

**PATIENT'S KNOWLEDGE OF DIABETES, ITS OCULAR  
COMPLICATIONS AND MANAGEMENT IN A PRIVATE PRACTICE  
POPULATION IN THE WESTERN CAPE, SOUTH AFRICA**

**by**

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**DECLARATION**

I hereby declare that the work which is submitted here is the result of my own independent investigation. Where help was sought, it was acknowledged. I further declare that the work is submitted for the first time at this university/faculty towards the Master of Optometry degree and that it has never been submitted to any other university/faculty for the purpose of obtaining a degree.

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## **DEDICATION**

This work is dedicated to my father Michael Phillips: coach, teacher, employer and skipper – one who embodies the spirit and ethos of mutual benefit; and also to my late mother Betsy Phillips, who always believed in my ability and my wife Louise, whose patience, love and caring support made this work possible.

*"Man may be the captain of his fate, but he is also the victim of his blood sugar"*

(Wilfred Oakley, 1962)

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**LIST OF ACRONYMS**

WHO	World Health Organisation
DM	Diabetes Mellitus
SEMDSA	Society for Endocrinology, Metabolism and Diabetes of South Africa
UKZN	University of Kwa-Zulu Natal
IFG	Impaired Fasting Glucose
BMI	Body Mass Index
FPG	Fasting Plasma Glucose
CVD	Cardio-vascular Disease
CHD	Coronary Heart Disease
QOL	Quality of Life
HADS	Hospital Anxiety and Depression Scale
LDL	Low Density Lipoprotein
HDL	High Density Lipoprotein
ED	Erectile Dysfunction

DR	Diabetic Retinopathy
PRP	Pan-retinal Photocoagulation
PDR	Proliferative Diabetic Retinopathy
PBODO	Professional Board for Optometry and Dispensing Opticians
SAOA	South African Optometric Association
HPCSA	Health Professions Council of South Africa

## **ABSTRACT**

The aim of this study was to determine management regimens and level of knowledge of diabetes and its' ocular complications among private patients in a sample of the population of the Western Cape region of South Africa. A population-based cross-sectional study design, using purposive accidental random sampling, was used. Questionnaires completed by diabetic patients who fund their condition privately outside of the South African Public Health sector were used. One hundred and twenty-two subjects participated in the research, 66 (54%) males and 56 (46%) females. There were 73 rural and 49 urban participants. The overall sample mean BMI was 30.7, average fasting plasma glucose (FPG) 8.1 mmol/l and the majority of respondents did not perform a daily FPG test or know the significance of the HbA1c test. The majority of participants were unaware of the serious ocular consequences of prolonged hyperglycaemia. Sixty-seven percent of respondents considered that they knew enough about diabetes to manage their own condition. From the data it is apparent that private patients' knowledge of the systemic and ocular complications of diabetes is sub-optimal. Whilst the majority considered annual eye examinations as important, less than one-third of respondents actually undertook them. Optometrists should be offered programmes to enhance their skills and co-manage and educate diabetic patients with other health care practitioners on a formal basis. Health insurance institutions should take cognisance of the value of patient education and preventative diabetic management and incentivize patients and health care providers in this regard.

## **LIST OF KEY WORDS**

Diabetes; Hypertension; Body Mass Index; diabetic retinopathy; obesity; patient knowledge

# **PATIENTS' KNOWLEDGE OF DIABETES, ITS OCULAR COMPLICATIONS AND MANAGEMENT IN PRIVATE PRACTICE POPULATION IN THE WESTERN CAPE**

## **CHAPTER 1**

### **BACKGROUND AND ORIENTATION TO THE STUDY**

#### **1.1 INTRODUCTION**

The World Health Organisation (WHO) (2005: 200) has claimed that chronic diseases caused 35 million of the 58 million annual deaths worldwide in 2005. Whereas previously those suffering from hypertension, diabetes or obesity were deemed to be upper or middle class white suburbanites, now the picture appears vastly different: a total of 80% of these deaths occurred in lower and middle-income countries with a consequent major impact on local economies. Alexander *et al.* (2008: 2088) argue that Diabetes Mellitus (DM) is common, costly and increasingly prevalent, maintaining that more expensive and complex therapies are being applied to an ever-increasing diabetic population. The Society for Endocrinology, Metabolism and Diabetes of South Africa (SEMDSA) (2007) estimates that almost 29% of the population of the Western Cape who are over 65 years old have diabetes. This alarming statistic probably represents only a portion of the true number of diabetics as many South Africans do not have adequate access to health care (Castro-Leal *et al.* 2000) and, it could be surmised that, if more people could be screened in the public sector, more diagnoses would be made. The disease appears to cross all boundaries; it has no respect for income, gender, race or socio-economic conditions

and is linked to obesity (Rippey, 1994:305). However, the specific health risks associated with obesity may differ according to gender, race and socio-economic condition (Paeratakul *et al.* 2002: 1205). Many higher income earners who over-indulge become sedentary, obese, and become victims of the Metabolic Syndrome with their lifestyle choices and habits determining their path into hypertension, hypercholesterolemia and diabetes (Paeratakul *et al.* 2002: 1205). Psaty *et al.* (2006: 177) state that clinicians should be treating individual risk factors which make up the metabolic syndrome by promoting diet, weight loss and exercise. In the words of Cheta (2006: 176) "all the components of the metabolic syndrome...can be discovered in the picture of obesity". Sparks *et al.* (2005: 1926) describe how obesity and type 2 diabetes have been associated with a high fat diet. Those from lower income groups often do not have access to good nutrition and rely on fatty diets to supplement their energy levels, which lead to obesity and the lifestyle diseases mentioned above (Drewnowski and Darmon, 2005: 265). These patients are often, though not always, rural, sub-optimally educated and seldom have access to information pertaining to their condition other than the periodic contact they have with various health workers in the public health system. In support of these factors, Motala *et al.* (2008: 1783) maintains that there is an epidemic of glucose intolerance, which is a known risk factor for diabetes, in the South African rural population.

