the revision loop will be determined by the way the student handles his/her self-management with Food available on campus. Food available on campus plays a controlling factor as the student needs to overcome the Social awareness and acceptance of the community surrounding him/her. The Food available on campus can be the solution that is required when the student changes his/her attitude from negative to positive in the feedback loop. The lack of knowledge and acceptance towards DM in the university environment has an impact on the students’ self-management towards their DM and the student needs to do the adjustment towards his/her diet. The student needs to do the adjustment towards the affinity to make a positive change. In this to Keep insulin cool positively will have a positive impact towards the Social awareness and acceptance in the same loop. The student needs to examine the effects that the Social awareness and acceptance has on his/her self-management. This effect can either be positive or negative. The outcome of this scenario can lead to a student being adherent to his/her self-management skills.

5.3.6.2 Revision loop

The Revision loop is the second feedback loop in the system (Figure 5-3) and it consists of three affinities namely Keeping insulin cool, Independent lifestyle and Food available on campus (as seen in Figure 5-6).

In the Revision loop, the second feedback loop in the system, we see the revision that needs to be made by the students to adhere to self-management of DM. Keeping insulin cool is the starting point to this loop as well as the exit for the Ignorance group. The loop moves from Keeping insulin cool to Independent lifestyle to the final affinity Food available on campus.

Keeping insulin cool plays a big part in both the Ignorance loop and the Revision loop. Looking at the Revision loop, it is the part where the student needs to revise his/her perception on his/her life to become more disciplined in his/her self-management.

Revision loop

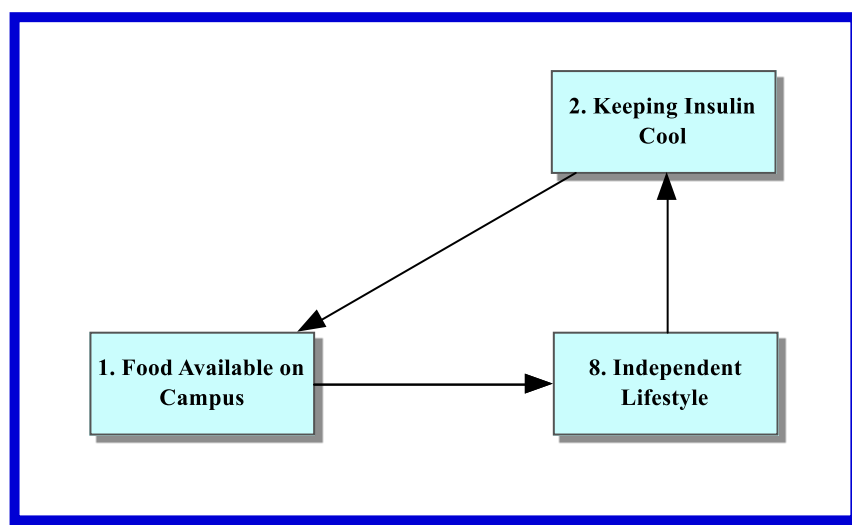


Figure 5-6: The Revision loop

5.3.6.2.1 Keeping insulin cool influences Independent lifestyle

To keep blood glucose at an optimal level is a challenge when living with DM. It takes an independent lifestyle to maintain blood glucose at optimum level. Keeping insulin cool has been an important part of being independent. When the students keep their insulin cool, they feel they have achieved a sense of independence. As seen in previous sections, other students see it as they have no choice, they need to keep their insulin cool, and it is their responsibility.

It all starts with planning for your day *“if I don’t plan ahead on how much insulin I have to keep with me I for example have only myself to blame”*. *“It just teaches you to take the steps of responsibility and to be independent and check up on yourself”* and *“having to keep insulin cool increases responsibility”* and has a positive outcome on the relationship between the affinities.

There is a hard truth that *“you have to take care of yourself. People that judge your choices based on your health, need to be educated”*.

5.3.6.2.2 Independent lifestyle influences Food available on campus

Most students, when attending university, must deal with living independently and doing everything for themselves (Hanna *et al.*, 2013b:96). The student must learn to take charge of all the self-management tasks that their parents used to do, like cooking and reminding them to take medication. A student needs to decide on buying food on campus or making food at home for themselves. Then there is the trouble of eating unhealthy food when you are surrounded by delicious, but unhealthy food daily. Sometimes the food on campus is not appropriate for a diabetic and sometimes there is not enough time to cook food at home.

According to the student the best and probably the safest option is to cook for oneself and *“part of being independent is knowing what to eat, so you decide that it is better to make your own food instead of buying”*. But time is a problem for some students and buying something between classes is the quickest way and *“living independently influences your choices in choosing what to eat on campus (no one is there to watch)”*. And when a student decides to eat something on campus *“it is sometimes very tempting to buy macaroni casseroles at the ‘Voorhuis’ (one of the cafeterias on campus) or frozen yogurt at the SS when it is very hot. So sometimes the temptation is too big”*. Some students find the time and make their own food at home to bring to campus to show their independence and increase their self-management skills. This type of student sees the Independent lifestyle in a different way *“e.g. I have to plan to pack my own snacks where my mother used to do it”*.

5.3.6.2.3 The Revision loop as a negative feedback loop

It was described before on how the feedback loops can become negative and “capture” the student in a negative cycle so that the one affinity influences the next negatively and there is no exit from this loop. This action can even push the direction back into the previous loop, thus sending the student further away from the self-management outcomes of the system.

The negative effects can also be pertained in the Revision loop. The Revision loop starts at Keeping insulin cool. This affinity influences Independent lifestyle. Independence starts when one realizes that *“it is still my own responsibility to keep my insulin cool”*. Parents are not there to accommodate you and *“you have to take care of yourself”*. If you have poor self-discipline and *“if you haven’t adjusted living independently then this might hinder the maintenance of your insulin”*. When your insulin is not managed *“it does not work, it is ineffective”*.

When their insulin does not work it has a negative impact on the Independent lifestyle, which in the Revision loop is the step to the third Developing loop, the cycle gets captured in this negative feedback loop. When the students have a poor Independent lifestyle, the choices they make regarding food becomes negative *"it is sometimes very tempting to buy"* unhealthy food and *"the temptation too big"*. When the temptation strikes and the student has a negative approach towards independence then *"some days I take just an extra unit so that I can have what they have and then I find myself in an emergency"*.

In this emergency state or negative approach to Food available on campus, insulin becomes more critical to be at optimum performance to help these students and *"if the insulin is not on its correct temperature (being cool) then regardless of the food available"* and Keeping insulin cool *"just teaches you to take the steps of responsibility and to be independent and check up on yourself"*. When the insulin is not effective it leads again to the poor and negative influence of an Independent lifestyle and the student can get locked in the Revision loop and get pushed back into the Ignorance loop from the Keeping insulin cool affinity.

In a scenario the student can find himself in a situation where he did not make food to take to campus for the day. He finds himself at lunchtime and he has only ten minutes to make it to his next class. He must eat now because his blood glucose has dropped below 3.5 mmol/L (hypoglycaemic). He rushes to the SS and gets a pie as the queue at the cooked food is too long. The pie has no nutritional index available for the student and the student is *"in the dark"* and not sure *"about how much insulin he has to inject"* and decides to inject himself with an extra unit just to make sure that he does not go too high. In class he feels bad, because *"if you take up one unit too much"* you go into a hypoglycaemic state and *"the thing is if you have a hyper (very high blood glucose) you don't feel it, but if you have a hypo (very low blood glucose) it takes you two to two and a half hours to feel better"*. The student did not buy something to assist and forgot to take a snack when he came to campus, because of his poor Independent lifestyle. He asks his friend next to him if he has something to help him with his low blood glucose. The friend is not educated on DM and gives him a chocolate. Desperate to get his/her blood glucose up again, the student eats the chocolate bar. After a few minutes his blood glucose starts to rise and he needs to act and inject insulin. The insulin started to get hot because he had no cooler bag to put it in as he felt self-conscious as *"it isn't just the cooler. It is the cold thing as well. You can't put in with your books, because it makes your books wet, then you walk around on campus and it is heavy"*. And with the insulin *"let's say my insulin gets warm, then it is ineffective. Then it doesn't work"*.

In the scenario the student could have started off by preparing food parcels to use through the day as *"the lack of proper food leads you to grow up, make your own solutions, take on the responsibility yourself"*. When the student had the responsibility to prepare food, he would have

had higher and a positive effect on Independent lifestyle and could have made the jump into the next feedback loop, the Developing loop. Even if the students had time and chose healthier food at the student centre *“my health, my responsibility. I choose not to eat SS food, because I want to be healthy. Therefore, I am independent”* and *“even though the food on campus isn’t always suitable, you have to realize it is still your own responsibility”*. With the positive effect on independent lifestyle, Keeping insulin cool will be more of a responsibility *“if I don’t plan ahead on how much insulin I have to keep with me, I for example have only myself to blame”* and *“Keeping insulin cool has an effect on independence – having to keep insulin cool increases responsibility”*. The insulin that is now cool as a positive influence from an Independent lifestyle has a positive effect on the direction of Food available on campus. Then the positive influence goes again into the Independent lifestyle. Now the Revision loop can move into the Developing loop, a step closer to Adapting to effects of changing blood sugar, the primary outcome.

5.3.6.3 Developing loop

The third feedback loop is the Developing loop (see Figure 5-3). The Developing loop has three affinities that makes up the loop in Independent lifestyle, Adjusting by cooking and Hurdles in the academic environment (as seen in Figure 5-7).

The Developing loop was formed by three affinities that came with the ability for students living with DM to do develop skills towards their self-management. These skills should be developed over the years to adapt easily to their situations and have a way to get out of the loop (Babler & Strickland, 2015:652). When considering the previous loop and the Developing loop, the reader can see that Independent lifestyle connects these two feedback loops. If the student can make a positive transition with their Independent lifestyle in the Revision loop, they can change their direction into the next loop, the Developing loop. In the Developing loop the student starts off with an Independent lifestyle, moves towards Adjusting by cooking and then reaches Hurdles in academic environment where it is possible to move into the final Self-management loop.

Developing loop

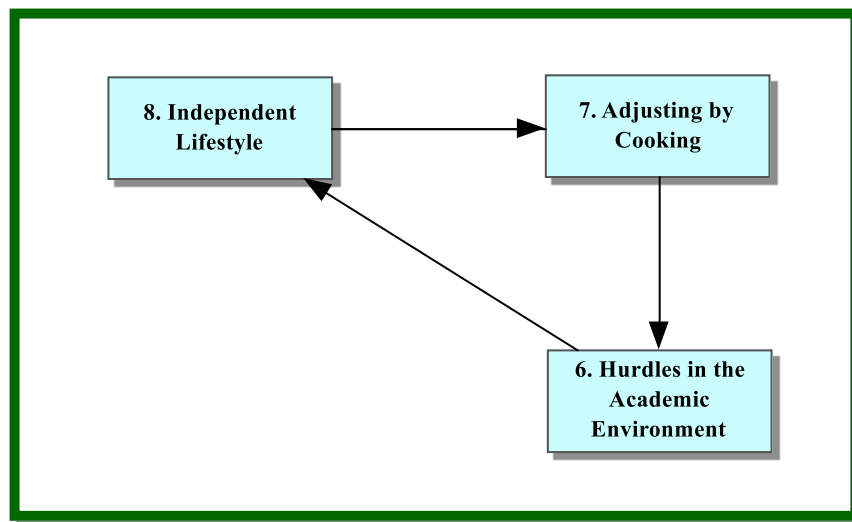


Figure 5-7: The Developing loop

5.3.6.3.1 Independent lifestyle influences Adjusting by cooking

To have an Independent lifestyle makes daily self-management tasks easier, or just more natural. Adjusting by cooking plays a part in the diet of the student on campus. It teaches them responsibility and a way of cooking food in a healthy way for themselves. In the university environment we see a lot of unhealthy options surrounding the students and to make and buy their own food they are taking charge of their own personal lives and making sure they have healthy options available for most parts of the day.

Students who have been diagnosed with DM before entering a university setup had the advantage of parents cooking their meals for them and making sure they stick to a healthy diet. However, once they exchange their home environment for university their situation changes. Becoming an independent student *“you have to grow up quickly, you adapt how you prepare your food equally as fast”*. They have control over their own future and they *“need to be healthy and therefore the need to change my cooking. I am responsible for buying my own food”*.

Adjusting by cooking and Independent lifestyle means *“accepting your condition that means better choices about 100% health and keeping everything thrill in your own bubble of being a diabetic”*. The first step is to accept their situation and accepting that *“my conditions is my own responsibility and I have to look for other alternatives sometimes, like cooking my own meals”*, because *“I have to make my food for myself – nobody is going to give me healthy meals 24/7”*.

5.3.6.3.2 Adjusting by cooking influences Hurdles in the academic environment

The students living with DM face Hurdles in the academic environment daily. And by Adjusting by cooking being a positive influencer, they can change these Hurdles in the academic environment for the good. Hurdles in the academic environment are the exit to the final feedback loop and the direction back to the Independent lifestyle. Most of the academic hurdles for students lie in the effects that unhealthy food choices have on their academic performance in the university environment. From the Independent lifestyle, Adjusting by cooking enhances the positive effects felt by the students when they cook their own meals to control Hurdles in the academic environment.

“Cooking is time consuming although I love and prefer cooking, maybe cause the food is so much better” and managing this time to cook can better the blood sugar control of the student. This Independent lifestyle change eliminates the need to obtain food from campus and lowering the effects of not nutritionally suited Food available on campus. To avoid any negative effects of campus food then *“if one decides to cook, then they can avoid hurdles like having high ketones during the school day”*. Better management of Hurdles in the academic environment, *“cooking my own meals means controlled sugar levels and therefore better academic performance”*.

“It is expensive” to eat healthy and *“buying monthly groceries and when you cook at night you create your own lunchbox while you’re cooking. That kind of saves money, cause if I cook the day before, maybe I cook let’s say a big meal and eat for that time and then I take a lunchbox and put it in the fridge and only if let’s say when there comes a day and I don’t have any money or I don’t find anything I like to go back home and eat that because I can’t risk going out for lunch and then everything will just be bad”*.

5.3.6.3.3 Hurdles in the academic environment influences Independent lifestyle

When a positive attitude is brought into an academic environment, the hurdles that will be faced will be met with a positive attitude and the Independent lifestyle will be enhanced when these hurdles are overcome. As Hurdles in the academic environment is the last affinity in the loop, a positive influence can move it back to an Independent lifestyle that will be enhanced or it can move to the next feedback loop, towards the end of the system and the primary outcome.

“Being in an academic environment gives one little space to be free and be yourself” so you have to find a way to not succumb to the disadvantages of being a student living with DM in the university environment. To do this the student needs to find that *“being independent teaches you to just manage the sugar level and do what needs to be done academically”* and *“You need to be*

in control and keep a strict watch on yourself to help limit academic hurdles caused by fluctuation in sugar levels”.

When the hurdles are present, the student needs to manage the situation in any way, for example *“sometimes I am dependent on a doctor’s letter to say that my blood glucose was too high for me to function which has an effect on how independently I am function cause I need medical doctor’s to back what I’m through since my lecturers don’t always understand what a high BG does to my brain function. My department also requires a letter not just printed stats from my insulin pumps continuous glucose monitor”.*

In the end *“I need to look after myself to perform academically. If I do not look after myself, I cannot write test / concentrate in class”* and overcome Hurdles in the academic environment.

5.3.6.3.4 Developing loop as a negative feedback loop

The Developing loop can become a negative feedback loop and just like the two previous feedback loops (Ignorance loop and Revision loop) force the system to become negative and move towards the drivers instead of moving to the primary outcome for the students in their management of DM.

This negative process starts when the Independent lifestyle from the Revision group moves into the Developing loop. Even if it came from a positive direction, the direction can still become negative and push the student back into the Revision loop again. When a student is negative in an Independent lifestyle, he/she can impact their Adjusting by cooking negatively. The students do not adjust their independence with their diet regarding their cooking, so they force a negative approach to Hurdles in the academic environment. When the Hurdles in the academic environment is met with negativity the student gets stuck in the Developing loop and cannot move towards the final Self-management loop as the direction gets thrown back to the Independent lifestyle. Now the loop becomes negative, the direction can either continue in the cycle of the Developing loop or it moves back through Independent lifestyle towards the Revision loop. Putting this description into a scenario will make the reader understand the Developing loop as a possible negative feedback loop.

Coming from the Revision loop, a student might have a positive approach to an Independent lifestyle and when this positive attitude reaches the Adjusting by cooking, it changes. The student came from a setup at home where he had his mother preparing all his food. When he woke up, she used to make his breakfast in a healthy and acceptable way to help her son in the management of his DM. She used to pack his lunchbox and insulin to prepare him for his day and

at night his meal would consist of nutritious and healthy food, acceptable for a person living with DM.

"Having to look after yourself leads to an independent lifestyle". The student then moved to a university setup where he needed to Adjust by cooking. The student needed to gain an Independent lifestyle and needed to start cooking for himself because *"nobody is going to give me healthy meals 24/7"*. Because he does not know how to cook for him and he does not have the skills and equipment, but *"cooking is an essential part of an independent lifestyle, to be independent you need to be able to look after yourself and cook to help with sugar regulating"*. Then he starts to force a negative attitude towards Adjusting by cooking. The student cannot eat healthier at home and needs to find an alternative to eating and that makes him turn to the cafeterias on campus and *"food is not friendly on campus"*.

Eating the food on campus or not preparing healthy and acceptable food at home makes the Hurdles in the academic environment negative. The student is now facing Hurdles in the academic environment that should not have been there. When the student goes into a hyperglycaemic state, they need to intervene by testing their blood glucose and administering insulin accordingly. The first hurdle is testing and *"some people are freaked out by some blood even by the tiniest amount"*. After testing your blood glucose, you need to inject insulin and *"sometimes you find that some people obviously are taken back by the fact that you are injecting yourself in a very public place so then you might want to resort to going to the restroom"*.

A short story to add to this scenario from one of the participants is *"I am very much shy about injecting in front of people. People can think what they want to. It's a drag as well because I carb count and if I go out and eat something then usually I count my carbs and then I sit there and I inject, usually in my leg not usually in my stomach, I don't like to reveal myself. One time I went to 'sêr' (serenade competition) and the 'sêr' is supposed to be my support group because it is my friends and everything and my best friends. There was this one girl, I injected in my leg because things wasn't good. Like my blood sugar was very high for some reason. I didn't know what was going on. So, I'm sitting there and injecting and she was like 'seriously? you need to do this in front of everyone?'. While I was injecting, she literally stood up and turned her back towards me, so she didn't have to see. It is this small needle and if I don't do this I'll die. So, I didn't inject in front of them again. I went to the bathroom the next time"*.

This story was shared to make the reader understand the Hurdles in the academic environment when a student needs to inject, because of a rising blood sugar level. Back to the scenario, after injecting himself, the student has to wait as *"it takes 15 minutes to start working"*. The student now struggles through the rest of the class to focus. He missed a few minutes of class, because

he had to go out to inject the insulin. The Hurdles in the academic environment now is negative. The student feels that he cannot take it anymore. He feels judged, he feels the academic strain on him and now he needs to try and manage his Independent lifestyle. His outlook on the academic environment is a negative outlook and the student gives up on trying adapting to the strains of being a student living with DM on campus.

This negative outlook on an Independent lifestyle on campus, changes the whole dynamic of the cycle in the feedback loop. He goes in circles and never escapes the feedback loop towards the final feedback loop towards the primary outcomes. He either stays stuck in the Developing loop or moves back into the Revision loop.

If the student had an Independent lifestyle that changed his whole mindset in the academic environment, he would Adjust by cooking easier, because *“if you know and have adjusted to independence then cooking for yourself wouldn’t be an issue”*. The positive movement from an Independent lifestyle now makes the Adjusting by cooking seem positive to the student. The student can now adjust his cooking by learning how to cook and gaining skills for a healthier, DM friendly diet, *“because I take responsibility for myself and my actions and life. I make healthy food for myself”*. Adjusting by cooking can now influence Independent lifestyle in a positive manner or the student can move towards the final feedback loop in the system towards self-management of DM.

5.3.6.4 Self-management loop

The final feedback loop of the system is the Self-management loop. This feedback loop consists of the three affinities of Hurdles in the academic environment, Causes for changing blood sugar and Adapting to the effects of changing blood sugar (as seen in Figure 5-8).

The Self-management loop is comprised from the affinities that makes students adapt to the barriers that surround them and perform their self-management tasks to obtain optimal blood sugar levels. The students will face Hurdles in the academic environment. These hurdles will affect the student and the student has to acknowledge the Causes of changing blood sugar levels. When they realise what these causes are, they can start Adapting to effects of changing blood sugar levels.

Self-management loop

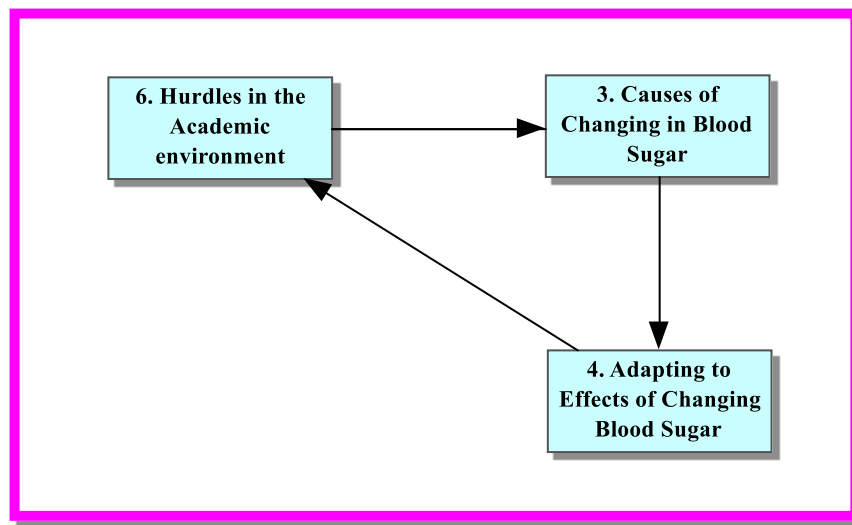


Figure 5-8: The Self-management loop

5.3.6.4.1 Hurdles in the academic environment influences Causes of changing blood sugar levels

The start of the Self-management loop is where Hurdles in the academic environment ends in the Developing loop and moves into the Self-management loop. Hurdles in the academic environment causes stress to the student and plays a part in the Causes of changing blood sugar levels. It is a task for the student to control these changes. But because the academic environment is flooded with stress, an uneducated community, uncertainty and other barriers, the students need to find a positive influence in this feedback loop.

It is not just in a test environment, but also in a normal period of distress in a classroom that “*when experiencing stress in the academic environment, it directly influences your blood sugar levels*”. And the effect of stress “*affects not just your classes, but it also affects your study time*”.

Stress in the academic environment has a “*ripple effect*”. “*You stress then it goes high. Then you stress about being stressed*”. “*When your blood sugar shoots and it seems like you are going to faint you are so tired that you can’t fall asleep, but you can’t wake yourself up and something is sitting on your shoulders and you can’t (wake up). I was in the middle of this test and this happened so I didn’t finish the test because of having this coma thing through half of the test so I was there to write the test so I couldn’t get a sick test or anything so that was very important to me and obviously I did very badly in that test*”.

It is not easy for these students to adapt to these hurdles because *“in the exam room when it’s been too high, this is disrupting how I am working now because I get very disorientated. So, I find myself not performing as I probably would perform”*.

Besides stress, other Hurdles in the academic environment can be just managing blood sugar in the academic environment. *“If factors like not being able to take insulin in public places weren’t an issue then the causes like BS being too high and its complications would stop considerably”* and *“not being able to eat or inject during a test is a cause of sugar being too high or low”*.

5.3.6.4.2 Causes of changing blood sugar levels influences Adapting to effects of changing blood sugar

The Causes of changing blood sugar levels will eventually make a student learn by Adapting to the effects of changing blood sugar, if the student applies good self-management techniques. There are two factors contributing to the changing blood sugar levels of these students living with DM. These effects can be controllable or uncontrollable for a student. Either it comes from factors on campus or from internal factors. This is the last step for the system to move to the primary outcome for self-management of a student living with DM.

The first and one of the important tasks for a student living with DM is to know that *“your blood sugar will change, it will happen now and again so you have to be able to adapt to change”*, and you need to know *“what causes the changes and what gives one information on how to counter attack the problems that arise with blood sugar changing”*.

When *“the cause of your blood sugar rising/dropping is within your control then steps to counter the effects should be taken (NB: PREPARE!!!) (prepare for any situation of changing blood sugar)”*. If *“you cause the fluctuation and you must then prepare or be able to deal with it”*.

If the causes are not in your control or the hurdles are owing to an external force, *“it is important to identify the causes of fluctuations in blood sugar and to be able to adapt accordingly. For example, avoid SS food due to hyperglycaemia”*. *“You need to learn how to adapt to all the changes in your body from high sugar and also understand why it is high”*.

5.3.6.4.3 Adapting to effects of changing blood sugar levels influences Hurdles in the academic environment

The primary outcome can still go in the direction of influencing Hurdles in the academic environment inside the final feedback loop. This will not always be a positive way to go, but it is possible to maintain a positive outlook in the final Self-management loop.

Adapting to effects of changing blood sugar levels can make the Hurdles in the academic environment less challenging if approached positively. It seems simple as *“you need to learn to adapt to the hurdles in academics so that you can control blood sugar”*, but *“it is not easy to adapt to changing BG during a test / exam / practical”*. But positive adapting can lead to better self-management of DM in a situation such as an academic environment.

5.3.6.4.4 Self-management loop as a negative feedback loop

It is possible for a student to get trapped or fall out of the final feedback loop. If the self-management loop turns into a negative feedback loop, it can propel the student out of the Self-management loop, through Hurdles in the academic environment, back into the Developing loop. The Self-management loop can also capture the student in a negative cycle and optimum self-management cannot be reached through the final and primary outcome, namely Adapting to effects of changing blood sugar.

“Hurdles in an academic environment like not being able to tend to your needs impact and can worsen the effects of changing BS levels”. And “you always have to plan on how you will cope with a hypo (very low blood glucose) in a class or exam environment” because “having hypos (very low blood glucose) or hyper (very high blood glucose) can create a number of problems and that can affect one’s concentration and being in public space it becomes hard to moderate it”.

When the student struggles with Adapting to effects of changing blood sugar and cannot change their situation they face *“a huge academic hurdle”* in *“high blood sugars, because they can knock you out for weeks at a time”*. The student then needs to *“learn to adapt because LIFE GOES ON and the world does not just stop for you cause you’re a diabetic”*. But that is not a simple task. As some students find *“it is not easy to adapt to changing BG”*. This poses to be a huge challenge to students who are either new in the university environment or to students who have been on campus for a while and still struggling to adapt. The Hurdles in the academic environment will become more demanding and multiply. These hurdles will then become so negative that it can push the student back into the Developing loop or move towards Causes of changing blood sugar levels with a negative effect. Students will struggle to figure out what the Causes of changing blood sugar are and how to manage it.

When these causes start to build up because of poor self-management the students will not find a way by Adapting to the effects of changing blood sugar levels. The students’ self-management in living with DM on campus will not be completed. They will be stuck in the Self-management loop not being able to escape or they will get pushed further back into the system, away from the primary outcome.

Plotting a scenario for the Self-management loop as a negative feedback loop will start at Hurdles in the academic environment. In a hypoglycaemic state, the student may not be allowed to eat, because it is exam time. All the students are in the exam hall and the student feels his blood sugar level dropping. Even though he knows it is dropping, he cannot test his blood glucose as there are no electronic systems allowed in the exam hall, except for calculators. The student can feel his head beginning to get sore, his eyes are starting to get blurred and he is shaking.

The student experienced stress in the lead up to the exam, because it is his final exam. Because of the stress, his blood sugar levels started to rise and he injected himself with insulin right before he entered the exam hall. Because of all the stress he decided to inject just a unit more to make sure the accumulating stress does not get his blood sugar too high. Now the insulin took effect and he cannot eat anything after his blood sugar went too low because of too much insulin.

The student knows the Causes of changing blood sugar levels, but in the current situation he cannot adapt. He tried to manage his levels in advance, but due to the university policy that states he cannot take his bag into the examination hall, there is nothing else he can do. He is falling asleep and he cannot seem to wake himself up. In this situation the student is not Adapting to effects of changing blood sugar levels. This causes more stress in the academic environment as he is too afraid to ask permission to attend to his needs as a DM student. The hurdles in the academic environment have intensified. He can now get stuck in this feedback loop or get pushed back to a poor Independent lifestyle, inside the Developing loop, with a negative effect.

In this scenario it is out of the students' control to bend the rules and use electronic devices in an exam hall, eat during an exam or even inject insulin. The student could still have managed his stress better by not injecting more insulin than was needed. While facing Hurdles in the academic environment he could have predicted the Causes of changing blood sugar levels and made sure he had preparations in place. The lecturers could have been informed of his situation. By preparing for the changes in blood sugar levels the student would have made positive strides in Adapting to effects of changing blood sugar levels and performing the tasks of self-management for a student living with DM.

5.4 Exercising the system

A part of the IQA is that the system can be exercised. By exercising the system, the researcher casts scenarios by presuming given states of the drivers and then investigating the expected results, which is known as prospective scenarios. The reverse or opposite exercise is also possible, called the retrospective scenario. In the retrospective scenarios the states of some of the outcomes are presumed. The system is examined to see what states of the drivers could have

produced the outcome. The third scenario is where the impact of a factor outside the system influences a given point in the system, the extra systemic scenario. These three scenarios to the system will be demonstrated to show the possibilities of the system.

5.4.1 Scenario 1: Optimal self-management for students living with DM

5.4.1.1 If Social awareness and acceptance were positive, what might be the outcome?

In the first scenario the researcher will look at the prospect of what if the Social awareness and acceptance was a positive driver and it did not influence the self-management of the student as the social environment will be informed. Then the researcher will explore what the result will be on the primary outcome, Adapting to the effects of changing blood sugar.

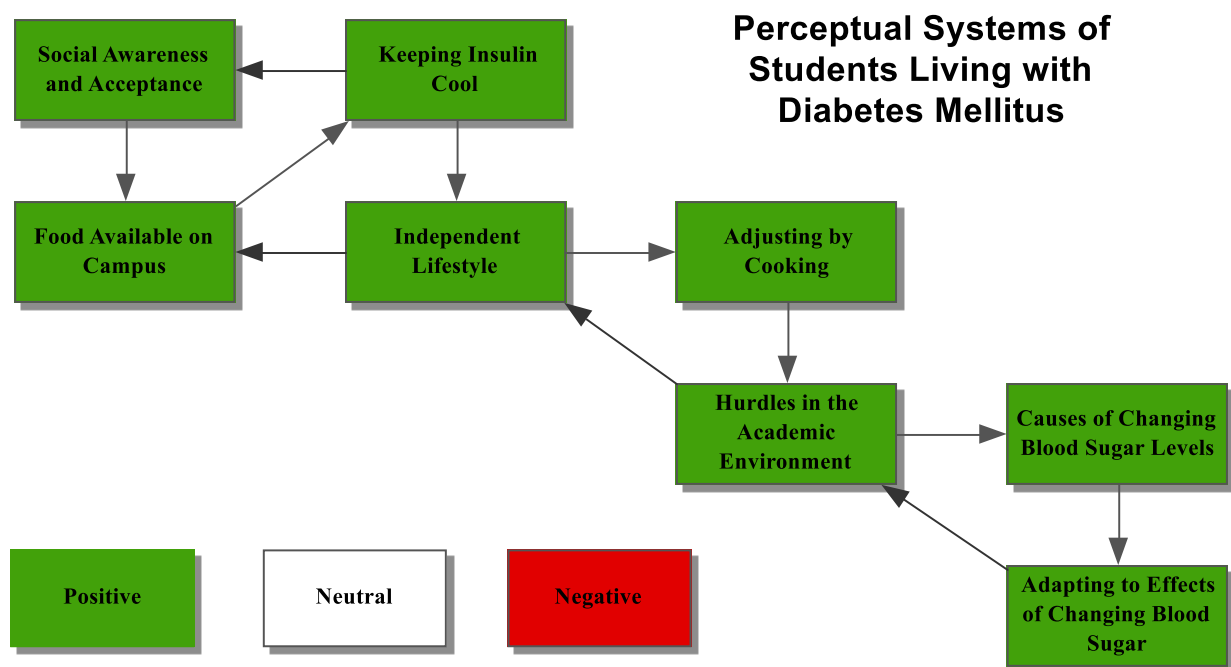


Figure 5-9: Scenario 1: Optimal self-management for students living with DM

Social awareness and acceptance is the primary driver of the system. A positive Social awareness and acceptance will have a positive impact on the rest of the system, the self-management of students living with DM on campus. It is assumed that the rest of the systems' affinities are all neutral and not in a negative state. If the other affinities were negative, then the positive influence of Social awareness and acceptance would not be able to overturn for example the Hurdles in the academic environment. The community as a Social awareness and acceptance factor could have been positive and would be well educated on the self-management tasks of a student living with

DM, but because the Hurdles in the academic environment is still negative and out of the hands of the student, the system will stay negative.

In the focus group, the participants defined Social and awareness and acceptance as “*if society was better educated about diabetics, it would be much easier to manage my life*”. In a perfect world this Social awareness and acceptance would be positive. The participants also identified a few factors that they regard to be influenced by Social awareness and acceptance.

In Figure 5-9, the ideal state of the system is represented. If we assume that all the factors mentioned by the participants were not negative, we can design and interpret the system as a positive system.

If there were more education surrounding DM, the social environment will be able to ask relevant questions to the student living with DM. Frustrating questions, such as “can you eat that”, will be eliminated and questions of changing blood sugar and how to counter them will be asked and the student living with DM will be able to feel cared for and supported.

If all of society would support the student living with DM, like their peers and families do, students with DM will feel included in all situations they find themselves in. For example, when they are at a social gathering and can drink and eat the same food as the rest of the social group and not feel left out because of the food and drink choices not accommodating them.

In diabetic emergencies, either hypoglycaemic or hyperglycaemic reactions, an educated society will either be able to assist the student or understand when they need to act as fast as possible to either lower or increase their blood sugar levels.

Social groups would not need to be kept small to accommodate the student as everybody will be educated and informed on choices to accommodate the whole group, and the social group will conform in order for everybody to fit in.

With a small group it is easier to keep your health status to yourself to avoid judgment by members of the community. In the ideal situation everybody can know your health status as a student living with DM as there will be no stigma surrounding the disease.

Sometimes the diagnoses of DM can be a big shock and adjustments need to be made by the family to accommodate the family member living with DM. There is time needed to be able to adjust. However, in the perfect world adjustments will happen naturally as no one needs to be educated before the adjustments need to take place.

Uneducated friends tend to make unintelligent comments and ask unintelligent questions. In an ideal system people will be educated about DM and no inappropriate questions will be asked, or inappropriate remarks made. The student can live a “normal DM” life and would not need to explain every decision.

Injecting insulin in public has had a lot of eyebrows raised and people reacting in disgust. In the ideal situation, injecting insulin would be acceptable and understood by the public in the same way as someone using their asthma pump.

If the public was well informed about DM, no wrong assumptions regarding DM or bad decisions by uninformed students will be made.

Testing, *id est*. pricking the finger for blood to test blood glucose levels has had people cringing as they do not like the idea of blood. For students living with DM, a community with ideal understanding of the consequences of no testing will benefit how the student handles tasks of self-management.

Not being able to eat and drink what your family and friends are enjoying can lead to a student feeling excluded, but in a system where their friends and family shows empathy towards them and understanding will help the student living with DM feel included and cared for.

Living with DM is not something students will wear on their sleeves. This means that the students on campus do not know about each other and cannot communicate with each other. If students living with DM knew about each other they could have positive interaction with other students living with DM.

In an ideal world where everyone understands DM, it will not rest on the student living with DM to educate everyone else on DM and the student would be able to live life knowing everyone surrounding him/her understood.

During the university years students experience a need to be socially active and to have friends. For a student living with DM the ideal situation will be to act as themselves around their friends and to not feel the need to act differently to make their friends feel comfortable around them.

If this perfect world that was just explained existed, the Food available on campus could be a positive factor and the student living with DM could have better self-management skills in the university environment. There would be less unhealthy food on campus and more DM friendly food options for the student living with DM to choose from and increase self-management.

The positivity towards the Food available on campus will then influence Keeping insulin cool. With better food options available, students do not need to take extra precautions when injecting insulin and thus keeping more insulin with the student becomes more bearable as the amount of insulin needed will be calculated and accounted for.

The student can now enhance his/her Independent lifestyle as the task of being independent becomes easier to maintain when the insulin is kept cool and managed through the daytime when the student is active on campus. This makes the student more independent.

Self-management becomes an easier task when a student has a positive factor in Adjust by cooking. Because the student is more independent, he/she either has an easy task of complying with cooking for himself/herself when there is enough time or knowing that the food available on campus is healthy enough to not need to cook for himself/herself.

Hurdles in the academic environment become fewer when the student gets a positive effect on Social awareness and acceptance. The hurdles, such as food available on campus and managing hypoglycaemia or hyperglycaemia in the public, are either eliminated by having healthy food options, or reacting to fluctuations in blood sugar in the moment as there is no judgement from the social groups.

With a positive flow coming from the Hurdles in the academic environment the Causes of changing blood sugar levels are handled in a positive way. Some causes will not be present as they are eliminated by previous positive influences like Food available on campus. Other factors that are driven by internal factors like emotions that cause fluctuations will be handled positively, because of positive factors such as a positive Independent lifestyle.

Adapting to effects of changing blood sugar turns positive when the Causes of changing blood sugar is positive. When the Causes of changing blood glucose are positive via elimination or better management, then Adapting to the effects of changing blood sugar becomes less complicated, because the self-management has increased through the positive system.

Unfortunately, this system might never realise. Even though Social awareness and acceptance is a primary driver for the system, the researcher is confident that the positive Social awareness and acceptance should not be the only answer for students to positively and successfully execute Adapting to the effects of changing blood sugar levels in their self-management system of living with DM.

The first scenario presented an ideal system where Social awareness and acceptance was a positive driver which led to the entire system becoming positive towards the primary outcome Adapting to effects of changing blood sugar.



The researcher will now give a second prospective scenario where the status of a secondary driver is known and tested by the possibility of “what if” and how this change will affect the system.

What will happen to the system when Independent lifestyle is negative? This scenario will portray a student that does not have an Independent lifestyle to self-manage DM.

In the second scenario, Social awareness and acceptance, Food available on campus and Keeping insulin cool are assumed to be in a neutral state.

Independent lifestyle requires an individual to be capable of doing tasks associated with DM self-management on their own. These requirements for an Individual lifestyle are required for a student if he/she wants to enhance their self-management skills. If Independent lifestyle was neutral as well, that would have indicated that the student had some sense of living an Independent lifestyle. But with a basic sense of an Independent lifestyle the student's life can be seen as quite average.

This neutral and average Independent lifestyle will in the end affect the primary outcome, Adapting to the effects of changing blood sugar levels, to also be 'just average'.

Independent lifestyle influences Adjusting by cooking. When a student is only average in Independent lifestyle skills, then the Adjusting by cooking will accept the challenge as positive and will in the end have the same effect on the Adapting to effects of changing blood sugar levels.

In reality the students do not have an average Independent lifestyle, but the student has an Independent lifestyle or no Independent lifestyle. The scenario needs to be changed to where a student does not have an Independent lifestyle. If the student then sees himself as someone with a poor Independent lifestyle, the student will not bother to adjust his/her cooking. The negative approach towards Adjusting by cooking leads to the Hurdles in the academic environment to become harder and negative. When the student experiences the Hurdles in the academic environment as negative and a barrier the Causes of changing blood sugar levels will be accepted as a negative effect from the Hurdles in the academic environment. A negative view on the Causes of changing blood sugar and not taking responsibility for actions will lead to poor Adapting to effects of changing blood sugar levels and ultimately not adhering to self-management tasks.

In the end the result is a negative Adapting to effects of changing blood sugar in the system, because of a poor Independent lifestyle that results in a student not being able to adapt to the negativity of Social awareness and acceptance and the following of poor Food available on campus.

5.4.3 Scenario 3: Uncontrollable changes in blood sugar

In the two previous scenarios, the researcher focused on the prospective scenarios of using a primary driver (Social awareness and acceptance) and a secondary driver (Independent lifestyle).

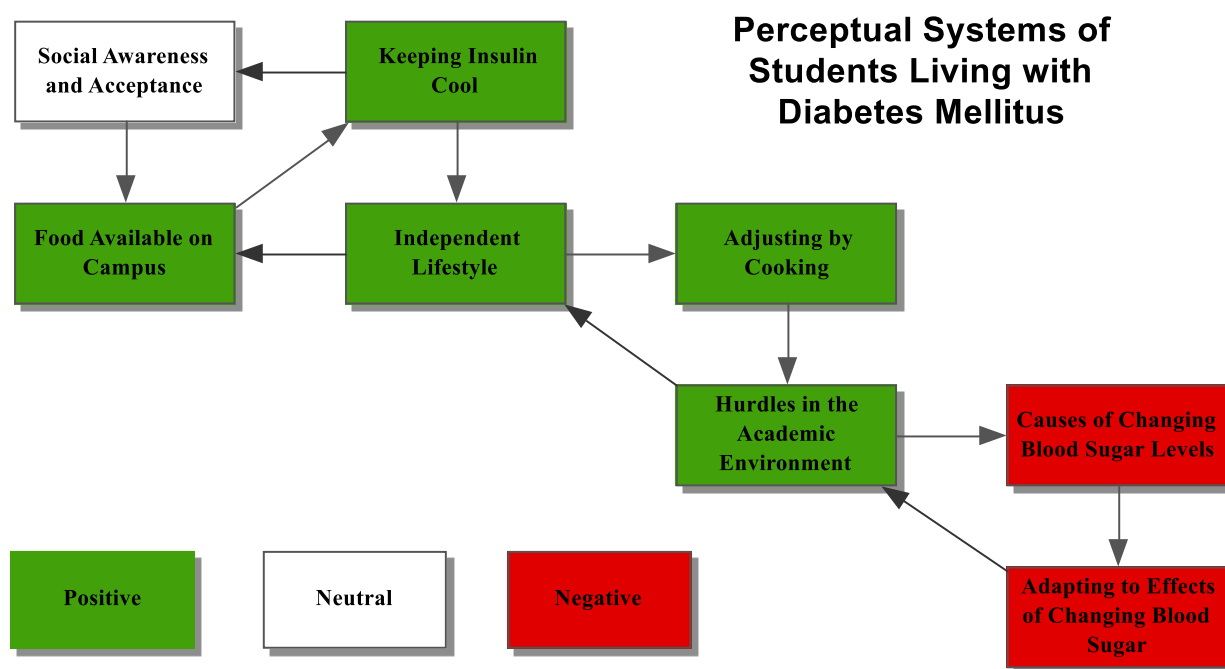


Figure 5-11: Scenario 3: Uncontrollable changes in blood sugar

In the third scenario the researcher focuses on a primary outcome, Adapting to effects of changing blood sugar, in a retrospective scenario.

5.4.3.1 If there are Causes of changing blood sugar, what are the causes that caused them?

The question can now be asked “what if the Causes of changing blood sugar is negative”. What were the situations like that could have produced negative Causes of changing blood glucose and will the consequences that follow be?

If the student living with DM cannot identify the Causes of changing blood sugar and they cannot act on the changes, they will form a negative perspective around the affinity and that will influence Adapting to effects of changing blood sugar levels negatively. The student will then not be able to control his blood sugar levels nor manage to accept or change the situation. As adapting to effects of changing blood sugar is the primary outcome of the system, if the student does not have a positive outcome, his self-management of DM will also be affected negatively.

Adapting to the effects of changing blood sugar is a part of the Self-management loop and this means that the student can try and change the negative outcome of Adapting to effects of changing blood sugar by going into the Hurdles in the academic environment. But the student, because of the negative effects of Adapting to effects of changing blood sugar, can find a barrier

towards the Hurdles in the academic environment. There was no negative influence on the Hurdles in the academic environment, but because of the inability to identify Causes in changing blood sugar and the inability to Adapt to effects of changing blood sugar, the Hurdles in the academic environment also becomes a barrier in the self-management of DM.

The Self-management loop is connected to the Developing loop via the Hurdles in the academic environment. Because of the inability to identify the Causes of changing blood glucose, the negative Self-management loop can now turn the Developing loop, consisting of Independent lifestyle, Adjusting by cooking and Hurdles in the academic environment, into a negative loop. This negative influence of Causes of changing blood glucose can turn both the Developing loop and Self-management into inescapable loops that are prone to self-destruct. Because of the inability to identify Causes in changing blood glucose, a student can face difficulty to manage an Independent lifestyle.

Independent lifestyle is also the connection between the Developing loop and the Revision loop (Independent lifestyle, Food available on campus and Keeping insulin cool). The Revision loop now has the ability to turn negative and force a trap for the student. Because of the inability for the student to identify Causes in changing blood glucose, the student struggles with the Hurdles in the academic environment. These barriers of hurdles in the academic environment hinder the student's ability to maintain an Independent lifestyle. A poor Independent lifestyle will then reduce the ability of the student in Keeping insulin cool. Keeping insulin cool is the link that can now force the system back to the start. The starting point was the Ignorance loop that consists of Social awareness, Food available on campus and keeping insulin cool.

The connection of the Revision loop to the Ignorance loop links at Keeping insulin cool. The negative process that was started at the Lack of identifying Causes of changing blood sugar making Adapting to effects of changing blood sugar difficult produced a ripple effect of negative influences that kept pushing the student backwards in the system or either locking them in a loop of self-destruction. The inability to identify Causes of changing blood sugar worsened the Hurdles in the academic environment that in return gave the student a poor independent lifestyle. The poor Independent lifestyle made Keeping insulin a struggle for the student and that effect pushed the student back to the start where Keeping insulin cool's negative influence made living in a society of uninformed students in the university environment a barrier in Social awareness and acceptance.

In this system we see that all four of the loops will turn negative if the student has a negative approach to Causes of changing blood sugar. A change in Causes of changing blood sugar from negative to positive will have a positive effect on Adapting to effects of changing blood sugar. The

positive influence of Adapting to effects of changing blood sugar will have a positive effect on the Hurdles in the academic environment that will lead to all four of the loops (Ignorance loop, Revision loop, Developing loop and Self-management loop) to turn positive.

5.4.4 Scenario 4: Adding an extra systemic factor on the system

The question that can be asked for a fourth possible scenario is “If a factor outside the system impacts at a given point how might the system react?” This scenario is called the extrasystemic scenario. The impact that an extra systemic factor might have can also be explained or predicted when we use the system. This system is based on an individual student living with DM and the change that the extra systemic factor brings, is a previously unknown factor to the student and the self-management of his/her DM.

The factor can come into the system, either as a positive or a negative factor, at any given loop. For this example, the factor will come into the system at the Ignorance loop at the Food available on campus. The factor will come in when a student faces a situation where he/she is trapped on campus in an emergency and all the cafeterias have closed. This factor can have a positive or a negative influence on the food available on campus. And as previously discussed, Food available on campus can influence Keeping insulin cool either negatively or positively. Keeping insulin cool is the binding between the Ignorance loop and the Revision group. The factor now influences the Revision loop in a positive or negative way and at the crossing between the Revision loop and the Developing loop, the factor influences Independent lifestyle. The factor now moves down the system from the Developing loop and moves into the Self-management loop where it can have an influence, positive or negative, on the primary outcome, Adapting to effects of changing blood sugar.

5.4.5 Conclusion of scenarios

The student does not have any control over Social awareness and acceptance. The lack of education regarding DM is a primary driver and the influence of this affinity can alter the rest of the system. But if the student can look at Social awareness and acceptance in a positive way and focus on an Independent lifestyle and Hurdles in the academic environment, the student can have a positive outcome in the system.

Identifying and acting towards Causes of changing blood sugar plays a big part in the outcome of the system. If the student living with DM can continue to develop the correct skills for a positive influence from Causes of changing blood sugar to Adapting to effects of changing blood sugar, the student’s self-management of DM can improve.

5.5 Predictions, Interventions and Practical implications

In the following section the researcher explores possible problems arising from the system for students' self-management living with DM. The researcher also tries to find possible solutions to these problems. It is important to notice that all the problems and solutions were formulated by the inputs from the participants and the interpretations of the researcher. When finding solutions, it is important to know that all the affinities in the system work towards a phenomenon and that the assumption of one problem and the focus of one solution must be avoided at all costs.

The research that is being done can help the students better manage their DM and to try and find solutions to the barriers they face on campus to assist with the students' self-management of DM.

5.5.1 The Ignorance loop

In the Ignorance loop, Social awareness and acceptance and Food available on campus are the two primary drivers of the system. As Social awareness and acceptance is the entry point for a student into the system, the researcher uses this as the starting point, thus saying that Social awareness and acceptance has an influence on the rest of the system through Food available on campus and Keeping insulin cool. Social awareness and acceptance can have a big impact on the system for example, when a student is in an exam room and feels his blood sugar levels are dropping rapidly and needs to react and 'fix' the low blood sugar level. This can be an indication that the student is not in control of his self-management even though he adapted to the situation and injected insulin before the exam to counter the stress, and even if the student did know the cause of his/her changing blood sugar levels.

There are other social factors that might arise and influence the system negatively, that do not require action at that exact moment, but that can hinder the system. Examples of such factors are a student sitting with friends at a lunch table and still being able to test blood sugar and inject insulin in the bathroom; or a student fainting at a rugby or netball practice where the equipment to assist is in his/her bag and the coach is aware of the situation, but not normally the teammates. These factors will not have an immediate impact or a long-lasting impact on the student's self-management as there is a way to still apply self-management and avoid awareness.

Social awareness and acceptance can have a negative effect on the attitude of the student in a social gathering. For example, the student does not want to feel left out and decides to eat or drink something that can influence their Causes of changing blood sugar levels. They will need to adapt to these changing blood sugar levels and have a negative experience with their self-management and disease.

The following table (Table 5-2) shows some of the possible challenges the participants or students may face associated with the Ignorance loop as well as solutions that is proposed to rectify the problems. The solutions are formulated by the researcher and the participants themselves.

Table 5-2: The Ignorance loop problems and possible solutions

Problem	Solution
1. I cannot test my blood sugar inject myself with insulin in front of the general public	1. Educate society on the topic of DM and its associated tasks of self-management
2. I find it difficult to adhere to a healthy diet on campus	2. Raise awareness of the diets that are acceptable and the diets that are not acceptable
3. I get judged when I walk around with my insulin in a cooler bag	3. Planning is the key to the solution

5.5.1.1 Problems and solutions associated with Social awareness and acceptance, Food available on campus and Keeping insulin cool

The participants of the focus group have identified fourteen different ways that Social awareness and acceptance gets influenced. There are two themes from the affinity that will be discussed as problems and solutions to these problems. The themes are the acceptance of someone in the university community having DM and the lack of awareness and education of DM as a disease in the university community.

5.5.1.1.1 Problem 1: I cannot test my blood sugar or inject myself with insulin in front of the general public

The first theme is focused on the acceptance from the university community. Because of the lack of healthy food on campus, students' blood glucose levels tend to be out of control. When the students eat food that is on campus, that as mentioned has no nutritional index, they need to inject insulin. However, this is a drawback, since the students do not know how much to inject to counter the effect the food will have on their glucose levels, as there is no indication of their nutrient intake. Injecting insulin in public (for example, on campus) is not easy and many people tend to judge this process with reactions of disgust, mainly due to the sight of blood when testing blood sugar levels, or at the sight of a needle when insulin has to be administered. All this has to be done (by the student living with DM) to stay healthy and alive. One participant said that:

“If your blood sugar levels rise because of the food on campus, you would have to inject insulin and probably in front of other people”.

“If people around you are uncomfortable with blood you don’t want to test yourself and thus you can’t for example lower high blood sugar when it is needed”.

“Due to the poor social awareness we can’t always adapt to the effects of changing BG. For example, due to SS food I need to inject my insulin, but it is not acceptable to do so in class.”

This claims two things, one that the food on campus is a problem (that will be discussed later) and that there is a fear of managing in front of people, for the sheer judgment the student might receive. A student exclaimed the judgment from an uneducated society:

“I know what causes changes in my BG, but society do not support diabetics to counter these changes in all environments”.

“Some people are judgmental on our lifestyle and how we do things to cope with our blood sugar level fluctuations”

Academic environments are not accommodating to DM. Lecturers and academic staff does not have enough knowledge to make the academic environment more accommodating for DM students.

“Lecturers don’t always understand the situation and don’t always accommodate diabetics, it may be seen as an excuse as we don’t always ‘look’ sick.”

There is also a link between acceptance and awareness, not only for the fear of injecting in front of social peers for the fear of judgement, but the fear of insensitive questions they ask as well.

The lack of awareness about DM among social groups on campus and the lack of knowledge regarding DM are causes for concern and lack of self-management for students living with DM. Because the society is uneducated, they tend to ask questions that are either irrelevant or give inadequate comments on DM. A student mentioned that being “different” makes people react differently:

“People tend to look at you differently and take interest in your condition when you eat differently”.

The lack of awareness surrounding DM causes stress in the social environment. This is a huge issue for students living with DM. They (the students with DM) do not know what everybody (the community) will think, how they will react in certain situations and how they react to choices made by a DM student.

“Less stress about how people will treat you and respond to you will give better sugar levels”

The lack of knowledge among members of the community is causing students living with DM to think that if they are in danger, society will not know what to do and how to react in the situation (to save their lives?).

“If my blood sugar is low and I start to shake and to feel faint, it will affect people around me. They wouldn’t know what is happening.”

“If I don’t adapt to the effects it has on me, people around me won’t know what’s wrong with me and won’t know how to react.”

“If someone is emotional due to high blood sugar, then society would not necessarily understand what the cause of being emotional is.”

There is still a big gap between the awareness of DM regarding the symptoms, risk factors and lifestyle choices (Kayyali *et al.*, 2019:9). Several people believe that taking insulin is harmful for treatment of DM and that taking oral medication for DM can cause kidney damage (Alsous *et al.*, 2019:9). This belief of DM medication is harmful to the management of DM.

The demographics and lifestyle of students influences their knowledge and awareness of DM (Amankwah-Poku, 2019:244). Demographic and lifestyle factors that influence students’ knowledge of DM are their gender, degree of study, level of study, family history, maintaining a healthy diet and physical exercise.

There is a feeling of embarrassment to inject oneself with insulin in public (Abu Hassan *et al.*, 2013:170). Some fear being identified as drug abusers because of the syringes and vials. Social factors contributing to poor management are among others, stigma, family and friend, economics, work and social activities (Ellis *et al.*, 2018:6). There is a feeling of upsetting the public when injecting insulin in the open.

The lack of acceptance and awareness surrounding DM is a problem for self-management of students living with DM. Public awareness and understanding of DM should be promoted in order to understand the burdens of living with DM. Public understanding will lead to acceptance of the actions taken by DM students to manage their DM.

5.5.1.1.2 Solution 1: Educate society on the topic of DM and its associated tasks of self-management

The participants had some ideas on what can help them when they are in a difficult situation and need to act on their DM. Mostly, they stated that public awareness and acceptance are factors which will help them to cope better.

If one can raise awareness of DM among the campus community it can boost people's realisation that a life with DM is not simple. The daily daunting task of self-management is a huge burden and barrier for these students living with DM.

Stress plays a big part in the managing of DM, as stress is a cause of fluctuating blood sugar levels. If the stress factor can be eliminated among social groups, students living with DM will be encouraged to act without pretence. The awareness and acceptance of DM will cancel out the need for DM students to explain themselves on every choice they make and cancel the unnecessary questions the students living with DM need to face.

"If people could understand diabetes then causes arising from being with people (stress) could stop"

"Social groups need to be aware that diabetes has an emotional impact on a person."

"If social community were aware of what it means to be diabetic, they would understand the effects that go together with blood sugar levels."

Students living with DM would be able to perform better in the academic environment and during exams if personnel better understood DM.

"If lecturers and those we study with know more about diabetes the academic hurdle of being too sick due to T1DM to work efficiently could be avoided to a certain extent since understanding could lead to accommodation."

"If people could have a better understanding of diabetes then it would be easier to adapt to the effects of changing sugar levels like being able to leave when you NEED to"

"I think when you are writing exams or something you have a letter you can present so when you are writing someone keeps on checking up are you still okay do you need to check you insulin cause when they see you falling asleep they can ask are you okay or when you stand up to go to your bag they understand you are taking out your insulin not taking out anything to check for answers."

One of the best ways to lower the stigma surrounding DM and to increase the awareness and acceptance of the disease is to focus on increasing diabetes education to the general public (Liu *et al.*, 2017:33).

Schabert *et al.*, (2013:8) suggested stigma-reducing interventions:

- “The health problem itself, using strategies such as public health initiatives to promote early detection and management”;
- “The sources of stigma, or people reinforcing the stigma, using strategies such as education, protest, and social marketing”;
- “The stigmatized person/group, aiming to reduce the emotional impact of stigma through counselling, peer support groups, and therapeutic communities”; and
- “Social policy, using strategies such as advocacy, lobbying, and legislation, or research support”.

If acceptance and awareness among the campus community increases, students with DM might be accommodated in different situations, for example, during exam or test time they could be allowed to write in a separate class room to allow for eating, testing blood sugar levels and injecting insulin when and if necessary. The campus management can consider allocating certain spaces on campus to students with DM. These would be safe spaces where students can test themselves in private, and inject insulin if need be without being judged by peers.

5.5.1.1.3 Problem 2: I find it difficult to adhere to a healthy diet on campus

Adhering to a DM accommodating diet as a self-management task in a university environment is no simple task, especially when surrounded by peers living a “normal” life, and when nutritional options for students with DM are few or non-accommodating.

“Food is one of the main factors responsible for changes in blood sugar levels. Eating right controls changes/fluctuations much better.”

“The food on campus (definitely) not diabetic friendly, causes dramatic spikes in blood sugar when one needs to eat on campus.”

Students finding themselves in a situation where they have to take in food, at least wants to see a nutritional index, to be aware of how much insulin will be needed to manage blood sugar levels in due time before reaching hyperglycaemia.

“Availability of food on campus can be a cause of changing in blood sugar because if you eat something at the SS or ‘Voorhuis’ (cafeteria) that has not a food index and there is something in

that can increase your blood sugar it is not entirely your fault because you were unaware of what was in there.”

“Incorrect food leads to unstable sugars; not providing food indexes makes injecting the right amount of insulin difficult.”

Maintaining a healthy diet in social situations is hard to accomplish. It goes hand in hand with the social awareness and acceptance, however, the main focus is still that the food available on campus does not cater for a student with DM. Such a student’s choice for food is limited, and he cannot eat at the same places as his friends.

“More food choices lead to better social environment eating with friends.”

“You can’t always go out and eat what your friends are eating; by you not eating or eating very little because of lack of availability, you receive comments or questions.”

Some students need to spend long periods of time per day on campus and some of these students do not have the facilities to go home in a rush to prepare a meal or to prepare food at home to bring along to campus. The food choices (on campus) are not suitable for students with DM and this led to poorer academic performance.

“If you are writing test in the afternoon and have been on campus the whole day and are very hungry. Are you going to eat bad food and not be hungry or eat and have a high blood sugar, both factors that influence your academic performance?”

“When spending the whole day on campus after having high blood sugars throughout the day one has the need for a good meal (healthy), which isn’t always available, this can be a hurdle in the academic environment since you have to waste precious time to go home and get/make a healthy meal.”

The feeling of eating different from other gathered overall frustration as it is seen as unfair (Breland et al., 2013:2896; Reyes et al., 2017:4).

Numerous students living with DM at university level have reported that they want to eat healthier (Hilger et al., 2017:102). The bigger part of the student population finds it easy to follow a healthy diet, especially female students. Although many students find it easy to follow a healthy lifestyle on campus, two barriers still remain, *id est.*, lack of time to prepare a healthy meal due to university commitments and a lack of healthy meals served at the university cafeteria.

Students find themselves eating at the cafeteria as a result of poor cooking skills and a lack of time to prepare healthy meals. Students lack motivation to eat healthy and they do not enjoy eating healthy as the food choices are not appetising. A lack of time is ascribed to university commitments, as well as the importance of their hobbies and other interests. Some students contribute poor eating habits to the fact that their diet changed since they moved to university, as well as having a side job. However, they also mentioned that money is not a reason for eating unhealthily.

5.5.1.1.4 Solution 2: Raise awareness of the diets that are acceptable and the diets that are not acceptable

If the awareness of DM and the dietary needs can be increased in the cafeterias, students do not need to cook for themselves anymore and can eat on campus. They can start enjoying more time with friends and feel comfortable eating with friends as they can order from the same menu which will also offer DM friendly meals.

"If people were more educated about diabetes, the food choices might be better on campus. Maybe the diabetic friendly food in the SS (in the future) should be reserved for diabetics only."

"The fact that people, even those who decide what food will be served or sold on campus lack social awareness about diabetes contributes to the lack of healthy, low-carb food options available on campus."

"If people at the SS are more aware of the struggles of people with diabetes, then there will be more food available for diabetes"

"Imagine like a banting counter."

Students living with DM need to (Di Onofrio *et al.*, 2018:5):

- Eliminate fructose from their diet;
- Need to eat at least five meals a day to maintain glycidic homeostasis; and
- Abandon sugary drinks.

The ADA (2019:S49) made special recommendations on how cafeterias can adapt their menus and cater for DM students on campus:

- Carbohydrates: getting carbohydrates from fruit, vegetables, whole grains, legumes and low-fat milk;

- Fat and cholesterol: limited saturated fats, minimize trans fats, limit dietary cholesterol and at least a meal with fish two or more times per week;
- Protein: limit protein intake for energy between 10-35%;
- Alcohol: should be avoided or limited to one drink per day.

When students can eat anywhere on campus, they will enjoy it and not feel judged. It reduces stress of not knowing what to eat or how to prepare for eating unhealthy food. With the possibility of eating with friends, you can lower the unwanted questioning from friends.

“More food choices lead to better social environment eating with friends.”

“If people were more aware of diabetes then the food available on campus would change (through faculty/student movement).”

5.5.1.1.5 Problem 3: I get judged when I walk around with my insulin in a cooler bag

Insulin is an inevitable part the life of a student living with DM. There are a lot of recommendations on how to keep insulin cool and effective. These recommendations cover keeping insulin cool for a day, but also to keep it effective as long as possible. Keeping insulin cool brings about some challenges (Hillson 2015:231), such as judgement from other students when they see someone carrying a cooler bag daily, as well as keeping the extreme heat in mind during summer. These factors contribute to a student rethinking and changing their behaviours when it comes to using their insulin and keeping it with them on campus.

“A fear of not having a cool place to store your insulin perhaps forces you to inject yourself with more insulin before class resulting in hypoglycaemia.”

“If insulin can’t be kept cool, it can cause changes in blood glucose (BG) due to the changes in stability”.