Genetically, some diabetics may also have risk factors which may predispose them to becoming diabetic. The angiotensin I converting enzyme gene was suspected of causing diabetic kidney disease (Dorin *et al.* 1994: 690) although this appears to be disputed in a 1998 study by Kimura *et al.* (1998: 1659). Although approximately

50% of genetic based diabetes is connected to the HLA genetic region (Steck *et al.* 2005: 2482), Concannon *et al.* (2009: 1018) found that five non-HLA chromosome regions showed some evidence of linkage to Type 1 diabetes; whilst Wang *et al.* (2009: 1401) suspect that the liver pyruvate kinase gene is the most likely gene responsible in Type 2 diabetes. Whatever the causative gene, however, it is not disputed that there is a definite genetic base in many instances of diabetes mellitus.

**Table 1.1:** Summary of Type 2 diabetes in different South African population groups (SEMDSA) (2007)

Population	Region (number prevalence of diabetics)	Age range (years)	Reference
African	Cape Town, urban 8%	30+	Diabet Care 1993;16:601
African	Qwa Qwa, rural 4.8%	25+	S Afr Med J 1995;85:90
African	Durban, urban 6%	15+	S Afr Med J 1993;83:641
Mixed (Coloured)	Cape Town 28.7%	65+	S Afr Med J 1997;87 (suppl 3):364
Mixed (Coloured)	Cape Town, peri-urban 10.8%	15 - 86	Diabet Med 1999;16:946
European	Durban, urban 3%	15 - 69	S Afr Med J 1994;84:257
Indian	Durban, urban 13%	15+	Diabet Care 1994;17:70

In terms of the prevalence of diabetes in South Africa, Cape Town has the largest rate where 28.7% of the Coloured population over the age of 65 is diabetic. This is illustrated in Table 1.1. A further study by Motala *et al.* (2006: 79) states that there is a global epidemic of Type 2 diabetes which will most affect the developing world. This is confirmed by statistics in the Diabetes Atlas published by the International Diabetes Federation (cf. Table 1.2), where it can be seen that the International Diabetes Federation estimates that currently there are some 194 million people with diagnosed diabetes and by 2025 there will be 333 million diabetes patients worldwide.

**Table 1.2:** International diabetic statistics (Diabetes Atlas)  
(International Diabetes Federation, 2006)

<b>All diabetes and Impaired glucose tolerance (IGT)</b>	<b>2003</b>	<b>2025</b>
Total world population (billions)	6.3	8.0
Adult population (billions) (20-79 years)	3.8	5.3
Number of people with diabetes (millions)(20-79 years)	194	333
World diabetes prevalence % (20-79 years)	5.1	6.3
Number of people with IGT (millions) (20-79 years)	314	472
IGT Prevalence % (20-79 years)	8.2	9.0

### **1.1.1 Types of Diabetes and its Ocular Complications**

According to Sukha and Rubin (2007: 120), diabetes can be classified into three main types: Type 1 (or insulin-dependent diabetes), Type 2 (or non-insulin

dependent diabetes) and gestational diabetes occurring only in pregnancy and a major risk factor to progress to Type 2 diabetes after the pregnancy (Buchanan and Xiang 2005: 485). Type 1 is divided into idiopathic or autoimmune diabetes mellitus both resulting in insulin dependence and loss of pancreatic beta cells, while Type 2 diabetes is largely a lifestyle disease, resulting from poor diet, sedentary living and lack of exercise, causing insulin resistance to glucose metabolism. Gestational diabetes is a state of carbohydrate intolerance often caused by hormonal changes during pregnancy affecting 2.5% of all pregnant women (Xiong 2003: 223). The World Health Organisation (WHO) has classified the diagnostic fasting plasma (blood) glucose value for the diagnosis of all diabetes to be  $\geq 7.0$  mmol/l (Alberti and Zimmert 1998: 539 – 553).

As far as the ocular complications and associations of diabetes are concerned, these include cranial nerve palsies, decreased corneal sensitivity and healing, open and closed angle glaucoma, pupil abnormalities, cataract, retinal ischaemic and hemorrhagic disorders and refractive changes (Sukha and Rubin 2007: 120 and Records 1970: 709).

### **1.1.2 Financial implications of diabetes**

Kowjala *et al.* (2007: 917) examined the costs of diabetes treatment and care in Pakistan, concluding that these costs are high. In the United States the estimated \$132 billion cost for diabetes treatment in 2003 probably underestimates the true burden of diabetes (American Diabetes Association 2003: 917) as there are certain aspects that cannot be measured like pain and suffering. Furthermore, the cost of

care given by unpaid caregivers and volunteers is not factored into the calculations as well as the incalculable cost to society and those suffering from the disease and their families. Motala *et al.* (2006: 79) indicated that treatment involves both direct (medication) and indirect (diet and lifestyle changes) interventions and developing countries can ill-afford the burden to the fiscus. They therefore recommended that more cost-effective programmes be introduced to reduce the financial burden on the State.

It can be argued that, by understanding the problems associated with diabetes and the possible consequences of the disease, compliance and management can be better achieved. Research conducted by Clarke-Farr *et al.* (2006: 134), which focused mainly on the public health sector, established the levels of knowledge of diabetic patients about their condition. Diabetes appears to be as much a problem in the private sector and it follows that a study needs to be conducted on the degree of knowledge that private sector diabetics have of their condition. Anecdotal evidence shows that, possibly due to the higher levels of education, there is a greater understanding of the condition *per se*, but knowledge of the consequences of the condition, especially ocular complications, remains somewhat vague. Private patients may also be able to spend more time with their physicians than would be the case at a public health care facility and thereby are perhaps able to gain a better understanding and insight into their condition and be better placed to manage their disease optimally.

This study, therefore, aims to examine the knowledge of diabetes and its consequences in diabetic patients in the private sector. In addition, comparisons can later be made between the studies involving the public sector by Clarke-Farr *et al.* (2006: 134) and Mashige *et al.* (2008: 95) to see if there are indeed differences in this knowledge and, if so, what these differences are and why they occur. As a result of this, planned strategies and interventions may be implemented to reduce the ocular complications in diabetic patients where better patient co-operation and compliance could improve the effectiveness in the treatment of diabetes. Improved knowledge of the condition and its dangers could reinforce information already received but, perhaps, long-forgotten or poorly understood. Furthermore the role and value of the optometrist in managing these patients may be expanded.

## **1.2 STATEMENT OF THE PROBLEM**

Previous studies by Clarke-Farr *et al.* (2006: 134) and Mashige *et al.* (2008: 95) have concentrated primarily on the public sector patient knowledge of diabetes mellitus and its ocular complications. This does not complete the picture as there are many thousands, possibly millions, of diabetic patients in the private sector who either self-fund their medical needs or are members of medical schemes. These patients also need to comply with their treatment regimen and be regularly screened for the consequences of diabetes. This raises the question: what is the current level of knowledge of diabetic patients about their disease in the private sector and how are they managing their diabetes?

Anecdotal evidence from patients in private optometric practice suggests that once diagnosed with diabetes private patients are given a diet sheet by their general practitioner and a prescription for medication and are told to return for a follow-up visit within a specified period. The majority of diagnoses are made by General Practitioners and referrals are made to specialist physicians only if diabetes control proves to be troublesome. This study therefore aimed to ascertain the depth of knowledge and understanding of the ocular complications of diabetes of privately treated diabetic patients with the further benefit of informing policy and recommendations for general practitioners and allied health care workers, optometry included.

### **1.3 THE AIM, GOAL AND OBJECTIVES OF THE STUDY**

The aim of this study was to determine the management regimens and level of knowledge of diabetes and its' ocular complications among private patients in a cross-section of the population of the Western Cape region of South Africa. The overall goal of the study was to enhance the role of the Primary Care Practitioner, including optometrists, in performing a constructive supporting service in the overall management and care of the diabetic patient in private practice.

In order to achieve the stated aims and goals, the following objectives were developed:

1. To determine the level of knowledge of diabetic patients in the private sector about diabetes

2. To determine the level of knowledge of diabetic patients in the private sector about the ocular complications of diabetes
3. To determine the level of knowledge of diabetic patients in the private sector about the management and treatment protocols of diabetes
4. To determine how diabetic patients manage their own condition
5. Determine possible differences in rural and urban respondents regarding knowledge and management of diabetes

#### **1.4 SCOPE OF THE STUDY**

The scope of the study was primarily based in the field of optometry and primary healthcare but also crossed the fields of general medical practice, ophthalmology and nursing as each of these health care providers participate in the management and treatment of the diabetic patient.

Due to the fact that one of the key complications of uncontrolled diabetes is blindness, optometrists see many of these patients routinely in their daily practice, often on referral from general practitioners. This provides an ideal interface for the optometrist to communicate valuable knowledge and make timely interventions if so indicated.

## **1.5 SIGNIFICANCE AND VALUE OF THE STUDY**

The increasing prevalence of diabetes, especially Type 2 diabetes, locally and worldwide, makes this disease one of the greatest health challenges of our time. Adequate blood glucose control is essential in keeping the consequences of diabetes at bay and knowledge of the consequences should assist patient compliance with their treatment regimens. This holds equally true for both those patients in the public sector and in the private sector.

A study of this type will compliment other studies which concentrated on the Public Health Sector and raise the profile of the private optometric practitioner as a primary healthcare provider. The optometrist would use their valuable knowledge and significant skills to play an important supportive role in the co-management of the diabetic patient. Information obtained from this and similar studies can be incorporated in training modules aimed specifically at the diabetic optometric patient, enabling practitioners to make even more informed decisions regarding referral, monitoring and counseling.

## **1.6 DESIGN OF THE STUDY AND METHODS OF INVESTIGATION**

### **1.6.1 Research design**

A population-based cross-sectional study, using purposive accidental random sampling, was used for this research. The study consisted of questionnaires completed by diabetic patients who fund their condition privately, that is outside of the South African Public Health sector. The patients were from mixed socio-

economic backgrounds. The quantitative aspect of the study involved the analysis and synthesis of the data collected and a thorough literature review together with the statistical analysis of the overall responses obtained from the questionnaire. The qualitative aspect utilised certain questions within the questionnaire which allowed for an assessment of the patients' own perceptions of his or her diabetes and general health status. Bowling (2002:187) describes the purposive sampling design as one which aims to sample a group of people with a particular characteristic and in this case all have diabetes. The questionnaire was developed after reviewing previous studies (Clarke-Farr *et al.* 2006: 134 and Mashige *et al.* 2008: 95), and the questions derived focussed on issues relating to the private sector patient.

### **1.6.2 Methods of investigation**

- A comprehensive literature study regarding the nature of the various types of diabetes and the various issues revolving around diabetes and its ocular complications was undertaken. These issues included the metabolic syndrome, obesity, the genetic basis of diabetes, stress-induced diabetes, depression and anxiety as a cause and as a result of diabetes as well as studies regarding the ethnic prevalence of the condition. General and ocular complications and the knowledge and lack of knowledge of diabetes were also researched. In addition, access to services was included in the questionnaire.
- A pilot study was conducted with the questionnaire prior to the commencement of the study.

- The questionnaire provided quantitative data derived from the question coding in the Likert Scale, while qualitative analysis was achieved through the analysis of the open-ended answers.
- A detailed questionnaire was used to determine patients' knowledge of their own diabetic status, treatment and other issues pertaining to their knowledge of the potential complications of diabetes. The questionnaire also contained biographical data for statistical analysis.