“It is hard to keep insulin cool on campus so that can cause a change in blood sugar because then it is hard to inject insulin.”

“I have a lot of classes and can’t always keep my insulin cool and that causes my blood sugar levels to rise.”

“If your insulin gets damaged by heat it will not be as effective, having an impact on your sugar levels.”

Being in a social situation where you must plan on taking insulin and storing it, you open yourself up to judgement and question from an uneducated community.

“Always having to plan for cool storage makes you feel awkward and rejected by society due to lack of social group education.”

“Keeping insulin cool has an effect on society’s perception of diabetes, e.g. others not understanding the struggle of keeping insulin cool.”

“Having to carry a cooler bag all day and to plan ahead can be socially challenging as being spontaneous, going out with a group of friends is not always safe or you don’t have everything with you.”

“People are unaware that insulin keeps me alive and that I repeatedly have to leave a social because my insulin at home needs to be injected at a certain time.”

5.5.1.1.6 Solution 3: Planning is the key to the solution

Keeping insulin cool is a self-management task that will have to be part of an independent lifestyle to students living with DM. The best solution to the barriers of keeping insulin cool is to work on the awareness and acceptance of DM as discussed in section 5.5.1.1.1 and to adhere to the recommendations of keeping insulin cool for long periods and keeping the insulin effective.

“If people were better educated, the importance of diabetics keeping insulin cool would not be a problem.”

“If the social community were aware that would likely increase the chance of having/creating long lasting temperature controller for the insulin to remain cool.”

“You have to be responsible and adopt by taking care of your insulin or else you’ll have to face the problems of your actions.”

“You are responsible for your condition. Maybe bring insulin in ice pack to keep cool. (independent of the university).”

Insulin needs to be kept cool in a refrigerator between 2°C and 8°C before use. It is important to make sure that the insulin does not freeze as it causes inactivity (Hilson, 2015:231). Insulin kept between 32°C and 37°C loses 14-18% of its potency.

When using the vials, insulin is allowed to be kept in temperatures of 20°C-25°C for up to six weeks. When the heat goes up to 30°C, the insulin vial can be used for up to four weeks. Insulin needs to be protected from direct sunlight (Bahendeka et al., 2019:346).

Insulin that gets used through an insulin pump should be discarded after 48 hours and any insulin in the pump that exceeds temperatures of over 37°C, should be discarded (Khurana & Gupta, 2019:7).

The recommendations are to keep insulin in a cooler bag to prevent the insulin from extreme heat and sunlight (Bahendeka *et al.*, 2019:350). If you are in an open area and not in a building, you must keep the cooler bag in the shade.

5.5.2 The Revision loop

The Revision loop consists of Keeping insulin cool, Independent lifestyle and Food available on campus. The researcher will now focus on the problems that arise with an Independent lifestyle and the possible solutions that could be made to assist in the Independent lifestyle of a student living with DM.

Table 5-3: The Revision loop problem and possible solution

Problem	Solution
1. I need to enhance my independence towards a healthy lifestyle living with DM	1. Diabetes self-management education is needed for the student to grow in independence living with DM

5.5.2.1 Problems and solutions associated with Independent lifestyle

5.5.2.1.1 Problem 1: I need to enhance my independence towards a healthy lifestyle living with DM

Being independent is an important skill to have when facing DM self-management. There are some effects of DM that students do not have control over. However, students need to know which factors they can control, and learn how to control these. It is important for students to learn to manage these factors independently, as no one else will help them. Such factors include factors influenced by other factors (e.g. blood sugar levels influenced by exam related stress). In this system, the students showed that all of the difficulties could be conquered if they lived independently and even though that is possible, independence is not easy and the factors that act as barriers still need to be adjusted to accommodate these students.

“Due to the lack of diabetic friendly foods on campus, you are forced to adapt and live an independent lifestyle. This forces you to take care of yourself.”

“You are responsible for your condition. Maybe bring insulin in ice pack to keep cool. (independent of the university).”

“You are independent and need to manage your disease and be aware of what affects your BG.”

“You don’t always have someone to check upon you so you have to deal with the effects yourself.”

“I had to learn to be comfortable about my condition when it comes to other people and that it is nothing to be ashamed of.”

“I need to look after myself to perform academically. If I do not look after myself, I cannot write test / concentrate in class.”

“Because I take responsibility for myself and my actions and life, I make healthy food for myself.”

For an individual living with DM, three themes have been identified, namely, taking over care, experiencing conflict with parents and realising diabetes is hard (Babler & Strickland, 2016:658). In these themes, there are conditions that prevented the transition into independence (Babler & Strickland, 2016:658):

- Fear of a needle;
- Forgetting to give insulin;
- Making judgements on insulin dosing effects outcomes;
- Feeling self-conscious or embarrassed about doing care in front of others;
- Experiencing conflict with parents occurs more when they are frequently asking about blood sugars;
- The rate of transition affects how the adolescent does (too soon, too slow); and
- Feeling that diabetes is hard when adolescents just want to fit in with peers.

5.5.2.1.2 Solution 1: Taking control as a student to grow in independence living with DM

To become independent, students need a few aspects in their lives to change. It is changes that they need to make and they need to take control over and accept their situation to become better as a person living with DM:

“Make responsible choices regarding meals.”

“You are an adult and need to take action to keep insulin cool.”

“When one accepts that being a diabetic is not really a train smash then control the blood levels become easy.”

“By adapting to the effects of changing blood sugar and learning how to manage diabetes, an independent lifestyle can be achieved.”

“If there was more awareness you wouldn’t need to live so independently, because people will understand and try to help.”

“I have to make my food for myself – nobody is going to give me healthy meals 24/7.”

“If you adapt your lifestyle for health, you won’t care what the greater community will think of you.”

Babler & Strickland came up with possibilities to increase students’ independence (2016:659):

- There is a dual purpose in the use of an insulin pump for adolescents in the improvement of independence and care, the insulin pump also has an alarm that reminds an adolescent to test their blood glucose and to use insulin;
- Making use of strategies to decrease fear of needles in assisting adolescents to successfully manage their own insulin and to increase their independence by placing their own insulin pumps;
- To assist in managing their blood glucose when they are active, they need to increase their awareness surrounding the effects that the activity has on their blood glucose;
- A productive and likable way needs to be formulated to assist adolescents in reminding them to test their blood glucose and to increase their adherence;
- Managing the correct dose of insulin will increase when there is a comfortable way to manage carb counting methods;
- Nagging between adolescents and parents tend to lower the willingness to practice care and thus the nagging needs to be lowered;
- To improve care and decrease conflict, the adolescent and parent needs to be educated surrounding DM to add knowledge to provide a smooth transition;
- Lowering the burden of DM will increase the management of DM and lower the emotional complications of DM; and
- When the trust between adolescents and their parents increase, there is a decreased need for the adolescent to lie about their blood glucose numbers.

5.5.3 The Developing loop

The Developing loop consists of three affinities of which two will be discussed. The researcher looks at two of these affinities and their potential problems and solutions. These are Adjusting by cooking and Hurdles in the academic environment.

Table 5-4: The Developing loop problems and possible solutions

Problem	Solution
1. I struggle to control my blood sugar in the academic environment	1. A student needs to avoid the hurdles with the assistance from the academics
2. Cooking for myself is not easy, I do not have time and skills	2. Learn, adjust, adapt in order to meet your personal health requirements (make it interesting)

5.5.3.1 Problems and solutions associated with Adjusting by cooking and Hurdles in the academic environment

5.5.3.1.1 Problem 1: I struggle to control my blood sugar in the academic environment

In the academic environment, a students' blood glucose does not stabilise, it keeps on changing. In this situation of being in a class- or an exam room, the student needs to manage his/her changing blood sugar. The lack of acceptance is one of the factors contributing to a student facing hurdles in the academic environment as it is frowned upon to inject insulin in front of some students. Lecturers seem to have a lack of awareness regarding students with DM in their classes. This leads to students being too afraid to ask for permission to either leave a class or an exam room to tend to changing blood sugar levels.

"The academic environment is not accommodating diabetic people or are unaware and because of that we face different kinds of situations where we are left uncomfortable."

"Not being able to eat or inject during a test is a cause of sugar being too high or low."

"Variations in BG levels and the aftermath thereof (getting sick more easily, being tired, lack of concentration, etc.) are definitely hurdles in the academic environment. Stress in the academic environment, on the other hand, also causes stress which leads to rising BG levels."

"Hurdles in an academic environment like not being able to tend to your needs impact and can worsen the effects of changing BS levels."

"For me eating in class at specific times was not allowed. For example, to eat during a test will irritate some students and will cause them to make assumptions."

"Not acceptable to inject / test during class. Causes me to go out of class (miss information) in order to check BG, due to stigma or not to disturb class."

The biggest struggle for students is to find a balance between their health and academic responsibilities. The challenge for students is characteristic to simultaneously managing their DM and finishing academic tasks (Hill *et al.*, 2013:240). One of the big effects (of DM) felt by students in the academic environment is fatigue from hypoglycaemia and hyperglycaemia.

Stress also affects DM self-management (Hill *et al.*, 2013:240). Students' A1C levels raised since joining university due to the stress associated with the university environment.

5.5.3.1.2 Solution 1: A student needs to avoid the hurdles with the assistance from the lecturers

Handling changing blood sugar levels in the academic environment is not a simple task without the help from other students and the lecturer. In both instances awareness of a student with DM is important as well as the acceptance by others when the student with DM has to tend to low or high blood sugar levels in class or during exams or even letting him/her leave class or an exam room to test blood glucose levels or inject insulin.

"If factors like not being able to take insulin in public places weren't an issue then the causes like blood sugar being too high and its complications would stop considerably."

"If lecturers and those we study with know more about diabetes the academic hurdle of being too sick due to T1DM to work efficiently could be avoided to a certain extent since understanding could help accommodation."

"Sometimes I am dependent on a doctor's letter to say that my blood glucose was too high for me to function which has an effect on how independently I am function cause I need medical doctors to back what I'm through since my lecturers don't always understand what a high BG does to my brain function. My department also requires a letter not just printed stats from my insulin pumps continuous glucose monitor."

Guidelines for classmates on how to treat a student who has DM (Chester & Auerbach, 2011:36):

- Support and encourage the student with DM by treating him/her the same as others who do not have DM;
- Be educated. The behaviour of a student living with DM is affected by changing blood sugar levels;
- Respect the privacy and confidentiality of a student in class; and
- Understand that a student living with DM needs to either check their blood sugar levels or need to eat to assist with low or high blood sugar.

Guidelines for lecturers regarding students living with DM in class and exam rooms (Chester & Auerbach, 2011:46):

- Participate in training on DM;
- Know the signs of hypoglycaemia and hyperglycaemia;
- Be supportive on the actions that a student needs to take to manage DM;
- Provide additional academic support to the student with DM, if the absence of the student is related to struggles with DM;
- Respect the privacy and confidentiality of the student; and
- Treat them the same as the other students who do not have DM.

5.5.3.1.3 Problem 2: Cooking for myself is not easy, I do not have time and skills

As mentioned in section 5.5.1.1.4, the nutritional requirements for a healthy diet for students living with DM are quite strict. Students need to adhere to the requirements of cooking within a certain nutritional frame. Such cooking requires specific skills and equipment which students might or might not have. Another challenge for self-cooking is the high cost of healthy, quality food. The last challenge and problem factor for these students is that it takes time to prepare healthy meals. With little time on their hands it is difficult to prepare daily meals.

“It is sometimes hard to cook 100% right because I am not well educated of what foods other than sugars are bad for me so my cooking can also be a reason for my blood sugar change.”

“Sometimes it is easier to buy food on campus than cook for myself because I don’t always have the time and it is difficult because there aren’t always suitable food for me on campus.”

“Because friends and family do not always understand my food requirements, I cook, I do not eat take away which people don’t always understand, but rather more expensive healthy food.”

“Time of class don’t allow for a daily routine as each day is different therefore meal planning and cooking is difficult and not always practical.”

Barriers to appropriate dietary behaviours of students living with DM can vary from (Marcy *et al.*, 2011:17):

- The excessive costs and the taste of cooking for oneself;
- Poor knowledge and commitment skills on what is needed in a proper diet (*id est.* carbohydrates and fats);
- Stress that triggers inappropriate eating; and
- Temptations on eating unhealthy food.

5.5.3.1.4 Solution 2: Learn, adjust, adapt in order to meet your personal health requirements (make it interesting)

Learning to cook for oneself and gaining the knowledge on the appropriate ingredients to a proper diet for DM management is a gap that needs to be filled by the student. If food on campus is more DM appropriate it will save time that the student needs to use in preparing own meals at home.

“If proper, diabetic foods were available, then the need to adapt to constantly cook would decrease.”

“If I cook my own meals. I won’t have to deal with the effects of changing blood sugar, because my blood sugar would be more controlled.”

“If social awareness of diabetes increased, more people / restaurants could adjust their cooking to accommodate people with diabetes.”

“You can’t just as easily eat out with friends or cheat all the time, you have to say no to friends otherwise you get tempted to be unhealthy.”

“I always have to carry an emergency snack with me during tests thus I will take it with me for example in a Tupperware into the hall.”

Learning to cook via a cooking course increases knowledge and skills (Abbott *et al.*, 2012:56). Cooking one’s own food reaps benefits of decreasing fat and salt consumption. Skills obtained from these classes include low-fat cooking techniques, hygienic food preparation, salad preparation and using a wider range of vegetables.

Through such courses students gain knowledge on how to shop for healthier food, and have a better understanding of information given on food labels (Abbott *et al.*, 2012:56). Effects of healthier cooking skills include weight-loss, improved well-being, improved DM self-management and greater motivation for other lifestyle changes.

5.5.4 The Self-management loop

In the Self-management loop we see Hurdles in the academic environment, Causes of changing blood sugar and Adapting to effects of changing blood sugar. In this feedback loop we find the two primary outcomes of the system. As Adapting to effects of changing blood sugar levels is the final step in completing the system, the researcher will view this as the exit point and final step.

Table 5-5: The Self-management loop problems and possible solutions

Problem	Solution
1. Almost everything contributes to blood sugar variation	1. Identify the triggers of changing blood sugar
2. Struggling to adapt to the effects that changing blood sugar has on the body	2. You have to understand the causes and effects and learn to counter them

5.5.4.1 Problems and solutions associated with Causes of changing blood sugar and Adapting to effects of changing blood sugar

5.5.4.1.1 Problem 1: Almost everything contributes to blood sugar variation

Blood sugar can change at any time. In the most uncertain times, a student living with DM can experience changes in blood sugar levels due to any external or internal factor. The student needs to identify factors that can cause these changes in order to prevent the changes where possible. Influencing factors include food choices, stress, emotions such as happiness and sadness, exercise and not adhering to medication use.

“Your blood sugar will change, it will happen now and again, so you have to be able to adapt to change.”

“You need to learn how to adapt to all the changes in your body from high sugar and also understand why it is high.”

“Stress due to the lack of social awareness about diabetes, especially under academic staff, may also cause variations in BG levels.”

“When experiencing stress in the academic environment, it directly influences your blood sugar levels.”

“Not being prepared causes blood sugar to become unregulated don’t depend on fast food or friends.”

“You are independent and need to manage your disease and be aware of what affects your BG.”

Factors that can contribute blood sugar to rise (ADA, 2018b:202):

- Eating food that has more carbohydrates than usual;
- Inactivity;

- Not adhering to medication use;
- Side-effect caused using other medication;
- Hormones related to healing the body when you are sick;
- Stress that releases hormones that raise blood sugar;
- Any short-term or long-term pain;
- Changes in hormones associated with menstrual periods; and
- Dehydration.

Factors that can contribute to blood sugar to fall (ADA, 2018b:202):

- Missing meals or eating foods with a lower carbohydrate index;
- Alcohol;
- Too much insulin or other diabetic medication;
- Side-effects caused by other medications; and
- Too much exercise, more than usual, can make the body more sensitive to insulin and lower blood sugar.

5.5.4.1.2 Solution 1: Identify the triggers of changing blood sugar and counter them

To know the causes of changing blood sugar levels can give a student living with DM the ability to either react to these changes with appropriate counter actions. Knowing what causes changes in blood sugar levels can teach a student living with DM to avoid the causes as much as possible and knowing what causes changes in blood sugar can help the student develop adapting skills to understand and accept the changes.

“You need to adapt by knowing what causes changes in BG. For example, avoid SS food due to hyperglycaemia.”

“Your blood sugar will change, it will happen now and again, so you have to be able to adapt to change.”

“It is important to identify the causes of fluctuations in blood sugar and to be able to adapt accordingly.”

“If the cause of your blood sugar rising/dropping is within your control then steps to counter the effects should be taken (NB: PREPARE!!!).”

“If factors like not being able to take insulin in public places weren’t an issue then the causes like BS being too high and its complications would stop considerably.”

“Not being prepared causes blood sugar to become unregulated don’t depend on fast food or friends.”

“By accepting responsibility and striving towards health, causes can be minimized.”

After attending a self-management education class, some factors in the lifestyle of patients living with DM changed. Changes need to be made and such changes need to be maintained. Three factors are needed in order to make changes: Obtain new knowledge, Taking responsibility for diabetes care and receiving confirmation of an already healthy lifestyle (Rise *et al.*, 2013:e64012).

These three factors can help an individual living with DM to make wholesome lifestyle changes (Rise *et al.*, 2013:e64011). Changes include: Self-monitoring of blood glucose levels meaning to measure blood sugar after different types of food, starting to measure blood sugar, buying an electronic blood glucose meter, measuring more frequently and measuring after exercises. Physical activity includes the increase of physical activities, using physical activities after big meals, bicycling daily, starting at the gym, using physical activity as a tool to control blood sugar levels, walking stairs and swimming. Dietary changes consist of fewer carbohydrate intakes, reading food contents, lowered fatty food, increased wholegrain foods, stopped buying unhealthy food, eating more fruits and vegetables, smaller portions of unhealthy food, more regular meals, bringing their own food to parties and less coffee and milk. Attitude changes to take control, being safe and secure, being more serious, getting motivated, taking responsibility, relaxing more, being more interested in DM and accepting the “diabetic identity”. Other changes are starting on new medication, enrolling in a local diabetes association and quit smoking.

5.5.4.1.3 Problem 2: Struggling to adapt to the effects that changing blood sugar has on the body

As described in section 5.5.4.1.2, factors, either by self or external, influences blood sugar levels in students living with DM. Sometimes the effects are uncontrollable and this leads to other difficulties like a foul mood, headaches, blurred vision or tiredness. Submitting to these effects can cause weakness in living life to the fullest. One needs to adapt to the changes in blood sugar levels by either attending to them as fast as possible, managing your DM better or to accept the consequences and fight through the negative effects.

“Unhealthy food leads to bad glucose levels, causing emotional stress; long-term damage on eyesight and ketones.”

“You have to adapt to unhealthy foods that are available and according to that you have to take action.”

“The effects of changing blood sugar appear when sugar levels are not controlled may be due to insulin not cooler or hormonal changes.”

“It is important to identify the causes of fluctuations in blood sugar and to be able to adapt accordingly.”

“A huge academic hurdle is HIGH BLOOD SUGARS, they can knock you out for weeks at a time. You have to also learn to adapt because LIFE GOES ON and the world does not just stop for you cause you’re a diabetic so that is why fostering your relationships, that are honest and transparent with academic staff is so important.”

“Changes in sugar levels is the reason for cooking for oneself and that it is for example a ‘necessity’.”

“By cooking one’s own food, it is possible to better manage diabetes and prevent changing blood sugar levels.”

Poor glycaemic control has been associated with more DM complications, depression and a worse quality of life (Penckofer *et al.*, 2012:303). Students with poor glycaemic control have greater anxiety, slightly higher anger levels and a lower quality of life. An experience of multiple emotions has a big impact on quality of life (Penckofer *et al.*, 2012:308). A variety in glycaemic experiences are related to poor quality of life. Glycaemic variability was the result of poor self-management, consistent episodes of hyperglycaemia and hypoglycaemia. These varieties can add to depression and anxiety. This adds up to poorer self-management and then more negativity in quality of life.

5.5.4.1.4 Solution 2: You have to understand the causes and effects and learn to counter it

“Social awareness about problems regarding diabetes will help you cope and adjust – people will also understand where you’re coming from and why act a certain way.”

“A lack of social awareness about T1DM has in a way forced me to adapt better, since I have to educate others around me for my own wellbeing and for them to understand my conditions. I have also had to learn to be open and honest about what diabetes does and entails, which and not care what others think.”

“You need to learn to adapt to the hurdles in academics so that you can control blood sugar.”

“Knowing that certain foods effect the blood sugar it is important to cook healthy food since not all franchises accommodate diabetic people.”

“If I cook my own meals. I won’t have to deal with the effects of changing blood sugar, because my blood sugar would be more controlled.”

Considering implementing the five characteristics of clarity, personal meaningfulness, frequency of feedback, active guidance and support and patient interpretation can increase the chances of a student applying effective implementation of behavioural change (Hood *et al.*, 2015:509). Teaching problem solving skills in clinical encounters is a way of helping a student to apply effective behavioural change implementation. Problem solving skills have proved beneficial in behavioural management of DM and health outcomes. Another way to encourage behavioural change implementation is by learning simple methods to identify problems, setting goals, brainstorming solutions and implementing and evaluating a solution.

Numerous components to behavioural change can be recommended, *id est*. bringing in another caregiver and people from the community and ensuring that health education and skills have been considered and addressed (Hood *et al.*, 2015:510); attempt to use recommendations that include age, gender, ethnicity, community infrastructure and perceptions about DM; screen for psychological factors that can hinder the student living with DM's ability to change and maintain behavioural change; psychological factors that can hinder change include: disordered eating, eating disorders, depressive symptoms, diabetes distress and worries and fears related to DM.

5.5.5 The total system solution

In the next section and the last part of the problems and solutions, the researcher will look at the complete system of the perceptual systems of students living with DM.

Table 5-6: The total system problem and possible solution

Problem	Solution
1. Adapting to the environment is in the way of optimal self-management	1. Education and intervention practices for improvement and change – moving towards better self-management for students living with DM

5.5.5.1 The problem: Adapting to the environment is in the way of optimal self-management

The researcher came to the conclusion that the system showed the university environment to be the barrier to students' self-management in living with DM. This system is a good representation of what students living with DM perceive as daily self-management at university.

The researcher sees the system as successful as the issue statement focused on the experiences of the students on the NWU Potchefstroom campus living with DM. The researcher found eight affinities in the system that depicts the daily lives of students with DM on campus. The researcher wanted to use this information to examine the self-management of these students. Self-management is an important facet of DM treatment consisting of four major aspects. These aspects of self-management are diet, exercise, medication use and blood sugar testing. Although the participants did not focus on the physical activities they performed in their self-management tasks, they did focus on their diet, testing of blood sugar levels and medication usage (specifically insulin).

The focus in the study was on the students' daily lives, and in these affinities, the researcher noticed the barriers the students face on campus. Although the researcher believes that the students will focus on self-management in the picture of their daily lives, they described the struggles of adhering to self-management tasks in their environment and how adapting to the environment was a bigger struggle than performing self-management.

Self-management (as described in Chapter 2) is taking responsibility for one's own behaviour and well-being. And as just mentioned, the self-management tasks of DM need to be taken by the individual.

Adding to that, barriers to self-management has proved to be hindering the progress of DM self-management. Students had to adapt and adjust their lives to fit in with the "normal" students on campus.

The self-management tasks stay the same - in this study and the literature. However, the barriers differ and with this system, the solutions to the problem can help improve the perceptions of the self-management of students living with DM on campus.

5.5.5.2 The possible solution: Education and intervention practices for improvement and change – moving towards better self-management for students living with DM

After identifying problems faced by students with DM in their self-management, the researcher found that the university environment is not diabetic friendly. From every affinity, the participants could point to where there was a barrier in the university that influenced them to comply with fewer of their self-management tasks. If these factors could be eliminated or be reduced, self-management of DM will improve significantly for students with DM living on campus.

In the previous problems and solutions, the researcher identified problems and solutions that were portrayed by each affinity in each of the feedback loops and used the information given by the participants, literature and the assumptions of the researcher. In this section the researcher will focus on each of the affinities individually to give possible solutions to the problems that each affinity provides to the students' self-management living with DM.

- Social awareness and acceptance

Social awareness, as a primary driver, influences the attitude of the student toward the system. Provided the affinity is negative, the rest of the system will be negative. The respondents bemoan the lack of knowledge from their social peers. The social environment is a problem for the students as they find it hard to commit to self-management tasks. Injecting insulin is frowned upon as "exposing" oneself in public is inappropriate.

The lack of knowledge surrounding insulin usage is a barrier as it keeps students from managing high blood sugar levels.

An ideal solution for this would be for the university to use their sources, like the student campus council, student counselling and development professional services, health care centre and the academics in the healthcare department, to launch DM awareness campaigns to educate peers on campus on DM's causes, effects and treatments. This will raise education and awareness regarding DM and relieve the pressure on the student of having to explain when decisions on managing DM in public. Acceptance will increase as awareness of students living with DM increase.

- Food available on campus

Once again, the results of the system highlighted the problem that food available on campus is not diabetic friendly. This forces students living with DM to eat what is available and suffer the consequences of high and uncontrolled blood sugar levels, or face low blood sugar levels when they refuse to eat, or force them to adapt to the university and prepare home cooked food to bring to campus. Last mentioned is time consuming and a burden when a student does not have enough knowledge on how to prepare diabetic friendly meals.

The campus boasts five cafeterias in addition to the SS and two restaurants supplying students with daily meals. However, none of these options has been pointed out by the participants as providing healthy, diabetic friendly food. The managers of these caterers need to be educated on the needs of DM students. The campus has dieticians in the form of lecturers and post-graduates who are able to assist the providers with DM friendly meal plans which should be added to menus.

There should be designated DM areas at all eateries on campus. Currently the SS has a stand specifically stacked with Halaal food. A stand dedicated to diabetic friendly food will improve the food choices on campus for these students, helping them to adhere to self-management.

- Keeping insulin cool

Keeping insulin cool is an affinity that the participants labelled as an own responsibility. There is not a decent way to assist students with DM in keeping their insulin cool whilst on campus. Participants pointed out factors such as Food available on campus, stress related to Social awareness and acceptance and stress related to the academic environment increase the need for insulin. When the insulin is not kept cool it becomes ineffective. By improving the Food available on campus, boosting Social awareness and acceptance and reducing the fear and stress related to the academic environment of not being able to manage changing blood sugar, less insulin will be needed.

Another solution is for students to be educated on insulin. Insulin can stand temperatures of between 2°C and 30°C before losing its potency. By educating students on insulin, the misperception of insulin can be ruled out and the proper handling of insulin can be enhanced to make sure that the insulin stays effective as long as possible for usage.

- Independent lifestyle

Transitioning from a home to the university has been discussed as a problem for individuals living with DM. At home students had the assistance of family members when it came to self-management tasks. In the university environment the student alone is responsible for performing self-management tasks.

The student counselling and development professional services can start a DM support group for the students on campus. This service should be available to students living with DM or students recently diagnosed with DM to receive counselling and assistance with the psychological aspects of transitioning into an Independent lifestyle. Such a service should also provide the opportunity for students to talk to peers facing the same struggles and share and receive advice on how to better manage their DM.

- Adjusting by cooking

Adjusting by cooking is another affinity that the participants pointed out as something they have had to do to be able to lead an independent lifestyle due to a lack of diabetic friendly food on campus; others see Adjusting by cooking as a barrier as they do not have appropriate knowledge

or skills to perform the task (of cooking) and that forces them into an unhealthy habit of eating on campus.

For this affinity the awareness of DM on campus needs to be improved as mentioned earlier. The skills and knowledge of cooking for oneself can be enhanced by attending cooking classes that can teach the students to cook healthier and DM appropriate for food. This newly attained knowledge can then assist them with being more vigilant about the kind of food they purchase. Such knowledge can be passed around in a DM support group.

- Hurdles in the academic environment

Hurdles pointed out by the participants is stress associated with the environment, stress of being in a situation where they cannot manage their changing blood sugar levels and finding themselves in a class or an examination and not being able to attend to their needs when blood sugar levels starts rising or falling.

A lack of knowledge about DM among lecturers and awareness of students with DM in their classes is a hurdle for the students. The director of student life could introduce an educational session to the deans of each faculty after which they can share the knowledge among their lecturers to be able to pay better attention to the students with DM and understand what is needed to manage DM. The lecturers could educate the students in their class to be able to accommodate the students with DM when they need to take action to manage their blood sugar levels. These actions are either to eat during class, test blood sugar levels, injecting insulin or being allowed to leave the classroom to attend to their need.

Two solutions are available for examination time. One would be for the student counselling and development professional services and the health care centre to provide letters of permission to these students to write their exams in separate locations. This would allow the students to eat, test their blood sugar levels or inject insulin as needed; it is also recommended to extend these students' exam time in cases where blood sugar levels cause loss of concentration or time is lost as a student waits for sugar levels to stabilize before resuming the exam.

The second option is for DM students to obtain a letter granting them permission to leave the exam room should they need to tend to their DM. This will also let the exam supervisor stay alert and attend to these students if they need help.

- Causes of changing blood sugar

The participants mentioned a few causes of changing blood sugar levels. Some of these causes cannot be managed by students. These are external factors leading to a change in blood sugar levels.

Causes which cannot be controlled by the students were emotional, hormonal and natural causes. Problems arise when a student with DM cannot attend to their needs due to Social awareness and acceptance, Food available on campus and Hurdles in the academic environment. The solutions to these have already been discussed.

The external causes of changing blood sugar levels are stress surrounding Social awareness and acceptance, poor choices in Food available on campus, struggles and stress of Keeping insulin cool, stress related to an Independent lifestyle and Hurdles in the academic environment. Solutions to these factors causing changes in blood sugar levels have already been discussed.

- Adapting to effects of changing blood sugar

The main problem that the researcher observed was the fact that most of the affinities refer to adaptations students living with DM have to make in order to care for themselves, because no one else will take care of them. Some factors have been mentioned with possible solutions that students living with DM can follow to adapt to the effects of DM. However, the main problem lies in the university not accommodating these students. The affinities that have had an effect on blood sugar levels and proved problems received solutions from the researcher.

The next section will touch on how this study can be applied and how to solve the problems mentioned with the solutions provided.

5.6 Applications for the model

The model that was created in this study (as seen in Figure 5-1) could be used not only by the North-West University's Potchefstroom campus, but at other universities across the country and across the globe. Although the perceptions are that of students with DM on the North-West University's Potchefstroom campus, the elements comprising the system might be applicable to some universities and students in general living with DM. These challenges are faced by students living with DM daily. The focus and discussions of the applications for this study will only focus on the North West University's Potchefstroom campus.

The model can be used by cafeteria management on the Potchefstroom campus who are in control of planning daily meals. As previously mentioned, the five cafeterias and the SS are mostly use by students to buy food on campus. The two restaurants on campus were not mentioned by the students as a problem. However, these restaurants' menus do not cater for DM students. The

management can use the model as an indication of how to adapt the menus to assist and accommodate students living with DM. Also, the faculty of health science can implement the model into post graduate studies in nutrition for students or staff to develop a nutritional menu for students living with DM. Such a menu could be used by cafeterias to accommodate students with DM.

The model can be of use for manufacturers of cooling bags specifically designed for insulin. It could assist in raising awareness of the need for special cooler bags, designed to keep insulin cool and effective. Easy carrier bags and longer cooling agents can be developed for the use of keeping insulin as effective as possible for as long as possible and making the bag “acceptable” to the campus community to reduce judgement from students not living with DM.

The student counselling and development department on campus can use the model to form DM support groups. Professional staff can lead groups in talking about their problems facing DM and assist with techniques to change behaviour towards DM and adapting to DM self-management. The student counselling and development department can also use this model as motivation to educate their staff in the topic of DM to be able to assist students living with DM to stay positive through the transition into independence. This department can also assist with academic hurdles students with DM face, as they are in control of assisting students who write exams in separate rooms due to other factors. With the help from the health care centre, students with DM could be accommodated during exam time by letters providing permission to write in a separate exam room. In such circumstances these students will be able to attend to their DM needs.

The student campus council of the NWU Potchefstroom campus together with the student counselling and development department, the health care centre and the healthcare department can use the model to launch campaigns to promote the awareness of DM on campus and by doing so, lowering the burden of social awareness. All students have access to social media platforms on campus, and hostels and the campus itself can host projects in promoting DM to the campus.

In the academic environment, the director of student life can, together with the deans of the faculties use the model to create awareness and educate staff. The student counselling and development department and the health care centre can focus on ways to educate staff members and lecturers on DM and how to accommodate these students. The lecturers can use the attained knowledge to educate students in the classroom on the causes of changing blood sugar levels in DM students and of the tasks required to attend to changing blood sugar levels.

Healthcare providers can use the model to educate themselves and patients diagnosed with DM on the perceptions that students living with DM have. By doing so they will improve their medicine practice, as well as assist patients living with DM improving their health.

Students living with DM can use the model to assist in their self-management tasks. By using the model, students living with DM who has either been diagnosed recently or are still struggling with DM self-management tasks can educate themselves by looking and learning from other students facing similar problems in the university environment.

Post-graduates doing studies in either chronic illnesses, communicable diseases or DM can use the model and the results obtained from the study to enrich their studies and further the study on DM.

5.7 Research questions reconsidered

In Chapter 1 the researcher focussed on the following research questions:

- What is DM?
- What is self-management?
- What are the components of self-management that relate to DM?
- What are the definitions of optimal self-management and sub-optimal self-management?
- What are the barriers to self-management for students living with DM?
- What are students' perceptions of taking care of their self-management of DM on the NWU Potchefstroom campus?
- How do the different elements of perceptions of these students compare with each other?

The researcher then used the research objectives laid out in Chapter 1 to address these research questions.

The following research objectives were formulated for the literature review:

- To conceptualise and contextualise self-management, DM and other related and applicable terms.
- To describe and investigate the self-management of students living with DM in a tertiary institute.

The specific research objectives for the empirical investigation were as follows:

- To determine the components of the students' perceptual system of their self-management while living with DM at a tertiary institute.

- To determine the relation between the components of the before mentioned perceptual system.

The following sections will indicate how the researcher addressed the research questions in the study.

What is DM?

As seen in section 2.2.2. under the definition of DM, DM can be described as a chronic disease relating to chronic elevated blood glucose levels (also known as hyperglycaemia) which is associated with either defective insulin secretion or an impairment of insulin action, or both (ADA, 2004:5; Kerner & Brückel, 2014:384; Nolte Kennedy, 2012:743; WHO, 2019b).

What is self-management?

The term self-management is described in section 2.3.2. and can be summarized as a term referring to the ability of an individual to manage the treatment, physical, symptom and psychosocial consequences and the changes in lifestyle characteristic in living with a chronic disease (Barlow *et al.*, 2002:366).

What are the components of self-management that relate to DM?

In section 2.3.5. the researcher found that Galaviz *et al.* (2018:14) stated that adjustments in lifestyle, like eating healthy, exercising daily and monitoring of blood-glucose levels, can delay the progression of DM. The WHO (2018) added that a person living with DM should partake in a lifestyle that is healthy, includes a healthy diet, the monitoring and maintenance of glucose levels and adherence to medicine usage. DM treatment also consists of losing weight, monitoring of carbohydrate intake, correct intake of fibre, restricting cholesterol, avoiding saturated fats, trans fats and sodium (Forouhi *et al.*, 2018a:1). Lastly, patients with DM require further tactics to address individual, family and social practices to improve DM self-management (Miller & DiMatteo, 2013:425).

What are the definitions of optimal self-management and sub-optimal self-management?

There are seven sets of tasks associated with self-management of DM that can be found in section 2.3.5. (Shrivastava *et al.*, 2013:2). These tasks include a healthy diet, being physically active, monitoring of blood glucose, medication compliance, good problem-solving skills, healthy coping skills and risk-reduction behaviours (Adu *et al.*, 2019:7; Mikhael *et al.*, 2019:4). A patient living with a chronic disease should be active in applying their knowledge in the continuous process of self-management (Mikhael *et al.*, 2019:16). All seven factors have proven positive

correlation with good glycaemic control, a decrease in complications and improvement in quality of life (Adu *et al.*, 2019:7; Mikhael *et al.*, 2019:16). A broader inspection of these seven sets of tasks are found in the sections following section 2.3.5.

Sub-optimal DM self-management could lead to polyuria (the excess passage of urine, 2.5 litres per day), weight loss, polyphagia, overeating, and blurred vision (ADA, 2014:S81; Lakhani & Lakhani, 2015:433; Rudd Bosch *et al.*, 2015:1). There are also slim chances of growth impairment and susceptibility to some infections (ADA, 2014:S81). Acute, life threatening, consequences could arise from uncontrolled DM. These factors can be seen in section 2.3.7.

What are the barriers to self-management for students living with DM?

Five main categories to the factors that influence self-management were found as seen in section 2.4. (Schulman-Green *et al.*, 2016:1472). These factors include health care system; resources; environmental characteristics; health status; and personal/lifestyle characteristics.

Eight sub-factors were identified (Peters & Laffel 2011:2479) to contribute to sub-optimal self-management of an emerging adult. That can be seen in the subsequent sections of section 2.4.

What are students' perceptions of taking care of their self-management of DM on the NWU Potchefstroom campus?

The final results in Chapter 4 that were constructed by the participants can be seen in Table 4-7. Table 4-7 contains the final eight affinities and their descriptions in the words of the participants of the focus group. The final eight affinities regarding the students' perceptions of taking care of their self-management of living with DM are Food available on campus, Keeping insulin cool, Causes of changing blood sugar, Adapting to the effects of changing blood sugar, Social awareness and acceptance, Hurdles in academic environment, Adjusting by cooking and Independent lifestyle.

The system (or mind map as seen in Figure 4-8) can be seen as a pathway beginning with Social awareness and acceptance and ending with Adapting to effects of changing blood sugar levels. Affinities, or elements, can be seen either as positive or negative. One affinity's experience can influence and change the experience of the next affinity.

The primary driver is Social awareness and acceptance and can be found at the top left of the system. The primary outcome is Adapting to effects of changing blood sugar and can be found in the bottom right corner of the system. The secondary drivers can be found at the bottom left and in the middle of the system. They are Food available on campus, Keeping insulin cool and Independent lifestyle. The secondary outcomes are found in the top right and in the middle of the

system. They are Adjusting by cooking, Causes of changing blood sugar and Hurdles in the academic environment.

How do the different elements of perceptions of these students compare with each other?

The comparisons and how these affinities relate can be seen in the final system in Figure 4-8. The final SID of students' perceptions of their self-management living with DM on campus can be seen in Figure 4-8, the descriptions in section 4-11 and the final system was subsequently discussed in Chapter 5.

The final perceptual system was an informative representation of the self-management of students living with DM. The system reflects barriers to compliance with self-management facing students living with DM. The system produced four recognisable loops or cycles (as seen in Figure 5-3). These loops were named and consisted of the following affinities:

- The Ignorance loop consisting of Social awareness and acceptance, Food available on campus and Keeping insulin cool;
- The Revision loop consisting of Keeping insulin cool, Independent lifestyle and Food available on campus;
- The Developing loop consisting of Independent lifestyle, Adjusting by cooking and Hurdles in the academic environment; and
- The Self-management Loop consisting of Hurdles in the academic environment, Causes of changing blood sugar and Adapting to effects of changing blood sugar.

These loops created pathways through the system for the students living with DM to find a way to better self-management.

5.8 Limitations and future directions

5.8.1 Limitations

There are a few limitations in the study that needs to be discussed.

- In the focus group, there were only three participants. Although the IQA methodology suggests that there be at least 12-20 participants, the study could probably have more affinities or richer information if there were 20-25 participants for this study.
- With the small focus groups the researcher and study supervisor managed to obtain nine more students to assist with the ART's. This brought the number of participants up to twelve, but the nine extra students were not in the focus group and only had the

information of the focus group to interpret their own ideas of what the affinities meant to them to complete the ART.

- Students are an important group to focus on when it comes to DM self-management. Unluckily they are also a tough group to work with due to their unreliability and busy schedules. The researcher thought that having the focus group on a weekend would help to obtain more students as they have more free time, but most of the students chose to go home for the weekend. In the future it will be better to try and host the focus group in the week as you are more certain that the students will be in Potchefstroom to partake in the focus group.
- There were no interviews held for the study, because the focus group was supposed to obtain enough information. The ART's ended up giving enough information to use in the study to keep the study and the data gathered relevant.
- There was only a single constituency used in the focus group to generate affinities. Different constituencies could have given different results and different power and distance relationships to the affinities.
- The perceptual system is only based on the NWU Potchefstroom campus and thus portrays the perceptions of this university and this campus. Not all the universities in South Africa have the same infrastructure and struggles that students face living with DM. And all the universities in the world probably have different approaches to students living with DM in the 21st century.
- For the focus group we allocated one focus group session of four hours. One limitation could have been the time as some students might have been drained by the activities in the focus group. A better option would be to host a focus group, stretched over two days to lower the burden of concentration for a long period of time.

5.8.2 Future directions

There has not been a study portraying the perceptual systems of the self-management students living with DM. This original study opens the possibility for future research on this topic to develop this study.

- A study can be replicated and the limitations could be limited to enrich the data that was obtained in this study.
- The system that was developed in this study could be the foundation for future studies where the results could be extended of different constituencies could be used to compare to this system.
- The two main drivers of this system need to be investigated, *id est*. the Social awareness and acceptance and the Food available on campus. The importance of these affinities

needs to be established and solutions to these barriers needs to be found to assist in the self-management tasks of students living with DM.

- More studies could be done in the future that focus on the importance of keeping insulin cool. This affinity was a very important part in the system and a lot of misconceptions are made about insulin and the handling of insulin.
- Studies need to be done on the independence of students. The transition from home to the university for students needs to be investigated and solutions should be the target of the study to assist with the transition into independence in the university environment.
- The hurdles that students face in the academic environment are a barrier that not many studies have been done on. Managing of DM is a hard task and to not be able to manage DM at all times should be eliminated.
- The knowledge that students living with DM have, need to be studied to find ways for them to be able to realise what are the causes in their lives when managing DM and the corresponding fluctuation of blood sugar and how to help them to adapt to these changes as this will enhance their self-management of their DM.

The last part is the conclusion of this research study.

5.9 Conclusion

The focus of this study was to understand the perceptions that students living with DM on the NWU Potchefstroom campus have towards their self-management. Self-management is the key in the lives of a student living with DM. In the literature review, it was pointed out how important self-management is to the treatment of DM.

The system was explored by the researcher and the insights were gained in the relationships between the affinities and the effects they had on the total system. The cause and effect of these relationships were examined and were put into different scenarios to see how the scenarios will pan out. Problems were then identified by the researcher from the insights of the affinities and their relationships and solutions to these problems were suggested for the self-management of DM in students. The identities of the two primary drivers were set at Social awareness and acceptance and Food available on campus. The primary outcomes in the system were identified by the system as Causes of changing blood sugar and Adapting to effects of changing blood sugar.

The system produced four feedback loops that consisted of its own affinities and influences on each other. The first feedback loop, the Ignorance loop, consisted of Social awareness and acceptance, Food available on campus and Keeping insulin cool. Social awareness and

acceptance was used as the starting point and influenced Food available on campus and influenced Keeping insulin cool. The second feedback loop, the Revision loop, consisted of Keeping insulin cool influenced by Food available on campus and influenced Independent lifestyle. The third feedback loop consisted of Independent lifestyle that influenced Adjusting by cooking that influenced Hurdles in the academic environment and the feedback loop was named the Developing loop. The final loop, the Self-management loop, contained Hurdles in the academic environment, Causes of changing blood sugar and Adapting to effects of changing blood sugar levels.

There was a pathway leading from the primary driver, Social awareness and acceptance, to the primary outcome, Adapting to effects of changing blood sugar. In this pathway, the four feedback loops were present and had to have connections with each other to complete the way for the primary driver to the primary outcome. The connections where feedback loops overlapped played an important role as they develop the potential for the student to move out of the one feedback loop to the other or for the student to get stuck in a negative cycle in the loop and have the potential of slipping back into previous loops. Keeping insulin cool is the connection between the Ignorance loop and the revision loop, Independent lifestyle the connection between the Revision loop and the Developing loop and Hurdles in the academic environment was the connection between the Developing loop and the Self-management loop.

Social awareness and acceptance is an important factor contributing to the burdens of self-management for students living with DM on the NWU Potchefstroom campus. The affinity was described in the words of the participants as “if society was better educated about diabetics, it would be much easier to manage my life”.

Food available on campus was also depicted by the participants as a primary driver. It is not the starting point of the system but plays the role of a primary driver. “There is not sufficient diabetic friendly food available on campus” was the description of the affinity by the participants.

Keeping insulin cool was conceptualised as “It is a “drag” to keep insulin cool for up to fourteen hour stretches, every day or trying”. Keeping insulin cool was a very important affinity as it is the first exit point to the next feedback loop.

“Accepting your condition and taking responsibility towards a healthy life” was the definition used to describe Independent lifestyle as an affinity. Independent lifestyle is almost a central focus for the system.

Adjusting by cooking is to “Learn, adjust, adapt in order to meet your personal health requirements (make it interesting)” according to the participants.

Hurdles in the academic environment defined as “The academic community has to be more accommodating” plays a role as a secondary outcome and a link between the Developing loop and the final Self-management loop.

“Almost everything contributes to blood sugar variation” in Causes of changing blood sugar. This affinity also acts as a primary outcome but is not the final step.

Adapting to effects of changing blood sugar was conceptualized as “You have to understand the causes and effects and learn to counter it”.

The researcher concluded that the perceived system was well formulated to answer the issue statement. The system showed exactly what students living with DM face in their daily lives on campus and how this has an impact on their self-management. The main finding by the researcher was that most of the changes that need to be made to make this a positive and functioning system, was awareness and acceptance in the university environment. By changing the influence of poor knowledge and acceptance on DM, the system can contribute to the self-management of DM and make the student living with DM feel accommodated.

The participants perceived that by adapting to the effects of changing blood sugar levels and managing the causes of changing blood sugar, they can manage their DM effectively even if there is poor social awareness and acceptance and there is not diabetic friendly food available on campus.

The model can be used by universities across the globe to get a better understanding of the perceptions of students living with DM. Management in the cafeterias and other providers of food on campus can use the model to change their meal plans to include the dietary needs of students living with DM that use these facilities to obtain their meals. Manufacturers can use the model to develop a way for students to keep their insulin at an optimal level for as long as possible and as comfortable as possible. The structures and management on campus that have the power to increase the awareness on campus for DM can use the model as reason to believe that a change in stigma and awareness can assist in the self-management and general life quality for students living with DM. Accommodation for students living with DM can be achieved if faculties used the model to change the academic environment for the better. Healthcare providers can use the model to educate themselves on perceptions that students living with DM have and to educate misunderstandings to students diagnosed with DM. Students living with DM or who have recently been diagnosed with DM can use the model and results to enhance their knowledge with regards to self-management of DM. Post-graduates can use the model to further their studies or increase the study on the topic.

A few limitations were identified in the study, none that compromised the integrity of the research process or the results and conclusions. Limitations such as struggles of working with students, the number of participants and the timeframe of the focus group were identified, but not limiting the study. This study opens the way for any future investigations of students living with DM. More constituencies could be brought in and be compared to this model. For example, current adults who had to make it through university living with DM.

This study was the first to be done on the perceptions of students with DM's self-management and to help by providing new information to the format of a system and model to the benefit of universities and students regarding DM. This study gives a small view into the daily lives of students living with DM on a university campus and how they deal with their self-management.

REFERENCE LIST

- Abbott, P.A., Davison, J.E., Moore, L.F. & Rubinstein, R. 2012. Effective nutrition education for aboriginal Australians: lessons from a diabetes cooking course. *Journal of nutrition education and behaviour*, 44(1):55-59.
- Abdulrehman, M.S., Woith, W., Jenkins, S., Kossman, S., Hunter, G.L. 2016. Exploring cultural influences of self-management of diabetes in coastal Kenya: An ethnography. *Global qualitative nursing research*, 3:1-13. doi: 10.1177/2333393616641825.
- Abolfotouh, M.A., Kamal, M.M., El-Bourgy, M.D. and Mohamed, S.G. 2011. Quality of life and glycemic control in adolescents with type 1 diabetes and the impact of an education intervention. *International journal of general medicine*, 4:141-152.
- Abu Hassan, H., Tohid, H., Mohd Amin, R., Badrulnizam Long Bidin, M., Muthupalaniappen, L. & Omar, K. 2013. Factors influencing insulin acceptance among type 2 diabetes mellitus patients in a primary care clinic: a qualitative exploration. *BMC family practice*, 14:164-173. doi: 10.1186/1471-2296-14-164.
- ADA (American Diabetes Association). 2000. Type 2 diabetes in children and adolescents. *Diabetes care*, 23(3):381-389.
- ADA (American Diabetes Association). 2003. Standards of medical care for patients with diabetes mellitus. *Diabetes care*, 26(1):33-49.
- ADA (American Diabetes Association). 2004. Diagnosis and classification of diabetes mellitus. *Diabetes care*, 27(Suppl 1):S5-S10.
- ADA (American Diabetes Association). 2005. Diabetic nephropathy: diagnosis, prevention, and treatment. *Diabetes care*, 28(1):164-176.
- ADA (American Diabetes Association). 2010. Standards of medical care in diabetes 2010. *Diabetes Care*, 33(Suppl 1):S11–S61.
- ADA (American Diabetes Association). 2013. Diagnosis and classification of diabetes mellitus. *Diabetes care* 36(Suppl 1):S67-S74.
- ADA (American Diabetes Association). 2014. Diagnosis and classification of diabetes mellitus. *Diabetes care*, 37(Suppl 1):S81-S90.

- ADA (American Diabetes Association). 2015. Measurements of gluconeogenesis and glycogenolysis: A methodological review. *Diabetes*, 64(12):3996-4010.
- ADA (American Diabetes Association). 2017a. Diabetic neuropathy: a position statement by the American Diabetes Association. *Diabetes care*, 40(1):136-154.
- ADA (American Diabetes Association). 2017b. Lifestyle management. *Diabetes care*, 40(Suppl 1):S33-S43.
- ADA (American Diabetes Association). 2018a. Classification and diagnosis of diabetes: standards of medical care in diabetes – 2018. *Diabetes care*, 41(Suppl 1):S13-S27.
- ADA (American Diabetes Association). 2018b. Factors affecting blood glucose. *Clinical diabetes*, 36(2):202-202.
- ADA (American Diabetes Association). 2019. Lifestyle management: Standards of medical care in diabetes – 2019. *Diabetes care*, 42(Suppl 1):S46-S60.
- ADA (American Diabetes Association). 2020. DKA (Ketoacidosis) & ketones. <https://www.diabetes.org/diabetes/complications/dka-ketoacidosis-ketones> Date of access: 23 Mar. 2020.
- Adeva-Andany, M.M., González-Lucán, M., Donapetry-García, C., Fernández-Fernández, C. and Ameneiros-Rodríguez, A. 2016. Glycogen metabolism in humans. *Biochimica et Biophysica Acta clinical*, 5:85-100.
- Adu, M.D., Malabu, U.H., Malau-Aduli, A.E.O. & Malau-Aduli, B.S. 2019. Enablers and barriers to effective diabetes self-management: A multi-national investigation. *PLoS One*, 14(6): e0217771. <https://doi.org/10.1371/journal.pone.0217771>.
- Ahmed, Z. & Yeasmeen, F. 2016. Active family participation in diabetes self-care: a commentary. *Open access journals*, 6(5):104-107.
- Ajzen, I. 1991. The theory of planned behaviour. *Organizational behavior and human decision processes*, 50(2):179-211.
- Akinsola, H.A. 2001. Fostering hope in people living with Aids in Africa: the role of primary health-care workers. *The Australian journal of rural health*, 9(4):158-165.
- Alberti, K.G.M.M., Zimmet, P.Z. & Shaw, J. 2005. The metabolic syndrome: a new worldwide definition. *Lancet*, 366(9491):1059-1062.

Alderson, M., Starr, L., Gow, S. & Moreland, J. 1999. The program for rheumatic independent self-management: a pilot evaluation. *Clinical rheumatology*, 18(4):283-292.

Ali, Z.H. 2011. Health and knowledge progress among diabetic patients after implementation of a nursing care program based on their profile. *Journal of diabetes and metabolism*, 2(2): 1-7. doi: 10.4172/2155-6156.1000121.

Aliu, E., Kanungo, S. & Arnold, G.L. 2018. Amino acid disorders. *Annals of translational medicine*, 6(24):471-480.

Alqarni, A.M., Alrahbeni, T., Al Qarni, A. & Al Qarni, H.M. 2019. Adherence to diabetes medication among diabetic patients in the Bisha governorate of Saudi Arabia: – a cross-sectional survey. *Patient preference and adherence*, 13:63-71.

Alsous, M., Abdel Jalil, M., Odeh, M., Al Kurdi, R. & Alnan, M. 2019. Public knowledge, attitudes and practices toward diabetes mellitus: a cross-sectional study from Jordan. *PLoS One*, 14(3):e0214479. doi: 10.1371/journal.pone.0214479.

Amankwah-Poku, M. 2019. A cross-sectional study of knowledge and awareness of type 2 diabetes mellitus in a student population in Ghana: do demographics and lifestyle make a difference. *Health psychology and behavioral medicine*, 7(1):234-252.

American Association of Diabetes Educators. 2019. Resources for People Living with Diabetes. <https://www.diabeteseducator.org/living-with-diabetes/aade7-self-care-behaviors> Date of access: 8 Nov. 2019.

Arnett, J.J. 2000. Emerging adulthood: A theory of development from the late teens through the twenties. *American psychologist*, 55(5):469-480.

Arnett, J.J. 2006. G. Stanley Hall's adolescence: brilliance and nonsense. *History of psychology*, 9(3):186-197.

Atkinson, M.A., Bluestone, J.A., Eisenbarth, G.S., Hebrok, M., Herold, K.C., Accili, D., Pietropaolo, M., Arvan, P.R., Von Herrath, M., Markle, D.S. & Rhodes, C.J. 2011. How does type 2 diabetes develop?: The notion of homicide or β -cell suicide revisited. *Diabetes*, 60(5):1370-1379.

Atkinson, M.A., Eisenbarth, G.S. & Michels, A.W. 2014. Type 1 diabetes. *The lancet*, 383(9911):69-82.

- Auduly, Å., Norbergh, K.G., Asplund, K. & Hörnsten, Å. 2009. An ongoing process of inner negotiation: a Grounded Theory study of self-management among people living with chronic illness. *Journal of nursing and healthcare of chronic illness*, 1(4):283-293.
- Babler, E.K. & Strickland, C.J. 2015. Moving the journey towards independence: adolescents transitioning to successful diabetes self-management. *Journal of paediatric nursing*, 30(5):648-660. doi:10.1016/j.pedn.2015.06.005.
- Bahendeka, S., Kaushik, R., Swai, A.B., Otieno, F., Bajaj, S., Kalra, S., Bavuma, C.M. & Karigire, C. 2019. EADSG guidelines: insulin storage and optimisation of injection technique in diabetes management. *Diabetes therapy*, 10(2):341-366.
- Baig, A.A., Benitez, A., Quinn, M.T. & Burnet, D.L. 2015. Family interventions to improve diabetes outcomes for adults. *Annals of the New York Academy of Sciences*, 1353(1):89-112.
- Balfe, M. 2007. Diets and discipline: the narratives of practice of university students with type 1 diabetes. *Sociology of health & illness*, 29(1):136-153.
- Balfe, M. 2009a. Healthcare routines of university students with type 1 diabetes. *Journal of advanced nursing*, 65(11):2367-2375.
- Balfe, M. 2009b. The body projects of university students with type 1 diabetes. *Qualitative health research*, 19(1):128-139.
- Balk, E.M., Earley, A., Raman, G., Avendano, E.A., Pittas, A.G. & P.L. 2015. Combined diet and physical activity promotion programs to prevent type 2 diabetes among persons at increased risk: a systematic review for the Community Preventive Services Task Force. *Annals of internal medicine*, 163(6):437-451.
- Bandura, A. 2001a. Social cognitive theory: an agentic perspective. *Annual review of psychology*, 52(1):1-26.
- Bandura, A. 2001b. Social cognitive theory of mass communication. *Media psychology*, 3(3):265-299.
- Bargate, K. 2014. Interactive qualitative analysis: a novel methodology for qualitative research. *Mediterranean journal of social sciences*, 5(20):11-19.
- Barlow, J.H., Sturt, J. & Hearnshaw, H. 2002. Self-management interventions for people with chronic conditions in primary care: examples from arthritis, asthma and diabetes. *Health education journal*, 61(4):365-378.

- Barlow, S.E. 2007. Expert committee recommendations regarding the prevention, assessment, and treatment of child and adolescent overweight and obesity: summary report. *Pediatrics*, 120(Suppl 4):S164-S192.
- Bayliss, E.A., Steiner, J.F., Fernald, D.H., Crane, L.A. & Main, D.S. 2003. Descriptions of barriers to self-care by persons with comorbid chronic diseases. *Annals of family medicine*, 1(1):15-21.
- Bech, A.P., Hofstra, J.M., Brenchley, P.E. & Wetzels, J.F.M. 2014. Association of anti-PLA₂R antibodies with outcomes after immunosuppressive therapy in idiopathic membranous nephropathy. *Clinical journal of the American Society of Nephrology*, 9(8):1386-1392.
- Bell, K.J., Smart, C.E., Steil, G.M., Brand-miller, J.C., King, B. & Wolpert, H.A. 2015. Impact of fat, protein, and glycemic index on postprandial glucose control in type 1 diabetes: implications for intensive diabetes management in the continuous glucose monitoring era. *Diabetes care*, 38(6):1008-1015.
- Bell, K.J., Toschi, E., Steil, G.M. & Wolpert, H.A. 2016. Optimized mealtime insulin dosing for fat and protein in type 1 diabetes: application of a model-based approach to derive insulin doses for open-loop diabetes management. *Diabetes care*, 39(9):1631-1634.
- Bellier-Teichmann, T. & Pomini, V. 2015. Evolving from clinical to positive psychology: understanding and measuring patients' strengths: a pilot study. *Journal of contemporary psychotherapy: on the cutting edge of modern developments in psychotherapy*, 45(2):99-108.
- Berg, C.A., King, P.S., Butler, J.M., Pham, P., Palmer, D. & Wiebe, D.J. 2011. Parental involvement and adolescents' diabetes management: the mediating role of self-efficacy and externalizing and internalizing behaviors. *Journal of pediatric psychology*, 36(3):329-339.
- Bhojani, U., Devedasan, N., Mishra, A., De Henauw, S., Kolsteren, P. & Criel, B. 2014. Health system challenges in organizing quality diabetes care for urban poor in south India. *PLoS One*, 9(9):e106522. <https://doi.org/10.1371/journal.pone.0106522>.
- Birkhäuser, J., Gaab, J., Kossowsky, J., Hasler, S., Krummenacher, P., Wermer, C. & Gerger, H. 2017. Trust in the health care professional and health outcome: A meta-analysis. *PLoS One*, 12(2): e01709881-13. doi: 10.1371/journal.pone.0170988.
- Bloomfield, H.E., Koeller, E., Greer, N., MacDonald, R., Kane, R. & Wilt, T.J. 2016. Effects on health outcomes of a Mediterranean diet with no restriction on fat intake. *Annals of internal medicine*, 165(7):491-501.

Bluestone, J.A., Herold, K. & Eisenbarth, G. 2010. Genetics, pathogenesis and clinical interventions in type 1 diabetes. *Nature*, 464(7293):1293-1300.

Bonnie, R.J., Stroud, C. & Breiner, H. 2015. Investing in the health and well-being of young adults. Washington, DC: The National Academies Press. Available at: <https://search-ebscohost-com.nwulib.nwu.ac.za/login.aspx?direct=true&db=cat01185a&AN=nwu.b2169672&site=eds-live>
Date of access: 24 Oct. 2019.

Boot, M., Volkening, L.K., Butler, D.A. & Laffel, L.M.B. 2013. The impact of blood glucose and HbA1c goals on glycaemic control in children and adolescents with type 1 diabetes. *Diabetic medicine*, 30(3):333-337.

Boucher, J.L. 2017. Mediterranean eating pattern. *Diabetes spectrum*, 30(2):72-76.

Bouhairie, V.E. & McGill, J.B. 2016. Diabetic kidney disease. *Missouri medicine*, 113(5):390-394.

Bowen, M.E., Cavanaugh, K.L., Wolff, K., Davis, D., Gregory, R.P., Shintani, A., Eden, S., Wallston, K., Elasy, T & Rothman, R.L. 2016. The diabetes nutrition education study randomized controlled trial: a comparative effectiveness study of approaches to nutrition in diabetes self-management education. *Patient education counselling*, 99(8):1368-1376.

Brand, C., Claydon-Platt, K., McColl, G. & Bucknall, T. 2010. Meeting the needs of people diagnosed with rheumatoid arthritis: an analysis of patient-reported experience. *Journal of nursing and healthcare of chronic illness*, 2(1):75–83.

Breland, J.Y., McAndrew, L.M., Gross, R.L., Leventhal, H. and Horowitz, C.R. 2013. Challenges to healthy eating for people with diabetes in a low-income, minority neighbourhood. *Diabetes care*, 36(10):2895-2901.

Brown, J.B., Harris, S.B., Webster-Bogaert, S., Wetmore, S., Faulds, C. & Stewart, M. 2002. The role of patient, physician and systemic factors in the management of type 2 diabetes mellitus. *Family practice*, 19(4):344–349.

Burton, R.S. 2015. Pursuing a child: an interactive qualitative analysis of the infertility treatment experience. Austin, TX: University of Texas at Austin. (Dissertation – PhD).