The questionnaire was developed using Microsoft Excel in order to assess the knowledge of the private patient regarding his or her diabetes. The first group of questions contained biographical details, including the patients' height and weight in order to establish their Body Mass Index (BMI), thereafter the questions elicited information regarding the patients' knowledge of diabetes, the ocular complications of diabetes, their management and treatment regimens and possible barriers for access to treatment. The questionnaire contained sections in a Likert scale format. There were various options for the patient to choose from for example "agree", "disagree" and "unsure" or "very important", "important" or "slightly important" as well as "never", "usually" or "always".

### **1.6.3 Sample Selection**

#### **1.6.3.1 Target population**

The target population for the study was diabetic patients who are members of medical schemes, or who privately fund their treatment and do not make use of public health facilities, within the selected private practices in the region of the

Western Cape Province of South Africa. Convenience sampling will be employed for patient selection.

### **1.6.3.2 Sample size**

To obtain a 95% confidence level at a confidence interval of 3, the minimum sample needed for all nine provinces of South Africa needed to be 1077 (Creative Research Systems, 2009). Calculations based on Creative Research Systems (2009), for the same level in the Western Cape determined the minimum sample to be  $0.101 \times 1077 = 108$ . The sample size consisted of 122 [ $n_{\text{sample}} = 122$ ] accidental purposively selected patients examined in the private optometric practices.

### **1.6.3.3 Description of the sample**

The geographical area of the study is located in the Western Cape region of South Africa. Private diabetic patients attending selected private optometric practices in the region were asked to complete an anonymous questionnaire containing information relevant to the study. The private optometric practices were selected in order to represent one urban and one rural population sample. One practice was in the near West Coast (Milnerton) and one in Malmesbury.

### **1.6.4 Data analysis**

Once the questionnaires were completed the data was captured using Microsoft Excel 2007. The data from the captured questionnaires was then statistically analyzed according to frequency, mean, median, mode, range and standard deviation where appropriate. The results were summarized quantitatively and qualitative inferences were also described.

### **1.6.5 Reliability, validity and trustworthiness**

When establishing reliability in research, an instrument is considered reliable if it consistently gives the same results. Polgar *et al.* (2000: 137) define reliability as “the reproducibility of results”. Bowling (2002: 147) refers to the reproducibility and consistency of the instrument, where it is free from random error and is homogenous. Therefore, in order to facilitate the reliability of the data gathering instrument, patients completed the same questions in the questionnaire at different times.

“Validity is an assessment of whether an instrument measures what it aims to measure” (Bowling 2002: 147). To evaluate the validity of the instrument, a pilot study was undertaken by the researcher to reinforce the internal validity. The size of the research population was aimed to give the study external validity, whereby the findings could be generalised to the wider population of interest, also known as population validity (Polgar and Thomas 2000: 41). In addition, the size of the sample also aimed to lend ecological validity, whereby the situation in which an investigation is carried out is generalisable to other situations.

Triangulation was achieved in this study by using data from the questionnaire, a literature review and from similar studies in the public health sector. This triangulation lends trustworthiness, or credibility, to the research and, according to Cohen and Crabtree (2008: 331), qualitative research should “use such techniques as triangulation ... to promote attainment of truth or validity through the process of verifying findings.” Green (2005: 66), citing Smaling (1992: 319), says that the aim

of triangulation is to perform the research study in at least two different ways either by using two or more kinds of data sources or, more appropriately in this study, using two or more research methods or approaches including working with other researchers.

### **1.6.6 Ethical considerations**

All human research studies require ethical approval and prior ethical approval for this study was obtained from the UKZN Biomedical Research and Ethics Committee. Furthermore, the study was undertaken in full conformity with the Ethical Rules of the Health Professionals Council of South Africa governing, in particular, the rights of patients and patient confidentiality. It follows that data obtained from the questionnaires would be kept confidential and all participants voluntarily completed the questionnaires with prior informed consent. Patients were also assured of anonymity at all times with a further understanding that any participant was free to withdraw from the study at any time without penalisation.

#### **1.6.6.1 Inclusion and exclusion criteria**

*Inclusion criteria:* All diagnosed diabetic patients on a medical scheme, dependent or privately-funded.

*Exclusion criteria:* Non-diabetic patients or diabetic patients being treated in the Public Health system.

## **1.7 DEFINING THE TERMINOLOGY**

- **Diabetes mellitus**

The Oxford Handbook of Clinical Medicine (1997: 528) defines diabetes mellitus as a syndrome caused by the lack of or diminished effectiveness of insulin, which is characterised by hyperglycaemia and “deranged metabolism”.

- **Ocular complications**

Ocular complications refer to pathological conditions of the eye which are directly attributable to the condition of diabetes. These include refractive changes, cataracts, neovascular complications, retinal changes, secondary glaucoma, ocular hypertension, nerve palsies and other neuro-ocular disorders and diabetic retinopathy.

- **Diabetic retinopathy**

Diabetic retinopathy results from changes in the blood vessels of the retina due to diabetes and is a major potential complication of the disease (Sopharak *et al.* 2008: 720-727). The symptoms can seriously affect the patient’s vision and are a major cause of blindness. Macular oedema, exudates and haemorrhages are the primary signs of diabetic retinopathy (Antonetti *et al.* 2006: 2407).

- **Metabolic syndrome**

Grundy *et al.* (2004: 433-438) have defined the metabolic syndrome as having six components. These are abdominal obesity, atherogenic dyslipidaemia, hypertension or elevated blood pressure, insulin resistance or glucose intolerance, proinflammatory state (recognized clinically by elevations of C-reactive protein) and prothrombotic state (characterized by increased plasma plasminogen activator inhibitor).

- **Patients**

For the purposes of this study, patients are defined as individuals attending an optometric practice for the purposes of having their eyes examined and being refracted with the view of providing spectacles or contact lenses. Diabetic patients are those individuals attending the private optometric practices who have been diagnosed with diabetes mellitus.