- Cal, S.F., de Sá, L.R., Glustak, M.E. & Santiago, M.B. 2015. Resilience in chronic diseases: a systematic review. *Cogent psychology*, 2(1):10249281-9. doi: 10.1080/23311908.2015.1024928.
- Callaghan, B.C., Cheng, H., Stables, C.L., Smith, A.L. & Feldman, E.L. 2012. Diabetic neuropathy: Clinical manifestations and current treatments. *Lancet neurology*, 11(6):521-534.
- Cambell, D.J.T., Manns, B.J., Hemmelgarn, B.R., Sanmartin, C., Edwards, A. & King-Shier, K. 2017. Understanding financial barriers to care in patients with diabetes: an exploratory qualitative study. *Diabetes educator*, 43(1):78-86.
- Cambell, D.J.T., Manns, B.J., Leblanc, P., Hemmelgarn, B.R., Sanmartin, C., King-Shier, K. 2016. Finding resiliency in the face of financial barriers: Development of a conceptual framework for people with cardiovascular-related chronic disease. *Medicine (Baltimore)*, 95(49):e5561-e5568. doi: 10.1097/MD.00000000000005561.
- Cameron, F.J., Scratch, S.E., Nadebaum, C., Northam, E.A., Koves, I., Jennings, J., Finney, K., Neil, J.J., Wellard, R.M., Mackay, M. & Inder, T.E. 2014. Neurological consequences of diabetic ketoacidosis at initial presentation of type 1 diabetes in a prospective cohort study of children. *Diabetes care*, 37(6):1554-1562.
- Campbell, A.P. 2017. DASH eating plan: an eating pattern for diabetes management. *Diabetes spectrum*, 30(2):76-81.
- Carroll, A.E. & Marrero, D.G. 2006. The role of significant others in adolescent diabetes: a qualitative study. *The diabetes educator*, 32(2):243-252.
- Casey, D., Murphy, K., Lawton, J., White, F.F. & Dineen, S.A. 2011. Longitudinal qualitative study examining the factors impacting on the ability of persons with T1DM to assimilate the Dose Adjustment For Normal Eating (DAFNE) principals into daily living and how these factors change over time. *BMC public health*, 11:672. doi: 10.1186/1471-2458-11-672.
- Cebeci, F. & Senol, S. 2008. Discharge training and counselling increase self-care ability and reduce post discharge problems in CABG patients, *Journal of clinical nursing*, 17(3):412-420.
- Centers for Disease Control and Prevention. 2016. Health, United States, 2016. <https://www.cdc.gov/nchs/data/abus/abus16.pdf#040> Date of access: 18 Oct. 2017.

- Cespedes, E.M., Bhupathiraju, S.N., Li, Y., Rosner, B., Redline, S. & Hu, F.B. 2016. Long-term changes in sleep duration, energy balance and risk of type 2 diabetes. *Diabetologia*, 59(1):101-109.
- Chen, Y. 2012. Metabolism: carbohydrate. (In Moore, F.C., ed. Encyclopedia of exercise medicine in health and disease. Berlin: Springer.) doi.org/10.1007/978-3-540-29807-6.
- Chester, M.D. & Auerbach, J. 2011. The Massachusetts guide to managing diabetes in schools. Malden, MA: Massachusetts Department of Elementary and Secondary Education. https://pdfs.semanticscholar.org/2e88/52535c8815afa43795230f56823cc15d6aeb.pdf?_ga=2.68043859.374085451.1574207573-248397676.1560431460 Date of access: 20 Nov. 2019.
- Chiang, J.L., Kirkman, M.S., Laffel, L.M.B. and Peters, A.L. 2014. Type 1 diabetes through the life span: a position statement of the American Diabetes Association. *Diabetes care*, 37(7):2034-2054.
- Chimen, M., Kennedy, A., Nirantharakumar, K., Pang, T.T., Andrews, R. & Narendran, P. 2012. What are the health benefits of physical activity in type 1 diabetes mellitus? A literature review. *Diabetologia*, 55(3):542-551.
- Chong, S., Ding, D., Byun, R., Comino, E., Bauman, A. & Jalaludin, B. 2017. Lifestyle changes after a diagnosis of type 2 diabetes. *Diabetes spectrum*, 30(1):43-50.
- Clark, N.M., Becker, M.H., Janz, N.K., Lorig, K., Rakowski, W. & Anderson, L. 1991. Self-management of chronic disease by older adults: a review and questions for research. *Journal of aging and health*, 3(1):3-27.
- Coffen, R.D. 2009. Type 1 self-management magnitude. *Postgraduate medicine*, 121(5):119-139.
- Colberg, S.R., Sigal, R.J., Fernhall, B., Regensteiner, J.G., Blissmer, B.J., Rubin, R.R., Chasan-Taber, L., Albright, A.L. & Braun, B. 2010. Exercise and type 2 diabetes. the American College of Sports Medicine and the American Diabetes Association: joint position statement. *Diabetes care*, 33(12):e147-e167. doi: 10.2337/dc10-9990.
- Colberg, S.R., Sigal, R.J., Yardley, J.E., Riddell, M.C., Dunstan, D.W., Dempsey, P.C., Horton, E.S., Castorino, K. & Tate, D.F. 2013. Physical activity/exercise and diabetes: a position statement of the American Diabetes Association. *Diabetes care*, 39(11):2065-2079.

- Cooper, J.M., Collier, J., James, V. & Hawkey, C.J. 2010. Beliefs about personal control and self-management in 30–40 year olds living with inflammatory bowel disease: a qualitative study. *International journal of nursing studies*, 47(12):1500-1509.
- Coppell, K.J., Kataoka, M., Williams, S.M., Chisholm, A.W., Vorgers, S.M. & Mann, J. 2010. Nutritional intervention in patients with type 2 diabetes who are hyperglycaemic despite optimised drug treatment—Lifestyle Over and Above Drugs in Diabetes (LOADD) study: randomised controlled trial. *British medical journal*, 341(7766):237-243.
- Corcoran, M. P., Lamon-Fava, S. and Fielding, R. A. 2007. Skeletal muscle lipid deposition and insulin resistance: effect of dietary fatty acids and exercise. *The American journal of clinical nutrition*, 85(3):662–677.
- Coser, A., Sittner, K.J., Walls, M.L. & Handeland, T. 2018. Caregiving stress among American Indians with type 2 diabetes: the importance of awareness of connectedness and family support. *Journal of family nursing*, 24(4):621-639.
- Costantini, L., Beanlands, H., McCay, E., Cattran, D., Hladunewich, M. & Francis, D. 2008. The self-management experience of people with mild to moderate chronic kidney disease. *Nephrology nursing journal*, 35(2):147–155.
- Creer, T.L., Rennie, C.M. & Christian, W.P. 1976. Behavioural contributions to rehabilitation and childhood asthma. *Rehabilitation literature*, 37(8):226-232.
- Cupisti, A., Kovesdy, C.P., D'Alessandro, C. and Kalantar-Zadeh, K. 2018. Dietary approach to recurrent or chronic hyperkalaemia in patients with decreased kidney function. *Nutrients*, 10(3):261-276.
- Daemane, M.E., Cilliers, S.S. & Bezuidenhout, H. 2010. An ecological study of plant communities in the proposed Highveld National Park, in the peri-urban area of Potchefstroom, South Africa. *Koedoe*, 52(1). doi: 10.4102/koedoe.v52i1.708.
- Dashiff, C., McCaleb, A. & Cull, V. 2006. Self-care of young adolescents with type 1 diabetes. *Journal of pediatric nursing*, 21(3):222-232.
- Dashiff, C., Riley, B.H., Abdullatif, H. & Moreland, E. 2011. Parents' experiences supporting self-management of middle adolescents with type 1 diabetes mellitus. *Pediatric nursing*, 37(6):304-310.

- Dashiff, C., Vance, D., Abdullatif, H. & Wallander, J. 2009. Parenting, autonomy and self-care of adolescents with Type 1 diabetes. *Child: care, health and development*, 35(1):79-88.
- De Brito-Ashurst, I., Perry L., Sanders, T., Thomas, J., Yaqoob, M. & Dobbie, H. 2011. Barriers and facilitators of dietary sodium restriction amongst Bangladeshi chronic kidney disease patients. *Journal of Human Nutrition and Dietetics*, 24(1):86-95.
- De Munter, J.S.L., Hu, F.B., Spiegelman, D., Franz, M. & van Dam, R.M. 2007. Whole grain, bran, and germ intake and risk of type 2 diabetes: a prospective cohort study and systematic review. *PLoS medicine*, 4(8):e26. doi: 10.1371/journal.pmed.0040261.
- Deci, E.L., Koestner, R., Ryan, R.M. 1999. A meta-analytic review of experiments examining the effects of extrinsic rewards on intrinsic motivation. *Psychological bulletin*, 125(6):627-668.
- Delahanty, L.M., Nathan, D.M., Lachin, J.M., Hu, F.B., Cleary, P.A., Ziegler, G.K., Wylie-Rosett, J. & Wexler, D.J. 2009. Association of diet with glycated haemoglobin during intensive treatment of type 1 diabetes in the diabetes control and complications trial. *American journal of clinical nutrition*, 89(2):518-524.
- Dempsey, P.C., Larsen, R.N., Sethi, P., Sacre, J.W., Straznick, N.E., Cohen, N.D., Cerin, E., Lambert, G.W., Owen, N., Kingwell, B.A. & Dunstan, D.W. 2016. Benefits for type 2 diabetes of interrupting prolonged sitting with brief bouts of light walking or simple resistance activities. *Diabetes care*, 39(6):964-972.
- Dheda, B.L. & Blackbeard, D.R. 2019. Caregivers of children with diabetes mellitus: challenges of caring for and perceptions of consultations in a South African public sector context. *South African family practice*, 61(4):117-135.
- Di Onofrio, V., Gallé, F., Di Dio, M., Belfiore, P. & Liguori, G. 2018. Effects of nutrition motivational intervention in patients affected by type 2 diabetes mellitus: a longitudinal study in Naples, South Italy. *BMC public health*, 18(1):1181. doi: 10.1186/s12889-018-6101-6.
- Dickinson, J.K., Guzman, S.J., Maryniuk, M.D., O'Brian, C.A., Kadohira, J.K., Jackson, R.A., D'Hondt, N., Montgomery, B., Close, K.L. & Funnell, M.M. 2017. The use of language in diabetes care and education. *Diabetes care*, 40(12):1790-1799.
- Dickson, V.V., McCauley, L.A. & Riegel, B. 2008. Work-Heart balance: The influence of biobehavioral variables on self-care among employees with heart failure. *American Association of Occupational Health Nurses journal*, 56(2):63-73.

- Dimitriadis, G., Mitrou, P., Lambadiari, V., Maratou, E. & Raptis, S.A. 2011. Insulin effects in muscle and adipose tissue. *Diabetes research and clinical practice*, 93(Suppl 1):S52-S59.
- Dineen-Griffin, S., Garcia-Cardenas, V., Williams, K. & Benrimoj, S.I. 2019. Helping patients help themselves: a systematic review of self-management support strategies in primary health care practice. *PLoS One*, 8(1)e0220116. doi: 10.1371/journal.pone.0220116.
- Dingley, C. & Roux, G. 2014. The role of inner strength in quality of life and self-management in women survivors of cancer. *Research in nursing & health*, 37(1):32-41.
- Ducat, L., Rubenstien, A., Philipson, L.H. & Anderson, B.J. 2015. A review of the mental health issues of diabetes conference. *Diabetes care*, 38(2):333-338.
- Dutton, G.R., Johnson, J., Whitehead, D., Bodenlos, J.S. & Brantley, P.J. 2005. Barriers to physical activity among predominantly low-income African-American patients with type 2 diabetes. *Diabetes care*, 28(5):1209–1210.
- Dyke, D.J. 2009. Adipokines as regulators of muscle metabolism and insulin sensitivity. *Applied physiology, nutrition & metabolism*, 34(3):396-402.
- Eckel, R.H., Jakicic, J.M., Ard, J.D., de Jesus, J.M., Houston Miller, N., Hubbard, V.S., Lee, I., Lichtenstein, A.H., Loria, C.M., Millen, B.E., Nonas, C.A., Sacks, F.M., Smith, S.C., Svetkey, L.P., Wadden, T.A. & Yanovski, S.Z. 2014. 2013 AHA/ACC guideline on lifestyle management to reduce cardiovascular risk: a report of the American College of Cardiology/American Heart Association Task Force on practice guidelines. *Journal of the American College of Cardiology*, 63(25):2960-2984.
- Ekinci, E.I., Clarke, S., Thomas, M.C., Moran, J.L., Cheong, K., MacIsaac, R.J. & Jerums, G. 2011. Dietary salt intake and mortality in patients with type 2 diabetes. *Diabetes care*, 34(3):703-709.
- Ellis, K., Mulnier, H. & Forbes, A. 2018. Perceptions of insulin use in type 2 diabetes in primary care: a thematic synthesis. *BMC family practices*, 19(1):70. <https://doi.org/10.1186/s12875-018-0753-2>.
- Emlet, C.A., Tozay, S. & Raveis, V.H. 2011. 'I'm not going to die from the AIDS': resilience in aging with HIV disease. *The Gerontologist*, 51(1):101-111.
- Engelgau, M.M., Narayan, K.M.V. & Herman, W.H. 2000. Screening for type 2 diabetes. *Diabetes care*, 32(10):1563-1580.

- Esposito, K., Maiorino, M.I., Di Palo, C. & Giugliano, D. 2009. Adherence to a Mediterranean diet and glycaemic control in Type 2 diabetes mellitus. *Diabetic medicine*, 26(9):900-907.
- Estruch, R., Ros, E., Salas-Salvadó, J., Covas, M., Corella, D., Arós, F., Gómez-Gracia, E., Ruiz-Gutiérrez, V., Fiol, M., Lapetra, J., Lamuela-Raventós, R.M., Serra-Majem, L., Pintó, X., Basora, J., Muñoz, M.A., Sorlí, J.V., Martínez, J.A. & Martínez-González, M.A. 2013. Primary prevention of cardiovascular disease with a Mediterranean diet. *New England journal of medicine*, 368(14):1279-1290.
- Evert, A.B., Boucher, J.L., Cypress, M., Dunbar, S.A., Franz, M.J., Mayer-Davis, E.J., Neumiller, J.J., Nwankwo, R., Verdi, C.L., Urbanski, P. and Yancy, W.S. 2014. Nutrition therapy recommendations for the management of adults with diabetes. *Diabetes care*, 37(Suppl 1):S120-S143.
- Fedor, A., Schumacher, J.R., Banning, J., McKinnis, R. & Wilson, M. 2017. Perceptions of how the transition from home life to college life affects type 1 diabetes management. *Diabetes spectrum*, 30(4):315-319.
- Fisher, M. 2004. Diabetes and atherogenesis. *Heart*, 90(3):336-340.
- Fitzpatrick, S.L., Schumann, K.P. & Hill-Briggs, F. 2013. Problem solving interventions for diabetes self-management and control: a systematic review of the literature. *Diabetes research and clinical practice*, 100(2):145-161.
- Flaxman, S.R., Bourne, R.A.R., Resnikoff, S., Ackland, P., Braithwaite, T., Cicinelli, M.V., Das, A., Jonas, J.B., Keeffe, J., Kempner, J.H., Leasher, J., Limburg, H., Naidoo, K., Pesudovs, K., Silvester, A., Stevens, G.A., Tahhan, N., Wong, T.Y. & Taylor, H.R. 2017. Global causes of blindness and distance vision impairment 1990-2020: a systemic review and meta-analysis. *Lancet global health*, 5(12):e1221-e1234. doi: 10.1016/S2214-109X(17)30393-5.
- Forouhi, N.G., Krauss, R.M., Taubes, G. & Willett, W. 2018a. Dietary fat and cardiometabolic health: evidence, controversies, and consensus for guidance. *British Medical Journal*, 361:k2139. doi: 10.1136/bmj.k2139.
- Forouhi, N.G., Misra, A., Mohan, V., Taylor, R. & Yancy, W. 2018b. Dietary and nutritional approaches for prevention and management of type 2 diabetes. *British Medical Journal*, 361:k2234. doi: 10.1136/bmj.k2234.
- Foster, P.P. & Gaskins, S.W. 2009. Older African Americans' management of HIV/AIDS stigma. *AIDS care*, 21(10):1306-1312.

- Fox, C.S., Golden, S.H., Anderson, C., Bray, G.A., Burke, L.E., de Boer, I.H., Deedwania, P., Eckel, R.H., Ershow, A.G., Fradkin, J., Inzucchi, S.E., Kosiborod, M., Nelson, R.G., Patel, M.J., Pignone, M., Quinn, L., Schauer, P.R., Selvin, E. & Vafiadis, D.K. 2015. Update on prevention of cardiovascular disease in adults with type 2 diabetes mellitus in light of recent evidence: a scientific statement from the American Heart Association and the American Diabetes Association. *Circulation*, 132(8):691-718.
- Franz, M.J., Boucher, J.L., Rutten-Ramos, S. & VonWormer, J. 2015. Lifestyle weight-loss intervention outcomes in overweight and obese adults with type 2 diabetes: a systematic review and meta-analysis of randomized clinical trials. *Journal of the Academy of Nutrition and Dietetics*, 115(9):1447-1463.
- Franz, M.J., MacLeod, J., Evert, A., Brown, C., Gradwell, E., Handu, D., Reppert, A. & Robinson, M. 2017. Academy of Nutrition and Dietetics Nutrition Practice guideline for type 1 and type 2 diabetes in adults: systematic review of evidence for medical nutrition therapy effectiveness and recommendations for integration into the nutrition care process. *Journal of the academy of nutrition and dietetics*, 117(1):1659-1679.
- Fredheim, S., Foli-Andersen, P., Laerkholm, G., Svensson, J., Juhl, C.B., Olsen, B., Pilgaard, K. & Johannesen, J. 2018. Adrenaline and cortisol levels are lower during nighttime than daytime hypoglycaemia in children with type 1 diabetes. *Acta paediatrica*, 107(10):1759-1765.
- Freeman-Hildreth, Y., Aron, D., Cola, P.A. & Wang, Y. 2019. Coping with diabetes: Provider attributes that influence type 2 diabetes adherence. *PLoS one*, 14(4):e0214713.
<https://doi.org/10.1371/journal.pone.0214713>
- Fritz, H. 2014. The influence of daily routines on engaging in diabetes self-management. *Scandinavian journal of occupational therapy*, 21(3):232–240.
- Fryan, K.N. 2002. Adipose tissue as a buffer for daily lipid flux. *Diabetologia*, 45(9):1201-1210.
- Fu, Z., Gilbert, E.R. & Liu, D. 2013. Regulation of insulin synthesis and secretion and pancreatic beta-cell dysfunctions in diabetes. *Current diabetes reviews*, 9(1):25-53.
- Gabir, M.M., Hanson, R.L., Dabelea, D., Imperatore, G., Roumain, J., Bennett. & Knowler, W.C. 2000. The 1997 American Diabetes Association and 1999 World Health Organization criteria for hyperglycemia in the diagnosis and prediction of diabetes. *Diabetes care*, 23(8):1108-1112.
- Galaviz, K.I., Narayan, V., Lobelo, F. & Weber, M.B. 2018. Lifestyle and the prevention of type 2 diabetes: a status report. *American journal of lifestyle medicine*, 12(1):4-20.

- Gale, E.A.M. 2005. Type 1 diabetes in the young: the harvest of sorrow goes on. *Diabetologie*, 48(8):1435-1438.
- Garcia-Perez, L., Alvares, M., Dilla, T., Vicente, G & Orozco-Beltran, D. 2013. Adherence to therapies in patients with type 2 diabetes. *Diabetes therapy*, 4(2):175-194.
- Gee, L., Smith, T.L., Solomon, M., Quinn, M.T. & Lipton, R.B. 2007. The clinical, psychosocial and socioeconomic concerns of urban youth living with diabetes. *Public health nursing*, 24(4): 318-328.
- Ghosh, A., Gao, L., Thakus, A., Siu, P.M. Lai, C.W.K. 2017. Role of free fatty acids in endothelial dysfunction. *Journal of biomedical science*, 24(1):50. doi: 10.1186/s12929-017-0357-5.
- Given, L.M., ed. 2008. The Sage encyclopedia of qualitative research methods. 15th ed. Los Angeles, CA: Sage.
- Gobeil-Lavoie, A., Chouinard, M., Danish, A. & Hudon, C. 2019. Characteristics of self-management among patients with complex health needs: a thematic analysis review. *BMJ open*, 9(5):e028344. doi: 10.1136/bmjopen-2018-028344.
- Goday, A., Bellido, D., Sajoux, I., Crujeiras, A.B., Burguera, B., Garcia-Luna, P.P., Oleaga, A., Moreno, B. & Casanueva, F.F. 2016. Short-term safety, tolerability and efficacy of a very low-calorie-ketogenic diet interventional weight loss program versus hypocaloric diet in patients with type 2 diabetes mellitus. *Nutrition and diabetes*, 6(9):e230. doi: 10.1038/nutd.2016.36.
- Gonzales, W.V., Mobashsher, A.T. & Abbosh, A. 2019. The progress of glucose monitoring: a review of invasive to minimally and non-invasive techniques, devices and sensors. *Sensors*, 19(4):800-844.
- Gordon, K., Smith, F. & Dhillon, S. 2007. Effective chronic disease management: patients' perspectives on medication-related problems. *Patient education and counselling*, 65(3):407-415.
- Grady, P.A. & Gough, L.L. 2014. Self-management: a comprehensive approach to management of chronic conditions. *American journal of public health*, 104(8):e25-e31. doi: 10.2105/AJPH.2014.302041.

- Grandes, G., Sánchez, A., Torcal, J., Sánchez-Pinilla, R.O., Lizarraga, K. & Serra, J. 2008. Targeting physical activity promotion in general practice: characteristics of inactive patients and willingness to change. *BMC public health*, 8:172. doi:10.1186/1471-2458-8-172.
- Grant, J.S. & Steadman, L.A. 2016. Barriers to diabetes self-management among rural individuals in the workplace. *Workplace health and safety*, 64(6):243-248.
- Green, A.D., Vasu, S. & Flatt, P.R. 2018. Cellular models for beta-cell function and diabetes gene therapy. *Acta physiologica*, 222(3). doi: 10.1111/apha.13012.
- Gregg, B.E., Moore, P.C., Demozay, D., Hall, B.A., Li, M., Hussain, A., Wright, A.J., Atkinson, M.A. & Rhodes, C.J. 2012. Formation of a human β -cell population within pancreatic islets is set early in life. *The journal of clinical endocrinology and metabolism*, 97(9):3197-3206.
- Grey, M., Whittemore, R., Jaser, S., Ambrosino, J., Lindemann, E., Liberti, L., Northrup, V. & Dziura, J. 2009. Effects of coping skills training in school-age children with type 1 diabetes. *Research in nursing & health*, 32(4):405-418.
- Griva, K., Ng, H.J., Loei, J., Mooppil, N, McBain and Newman, S.P. 2013. Managing treatment for end-stage renal disease: a qualitative study exploring cultural perspectives on facilitators and barriers to treatment adherence. *Psychology and health*, 28(1):13-29. <https://doi.org/10.1080/08870446.2012.703670>.
- Haas, L. & Maryniuk, M. 2014. National Standards for Diabetes Self-Management Education and Support. *Diabetes Care*, 37(Suppl 1): S144-S153.
- Haghighi, M.M., Mavros, Y. & Singh, M.A.F. 2018. The effects of structured exercise or lifestyle behavior interventions on long-term physical activity level and health outcomes in individuals with type 2 diabetes: a systematic review, meta-analysis, and meta-regression. *Journal of physical activity and health*, 15(9):697-707.
- Hamasaki, H. 2016. Daily physical activity and type 2 diabetes: a review. *World journal of diabetes*, 7(12):243-251.
- Hamman, R.F., Bell, R.A., Dabelea, D., D'Agostino, R.B., Dolan, L., Imperatore, G., Lawrence, J.M., Linder, B., Marcovina, S.M., Mayer-Davis, E.J., Pihoker, C., Rodriguez, B.L. & Saydah, S. 2014. The SEARCH for diabetes in youth study: rationale, findings, and future directions. *Diabetes care*, 37(12):3336-3344. <https://doi.org/10.2337/dc14-0574>.

- Hampson, S.E., Skinner, T.C., Hart, J., Storey, L., Gage, H., Foxcort, D., Kimber, A., Shaw, K. & Walker, J. 2001. Effects of educational and psychosocial interventions for adolescents with diabetes mellitus: a systematic review. *Health technology assessment (Winchester, England)*, 5(10):1-79. doi.org/10.3310/hta5100.
- Handley, J., Pullon, S. & Gifford, H. 2010. Living with type 2 diabetes: 'Putting the person in the pilots' seat'. *Australian journal of advanced nursing*, 27(3):12-19.
- Haneda, M., Utsunomiya, K., Koya, D., Babazono, T., Moriya, T., Makino, H., Kimura, K., Suzuki, Y., Wada, t., Ogawa, S., Inaba, M., Kanno, Y., Shigematsu, T., Masakane, I., Tsuchiya, K., Honda, K., Ichikawa, K. & Shide, K. 2015. A new classification of diabetic nephropathy 2014: a report from Joint Committee on Diabetic Nephropathy. *Journal of diabetes investigation*, 6(2):242-246.
- Hanna, K.M. & Decker, C.L. 2010. A concept analysis: assuming responsibility for self-care among adolescents with type 1 diabetes. *Journal for specialists in pediatric nursing*, 15(2):99-110.
- Hanna, K.M., Juarez, B., Lenss, S.S. & Guthrie, D. 2003. Parent-adolescent communication and support for diabetes management as reported by adolescents with type 1 diabetes. *Issues in comprehensive pediatric nursing*, 26(3):145-158.
- Hanna, K.M., Weaver, M.T., Stump, T.E., DiMeglio, L.A., Miller, A.R., Crowder, S. & Fortenberry, J.D. 2013a. Initial findings: primary diabetes care responsibility among emerging adults with type 1 diabetes post high school and move out of parental home. *Child: care health and development*, 39(1):61-68.
- Hanna, K.M., Weaver, M.T., Stump, T.E., Slaven, J.E., Fortenberry, J.D. & DiMeglio, L.A. 2013b. Readiness for living independently among emerging adults with type 1 diabetes. *The diabetes educator*, 39(1):92-99.
- Hansen, E., Landstad, B.J., Hellzén, O. & Svebak, S. 2011. Motivation for lifestyle changes to improve health in people with impaired glucose tolerance. *Scandinavian journal of caring sciences*, 25(3):484-490.
- Hatting, M., Tavares, C.D.J., Sharabi, K., Rines, A.K. and Puigserver, P. 2018. Insulin regulation of gluconeogenesis. *Annals of the New York Academy of Science*, 1411(1):21-35.

- Head, T., Daunert, S. & Goldschmidt-Clermont, P.J. 2017. The aging risk and atherosclerosis: a fresh look at arterial homeostasis. *Frontiers in genetics*, 8:216. doi: 10.3389/fgene.2017.00216.
- Henriques, M.A., Costa, M.A. and Cabrita, J. 2012. Adherence and medication management by the elderly. *Journal of clinical nursing*, 21(21-22):3096-3105.
- Hewitt, J., Smeeth, L., Chaturvedi, N., Bulpitt, C.J. & Fletcher, A.E. 2011. Self management and patient understanding of diabetes in the older person. *Diabetic medicine*, 28(1):117-122.
- Hilger, J., Loerbroks, A. & Diehl, K. 2017. Eating behaviour of university students in Germany: dietary intake, barriers to healthy eating and changes in eating behaviour since the time of matriculation. *Appetite*, 109(1):100-107.
- Hill, S., Ginngas, J. & Gucciardi, E. 2013. The lived experience of Canadian university students with type 1 diabetes mellitus. *Canadian journal of diabetes*, 37(1):237-242.
- Hill-Briggs, F. 2003. Problem solving in diabetes self-management: a model of chronic illness self-management behavior. *Annals of behavioural medicine*, 25(3):182-193.
- Hilliard, M.E., Holmes, C.S., Chen, R. Maher, K., Robinson, E. and Streisand, R. 2013. Disentangling the roles of parental monitoring and family conflict in adolescents' management of type 1 diabetes. *Health psychology*, 32(4):388-396.
- Hillson, R. 2015. Temperature and blood glucose management. *Practical diabetes*, 32(7):231-235.
- Ho, M.Y., Cheung, F.M. & Cheung, S.F. 2010. The role of meaning in life and optimism in promoting well-being. *Personality and individual differences*, 48(5):658-663.
- Hoey, H. 2009. Psychosocial factors are associated with metabolic control in adolescents: research from the Hvidoere Study Group on Childhood Diabetes. *Pediatric diabetes*, 10(Suppl 13):9-14.
- Holman, H. & Lorig, K. 2004. Patient self-management: a key to effectiveness and efficiency in care of chronic disease. *Public health reports*, 119(1):239-243.
- Holst, J.J., Vilsbøll, T. & Deacon, C.F. 2009. The incretin system and its role in type 2 diabetes mellitus. *Molecular and cellular endocrinology*, 297(1):127-136.

- Hood, K.K., Hilliard, M., Piatt, G. & levers-Landis, C.E. 2015. Effective strategies for encouraging behavior change in people with diabetes. *Diabetes management (London)*, 5(6):499-510.
- Howson, J.M.M., Rosinger, S., Smyth, D.J., Boehm, B.O. & Todd, J.A. 2010. Genetic analysis of adult-onset autoimmune diabetes. *Diabetes*, 60(10):2645-2653.
- Hu, F.B. 2011. Globalization of diabetes: the role of diet, lifestyle, and genes. *Diabetes care*, 34(6):1249-1257.
- Huang, S. & Czech, M.P. 2007. The GLUT4 glucose transporter. *Cell metabolism*, 5(4):237-252.
- Human-Vogel, S. & Van Petegem, P. 2008. Causal judgements of positive mood in relations to self-regulation: a case study with Flemish students. *Contemporary educational psychology*, 33(4):451-485.
- Hwu, Y.J. & Yu, C.C. 2006. Exploring health behaviour determinants for people with chronic illness using the constructs of planned behavior theory. *Journal of nursing research*, 14(4):261-270.
- Iannotti, R.J., Schneider, S., Nansel, T.R, Haynie, D.L., Plotnick, L.P., Clark, L.M., Sobel, D.O. & Simon-Mortan, B. 2006. Self-efficacy, outcome expectations, and diabetes self-management in adolescents with type 1 diabetes. *Developmental and behavioural paediatrics*, 27(2):98-105.
- IDF (International Diabetes Federation). 2015a. Diabetes in South Africa – 2015. <http://www.idf.org/membership/afr/southafrica> Date of access: 28 Mar. 2017.
- IDF (International Diabetes Federation). 2015b. IDF Diabetes Atlas. 7th ed. Brussels. <https://www.idf.org/e-library/epidemiology-research/diabetes-atlas/13-diabetes-atlas-seventh-edition.html> Date of access: 28 Jun 2018.
- IDF (International Diabetes Federation). 2017. IDF Diabetes Atlas. 8th ed. Brussels. <http://fmdiabetes.org/wp-content/uploads/2018/03/IDF-2017.pdf>.
- IDF (International Diabetes Federation). 2019a. Diabetes in Africa. <https://www.idf.org/our-network/regions-members/africa/diabetes-in-africa.html> Date of access: 20 Oct. 2019.
- IDF (International Diabetes Federation). 2019b. Diabetes facts and figures. <https://www.idf.org/aboutdiabetes/what-is-diabetes/facts-figures.html> Date of access: 20 Oct. 2019.

IDF (International Diabetes Federation). 2019c. 11 October - World Obesity Day. <https://www.idf.org/our-network/regions-members/europe/europe-news/71:11-october-world-obesity-day.html> Date of access: 25 Oct. 2019.

IDF (International Diabetes Federation). 2020. IDF Diabetes Atlas – 9th ed. Brussels. <https://www.diabetesatlas.org/en/> Date of access: 2 Apr. 2020.

Ingerski, L.M., Anderson, B.J., Dolan, L.M. and Hood, K.K. 2010. Blood glucose monitoring and glycemic control in adolescence: contribution of diabetes-specific responsibility and family conflict. *Journal of adolescent health*, 47(2):191-197.

Insabella, G., Grey, M., Knafl, G. & Tamborlane, W. 2007. The transition to young adulthood in youth with type 1 diabetes on intensive treatment. *Pediatric diabetes*, 8(4):228-234.

Inzucchi, S.E., Bergenstal, R.M., Buse, J.B., Diamant, M., Ferrannini, A.L., Nauck, M., Peters, A.L., Tsapas, A., Wender, R. & Matthews, D.R. 2015. Management of hyperglycemia in type 2 diabetes, 2015: a patient centered approach. *Diabetes care*, 38(1):140-149.

Jansen, M.J., Viechtbauer, W., Lenssen, A.F., Hendriks, E.J.M. & de Bie, R.A. 2011. Strength training alone, exercise therapy alone, and exercise therapy with passive manual mobilisation each reduce pain and disability in people with knee osteoarthritis: a systematic review. *Journal of physiotherapy*, 57(1):11-20.

Jansink, R., Braspenning, J., Keizer, E. van der Weijden, T, Elwyn, G. & Grol, R. 2012. Misperception of patients with type 2 diabetes about diet and physical activity, and its effects on readiness to change. *Journal of diabetes*: 4(4):417-423. *Journal of physiotherapy*, 57(1):11-20.

Jerant, A.F., von Friederichs-Fitzwater, M.M. & Moore, M. 2005. Patients' perceived barriers to active self-management of chronic conditions. *Patient education and counselling*, 57(1):300-307.

Jin, J., Sklar, G.E., Oh, V.M.S. & Li, S.C. 2008. Factors affecting therapeutic compliance: a review from the patient's perspective. *Therapeutics and clinical risk management*, 4(1):269-286.

Jo Wu, C.J., Chang, A.M. & McDowell, J. 2008. Perspectives of patients with type 2 diabetes following a critical cardiac event - an interpretative approach. *Journal of clinical nursing* 17(5A):16-24.

- Jones, A., Vallis, M., Cooke, D. & Pouwer, F. 2016. Working together to promote diabetes control: a practical guide for diabetes health care providers in establishing a working alliance to achieve self-management support. *Journal of diabetes research*, 2016:e2830910. <http://dx.doi.org/10.1155/2016/2830910>.
- Jowsey, T., Jeon, Y.H., Dugdale, P., Glasgow, N.J., Kljakovic, M. & Usherwood, T. 2009. Challenges for co-morbid chronic illness care and policy in Australia: a qualitative study. *Australia and New Zealand health policy*, 6(1):22-29.
- Juster-Switlyk, K. & Smith, A.G. 2015. Updates in diabetic peripheral neuropathy. *F1000research*, 5(1) doi:10.12688/f1000research.7898.1..
- Karimy, M., Koohestani, H.R. & Araban, M. 2018. The association between attitude, self-efficacy, and social support and adherence to diabetes self-care behaviour. *Diabetology & metabolic syndrome*, 10(86). <https://doi.org/10.1186/s13098-018-0386-6>.
- Katz, M.L., Mehta, S., Nansel, T., Quinn, H., Lipsky, L.M. & Laffel, L.M.B. 2014. Associations of nutrient intake with glycemic control in youth with type 1 diabetes: differences by insulin regimen. *Diabetes technology and therapeutics*, 16(8):512-518.
- Katzmarzyk, P.T., Church, T.S., Craig, C.L. & Bouchard, C. 2009. Sitting time and mortality from all causes, cardiovascular disease, and cancer. *Medicine & science in sports & exercise*, 41(5):998-1005.
- Kayyali, R., Slater, N., Sahi, A., Mepani, D., Lalji, K. & Abdallah, A. 2019. Type 2 diabetes: how informed are the general public? A cross-sectional study investigating disease awareness and barriers to communicating knowledge in high-risk populations in London. *BMC public health*, 19(1):138. doi: 10.1186/s12889-019-6460-7.
- Keenan, H.A., Sun, J.K., Levine, J., Doria, A., Aiello, L.P., Eisenbarth, G., Bonner, Weir, S. & King, G.L. 2010. Residual insulin production and pancreatic β -cell turnover after 50 years of diabetes: Joslin Medallist Study. *Diabetes*, 59(11):2846-2853.
- Kempen, J.H., O'Colmain, B.J., Leseke, M.C., Haffner, S.S.M., Klein, R., Moss, S.E., Taylor, H.R. & Hamman, R.F. 2004. The prevalence of diabetic retinopathy among adults in the United States. *Archives of ophthalmology*, 122(1):552-563.
- Kennedy, A., Narendran, P., Andrews, R.C., Daley, A. & Greenfield, S.M. 2018. Attitudes and barriers to exercise in adults with a recent diagnosis of type 1 diabetes: a qualitative study of

participants in the exercise for type 1 diabetes (EXTOD) study. *BMJ open*, 8(1):e017813. doi: 10.1136/bmjopen-2017-017813.

Keough, L., Sullivan-Bolyai, S., Crawford, S., Schilling, L. & Dixon, J. 2011. Self-management of type 1 diabetes across adolescence. *The diabetes educator*, 37(4):486-500.

Kerner, W. & Brückel, J. 2014. Definition, Classification and Diagnoses of Diabetes Mellitus. *German Diabetes Association: Clinical Practice Guidelines*, 122(7):384-386.

Kharroubi, A.T. & Darwish, H.M. 2015. Diabetes mellitus: the epidemic of the century. *World journal of diabetes*, 6(6):850-867.

Khurana, G. & Gupta, V. 2019. Effect on insulin upon storage in extreme climatic conditions (temperature and pressure) and their preventive measures. *Journal of social health and diabetes*, 7(1):6-10. doi: 10.1055/s-0039-1692371.

Klinkner, G.E., Yaeger, K.M., Brenny-Fitzpatrick, M.T. & Vorderstrasse, A.A. 2017. Improving diabetes self-management support: goal-setting across the continuum of care. *Clinical diabetes*, 35(5):305-312.

Ko, G.J., Obi, Y., Tortorici, A.R. & Kalantar-Zadeh, K. 2017. Dietary protein intake and chronic kidney disease. *Current opinion in clinical nutrition & metabolic care*, 20(1):77-85.

Kolb, H. & Martin, S. 2017. Environmental/lifestyle factors in the pathogenesis and prevention of type 2 diabetes. *BMC medicine*, 15(1):131. doi: 10.1186/s12916-017-0901-x.

Krentz, A. 2002. Insulin resistance: a clinical handbook. Oxford: Blackwell Science.

Kristjansdottir, O.B., Stenberg, U., Mirkovic, J., Krogseth, T., Ljoså, T.M., Stange, K.C. & Ruland, C.M. 2018. Personal strengths reported by people with chronic illness: a qualitative study. *Health expectations*, 21(4):787-795.

Kueh, Y.C., Morris, T., Borkoles, E. & Shee, H. 2015. Modelling of diabetes knowledge, attitudes, self-management, and quality of life: a cross-sectional study with an Australian sample. *Health and quality of life outcomes*, 13:129. doi 10.1186/s12955-015-0303-8.

Kumar, A., Jeengar, M.K. & Naidu, V.G.M. 2015. Sucrose, fructose, glucose, and their link to metabolic syndrome and cancer. *Nutrition*, 31(1):249-257.

Lakhani, O.J. & Lakhani, J.D. 2015. *Kumbhakarna*: did he suffer from the disorder of the hypothalamus? *Indian journal of endocrinology and metabolism*, 19(3):433-434.

Lakhtakia, R. 2013. The history of diabetes mellitus. *Sultan Qaboos University medical journal*, 13(3):368-370.

Laranjo, L., Neves, A.L., Costa, A., Ribeiro, R.T., Couto, L. & Sá, A.B. 2015. Facilitators, barriers, and expectations in the self-management of type 2 diabetes: a qualitative study from Portugal. *European journal of general practice*, 21(2):103-110.

Lascar, N., Kennedy, A., Hancock, B., Jenkins, D., Andrews, R.C., Greenfield, S. & Narendran, P. 2014. Attitudes and barriers to exercise in adults with type 1 diabetes (T1DM) and how best to address them: qualitative study. *PLoS One*, 9(9): e108019. doi: 10.1371/journal.pone.0108019.

Laska, M.N., Pasch, K.E., Lust, K., Story, M. & Ehlinger, E. 2009. Latent class analysis of lifestyle characteristics and health risk behaviors among college youth. *Prevention science*, 10(4):376-386.

Laurenzi, A., Bolla, A.M., Panigoni, G., Doria, V., Uccellatore, A., Peretti, E., Saibene, A., Galimberti, G., Bosi, E., Scavini, M. 2011. Effects of carbohydrate counting on glucose control and quality of life over 24 weeks in adult patients with type 1 diabetes on continuous subcutaneous insulin infusion. *Diabetes care*, 34(4):823-827.

Layman, D.K., Clifton, P., Gannon, M.C., Krauss, R.M. & Nuttal, F.Q. 2008. Protein in optimal health: heart disease and type 2 diabetes. *American journal of clinical nutrition*, 87(5):1571S-1575S.

Lee, J.H., Nam, S.K., Kim, A., Kim, B., Lee, M.Y. and Lee, S.M. 2013. Resilience: a meta-analytic approach. *Journal of counselling & development*, 91(3):269-279.

Lee, R., Wong, T.Y. & Sabanayagam, C. 2015. Epidemiology of diabetic retinopathy, diabetic macular edema and related vision loss. *Eye and vision*, 2:17. doi:10.1186/s40662-015-0026-2.

Lehmkuhl, H.D., Merlo, L.J., Devine, K., Gaines, J., Storch, E.A., Silverstein, J.H. & Geffken, G.R. 2009. Perceptions of type 1 diabetes among affected youth and their peers. *Journal of clinical psychology*, 16(3):209-215.

Lehohla, P.J. 2017. Mortality and causes of death in South Africa, 2015: Findings from death notification. <http://www.statssa.gov.za/publications/P03093/P030932015.pdf> Date of access: 9 May 2017.

- Lehuen, A., Diana, J., Zacccone, P. & Cooke, A. 2010. Immune cell crosstalk in type 1 diabetes. *Natural reviews immunology*, 10(7):501-513.
- Leitner, D.R., Frühbeck, G., Yumuk, V., Schindler, K., Micic, D., Woodward, E. and Toplak, H. 2017. Obesity and type 2 diabetes: two diseases with a need for combined treatment strategies - EASO can lead the way. *Obesity facts*, 10(5):483-492.
- Leon, B.M. & Maddox, T.M. 2015. Diabetes and cardiovascular disease: epidemiology, biological mechanisms, treatment recommendations and future research. *World journal of diabetes*, 6(13):1246-1258.
- Leonard, B.J., Jang, Y., Savik, K. & Plumbo, M.A. 2005. Adolescents with type 1 diabetes: family functioning and metabolic control. *Journal of family nursing*, 11(2):102-121.
- Leslie, R.D. 2010. Predicting adult-onset autoimmune diabetes: clarity from complexity. *Diabetes*, 59(2):330-331.
- Levy, D. 2011. Type 1 diabetes. 2nd ed. Oxford: Oxford University Press. Date of access: 20 Oct. 2019.
- Ley, S.H., Hamdy, O., Mohan, V. & Hu, F.B. 2014. Prevention and management of type 2 diabetes: dietary components and nutritional strategies. *Lancet*, 383(9933):1999-2007.
- Lin, C., Anderson, R.M., Hagerty, B.M. & Lee, B. 2008. Diabetes self-management experience: a focus group study of Taiwanese patients with type 2 diabetes. *Journal of nursing & healthcare of chronic illness*, 17(1):34-42.
- Lin, C.Y., Ni, C.C., Yin, M.C., and Lii, C.K. 2012. Flavonoids protect pancreatic beta-cells from cytokines mediated apoptosis through the activation of PI3-kinase pathway. *Cytokine*, 59(1):65-71.
- Lincoln, Y.S. & Guba, E.G. 1985. Naturalistic inquiry. London: SAGE.
- Lind, M., Garcia-Rodriguez, L.A., Booth, G.L., Cea-Soriano, L., Shah, B.R., Ekeröth, G. & Lipscombe, L.L. 2013. Mortality trends in patients with and without diabetes in Ontario, Canada and the UK from 1996 to 2009: a population-based study. *Diabetologia*, 56(21):2601-2608.
- Linmans, J.J., Knottnerus, J.A. & Spigt, M. 2015. How motivated are patients with type 2 diabetes to change their lifestyle? A survey among patients and healthcare professionals. *Primary care diabetes*, 9(6):439-445.

- Little, J.P., Gillen, J.B., Percival, M.E., Safdar, A., Tarnopolsky, M.A., Punthakee, Z., Jung, M.E. & Gibala, M.J. 2011. Low-volume high-intensity interval training reduces hyperglycemia and increases muscle mitochondrial capacity in patients with type 2 diabetes. *Journal of applied physiology*, 111(6):1554-1560.
- Liu, A.G., Ford, N.A., Hu, F.B., Zelman, K.M., Mozaffarian, D. & Kris-Etherton, P.M. 2017a. A healthy approach to dietary fats: understanding the science and taking action to reduce consumer confusion. *Nutrition journal*, 16(1):53. doi: 10.1186/s12937-017-0271-4.
- Liu, K.T., Kueh, Y.C., Arifin, W.N., Kim, Y. & Kuan, G. 2018. Application of transtheoretical model on behavioral changes, and amount of physical activity among university's students. *Frontiers in psychology*, 9:2402. doi: 10.3389/fpsyg.2018.02402.
- Liu, N.F., Brown, A.S., Folias, A.E., Younge, M.F., Guzman, S.J., Close, K.L. & Wood, R. 2017b. Stigma in people with type 1 or type 2 diabetes. *Clinical diabetes*, 35(1):27-34.
- Loh, S.Y. 2018. Self-care or self-management in palliative survivorship care in Asia: A call for more research. *Nursing and palliative care*, 3(4):1-3. doi: 10.15761/NPC.1000195.
- Lorig, K.R. & Holman, H.R. 2003. Self-management education: History, definition, outcomes and mechanisms. *Annals of behavioural medicine*, 26(1):1-7. doi: 10.1207/S15324796ABM2601_01.
- Lovejoy, J.C. 2002. The influence of dietary fat on insulin resistance. *Current diabetes reports*, 2(5):435-440.
- Low, L.L., Tong, S.F. & Low, W.Y. 2014. Mixed feelings about the diagnosis of type 2 diabetes mellitus: a consequence of adjusting to health related quality of life. *Collegium Antropologicum*, 38(1):11-20.
- Lowe, P. & McBride-Henry, K. 2012. What factors impact upon the quality of life of elderly women with chronic illnesses: Three women's perspectives. *Contemporary Nurse*, 41(1):18-27.
- Lundberg, P.C. & Thrakul, S. 2011. Diabetes type 2 self-management among Thai Muslim women. *Journal of nursing and healthcare of chronic illness*, 2011:3(1):52-60.
- Lundberg, P.C. & Thrakul, S. 2012. Type 2 diabetes: how do Thai Buddhist people with diabetes practise self-management? *Journal of Advanced Nursing*, 68(3), 550-558.
- MacLeod, J., Franz, M.J., Handu, D., Gradwell, E., Brown, C., Evert, A., Reppert, A. & Robinson, M. 2017. Academy of nutrition and dietetics nutrition practice guideline for type 1

and type 2 diabetes in adults: nutrition intervention evidence reviews and recommendations. *Journal of the academy of nutrition and dietetics*, 117(10):1637-1658.

Mahabalshetti, A.D., Ramdurg, S.I. & Dhananjaya, M. 2016. Prevalence of fear of hypoglycemic attack in patients with uncontrolled diabetes mellitus and correlation analysis in diabetes. *International journal of scientific study*, 3(12):173-177.

Maillot, M & Drewnowski, A. 2011. A conflict between nutritionally adequate diets and meeting the 2010 dietary guidelines for sodium. *American journal of preventive medicine*, 42(2):174-179.

Mamo, Y., Bekele, F., Nigussie, T. & Zewudie. 2019. Determinants of poor glycemic control among adult patients with type 2 diabetes mellitus in Jimma University Medical Center, Jimma zone, south west Ethiopia: a case control study. *BMC endocrine disorders*, 19(1):91. doi: 10.1186/s12902-019-0421-0.

Mamykina, L., Smaldone, A.M. & Bakken, S.R. 2015. Adopting the sensemaking perspective for chronic disease self-management. *Journal of biomedical informatics*, 56(1):406-417.

Marcy, T.R., Britton, M.L. and Harrison, D. 2011. Identification of barriers to appropriate dietary behavior in low-income patients with type 2 diabetes mellitus. *Diabetes therapy*, 2(1):9-19. doi: 10.1007/s13300-010-0012-6.

Marín-Peñalver, J.J., Martín-Timón, I., Sevillano-Collantes, C. and Cañizo-Gómez, F.J. 2016. Update on the treatment of type 2 diabetes mellitus. *World journal of diabetes*, 7(17):354-395.

Martinez, K., Frazer, S.F., Dempster, M., Hamill, A., Fleming, H. & McCorry, N.K. 2018. Psychological factors associated with diabetes self-management among adolescents with tType 1 diabetes: a systematic review. *Journal of health psychology*, 23(13):1749-1765.

Maryniuk, M.D. 2017. From pyramids to plates to patterns: perspectives on meal planning. *Diabetes spectrum*, 30(2):67-70.

McCarthy, A.L., Shaban, R., Boys, J. & Winch S. 2010. Compliance, normality and the patient on peritoneal dialysis. *Nephrology nursing journal*, 37(3):243–250.

McDuffie, R.H., Struck, L. & Burshell, A. 2001. Empowerment for diabetes management: integrating true self-management into the medical treatment and management of diabetes mellitus. *Ochsner journal*, 3(3):149-157.

- McGowan, P. 2005. Self-management: a background paper. Centre on Aging. University of Victoria. <https://docplayer.net/28825459-Self-management-a-background-paper-patrick-mcgowan-ph-d-university-of-victoria-centre-on-aging.html> Date of access: 12 Aug 2019.
- McMacken, M. & Shah, S. 2017. A plant-based diet for the prevention and treatment of type 2 diabetes. *Journal of geriatric cardiology*, 14(5):342-354.
- McQuaid, S.E., Hodson, L., Neville, M.J., Dennis, A.L., Cheeseman, J., Humphreys, S.M., Ruge, T., Gilbert, M., Fielding, B.A., Frayn, K.N. & Karpe, F. 2011. Downregulation of adipose tissue fatty acid trafficking in obesity. *Diabetes*, 60(1):47-55.
- Mead, H., Andres, E., Ramos, C., Siegel, B. & Regenstein, M. 2010. Barriers to effective self-management in cardiac patients: the patient's experience. *Patient Education and counselling* 79(1):69–76.
- Medagama, A., & Galgomuwa, M. 2018. Comorbidities and ethnocultural factors limit the physical activity of rural Sri Lankan patients with diabetes mellitus. *Journal of diabetes research*, 1: 4319604. <https://doi.org/10.1155/2018/4319604>.
- Meng, Y., Bai, H., Wang, S., Li, Z., Wang, Q. & Chen, L. 2017. Efficacy of low carbohydrate diet for type 2 diabetes mellitus management: A systematic review and meta-analysis of randomized controlled trials. *Diabetes research and clinical research*, 131:124-131. doi: 10.1016/j.diabres.2017.07.006.
- Mergenthaler, P., Lindauer, U., Dienel, G.A. and Meisel, A. 2013. Sugar for the brain: the role of glucose in physiological and pathological brain function. *Trends in neuroscience*, 36(10):587-597.
- Meyer, R.A., Fish, A.F. & Lou, Q. 2017. Use of the Hage framework for theory construction: factors affecting glucose control in the college-aged student with type 1 diabetes. *Applied nursing research*, 37(1):61-66.
- Mikhael, E.M., Hassali, M.A., Hussain, S.A. & Shawky, N. 2019. Self-management knowledge and practice of type 2 diabetes mellitus patients in Baghdad, Iraq: a qualitative study. *Diabetes, metabolic syndrome and obesity: targets and therapy*, 12:1-17. doi: 10.2147/DMSO.S183776.
- Miller, T.A. & DiMatteo, M.R. 2013. Importance of family/social support and impact on adherence to diabetic therapy. *Diabetes, metabolic syndrome and obesity: targets and therapy*, 6(1):421-426.

- Miller, W.R., Lasiter, S., Ellis, R.B. & Buelow, J.M. 2015. Chronic disease self-management: a hybrid concept analysis. *Nursing outlook*, 63(2):154-161.
- Modeste, R.R.M. & Majeke, S.J. 2010. Self-care symptom management strategies amongst women living with HIV/AIDS in an urban area in KwaZulu-Natal: original research. *Health SA gesondheid*, 15(1):162-169.
- Morris, J.L. & Chasens, E.R. 2017. Financial difficulty- a barrier to self-care in patients with diabetes. *Diabetes educator*, 43(3):247-248.
- Muchiri, J.W., Gericke, G.J. & Rheeder, P. 2016. Impact of nutrition education on diabetes knowledge and attitudes of adults with type 2 diabetes living in a resource-limited setting in South Africa: a randomised controlled trial. *Journal of endocrinology, metabolism and diabetes of South Africa*, 21(2):26-34.
- Mudaliar, S., Alloju, S. & Henry, R.R. 2016. Can a shift in fuel energetics explain the beneficial cardiorenal outcomes in the EMPA-REG OUTCOME study? a unifying hypothesis. *Diabetes care*, 39(7):1115-1122. doi: 10.2337/dc16-0542.
- Mukherjee, E., Carroll, R. & Matfin, G. 2011. Endocrine and metabolic emergencies: hypoglycaemia. *Therapeutic advances in endocrinology and metabolism*, 2011(2):81-93.
- Muranen, T., Iwanicki, M.P., Curry, N.L., Hwang, J., DuBois, C.D., Coloff, J.L., Hitchcock, D.S., Clish, C.B., Brugge, J.S. & Kalaany, N.Y. 2017. Starved epithelial cells uptake extracellular matrix for survival. *Nature communications*, 8:13989. doi: 10.1038/ncomms13989.
- Murray, B. & Rosenbloom, C. 2018. Fundamentals of glycogen metabolism for coaches and athletes. *Nutrition reviews*, 6(4):243-259.
- Nagelkerk, J., Reick, K. & Meengs, L. 2006. Perceived barriers and effective strategies to diabetes self-management. *Journal of advanced nursing*, 54(2):151-158.
- Nansel, T.R., Lipsky, L.M. & Liu, A. 2016. Greater diet quality is associated with more optimal glycemic control in a longitudinal study of youth with type 1 diabetes. *American journal of clinical nutrition*, 104(1):81-87.
- Nascimento, C.M.O. do, Ribeiro, E.B. & Oyama, L.M. 2009. Metabolism and secretory function of white adipose tissue: effect of dietary fat. *Anais da Academia Brasileira de Ciências*, 81(3):453-466.

- Newbould, J., Taylor, D. & Bury, M. 2006. Lay-led self-management in chronic illness: a review of the evidence. *Chronic illness*, 2(4):249-261.
- Newsholme, P., Cruzat, V., Arfuso, F. & Keane, K. 2014. Nutrient regulation of insulin secretion and action. *Journal of endocrinology*, 221(3):R105-R120.
- Nolte Kennedy, M.S & Masharani, U. 2012. Pancreatic hormones and antidiabetic drugs. (In Katzung, B.G., Masters, S.B. & Trevor, A.J., eds. Basic & clinical pharmacology. 12th ed. Boston, MA: Mc Graw Hill Lange. p. 743-744).
- Northcutt, N. & McCoy, D. 2004. Interactive qualitative analysis: a systems method for qualitative research. Thousand Oaks, CA: SAGE.
- Northcutt, N. & McCoy, D. 2015. Overview of interactive qualitative analysis process. (Unpublished document provided by the authors and used with their permission).
- Northcutt, N. & McCoy, D. 2016a. Drawing IQA systems. (Unpublished document provided by the authors and used with their permission).
- Northcutt, N. & McCoy, D. 2016b. IQA research design: thinking about the problem. (Unpublished document provided by the authors and used with their permission).
- Northcutt, N. & McCoy, D. 2016c. IQA research design protocol. (Unpublished document provided by the authors and used with their permission).
- Northcutt, N. & McCoy, D. 2016d. Composite systems: pareto protocol analysis. (Unpublished document provided by the authors and used with their permission).
- North-West University. 2017a. Student statistics of the NWU Potchefstroom Campus. http://www.nwu.ac.za/sites/www.nwu.ac.za/files/files/studentstats/GR_Student_statistics_of_the_North-West_University.pdf Date of access: 24 Apr. 2020.
- North-West University. 2017b. Residence rules.
- Nyoni, C.N. & Reid, M. 2019. Perceptions of patients regarding diabetes-related health communication strategies in the Free State, South Africa. *Health SA gesondheid*, 24:1089. doi: 10.4102/hsag.v24i0.1089.
- Oftedal, B., Karlsen, B. & Bru, E. 2010. Life values and self-regulation behaviours among adults with type 2 diabetes. *Journal of clinical nursing*, 19(17–18):2548-2556.

- Ogurtsova, K., da Rocha Fernandes, J.D., Huang, Y., Linnenkamp, U., Guariguata, L., Cho, N.H., Cavan, D., Shaw, J.E. & Makaroff, L.E. 2017. IDF Diabetes atlas: Global estimates for the prevalence of diabetes for 2015 and 2040. *Diabetes Research and clinical practice*, 128(2017):40-50.
- Olokoba, A.B., Obatero, O.A., Olokoba, L.B. 2012. Type 2 diabetes mellitus: a review of current trends. *Oman medical journal*, 27(4):269-273.
- Omisakin, F.D. & Ncama, B.P. 2011. Self, self-care and self-management concepts: implications for self-management education. *Education research*, 2(12):1733-1737.
- Orzech, K.M., Vivian, J., Torres, C.H., Armin, J. & Shaw, S.J. 2013. Diet and exercise adherence and practices among medically underserved patients with chronic disease variation across four ethnic groups. *Health education & behavior*, 40(1):56-66.
- Pamungkas, R.A., Chamroonsawasdi, K. & Vatanasomboon, P. 2017. A systematic review: family support integrated with diabetes self-management among uncontrolled type ii diabetes mellitus patients. *Behavioral sciences*, 7(3):62-78.
- Pascucci, M.A., Leasure, A.R., Belknap, D.C. & Kodumthara, E. 2010. Situational challenges that impact health adherence in vulnerable populations. *Journal of cultural diversity*, 17(1):4-12.
- Pasnoor, M., Dimachkie, M.M., Kluding, P. & Barohn, R.J. 2013. Diabetic neuropathy part 1: overview and symmetric phenotypes. *Neurology clinic*, 31(2):425-445.
- Paterson, M.A., Smart, C.E.M., Lopez, P.E., McElduff, P., Attia, J., Morbey, C. & King, B.R. 2016. Influence of dietary protein on postprandial blood glucose levels in individuals with type 1 diabetes mellitus using intensive insulin therapy. *Diabetic medicine*, 33(5):592-598.
- Patino, S.C. & Mohiuddin, S.S. 2019. Statpearls. Biochemistry, Glycogenesis. <https://www.ncbi.nlm.nih.gov/books/NBK549820/> Date of access: 2 Apr. 2020.
- Patrick, H. & Williams, G.C. 2012. Self-determination theory: its application to health behavior and complementarity with motivational interviewing. *International journal of behavioral nutrition and physical activity*, 9(18):18-29.
- Patton, G.C., Saywer, S.M., Santelli, J.S., Ross, D.A., Afifi, R., Allen, N.B., Arora, M., Azzopardi, P., Baldwin, W., Bonell, C., Kakuma, R., Kennedy, E., Mahon, J., McGovern, T., Mokdad, A.H., Patel V., Petroni, S., Reavley, N., Taiwo, K., Waldfogel, J., Wickremarathne, D., Barroso, C., Bhutta, Z., Fatusi, A.O., Mattoo, A., Diers, J., Fang, J., Ferguson, J., Ssewamala, F & Viner,

R.M. 2016. Our future: a Lancet commission on adolescent health and wellbeing. *Lancet*, 387(10036):2423-2478.

Pawlak, R. 2017. Vegetarian diets in the prevention and management of diabetes and its complications. *Diabetes spectrum*, 30(2):82-88.

Penckofer, S., Quinn, L., Byrn, M., Ferrans, C., Miller, M. & Strange, P. 2012. Does glycemic variability impact mood and quality of life?. *Diabetes technology & therapeutics*, 14(4):303-310.

Peters, A. & Laffel, M.D. 2011. Diabetes care for emerging adults: recommendations for transition from pediatric to adult diabetes care systems. *Diabetes care*, 34(11):2477-2485.

Peters, L.W.H., Nawijn, L. & van Kesteren, N.M.C. 2014. How adolescents with diabetes experience social support from friends: two qualitative studies. *Scientifica (Cairo)*, 2014(1):415849. doi: 10.1155/2014/415849.

Petit, J., Burlet-Godinot, S., Magistretti, P.J. and Allaman, I. 2015. Glycogen metabolism and the homeostatic regulation of sleep. *Metabolic brain disease*, 30(1):263-279.

Pettitt, D.J., Talton, J., Dabelea, D., Divers, J., Imperatore, G., Lawrence, J.M., Liese, A.D., Linder, B., Mayer-Davis, E.J., Pihoker, C., Saydah, S.H., Standiford, D.A. & Hamman, R.F. 2014. Prevalence of diabetes in U.S. youth in 2009: the SEARCH for diabetes in youth study. *Diabetes care*, 37(2):402-408.

Pinhas-Hamiel, O., Tisch, E., Levek, N., Ben-David, R.F., Graf-Bar-El, C., Yaron, M., Boyko, V. & Lerner-Geva, L. 2017. Sexual lifestyle among young adults with type 1 diabetes. *Diabetes-metabolism research and reviews*, 33(2): e2837. <https://doi.org/10.1002/dmrr.2837>.

Piva, S.R., Susko, A.M., Khoja, S.S., Josbeno, D.A., Fitzgerald, G.K. and Toledo, F.G.S. 2015. Links between osteoarthritis and diabetes: implications for management from a physical activity perspective. *Clinics in geriatric medicine*, 31(1):67-87.

Ploughman, M., Austin, M.W., Murdoch, M., Kearny, A., Godwin, M. and Stefanelli, M. 2012. The path to self-management: a qualitative study involving older people with multiple sclerosis. *Physiotherapy Canada*, 64(1):6-17.

Pop-Busui, R., Boulton, J.M., Feldman, E.L., Bril, V., Freeman, R., Malik, R.A., Sosenko, J.M. & Ziegler, D. 2017. Diabetic neuropathy: A position statement by the American Diabetes Association. *Diabetes care*, 40(1):136-154.

- Powell, P.W., Corathers, S.D., Raymond, J. & Streisand, R. 2015. New approaches to providing individualized diabetes care in the 21st century. *Current diabetes reviews*, 11(4):222-230.
- Prochaska, J.J. & Prochaska, J.O. 2011. A review of multiple health behavior change interventions for primary prevention. *American journal of lifestyle medicine*, 5(3):208-221.
- Prochaska, J.O. & Velicer, W.F. 1997. The transtheoretical model of health behavior change. *American journal of health promotion*, 12(1):38-48.
- Rajendran, P., Rengarajan, T., Thangavel, J., Nishigaki, Y., Sakthisekaran, D., Sethi, G. & Nishigaki, I. 2013. The vascular endothelium and human disease. *International journal of biological science*, 9(10):1057-1069.
- Ramchandani, N., Cantey-Kiser, J.M., Alter, C.A., Brink, S.J., Yeager, S.D., Tamborlane, W.V. & Chipkin, S.R. 2000. Self-reported factor that affect glycemic control in college students with type 1 diabetes. *The diabetes educator*, 26(4):656-666.
- Rasmussen, B., Ward, G., Jenkins, A., King, A.J. and Dunning, T. 2011. Young adults' management of type 1 diabetes during life transitions. *Journal of clinical nursing*, 20(14):1981-1992.
- Rausch, J.R., Hood, K.K., Delamater, A., Pendley, J.S., Rohan, J.M., Reeves, G., Dolan, L. and Drotar, D. 2012. Changes in treatment adherence and glycemic control during the transition to adolescence in type 1 diabetes. *Diabetes care*, 35(6):1219-1224.
- Ravert, R.D., Boren, S.A. & Wiebke, E. 2015. Transitioning through college with diabetes: themes found in online forums. *Journal of American college health*, 63(4):258-267.
- Razmaria, A.A. 2015. Diabetic neuropathy. *Journal of the American Medical Association*, 314(20):2202. doi:10.1001/jama.2015.15899.
- Reid, M., Walsh, C., Raubenheimer, J., Bradshaw, T., Pienaar, M., Hassan, C., Nyoni, C. & Le Roux, M. 2018. Development of a health dialogue model for patients with diabetes: A complex intervention in a low-/middle income country. *International journal of Africa nursing sciences*, 8:122-131.
- Rejeski, W.J., Ip, E.H., Bertoni, A.G., Bray, G.A., Evans, G., Gregg, E.W. & Zhang, Q. 2012. Lifestyle change and mobility in obese adults with type 2 diabetes. *The New England journal of medicine*, 366(13):1209-1217.