- **Primary health care**

The WHO refers to primary health care as providing a place to which people can bring a wide range of health problems. It is further described as “a hub from which patients are guided through the health system” (WHO 2008 :xvii) and, as such, primary care can be seen as a starting point for those with health problems from which appropriate referral can be made.

## **1.9 CONCLUSION**

In this chapter a broad overview of the study has been given with emphasis on the global problem of diabetes and its attendant factors such as obesity and the metabolic syndrome. Further attention has been given to the cost implications of treatment, both to the individual and the State. The significance of the study was described as well as the research methodology, including the sample description, sample size and sampling techniques and the statistical methods employed in order to derive the results. Finally, a list of important terms used in the study is provided. In Chapter Two a comprehensive literature study is presented whereby diabetes and the aspects incorporated in the questionnaire are described in order to give them

relevance and context. Studies are reviewed concerning the prevalence, risk factors, general complications and ocular complications of diabetes as well as the benefits of knowledge of and lack of knowledge of diabetes by the diabetic patient.

## CHAPTER 2

### LITERATURE REVIEW

#### 2.1 DIABETES MELLITUS

This chapter will examine the literature pertinent to this study. It will include, inter alia, the mechanism of diabetes mellitus (DM) and its actions, its aetiology, prevalence, risk factors and the general complications consequent to the condition. Furthermore, literature concerning the ocular effects and complications of DM as well as the knowledge and lack of knowledge of the condition and how these two concepts impact on the treatment of DM is reviewed.

Rippey (1994:303) describes diabetes mellitus as a chronic disorder of metabolism where insulin is either absent or fails to act as it should. Fowler (2008:77) explains diabetes as a group of chronic diseases characterised by one main criteria, hyperglycaemia. Evidence of changes in glucose concentrations, insulin resistance (or insensitivity) and insulin secretion has been shown as much as three to six years before diagnosis of diabetes. This is a concept sometimes referred to as pre-diabetes and is reported by Tabak *et al.* (2009: 2215 – 2221). Pre-diabetes consists of Impaired Fasting Glucose (IFG) and/or impaired glucose tolerance and is a major risk factor for the development of true diabetes with micro- and macrovascular complications (Aroda and Ratner, 2008: 3259). Interestingly, this so-called pre-diabetes is reversible according to Perreault *et al.* (2009: 1346) and normal glucose regulation can often be attained through weight loss and lifestyle modification. In terms of primary health care, this reversibility should be a major target for treatment

and counselling. In the overall battle against this disease, education about the risks and potential complications of DM and the promotion of lifestyle modification will reap great benefits for at-risk individuals in the future. Joshi and Joshi (2008: 22) emphasise that development of Type 2 diabetes from pre-diabetes can be prevented by diet changes, moderate weight loss and exercise. In a 10-year study by Mozaffarian *et al.* (2009: 798) lifestyle risk factors were examined in accordance with their risk factors for diabetes. Low-risk groups were defined as those who included: moderate physical activity (walking), dietary score (higher fibre, lower saturated and trans fats), never smoked or former smoker more than 20 years ago, Body Mass Index (BMI) < 25 and female waist circumference of 88cm and 92 cm for men. These researchers found that the rate of incident diabetes was 35% lower for those who had a positive lifestyle combination than those who did not. In Sri Lanka, Katulanda *et al.* (2008: 1062) noted that those with diabetes and pre-diabetes were older, physically inactive, frequently lived in urban areas and had a family history of diabetes. Furthermore, they had a higher BMI, greater waist circumference and waist-hip ratio, higher blood pressure, higher LDL cholesterol and higher triglycerides.

De Fronzo (2009: 773) maintains that the core pathophysiological defects in diabetes are insulin resistance in liver and muscle, and beta cell failure. Furthermore, beta cell failure occurs much earlier than previously understood and those who are in the upper levels of glucose intolerance have lost up to 80% of their beta cell function. Moreover, the fat cell, with accelerated lipolysis, the gastro-intestinal tract with incretin, a hormone which increases insulin secretion, deficiency or resistance and the brain with insulin resistance are all important facets in the development of

glucose intolerance in Type 2 diabetes (De Fronzo, 2009: 773). In clinical diabetes, however, there is evidence of impaired carbohydrate metabolism and the primary diagnostic feature is raised blood glucose or hyperglycaemia. The importance of protecting the body against hyperglycaemia cannot be overstated, stresses Fowler (2008: 77), adding that the effects of hyperglycaemia are macrovascular and microvascular. Macrovascular effects include coronary artery disease, peripheral artery disease and stroke while microvascular complications include nephropathy, neuropathy and retinopathy. In terms of hyperglycaemia, the World Health Organisation (WHO) has classified the diagnostic fasting plasma (blood) glucose (FPG) value for the diagnosis of all diabetes to be  $\geq 7.0$  mmol/l (Alberti and Zimmert, 1998: 539). The HbA1c test, which measures the glycosylated haemoglobin in the blood, used in combination with the FPG is also cited by Sato *et al.* (2009:644) as a valuable predictor of Type 2 diabetes. Inoue *et al.* (2008: 1157) studied the combination of the FPG and HbA1c tests as a predictor of diabetes and, using the definition of diabetes as  $>7.0$  mmol/l, found the cumulative incidence was 24.8% compared with those with normal fasting glucose and conclude that the combination of these tests identifies those individuals who are at risk of progression to Type 2 diabetes. Elley *et al.* (2008: 1295) found, however, that the HbA1c test as a stand-alone was an equally valuable predictor of risk for cardiovascular disease (CVD) and for each 1% increase of HbA1c there was a 1.08 increase in risk for a CVD event – the so-called hazard ratio.