- Reyes, J., Tripp-Reimer, T., Parker, E., Muller, B. and Laroche, H. 2017. Factors influencing diabetes self-management among medically underserved patients with type 2 diabetes. *Global qualitative nursing research*, 4:2333393617713097. doi: 10.1177/2333393617713097.
- Richard, A. & Shea, K. 2011. Delineation of self-care and associated concepts. *Journal of nursing scholarship*, 43(3):255-264.
- Riegel, B., Dickson, V.V., Goldberg, L.R. & Deatrick, J.A. 2007. Factors associated with the development of expertise in heart failure self-care. *Nursing research*, 56(4):235-243.
- Riegel, B., Dickson, V.V., Kuhn, L., Page, K. & Worrall-Carter, L. 2010. Gender-specific barriers and facilitators to heart failure self-care: a mixed methods study. *International journal of nursing studies*, 47(7):888-895.
- Riiser, K., Løndal, K., Ommundsen, Y., Småstuen, M.C., Misvær, N. & Helseth, S. 2014. The outcomes of a 12-week internet intervention aimed at improving fitness and health-related quality of life in overweight adolescents: the young & active controlled trial. *PLoS One*, 9(12):e114732. doi: 10.1371/journal.pone.0114732.
- Riley, W.T., Rivera, D.E., Atienza, A.A., Nilsen, W., Allison, S.M. & Mermelstein, R. 2011. Health behavior models in the age of mobile interventions: are our theories up to the task? *Translational behavioral medicine*, 1(1):53-71.
- Rinaldi, S., Campbell, E.E., Fournier, J., O'Connor, C. & Madill, J. 2016. A comprehensive review of the literature supporting recommendations from the Canadian Diabetes Association for the use of a plant-based diet for management of type 2 diabetes. *Canadian journal of diabetes*, 40(5):471-477.
- Rintala, T.M., Paavilainen, E. & Åstedt-Kurki, P. 2013. Everyday life of a family with diabetes as described by adults with type 1 diabetes. *European diabetes nursing*, 10(3):86-90.
- Ripsin, C.M., Kang, H. and Urban, R.J. 2009. Management of blood glucose in type 2 diabetes mellitus. *American family physician*, 79(1):29-36.
- Rise, M.B., Pellerud, A., Rygg, L.Ø. & Steinbekk, A. 2013. Making and maintaining lifestyle changes after participating in group based type 2 diabetes self-management educations: a qualitative study. *PLOS one*, 8(5):e64009. doi: 10.1371/journal.pone.0064009.

- Roberto, K.A., Gigliotti, C.M. & Husser, E.K. 2005. Older women's experiences with multiple health conditions: daily challenges and care practices. *Health care for woman international*, 26(8):672-692.
- Robinson, D.J., Coons, M., Haensel, H., Vallis, M. & Yale, J.F. 2018. Diabetes and mental health. *Canadian journal of diabetes*, 42(Suppl 1):S130-S141.
- Röder, P.V., Wu, B., Liu, Y. and Han, W. 2016. Pancreatic regulation of glucose homeostasis. *Experimental & molecular medicine*, 48(3):e219. doi: 10.1038/emm.2016.6.
- Roep, B.O. & Peakman, M. 2011. Diabetogenic T lymphocytes in human type 1 diabetes. *Current opinion in immunology*, 23(6):746-753.
- Roisman, G.I., Masten, A.S., Douglas Coatsworth, J. & Teegen, A. 2004. Salient and emerging developmental tasks in the transition to adulthood. *Child development*, 75(1):123-133.
- Rosland, A., Heisler, M., Choi, H., Silveira, M.J. & Piette, J.D. 2010. Family influences on self-management among functionally independent adults with diabetes or heart failure: do family members hinder as much as they help? *Chronic illness*, 6(1):22-33.
- Rossi, M.C.E., Nicolucci, A., Di Bartolo, P., Bruttomesso, D., Girelli, A., Ampudia, F.J., Kerr, D., Ceriello, A., De La Questa Mayor, C., Horwitz, D. & Vespasiani. 2010. Diabetes interactive diary: a new telemedicine system enabling flexible diet and insulin therapy while improving quality of life. *Diabetes care*, 33(1):109-115. <https://doi.org/10.2337/dc09-1327>.
- Rotegård, A., Moore, S.M., Fagermoen, M., Ruland, C.M. 2010. Health assets: a concept analysis. *International journal of nursing studies*, 47(4):513-525.
- Rother, K.I. 2007. Diabetes treatment – bridging the divide. *The New England journal of medicine*, 356(15):1499-1501.
- Rowley, W.R., Bezold, C., Arian, Y., Byrne, E. & Krohe, S. 2017. Diabetes 2030: insights from yesterday, today, and future trends. *Population health management*, 20(1):6-12.
- Rudd Bosch, J.L.H., Everaert, K., Weiss, J.P., Hashim, H., Sajjad Rahnema'i, M., Goessaert, A. & Aizen, J. 2015. Would a new definition and classification of nocturia and nocturnal polyuria improve our management of patients? *Neurourology and urodynamics*, 35(2):283-287.
- Rutter, M. 2012. Resilience as a dynamic concept. *Development and psychopathology*, 24(2):335-344.

- Rutter, P. 2015. Role of community pharmacists in patients' self-care and self-medication. *Integrated pharmacy research and practice*, 4:57-65. doi: 10.2147/IPRP.S70403.
- Ryan, P. & Sawin, K.J. 2009. The individual and family self-management theory: background and perspectives on context, process, and outcomes. *Nursing outlook*, 57(4):217-225.
- Ryan, R.M., Kuhl, J., Deci, E.L. 1997. Nature and autonomy: an organizational view of social and neurobiological aspects of self-regulation in behavior and development. *Development and psychopathology*, 9(4):701-728.
- Sacks, F.M., Lichtenstein, A.H., Wu, J.H.Y., Appel, L.J., Creager, M.A., Kris-Etherton, P.M., Miller, M., Rimm, E.B., Rudel, L.L., Robinson, J.G., Stone, N.J. & Van Horn, L.V. 2017. Dietary fats and cardiovascular disease: a presidential advisory from the American Heart Association. *Circulation*, 136(3):e1-e23. doi: 10.1161/CIR.0000000000000510.
- Said, G. 2013. Diabetic neuropathy. *Handbook of clinical neurology*, 115:579-589. doi: 10.1016/B978-0-444-52902-2.00033-3.
- Saldana, J. 2011. Fundamentals of qualitative research. Auckland: Oxford University Press.
- Samra, J.S. 2000. Regulation of lipid metabolism in adipose tissue. *Proceedings of the nutrition society*, 59(3):441-446.
- Saslow, L.R., Daubenmier, J.J., Moskowitz, J.T., Kim, S., Murphy, E.J., Phinney, S.D., Ploutz-Snyder, R., Goldman, V., Cox, R.M., Mason, A.E., Moran, P. & Hecht, F.M. 2017. Twelve-month outcomes of a randomized trial of a moderate-carbohydrate versus very low-carbohydrate diet in overweight adults with type 2 diabetes mellitus or prediabetes. *Nutrition & diabetes*, 7(12):304. doi: 10.1038/s41387-017-0006-9.
- Sawyer, S.M., Afifi, R.A., Bearinger, L.H., Blakemore, S., Dick, B., Ezech, A.C. & Patton, G.C. 2012. Adolescence: a foundation for future health. *Lancet*, 379(9826):1630-1640.
- Sawyer, S.M., Azzopardi, P.S., Wickremarathne, D. & Patton, G.C. 2018. The age of adolescence. *Lancet child adolescent health*, 2(3):223-228.
- Scavone, G., Manto, A., Pitocco, D., Gagliardi, L., Caputo, S., Mancini, L., Zaccardi, F. & Ghirlanda, G. 2010. Effect of carbohydrate counting and medical nutritional therapy on glycaemic control in type 1 diabetic subjects: a pilot study. *Diabetic medicine*, 27(4):477-479.

- Schabert, J., Browne, J.L., Mosely, K. & Speight, J. 2013. Social stigma in diabetes: a framework to understand a growing problem for an increasing epidemic. *The patient: – patient-centered outcomes research*, 6(1):1-10. doi: 10.1007/s40271-012-0001-0.
- Scherer, P.E. 2006. Adipose tissue: from lipid storage compartment to endocrine organ. *Diabetes*, 55(6):1537-1545.
- Schulman-Green, D., Jaser, S., Martin, F., Alonzo, A., Grey, M., McCorkle, R., Redeker, N.S., Reynolds, N. and Whittemore, R. 2012. Processes of self-management in chronic illness. *Journal of nursing scholarship*, 44(2):136-144.
- Schulman-Green, D., Jaser, S.S., Park, C. and Whittemore, R. 2016. A metasynthesis of factors affecting self-management of chronic illness. *Journal of advanced nursing*, 27(7):1469-1489.
- Schuster, D.P. 2010. Obesity and the development of type 2 diabetes: the effects of fatty tissue inflammation. *Diabetes, metabolic syndrome and obesity: targets and therapy*, 3:253-262.
- Schwingshackl, L., Hoffmann, G., Lampousi, A., Knüppel, S., Iqbal, K., Schwedhelm, C., Bechthold, A., Schlesinger, S. & Boeing, H. 2017. Food groups and risk of type 2 diabetes mellitus: a systematic review and meta-analysis of prospective studies. *European journal of epidemiology*, 32(5):363-375.
- SEARCH for Diabetes in Youth Study Group* TWGFT. 2007. Incidence of Diabetes in Youth in the United States. *Journal of the American Medical Association*, 297(24):2716–2724.
- Sen, S., Chakraborty, R. & De, B. 2016. Diabetes mellitus in 21st century. Singapore: Springer.
- Sergeant, C. & Dyson, P.A. 2018. Diabetes and diet: a patient and dietitian's perspective. *Diabetes therapy*, 9(5):1733-1739.
- Shalom, R. 1991. A pilot study of support and education groups for college students with insulin-dependent diabetes mellitus. *Journal of American college health*, 39(6):277-279.
- Sharma, P., Malhotra, C., Taneja, D.K. & Saha, R. 2008. Problems related to menstruation amongst adolescent girls. *Indian journal of paediatrics*, 75(2):125-129.

- Shen, H., Edwards, H.E., Courtney, M.D., McDowell, J.K. & Wei, J. 2013. Barriers and facilitators to diabetes self-management: perspectives of older community dwellers and health professionals in China. *International journal of nursing practice*, 19(6):627-635.
- Shrivastava, S.R., Shrivastava, P.S. & Ramasamy, J. 2013. Role of self-care in management of diabetes mellitus. *Journal of diabetes & metabolic disorders*, 12(1):14. doi: 10.1186/2251-6581-12-14.
- Snorgaard, O., Poulsen, G.M., Andersen, H.K. & Astrup, A. 2017. Systematic review and meta-analysis of dietary carbohydrate restriction in patients with type 2 diabetes. *BMJ open diabetes research and care*, 5(1):e000354 doi: 10.1136/bmjdr-2016-000354.
- Sommer, L. 2011. The theory of planned behaviour and the impact of past behaviour. *International business & economics research journal*, 10(1):91-110.
- Song, M., Lee, M. & Shim, B. 2010. Barriers to and facilitators of self-management adherence in Korean older adults with type 2 diabetes. *International journal of older people nursing*, 5(3), 211-218.
- Sözen, T., Başaran, N.C., Tınazlı, M. and Özişik, L. 2018. Musculoskeletal problems in diabetes mellitus. *European journal of rheumatology*, 5(4):258-265.
- Szablewski, L. 2011. Glucose homeostasis and insulin resistance. Sharjah: Bentham Science Publishers. <https://search-ebscohost-com.nwulib.nwu.ac.za/login.aspx?direct=true&db=cat01185a&AN=nwu.b2151590&site=eds-live>
Date of accessed: 21 Oct. 2019.
- Tay, J., Luscombe-Marsh, N.D., Thompson, C.H., Noakes, M., Buckley, J.D., Wittert, G.A., Yancy, W.S. & Brinkworth, G.D. 2015. Comparison of low- and high-carbohydrate diets for type 2 diabetes management: a randomized trial. *American journal of clinical nutrition*, 102(4):780-790.
- Thomas, D. & Elliot, E.J. 2009. Low glycaemic index, or low glycaemic load, diets for diabetes mellitus. *Cochrane database of systematic reviews*, 21(1):CD006296. doi: 10.1002/14651858.CD006296.pub2.
- Thomas, M.C., Moran, J., Forsblom, C., Harjutsalo, V., Thorn, L., Ahola, A., Wadén, J., Tolonen, N., Saraheimo, M. & Gordin, D. 2011. The association between dietary sodium intake, ESRD, and all-cause mortality in patients with type 1 diabetes. *Diabetes care*, 34(4):861-866.

- Thorne, S., Paterson, B. & Russell, C. 2007. The structure of everyday self-care decision making in chronic illness. *Qualitative health research*, 13(10):1337-1352.
- Thrent, Z.C., Das, S. & Henry, L.J. 2013. Role of exercise in the management of diabetes mellitus: the global scenario. *PLoS One*, 8(11):e80436. doi: 10.1371/journal.pone.0080436.
- Todd, J.A. 2010. Etiology of type 1 diabetes. *Immunity*, 32(4):457–467.
- Toobert, D.J., Hampson, S.E. & Glasgow, R.E. 2000. The summary of diabetes self-care activities measure. *Diabetes care*, 23(7):943-950.
- Umanath, K. & Lewis, J.B. 2018. Update in diabetic nephropathy: Core curriculum 2018. *American journal of kidney disease*, 71(6):884-895.
- UNESCO (United Nations Educational, Scientific and Cultural Organization). 1985. World Congress on Youth. Barcelona. <https://digitallibrary.un.org/record/1020?ln=en> Date of access: 10 Jul 2019.
- Unger, W. & Buelow, J. 2009. Hybrid concept analysis of adults newly diagnosed with epilepsy. *Epilepsy & behavior*, 14(1):89-95. doi:10.1016/j.yebeh.2008.09.002.
- University Health System. 2020. Diabetes Statistics. <https://www.universityhealthsystem.com/services/diabetes/diabetes-statistics> Date of access: 24 Apr. 2020.
- Utz, S.W., Steeves, R.H., Wenzel, J., Hinton, I., Jones, R.A., Andrews, D., Muphy, A. & Oliver, M.N. 2006. 'Working hard with it': self-management of type 2 diabetes by rural African Americans. *Family & community health*, 29(3):195-205.
- Vaala, S.E., Lee, J.M., Hood, K.K. & Mulvaney, S.A. 2018. Sharing and helping: predictors of adolescents' willingness to share diabetes personal health information with peers. *Journal of the American Medical Informatics Association*, 25(2):135-141.
- Van Biljon, L., Roos, V. & Botha, K. 2015. A conceptual model of quality of life for older people in residential care facilities in South Africa. *Applied research in quality of life*, 10(3):435-457.
- Van Gaal, L. & Scheen, A. 2015. Weight management in type 2 diabetes: current and emerging approaches to treatment. *Diabetes care*, 38(6):1161-1172.
- Van Wyk, H.J., Davis, R.E. & Davies, J.S. 2016. A critical review of low-carbohydrate diets in people with type 2 diabetes. *Diabetic medicine*, 33(2):148-157.

- Vassilev, I, Rogers, A., Kennedy, A. and Koetsenruijter, J. 2014. The influence of social networks on self-management support: a metasynthesis. *BMC public health*, 14(1):719. <http://www.biomedcentral.com/1471-2458/14/719>.
- Vermunt, P.W., Milder, I.E., Wielaard, F., Baan, C.A., Schelfhout, J.D., Westert, G.P. & van Oers, H.A.M. 2012. Behaviour change in a lifestyle intervention for type 2 diabetes prevention in Dutch primary care: opportunities for intervention content. *BMC family practice*, 13:79. doi: 10.1186/1471-2296-14-78.
- Vest, B.M., Kahn, L.S., Danzo, A., Tumiel-Berhalter, L., Schuster, R.C., Karl, R. & Fox, C.H. 2013. Diabetes self-management in a low-income population: impacts of social support and relationships with the health care system. *Chronic illness*, 9(2):145-155.
- Violi, F, Lip, G.Y.H., Pignatelli, P. and Pastori, D. 2016. Interaction between dietary vitamin K intake and anticoagulation by vitamin K antagonists: is it really true?: a systematic review. *Medicine*, 95(10):e2895. doi: 10.1097/MD.0000000000002895.
- Wallace, A.S., Perkhounkova, Y., Sussman, A.L., Hein, M., Chung, S.J. & Tripp-Reimer, T. 2017. Implementation of collaborative goal setting for diabetes in community primary care. *Translational behavioural medicine: practice, policy, research*, 6(2):202-211.
- Walley, A.J., Blakemore, A.I.F. and Froguel, P. 2006. Genetics of obesity and the prediction of risk for health. *Human molecular genetics*, 15(2):R124-R130.
- Wang, D.D., Li, Y., Chiuve, S.E., Stampfer, M.J., Manson, J.E., Rimm, E.B., Willett, W.C. & Hu, F.B. 2016. Association of specific dietary fats with total and cause-specific mortality. *Journal of the American Medical Association internal medicine*, 176(8):1134-1145.
- Wang, W.F. & Jia, W. 2018. Determination of glucose and continuous glucose monitoring. (In Jia, W., ed. Continuous glucose monitoring. Singapore: Springer).
- Warren, R.E. 2004. The stepwise approach to the management of type 2 diabetes. *Diabetes research and clinical practice*, 65(Suppl 1):S3-S8.
- Wasserman, D.H., Wang, T.J. & Brown, N.J. 2018. The vasculature in prediabetes. *Circulation research*, 122(8):1135-1150.
- Watkins, P.J., Amiel, S.A., Howell, S.L. & Turner, E. 2008. Diabetes and its management. 6th ed. Maiden, MA: Blackwell.

- Wdowik, M.J., Kendall, P.A. & Harris, M.A. 1997. College students with diabetes: using focus groups and interviews to determine psychosocial issues and barriers to control. *The diabetes educator*, 23(5):558-562.
- Wdowik, M.J., Kendall, P.A., Harris, M.A. & Auld, G. 2001. Expanded health belief model predicts diabetes self-management in college students. *Journal of nutrition education*, 33(1):17-23.
- Wellard, S.J., Rennie, S. & King, R. 2008. Perceptions of people with type 2 diabetes about self-management and the efficacy of community based services. *Contemporary nurse*, 29(2): 218-226.
- Wermeling, M., Thiele-Manjali, U., Koschack, J. Lucius-Hoene, G & Himmel, W. 2014. Type 2 diabetes patients' perspectives on lifestyle counselling and weight management in general practice: a qualitative study. *BMC family practice*, 15(15):97. doi: 10.1186/1471-2296-15-97.
- Wheeler, M.L., Dunbar, S.A., Jaacks, L.M., Karmally, W., Mayer-Davis, E.J., Wylie-Rossett, J. & Yancy, W.S. 2012. Macronutrients, food groups, and eating patterns in the management of diabetes: a systematic review of the literature, 2010. *Diabetes care*, 35(2):434-445.
- Wherrett, D.K., Ho, J., Huot, C., Legault, L., Nakhla, M. & Rosolowsky. 2018. Type 1 diabetes in children and adolescents. *Canadian journal of diabetes*, 42(Suppl 1):S234-S246.
- WHO (World Health Organization), Regional Office for South-East Asia. 2009. Self-care in the context of primary health care. WHO Regional Office for South-East Asia.
<https://apps.who.int/iris/handle/10665/206352> Date of access: 22 Oct. 2019.
- WHO (World Health Organization). 1964. Health problems of adolescence: report of a WHO Expert Committee [meeting held in Geneva from 3 to 9 November 1964].
<https://apps.who.int/iris/handle/10665/38425> Date of access: 24 Oct. 2019.
- WHO (World Health Organization). 1977. Health needs of adolescents: report of a WHO expert committee [meeting held in Geneva from 28 September to 4 October 1976].
<https://apps.who.int/iris/handle/10665/41252> Date of access: 24 Oct. 2019.
- WHO (World Health Organization). 1984. Thirty-seventh World Health Assembly, Geneva, 7-17 May 1984: summary records of committees. <https://apps.who.int/iris/handle/10665/160776>
Date of access: 22 Oct. 2019.

WHO (World Health Organization). 1987. Economic support for national health for all strategies, Fortieth World Health Assembly. Geneva.

WHO (World Health Organization). 1998. The role of the pharmacist in self-care and self-medication. <https://apps.who.int/medicinedocs/en/d/Jwhozip32e/> Date of access: 22 Oct. 2019.

WHO (World Health Organization). 2013. Community health workers for universal health-care coverage: from fragmentation to synergy. <https://www.who.int/bulletin/volumes/91/11/13-118745/en/> Date of access: 22 Oct. 2019.

WHO (World Health Organization). 2015. The global strategy for women's, children's, and adolescents' health (2016–30). 2015. <http://www.who.int/life-course/partners/global-strategy/ewec-globalstrategyreport-200915.pdf?ua=1> Date of access 23 Apr. 2020.

WHO (World Health Organization). 2016a. Diabetes. <http://www.who.int/mediacentre/factsheets/fs312/en/> Date of access: 28 Mar. 2017.

WHO (World Health Organization). 2016b. Global report on diabetes. http://apps.who.int/iris/bitstream/10665/204871/1/9789241565257_eng.pdf?u Date of access: 23 May 2018.

WHO (World Health Organization). 2018. Diabetes. <https://www.who.int/news-room/factsheets/detail/diabetes> Date of access: 20 May 2019.

WHO (World Health Organization). 2019. Diabetes. <https://www.who.int/health-topics/diabetes> Date of access: 20 Oct 2019.

WHO (World Health Organization). 2020. Diabetes. https://www.who.int/health-topics/diabetes#tab=tab_1 Date of access: 23 Mar 2020.

Wilde, M.H. & Garvin, S. 2007. A concept analysis of self-monitoring. *Journal of advanced nursing*, 57(3):339-350.

Wilkinson, A. & Whitehead, L. 2009. Evolution of the concept of self-care and implications for nurses: a literature review. *International journal of nursing studies*, 46(8):1143-1147.

Winters, C.A., Cudney, S.A., Sullivan, T. & Thuesen, A. 2006. The rural context and women's self-management of chronic health conditions. *Chronic illness*, 2(4):273-289.

Wortz, K, Cade, A., Menard, J.R., Lurie, S., Lykens, K., Bae, S., Jackson, B., Su, F., Singh, K. and Coultas, D. 2012. A qualitative study of patients' goals and expectations for self-management of COPD. *Primary care respiratory journal*, 21(4):384-391.

Wu, F., Juang, J. & Yeh, M.C. 2011. The dilemma of diabetic patients living with hypoglycaemia. *Journal of clinical nursing*, 20(1516):2277-2285.

Wysocki, T., Harris, M.A., Buckloh, L.M., Mertlich, D., Lochrie, A.S., Taylor, A., Sadler, M., Mauras, N. & White, N.H. 2006. Effects of behavioural family system therapy for diabetes on adolescents' family relationship, treatment adherence, and metabolic control. *Journal of pediatric psychology*, 31(9):928-938.

Wysocki, T., Iannotti, R., Weissberg-Benchell, J., Laffel, L., Hood, K., Anderson, B. and Chen, R. 2008. Diabetes problem solving by youths with type 1 diabetes and their caregivers: measurement, validation, and longitudinal associations with glycemic control. *Journal of pediatric psychology*, 33(8):875-884.

Young, M.T., Lord, J.H., Patel, N.J., Gruhn, M.A. & Jaser, S.S. 2014. Good cop, bad cop: quality of parental involvement in type 1 diabetes management in youth. *Current diabetes reports*, 14(11):546-564.

Yu, J.H., Shin, M.S., Kim, D.J., Lee, J.R., Yoon, S.Y., Kim, S.G., Koh, E.H., Lee, W.J., Park, J.Y. and Kim, M.S. 2013. Enhanced carbohydrate craving in patients with poorly controlled type 2 diabetes mellitus. *Diabetic medicine*, 30(9):1080-1086.

Zautra, A.J., Hall, J.S. & Murray, K.E. 2010. Resilience: a new definition of health for people and communities. (In Reich, J., Zautra, A. & Hall, J., eds. *Handbook of adult resilience*. New York, NY: The Guilford Press). doi: 10.1080/17437190802298568.

Zhang, J. & Verhoef, M.J. 2002. Illness management strategies among Chinese immigrants living with arthritis. *Social science & medicine*, 55(10), 1795–1802.

Zhang, L., Krzentowski, G., Albert, A. & Lefebvre, P.J. 2001. Risk of developing retinopathy in Diabetes Control and Complications Trial type 1 diabetic patients with good or poor metabolic control. *Diabetes care*, 24(7):1275-1279.

Zheng, C. & Liu, Z. 2015. Vascular function, insulin action, and exercise: an intricate interplay. *Trends in endocrinology and metabolism*, 26(6):297–304.

Zheng, Y., Ley, S.H. & Hu, F.B. 2018. Global aetiology and epidemiology of type 2 diabetes mellitus and its complications. *Nature reviews. Endocrinology*, 14(2):88-98.

Zhou, B., Lu, Y., Hajifathalian, K., Bentham, J., Di Cesare, M., Danaei, G., Bixby, H., Cowan, M.J., Ali, M.K., Taddei, C., Lo, W., Reis-Santos, B., Stevens, G.A., Riley, L.M., Miranda, J.J., Bjerregaard, P., Rivera, J.A., Fouad, H.M., Ma, G., Mbanya, J.C.N., McGarvey, S.T., Mohan, V., Onat, A., Pilav, A., Ramachandran, A., Romdhane, H.B., Paciorek, C.J., Bennett, J.E. & Ezzati, M. 2016. Worldwide trends in diabetes since 1980: a pooled analysis of 751 population-based studies with 4·4 million participants. *The lancet*, 387(1):1513-1530.

ANNEXURE A: ARTICLE

Proof of submission

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Jozua Jacobs <jozuakdjacobs5@g

A manuscript number has been assigned to Perceptual systems of the selfmanagement of students living with diabetes mellitus: an IQA approach

JEMDSA <em@editorialmanager.com>

20 May 2020 at 21:41

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Article

Perceptual systems of the self-management of students living with diabetes mellitus: an IQA approach

Introduction: Diabetes mellitus (DM) is a chronic and metabolic disease defined by elevated blood glucose levels over a long period of time. One in 10 people are living with DM.

Objective: The main purpose of this investigative study was to gain knowledge regarding the perceptions of students' self-management living with diabetes mellitus at a tertiary institute.

Methods: Using the Interactive Qualitative Analysis (IQA) to construct and describe a cognitive mind map of students' perceptions of their self-management living with DM.

Results: An analysis of the participants' mind map representing students living with DM revealed eight main components (affinities) namely, Social awareness and acceptance, Food available on campus, Keeping insulin cool, Independent lifestyle, Adjusting by cooking, Hurdles in the academic environment, Causes of changing blood sugar and Adapting to effects of changing blood sugar.

Conclusion: The final perceptual system was an informative representation of the self-management of students living with DM. The system reflects barriers to compliance with self-management facing students living with DM. The system produced four recognisable loops or cycles namely The Ignorance loop, The Revision loop, The Developing loop and The Self-management Loop. These loops created pathways through the system for the students living with DM to find a way to better self-management.

Keywords: Interactive Qualitative Analysis, IQA, Self-management, Diabetes Mellitus, Students, University, Systems Influence Diagram, Self-management of diabetes

Introduction

Diabetes Mellitus (DM) is currently known as the epidemic of the century. The global DM statistics grew phenomenally from 1980 to 2017 and show a 393.5% increase from 108 million people diagnosed with either T1DM or T2DM to 425 million people. With this trend the

International Diabetes Federation (IDF) estimates an increase to 629 million people living with DM by 2045.¹

Many complications inter alia the loss of vision, kidney failure, heart attacks, strokes, loss of lower limbs and death are attributable to DM. DM is ranked seventh on the World Health Organisation's (WHO) death statistics with almost half of the deaths of people younger than 70 years in 2016.²

In Africa, 3.1% of adults (between 18 and 99 years old) lives with DM, accounting for 516 million people of the total population in 2017 and 0.258% of the children (between 0 and 18 years old) lives with the disease, accounting for 50 600 people of the total population.³

In 2019, 5.4% of the South African adult population was diagnosed with DM, a total of 1 826 100 out of 33 762 000. The DM epidemic in South Africa is worsening with an increase of diagnosed patients and deaths as a result of DM complications between 1997 and 2015.⁴ With 25 070 deaths out of 55 290 000, DM was ranked as the second highest cause of deaths in South Africa in 2015, accounting for 0.04% of the population.

Diabetes Mellitus

The American Diabetes Association (ADA) describes DM as a chronic disease pertaining to continuous raised blood glucose levels as a result of either defective insulin secretion or an impairment of insulin action or both.³⁻⁷ There are two main types of DM, namely Type 1 DM (T1DM) and Type 2 DM (T2DM). T1DM is found mostly in children aged 0 to 18 years old and is defined as the failure to produce insulin in the body. The T2DM individual's pancreas does secrete insulin, but the body does not use the insulin like it should. This also known as insulin resistance.^{3,8} Over a period of time various complications are caused by DM.⁹ These complications include, amongst others, cardiac problems and stroke, high blood pressure, loss of vision and other problems related to the eyes, renal problems, nervous system disease, the loss of limbs due to amputations, diseases of the teeth, complications during pregnancy and other

difficulties.⁹ Finally, DM could be caused by various factors, including disturbances in the metabolism of carbohydrates, fat and protein.¹⁰ DM cannot be described by one definition alone. The various components and factors relating to DM need to be examined.

Self-management

Self-management is a term referring to the ability of an individual to manage his treatment, physical symptoms and psychosocial consequence together with the lifestyle changes and characteristics of living with a chronic disease.¹¹

As the mortality rates associated with DM rise, the prevalence of DM appears to double by 2030.¹² Adjustments to lifestyle, such as eating healthier, daily exercise and monitoring of blood glucose levels, delay the advancement of DM.¹³ The WHO added that individuals living with DM need to adjust to a healthy lifestyle that consist of dieting, monitoring and maintenance of blood glucose levels, and adherence to medicine usage.¹⁴ Forouhi *et al.* contributed to the self-management practice of DM by advising weight loss, monitoring the intake of carbohydrates and fibre, restricting cholesterol, avoiding saturated fats, trans fats and sodium.¹⁵ Finally, individuals with DM are required to enhance their tactics towards individual, family and social practices to improve self-management of DM.¹⁶

Problems university students face according to literature

The main stressor for students when transitioning to independence are assuming responsibility of caring for themselves, facing conflicts with parents and realising DM is tough.¹⁷ The main goal students with DM tend to aim for is the independent management of their DM by assuming the burden of self-care. Factors formulated by Babler & Strickland that are inherent in the task of achieving independence are the fear of needles and forgetting to give insulin.¹⁷

This article focuses on one issue, namely describing and investigating self-management of students living with DM at a tertiary institute.