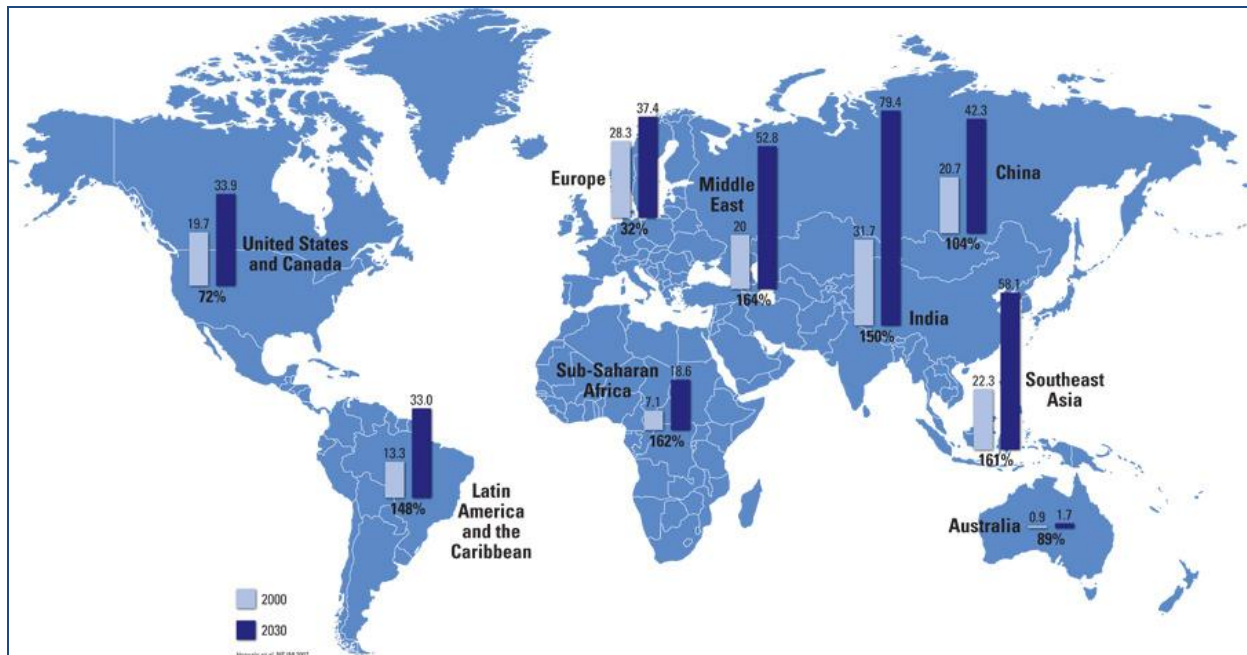
The action or presence of insulin is critical for the normal functioning of the human body. In contrast, the inaction or absence of insulin gives rise to glucose not being metabolised as it should. The most important action of insulin is to facilitate the

transfer of glucose into cells while also maintaining the plasma glucose level between 3 and 5mmol/l (Rippey, 1994: 303). It is this lack of glucose control in diabetes which needs to be tackled aggressively according to Gale (2008: 9) with the central objective of therapy being to reduce vascular risk "by any means available." Clinically, what physicians are attempting with treatment is to improve the quality of life and in this context Collins *et al.* (2009: 603) feel that the diabetic patients' quality of life is definitely enhanced when care is provided at a primary care setting, provided the primary care provider renders good quality care. This research is an attempt to deal with this principle. It aims further to provide primary care practitioners, including optometrists, with insights regarding the lack of information regarding diabetes by those who have the disease. By knowing of a deficiency in the system, practitioners can act accordingly and provide better information to their patients in order to supplement and enhance current treatment regimens.

## **2.2 PREVALENCE OF DIABETES**

Wild *et al.* (2004: 1047), report on the global "diabetes epidemic". They maintain that the increase in obesity worldwide will result in any projections being an underestimate. The figures quoted in this study indicate the prevalence of diabetes worldwide to be 2.8% of the global population in 2000, rising to 4.4% in 2030; this represents 171 million people in 2000, some 11% higher than previous estimates increasing to 366 million in 2030 (Wild *et al.* 2004: 1051) (cf. Figure 2.1). In sub-Saharan Africa the estimate was 7.146 million people in 2000 rising to 18.645 million in 2030, representing a 161% increase. The global percentage increase to the year 2030 is 114%. By far the greatest area of prevalence is in the age group 46 – 64

and it is in this group that the projected increase will escalate from 80 million in 2000 to 141 million by 2030.



**Figure 2.1** Worldwide prevalence of diabetes (Hossain *et al.* 2007:213 – 215)

Prevalence rates for those under 40 years will double by 2030 while those over 65 will rise from approximately 55 million to 130 million (Wild *et al.* 2004: 1050). The global prevalence is slightly higher in men younger than 60 but higher in older women, possibly due to women living longer; there is an overall higher prevalence in men, although there are more women with diabetes (Wild *et al.* 2004: 1050).

In developed countries the prevalence is also a matter for concern. Harris *et al.* (1998: 518) reported on the prevalence of diabetes in the United States between 1988 and 1994 and concluded that the prevalence of diagnosed diabetes for that period was 5.1% of adults  $\geq 20$  years of age, while the estimate of undiagnosed

diabetes was 2.9%. Those with Impaired Fasting Glucose (IFG) were reported to be 6.9% or 13.4 million people. Table 2.1 lists the countries with the highest numbers of diabetes from 2000 and projected to 2030.

**TABLE 2.1** List of countries with the highest numbers of estimated cases of diabetes for 2000 and 2030 (Wild 2004:1049)

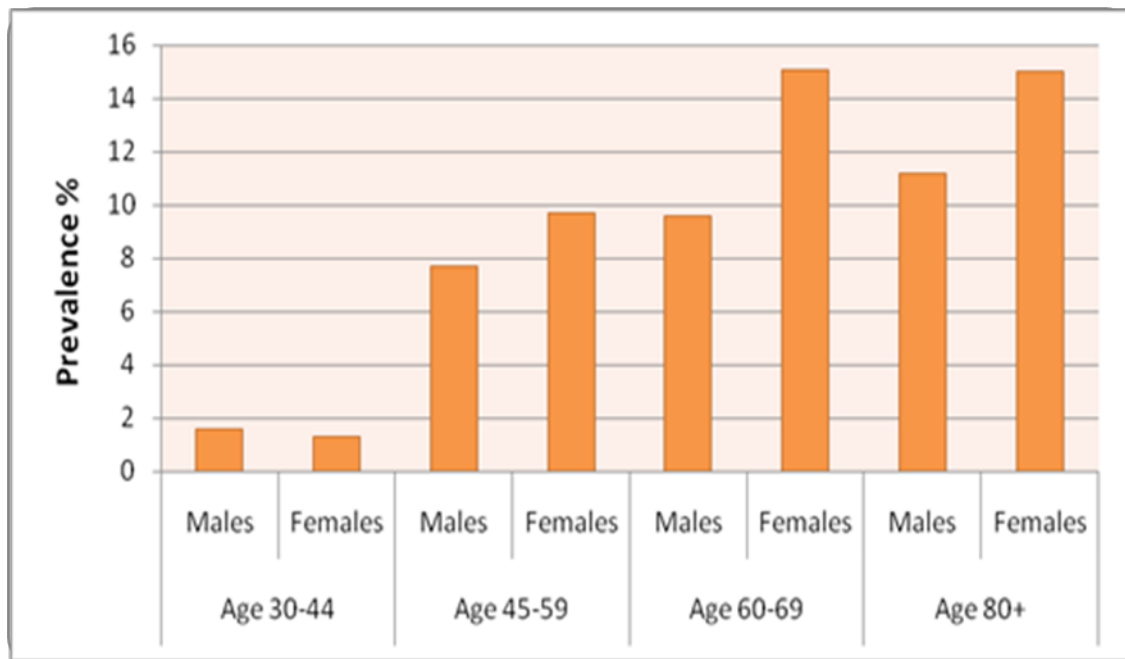
Country and ranking		People with diabetes	Country and ranking		People with diabetes
		2000 (millions)			2030 (millions)
1.	India	31.7	1.	India	79.4
2.	China	20.8	2.	China	42.3
3.	U.S.	17.7	3.	U.S.	30.3
4.	Indonesia	8.4	4.	Indonesia	21.3
5.	Japan	6.5	5.	Pakistan	13.9
6.	Pakistan	5.2	6.	Brazil	11.3
7.	Russian Fed	4.6	7.	Bangladesh	11.1
8.	Brazil	4.6	8.	Japan	8.9
9.	Italy	4.3	9.	Philippines	7.8
10.	Bangladesh	3.2	10.	Egypt	6.7

Cowie *et al.* (2008: 287) examined the prevalence of diagnosed diabetes, undiagnosed diabetes and pre-diabetes in the United States during 2005 – 2006 and found the prevalence of diabetes in people  $\geq 20$  years of age to be 12.9%. Forty per cent of individuals had diabetes or pre-diabetes and almost a third of the elderly had diabetes. Of the elderly, 75% had diabetes or pre-diabetes. In their study diabetes prevalence was approximately twice as high in non-Hispanic black citizens and

Mexican-Americans. According to their results the crude prevalence of diagnosed diabetes rose from 5.1% in 1988 – 1994 to 7.7% in 2005 – 2006 and they conclude by stating that over 40% of persons  $\geq 20$  years of age have hyperglycaemia, with a higher prevalence in minorities. In New York City, Thorpe *et al.* (2009: 57) reported that the prevalence of diabetes was 12.5%, with 3.8% of those being undiagnosed. In this study Asians had the highest prevalence of impaired glucose metabolism but were significantly less likely to be obese. In Germany, Heidemann *et al.* (2009: 655) reported a prevalence of 5.34% between 2002 – 2005, while in Australia Catanzariti *et al.* (2009: 596) state that the incidence of Type 1 diabetes among 0 – 14 year-olds is very high compared to many other countries, citing the mean adjusted incidence rate for Type 1 diabetes in Australia between 2000 – 2006 as 21.6 per 100 000 person years. A Swedish study by Ringborg *et al.* (2008: 1178) found that prevalence of diabetes increased from 2.2% to 3.5% between 1996 and 2003, citing relatively stable incidence and declining mortality as perhaps the reason for the slight increase. On the Asian sub-continent, Katulanda *et al.* (2008: 1062) report that one in 5 adults in Sri Lanka has either diabetes or pre-diabetes and that 33% of those with diabetes are undiagnosed. In Africa, Motala *et al.* (2008: 1783) conducted a study in rural areas of South Africa and found the prevalence of diabetes to be 3.9% but IFG was higher in men (4%) than women (0.8%). They concluded that there was a moderate prevalence of diabetes in the rural areas but a higher prevalence of total disorders of glycaemia which indicated to them that rural communities in South Africa may well be into an “epidemic” of glucose intolerance. In terms of South African diabetes prevalence, Rheeder (2006: 20) estimates that Type 2 diabetes prevalence in South Africa varies between 3% and 28.7%, with the

greatest prevalence in the South African Indian population (13%) and the elderly Cape Coloured community (28.7%) (cf. Figure 2.2).