Method

IQA data were collected during a focus group with students, selected from a constituency representing students living with DM on the NWU Potchefstroom campus. An ethical application was submitted to the Health Research Ethics Committee (HREC) of the NWU Potchefstroom campus. The researcher obtained ethical approval for the study from HREC on 19 November 2018 with the ethics number being NWU-00124-17-A1.

The IQA process that was used in this study consisted of a focus group and additional participants' Affinity Relationship Tables. The processes followed by the researcher, the specific protocol as well as documentation used was developed by Northcutt and McCoy.¹⁸ "IQA as a qualitative methodology is grounded in systems theory whose primary purpose is to present the meaning of a phenomenon in terms of elements (affinities) and the relationships among them."¹⁸

The IQA data-collection tool - the focus group - assisted the participants to describe and label their experiences. The results of the focus group were conceptualised in a mind map (a composite picture of the system) of the participants and formed a systematic representation of how the group understood the specific problem or phenomenon.

The system, or mind-map, entails the affinities or categories of meaning and the perceived perceptual relationships amongst the affinities.¹⁸ The IQA focus group was used to identify the affinities, each of which was well documented as part of the focus group protocol, according to the prescribed methods of Northcutt and McCoy. In the focus group the participants expand their meaning on each affinity. Affinities are like the quantitative concept of elements, or variables.

The idea of rigor that is used in the IQA refers to a specific procedure for both data collection and analysis.¹⁸ The purpose of the IQA was to draw a picture of the system, or mind-map, by means of the System Influence Diagram (SID) that is a representation of the perceptual topography of the mind-map of the group of participants in regard to the phenomenon.

Theoretical coding is aimed at the establishment of the perceived cause and effect relationship, or influences, amongst all the affinities of the system.

The participants of the focus group, and the additional participants in this study, analysed the nature of the relationships amongst the affinities according to the guidelines that was published by Northcutt and McCoy.¹⁸ The results of these relationships could either have been $A \rightarrow B$ (A influences B), $A \leftarrow B$ (B influences A) or $A \diamond B$ (no relationship).

The study proceeded as follow:

Phase 1: The IQA research design offered a series of tools to support and articulate the problem to the researcher. It helped to identify constituencies for the focus group, and to state a research question which is applicable to the problem statement.

Phase 2: The focus group was formed by individuals who shared a common experience, lived in a common structure and had the same background pertaining to the phenomenon. The main concept of the IQA was to allow the participants of the constituency to define their meaning and the range of affinities of the phenomenon and to articulate how these affinities are linked in their perception of the phenomenon.

Phase 3: There are two main parts in the last phase of the IQA. They are the results and analysis, and interpretations and implications that will be discussed by the researcher using all the data from the participants.

We therefore report on:

- Naming and describing the elements of the system; and
- Explaining the relationships between the elements of the system.¹⁹

The results from the relationships of the Affinity Relationship Tables (ART) of all the participants were tallied in the Combined Theoretical Code Frequency.

The SID Assignment Protocol was used to allow the researcher to identify all the relationships and to determine what the basic flow of the system will be, from primary driver to

primary outcome.¹⁹ The Cluttered SID was built first, but consisted of saturated links between the affinities. However, it was wide-ranging and rich and thus difficult to interpret.¹⁹ The next step was the Unflustered SID where all the redundant links were removed. It was then represented the simplest possible form.

The Pareto Protocol was applied to the system, the mind-map, and results in the final Uncluttered Reconciled SID. In the final Uncluttered Reconciled SID all the vague relationships were resolved and the optimal numbers of relationships for the SID were determined. The Pareto Protocol specifies that the minority of the relationships in any system will account for the majority of the variation within the system.¹⁹ Only one relationship could be used in the ART and thus the relationships with the highest amount of frequencies was used in the SID Assignment Protocol. The other relationships might have a significant impact on the final system and was reconciled according to the stipulations of the Pareto Protocol.¹⁸

Results

All participants that partook in this investigation were well-suited for the study. The focus group consisted of 13 participants consisting of nine females and four males. Their ages stretched between 19 and 28. There were 11 participants diagnosed with T1DM and two participants diagnosed with T2DM. The participants spent between one and nine years on campus between themselves and were diagnosed with DM between the ages of four and 18 years.

The final results constructed by the focus group can be seen in Table 1. Table 1 consists of the final eight affinities produced by the participants and the descriptions allocated to each affinity in their own words.

Table 1. Affinities and descriptions

Name of the affinity	Definition of the affinity
Food available on campus	There is not sufficient diabetic friendly food available on campus

Keeping insulin cool	It is a “drag” to keep insulin cool for up to 14 hour stretches, every day or trying
Causes of changing blood sugar	Almost everything contributes to blood sugar variation
Adapting to the effects of changing blood sugar	You have to understand the causes and effects and learn to counter it
Social awareness and acceptance	If society was better educated about diabetics, it would be much easier to manage my life
Hurdles in academic environment	The academic community has to be more accommodating
Adjusting by cooking	Learn, adjust, adapt in order to meet your personal health requirements (make it interesting)
Independent lifestyle	Accepting your condition and taking responsibility towards a healthy life

The results of the Detailed ART’s are corresponded in a Combined Theoretical Frequency table. The purpose of the Detailed ART was to indicate the relationship between affinities. All the affinities received arbitrary numbers for the processing of the data.

The information of all 13 participants was tallied and the product was the Combined Theoretical Frequency Table. The affinities at first were randomly ordered and numbered during the focus group activities and were then sorted to be added to the Combined Theoretical Frequency Table.

The researcher used the information from the Combined Theoretical Code Frequency Table and following the Systems Influence Diagram (SID) Assignments protocol the researcher created the SID or mind map of the students’ perceptual system of their self-management living with DM.

After following the Pareto Protocol the result was the Cluttered SID (see Figure 1), the first version of the SID that was developed.¹⁸

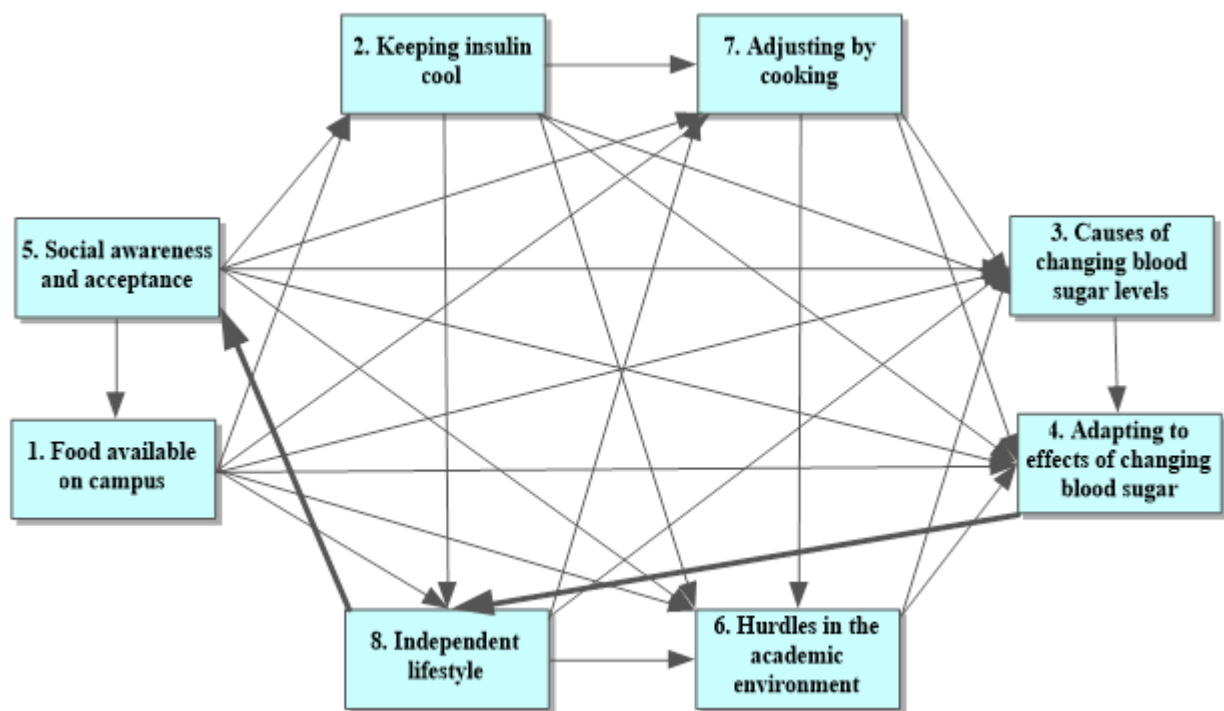


Figure 1. Cluttered Systems Influence Diagram

After following the rest of the Pareto Protocol the Uncluttered SID (see Figure 2) was formed.¹⁸

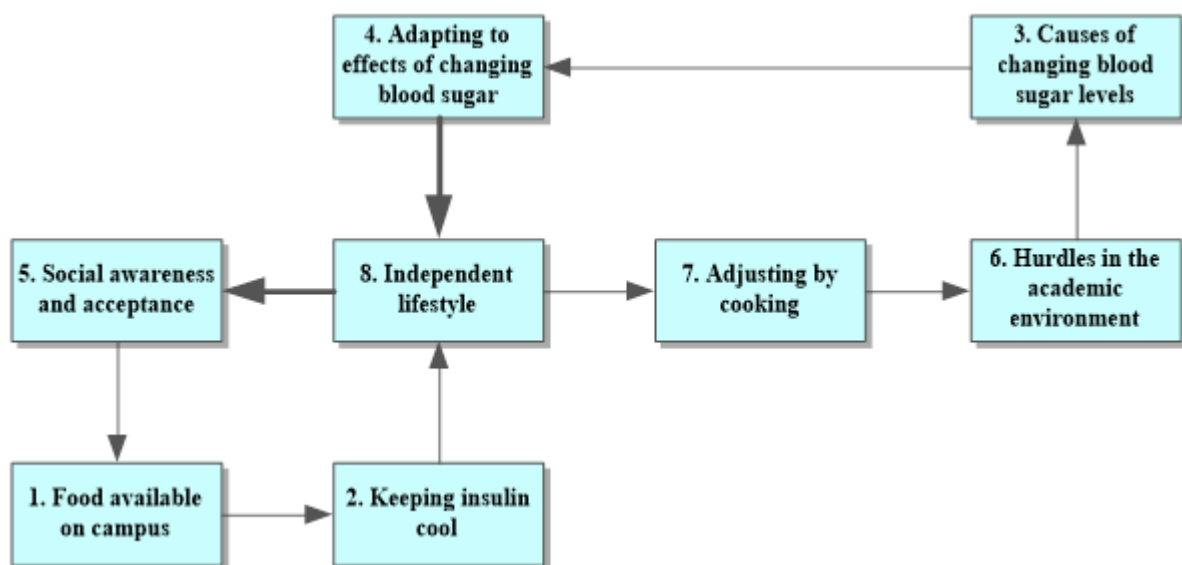


Figure 2. Uncluttered Systems Influence Diagram

The Pareto Protocol was applied to the system to determine the optimal number of relationships in the composite system and to assist in resolving all the ambiguous relationships and the Uncluttered Reconciled SID was developed as seen in Figure 3.

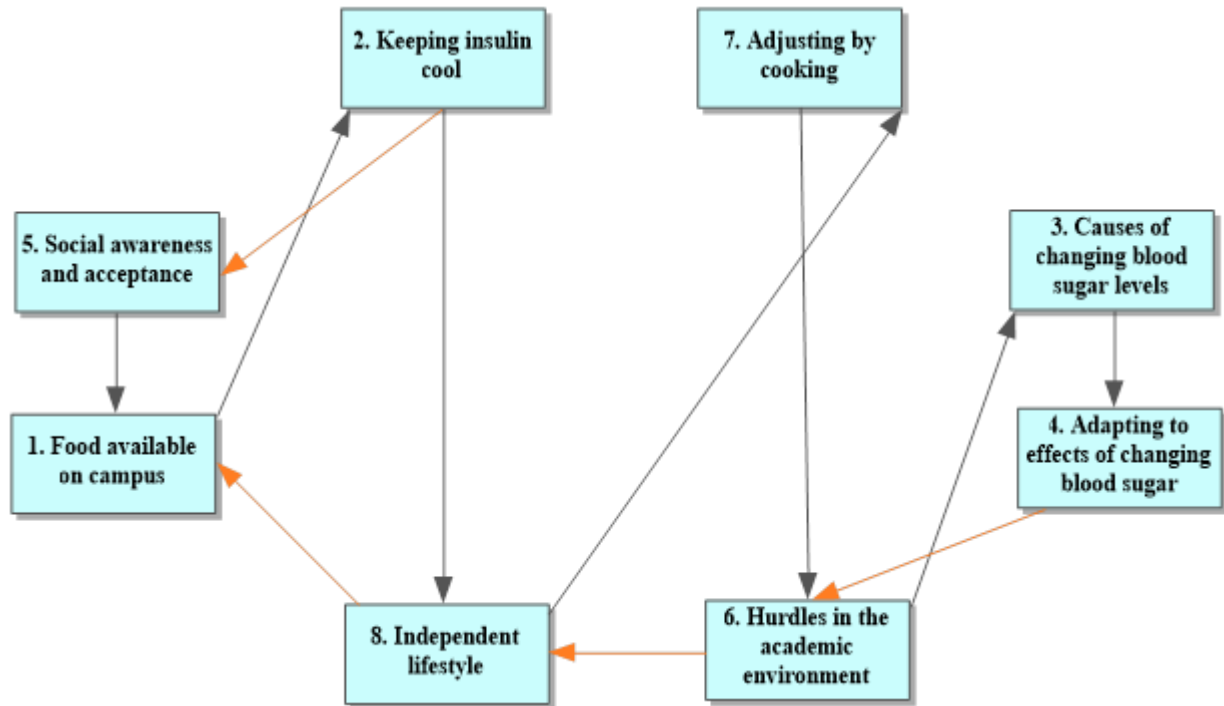


Figure 3. Uncluttered Reconciled Systems Influence Diagram

The final SID was developed as seen in Figure 4.

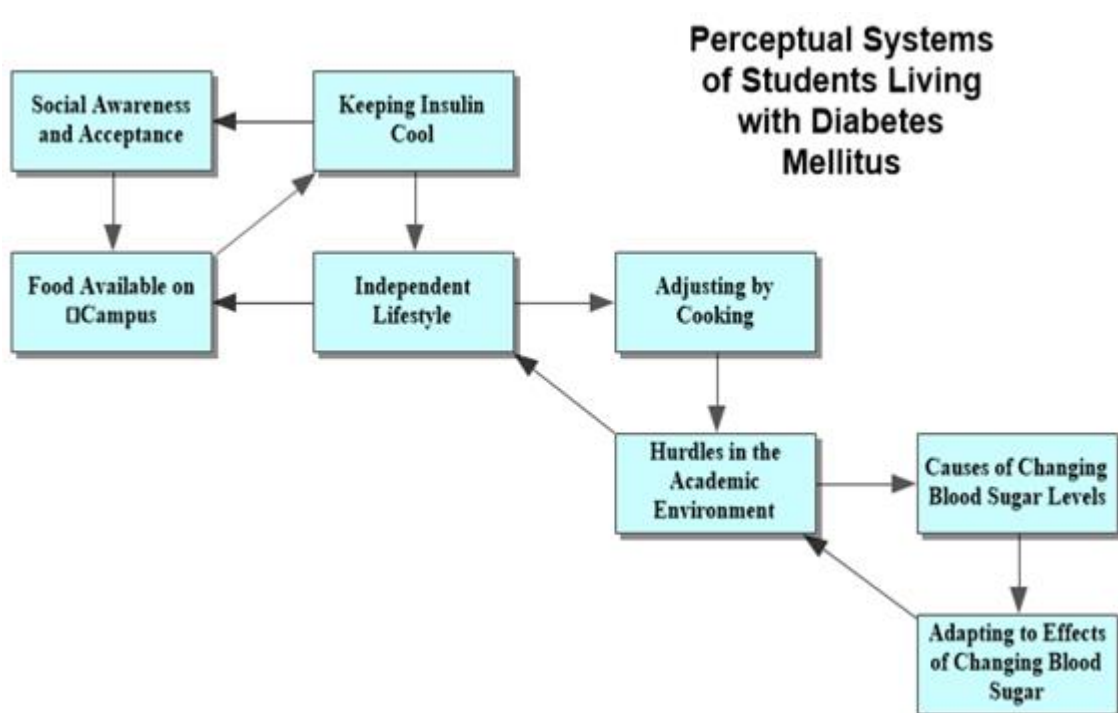


Figure 4. Final Composite Systems Influence Diagram

Discussion

The system can be seen as a pathway beginning with Social awareness and acceptance and ending with Adapting to effects of changing blood sugar levels. Affinities, or elements, can be seen either as positive or negative. One affinity's experience can influence and change the experience of the next affinity.¹⁸

In figure 4 the primary driver, named Social awareness and acceptance, can be found at the top left of the figure. The primary outcome, named Adapting to effects of changing blood sugar, can be found in the bottom right corner. The secondary drivers can be found at the bottom left and in the middle of the figure. They are Food available on campus, Keeping insulin cool and Independent lifestyle. The secondary outcomes are found in the top right and in the middle. They are Adjusting by cooking, Causes of changing blood sugar and Hurdles in the academic environment.

A part of the IQA was the exercising of the system. The researcher exercised the system and casted scenarios by presuming given states of the drivers and investigated the expected results, which is known as prospective scenarios. The opposite or reverse exercise was also done and is known as the retrospective scenario. In the retrospective scenarios the states of some of the outcomes were presumed. The system was then examined to see what states of the drivers produced these outcomes. The third scenario was the impact of a factor outside the system that influenced the system at a given point and is known as the extra systematic scenario.

A prospective scenario will be used, in the article, as an example of how to exercise the system (as seen in figure 5). In this scenario the researcher will look at the prospect of what if the **Social awareness and acceptance** was a **positive driver** and it did not influence the self-management of the student as the social environment will be informed. Then the researcher will

explore what the result will be on the primary outcome, **Adapting to the effects of changing blood sugar.**

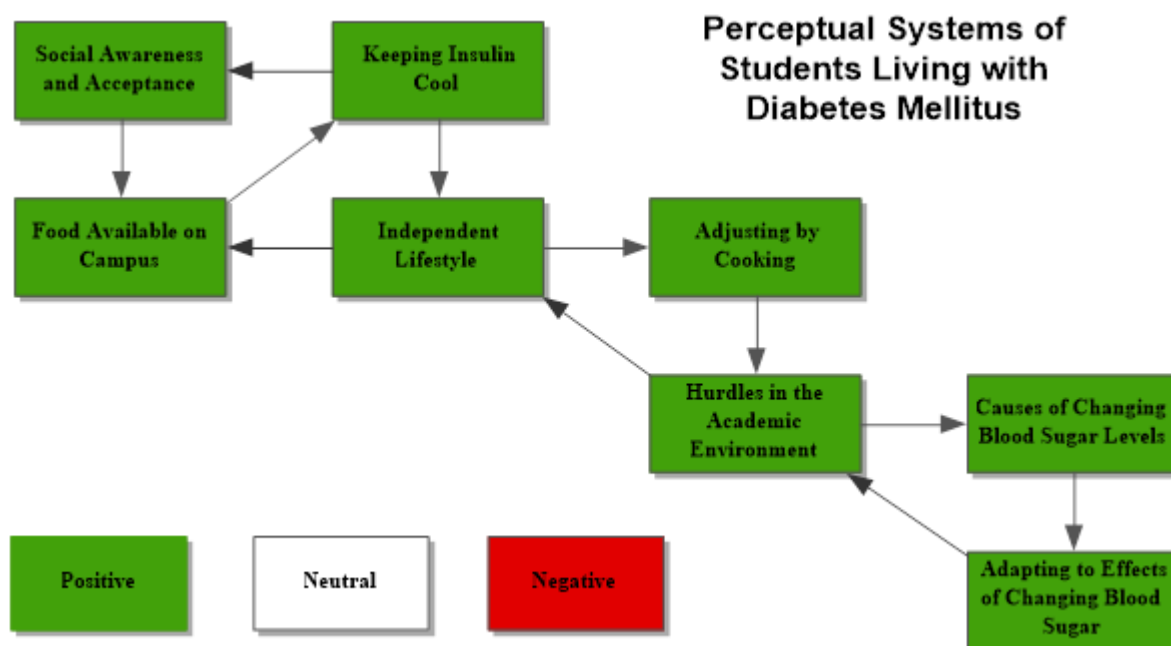


Figure 5. Optimal self-management for students living with DM

Social awareness and acceptance is the primary driver of the system. A positive Social awareness and acceptance will have a positive impact on the rest of the system, the self-management of students living with DM on campus. It is assumed that the rest of the system's affinities are all neutral. If the other affinities were negative, then the positive influence of Social awareness and acceptance would not be able to overturn for example the Hurdles in the academic environment. The community as a Social awareness and acceptance factor could have been positive and would be well educated on the self-management tasks of a student living with DM, but because the Hurdles in the academic environment is still negative and beyond the student's control, the system will stay negative.

Better education regarding DM will lead to people in the student's social environment asking more relevant questions on DM. Frustrating questions, such as "can you eat that", will be eliminated and questions about changing blood sugar levels and how to counter these will rather be asked. This will result in the student living with DM feeling supported and cared for.

Injecting insulin in public draws negative reaction. In the ideal situation, injecting insulin would be acceptable and understood by the public in the same way as someone using an inhaler for asthma.

Testing, *id est*. pricking and doing a blood test to check blood glucose levels, has had people cringing as they do not like the idea of blood. For students living with DM a community with ideal understanding of the consequences of not testing, will encourage the student to engage in self-management tasks.

Living with DM is not something students advertise to the public. Consequently, students with DM on campus do not know about each other and cannot communicate with each other. Knowing other students with DM will result in positive interactions between students living with DM.

In an ideal world where everyone understood DM, the burden of educating the public about DM will not be the student with DM's responsibility. In such an ideal scenario the DM student will live life without the stress of having to educate those around him on aspects of DM.

Students at tertiary institutions are under pressure to be socially active. The ideal for a student with DM is to know that you do not have to pretend to make others feel comfortable, and that you can be yourself around your peers.

Food available on campus

If the perfect world existed, the Food available on campus would be a positive factor and the student living with DM would have better self-management skills in the university environment. There would be less unhealthy food on campus and more DM friendly food options for the student living with DM to choose from and increase self-management. *“People are uninformed (management) and thus order/provide unhealthy/inappropriate foods.”*

Keeping insulin cool

The positivity towards the Food available on campus will then influence Keeping insulin cool.

“What you eat on campus (healthy or not) then determines how your blood sugar will be, in turn affecting how much insulin you’ll need (influencing how much you bring)”.

Independent lifestyle

The student can now enhance his/her Independent lifestyle as the task of being independent becomes easier to maintain when the insulin is kept cool and managed through the daytime when they are active on campus. *“It just teaches you to take the steps of responsibility and to be independent and check up on yourself”.* This makes the student more independent.

Adjusting by cooking

Self-management becomes easier when a student has a positive factor in Adjust by cooking. Because the student is more independent, he/she either has an easy task of cooking for himself/herself when there is time, or that the food available on campus is healthy enough to not need to cook for oneself. *“Adjusting by cooking helps one to be more independent by being able to manage one’s diabetes better”.*

Hurdles in the academic environment

There are Hurdles in the academic environment when the student gets a positive effect on the Social awareness and acceptance. The hurdles, such as food available on campus and managing hypoglycaemia or hyperglycaemia in public are either eliminated by having healthy food options or reacting to fluctuations in blood sugar in the moment as there is no judgement from the social groups. *“If one decides to cook then they can avoid hurdles like having high ketones during the school day. Cooking my own meals means controlled sugar levels and therefore better academic performance.”*

Causes of changing blood sugar

With a positive flow coming from Hurdles in the academic environment the Causes of changing blood sugar is handled in a positive way and not in a negative way as *“when experiencing stress in the academic environment, it directly influences your blood sugar levels”*. Some causes will not be present as they are eliminated by previous positive influences like Food available on campus. Other factors driven by internal factors like emotions that cause fluctuations will be handled positively, because of positive factors such as a positive Independent lifestyle.

Adapting to effects of changing blood sugar

Adapting to effects of changing blood sugar turns positive when the Causes of changing blood sugar are positive. *“If the cause of your blood sugar rising/dropping is within your control then steps to counter the effects should be taken”*. When the Causes of changing blood glucose are positive via elimination or better management, then Adapting to the effects of changing blood sugar becomes less complicated, because the self-management has increased through the positive system. *“Understanding why hypos occur at night helps one adapt to the effects of changing blood sugar, e.g. practicing emotional self-control”*.

Conclusion

Social awareness and acceptance was identified as the primary driver to the system with Adapting to effects of changing blood sugar levels as the primary outcome to self-management living with DM.

The system produced four recognisable loops or cycles namely The Ignorance loop, The Revision loop, The Developing loop and The Self-management Loop.

The students experienced Social awareness and acceptance as a negative aspect in their daily lives as they have limited power over the stigma surrounding DM. Social and awareness plays a significant role in the lives of students living with DM as it influences self-management of DM.

The perceptual system might not be a complete representation of self-management of DM but rather a system reflecting barriers towards compliance with self-management. However, it shows a significant but unknowing shift in terms of independence towards changing and adapting to DM.

The model can be used by universities across the globe to get a better understanding of the perceptions of students living with DM. Management in the cafeterias and other providers of food on campus can use the model to change their meal plans to include the dietary needs of students living with DM. Manufacturers can use the model to develop a way for students to keep their insulin at an optimal level for as long as possible and as comfortable as possible. The structures and management on campus have the power to increase awareness on DM. They can use the model to enforce the believe that a change in stigma and awareness can assist in the self-management and quality of life of students living with DM. Accommodation for students living with DM can be achieved if faculties used the model to change the academic environment for the better. Healthcare providers can use the model to educate themselves on perceptions that students living with DM have and to communicate misunderstandings to students diagnosed with DM. Students living with DM or recently diagnosed with DM can use the model and results to enhance their knowledge with regards to self-management of DM. Post-graduates can use the model to build their study around or increase the study on the topic.

A few limitations were identified in the study, none that compromised the integrity of the research process or the results and conclusions. Limitations such as struggles of working with students, the number of participants and the timeframe of the focus group were present but not limiting the study. This study opens the way for any future investigations of students living with DM. More constituencies can be brought in and be compared to this model, for example, adults who had to make it through university living with DM.

This study was the first to be done on the perceptions of students' self-management living with DM. It helps by providing new information to the format of a system and model to the benefit of universities and students regarding DM. This study gives a small view into the daily lives of students living with DM on campus and how they deal with self-management.

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Conflict of interest

The authors declare they have no conflict of interest.

References

- (1) International Diabetes Federation. Diabetes facts and figures; 2019 [cited 2019 Oct 20]. Available from: <https://www.idf.org/aboutdiabetes/what-is-diabetes/facts-figures.html>.
- (2) World Health Organization. Global Report on Diabetes; 2016 [cited 2018 May 23]. Available from: For numbered lists. http://apps.who.int/iris/bitstream/10665/204871/1/9789241565257_eng.pdf?u.
- (3) International Diabetes Federation. Diabetes in Africa; 2019 [cited 2019Oct 20]. Available from: <https://www.idf.org/our-network/regions-members/africa/diabetes-in-africa.html>.
- (4) Lehohla PJ. Mortality and causes of death in South Africa, 2015: Findings from death notification; 2017 [cited 2017 May 9]. Available from: <http://www.statssa.gov.za/publications/P03093/P030932015.pdf>.
- (5) American Diabetes Association. Diagnosis and classification of diabetes mellitus. Diabetes Care. 2004;27(Supplement_1):S5-S10. doi: 10.2337/dc10-S062

- (6) Nolte Kennedy MS, Masharani U. Pancreatic hormones and antidiabetic drugs. In: Katzung BG, Masters SB, Trevor AJ, editors. Basic & clinical pharmacology. Boston, MA: Mc Graw Hill Lange; 2012. p. 743-68.
- (7) Kerner W, Brückel J. Definition, classification and diagnosis of diabetes mellitus. *Exp Clin Endocrinol Diabetes*. 2014;122(7):384–6. doi: 10.1055/s-0034-1366278.
- (8) American Diabetes Association. Lifestyle management: Standards of medical care in diabetes – 2019. *Diabetes Care*. 2019;42(Supplement_1):S46-S60.
- (9) Centers for Disease Control and Prevention. Health, United States; 2016 [cited 2017 Oct 18]. Available from: <https://www.cdc.gov/nchs/data/hus/hus16.pdf#040>.
- (10) De Munter JSL, Hu FB, Spiegelman D, et al. Whole grain, bran, and gem intake and risk of type 2 diabetes: a prospective cohort study and systematic review. *PLoS Med*. 2007;4:1385-95. Available from: <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC1952203/pdf/pmed.0040261.pdf>
doi:10.1371/journal.pmed.0040261
- (11) Barlow JH, Sturt J, Hearnshaw H. Self-management interventions for people with chronic conditions in primary care: examples from arthritis, asthma and diabetes. *HealthEduc J*. 2002;61:365-78.
- (12) Rowley WR, Bezold C, Arian Y, et al. Diabetes 2030: insights from yesterday, today, and future trends. *Popul Health Manag*. 2017;20:6-12. doi: 10.1089/pop.2015.0181.
- (13) Galaviz KI, Narayan KMV, Lobelo F, Weber MB. Lifestyle and the prevention of type 2 diabetes: a status report. *Am J Lifestyle Med*. 2015;12(1):4–20. doi: 10.1177/1559827615619159
- (14) World Health Organization. Diabetes. 2018 [cited 2019 May 20]. Available from: <https://www.who.int/news-room/fact-sheets/detail/diabetes>.

- (15) Forouhi NG, Krauss RM, Taubes G, Willett W. Dietary fat and cardiometabolic health: evidence, controversies, and consensus for guidance. *BMJ*. 2018;361:k2139. doi: 10.1136/bmj.k2139.
- (16) Miller TA, DiMatteo MR. Importance of family/social support and impact on adherence to diabetic therapy. *Diabetes Metab. Syndr. Obes.* 2013;2013:421–6. doi: 10.2147/DMSO.S36368.
- (17) Babler E, Strickland CJ. Moving the journey towards independence: adolescents transitioning to successful diabetes self-management. *J Pediatr Nurs* 2015;30(5):648–60. doi: 10.1016/j.pedn.2015.06.005.
- (18) Northcutt N, McCoy D. Interactive qualitative analysis: a systems method for qualitative research. London: SAGE; 2004.
- (19) Northcutt N, McCoy D. Overview of interactive qualitative analysis process. s.l. Forthcoming 2015.

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20 May 2020

To whom it may concern

Confirmation of editing the dissertation of Mr. Jozua Jacobs

This letter confirms that I, Maretha Botes, freelance language practitioner, proofread and edited the thesis submitted for the degree Magister Scientiae in Pharmacy Practice at the North-West University of Mr. Jozua Jacobs. My services included marking and editing language errors and reconstructing paragraphs and sentences where necessary.

Yours sincerely



Maretha Botes
Freelance journalist and language practitioner