**Figure 2.2:** Estimated prevalence of diabetes by age and gender, South Africa 2000. (Bradshaw *et al.* 2007: 702)

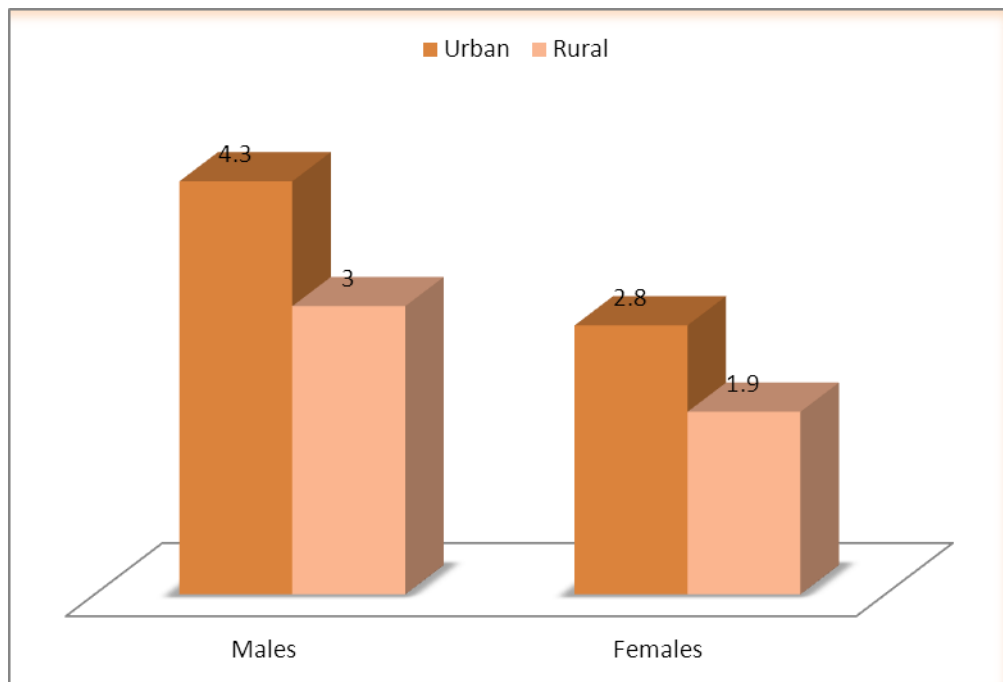


The South African prevalence of diabetes in terms of age and gender is illustrated in Figure 2.2. It can be seen that females in the age group 60 – 69 and 80 years and over are most affected. Figure 2.3 illustrates, however, how the urban male is highest affected and that males overall appear to be most susceptible to becoming diabetic. Table 2.4 indicates the prevalence of diabetes by population group, age and sex, illustrating that the urban black African between 60 and 80 years has 10.8% prevalence, almost equal to that of the white population. This, however pales in comparison to the Coloured population group who, between the ages of 70 – 80 have a prevalence of 26.9% and the Asian/Indian population group, a quarter of whom are diabetic by the age of 45, rising to a third between 60 – 80 years.

Bradshaw *et al.* (2007: 700) found that, of South Africans over the age of 30, 5.5% had diabetes, a figure that increased with age. These authors found that 14% of ischaemic heart disease, 10% of stroke, 12% of hypertensive disease and 12% of renal disease in adults were attributable to diabetes. They also estimate that 22 412 deaths in South Africa in the year 2000 were caused by diabetes (cf. Table 2.2). These figures are further summarised in Table 2.5.

**Figure 2.3:** Prevalence of diabetes in rural and urban South Africa

2003. (RSA DoH Demographic and Health Survey: 2003)



**Table 2.2:** Prevalence percentage of diabetes by population group, age and gender, South Africa 2000. (Bradshaw *et al.* 2007:703)

Population Group South Africa	Age group	Males %	Females %
<b>Urban Black African</b>	30-44	2.2	1.5
	45-59	9.2	13
	60-69	10.8	16.7
	70-79	10.8	16.7
	80+	10.8	16.7
	30+	5.4	7.3
<b>Non-urban Black African</b>	30-44	1.1	0.8
	45-59	4.6	6.5
	60-69	5.4	8.4
	70-79	5.4	8.4
	80+	5.4	8.4
	30+	2.7	3.7
<b>Coloured</b>	30-44	0.8	0.4
	45-59	8.4	8.7
	60-69	12.5	33.3
	70-79	26.9	19.4
	80+	26.9	19.4
	30+	5.1	7.3
<b>White</b>	30-44	0.5	0.8
	45-59	7.3	8.2
	60-69	10	13.9
	70-79	10.8	16.7
	80+	10.8	16.7
	30+	5.1	7.3
<b>Asian/Indian</b>	30-44	9.6	9.8
	45-59	25.2	18.4
	60-69	30	30
	70-79	30	30
	80+	30	30
	30+	18	16.4
<b>South Africa</b>	30-44	1.6	1.3
	45-59	7.7	9.7
	60-69	9.6	15.1
	70-79	10.7	14.7
	80+	11.2	15
	30+	4.7	6.2

**Table 2.3:** Prevalence of diabetes in South Africa (SEMDSA)

Population	Region (number of participants)	Prevalence (%)	Age range (years)	Reference
<i>African</i>	Cape Town, urban (729)	8	30 +	Diabet Care 1993;16:601
<i>African</i>	QwaQwa, rural (853)	4.8	25 +	S Afr Med J 1995;85:90
	Mangaung, urban (758)	6		
<i>African</i>	Durban, urban (479)	5.3	15 +	S Afr Med J 1993;83:641
<i>Mixed</i>	Cape Town, urban (200)	28.7	65 +	S Afr Med J 1997;87 (suppl 3):364
<i>Mixed</i>	Cape Town, peri-urban (974)	10.8	15 - 86	Diabet Med 1999;16:946
<i>European</i>	Durban, urban (396)	3	15 - 69	S Afr Med J 1994;84:257
<i>Indian</i>	Durban, urban (2479)	13	15 +	Diabet Care 1994;17:70

**Table 2.4:** Diabetes prevalence (percentage) in South Africa by Province 2003.  
(RSA DoH Demographic and Health Survey: 2003)

Province	Females	Males
<b>Western Cape</b>	6.6	3.7
<b>Eastern Cape</b>	3.8	2.7
<b>Northern Cape</b>	3	3
<b>Free State</b>	4	1.8
<b>KZN</b>	4	2.5
<b>North West</b>	1.8	1.5
<b>Gauteng</b>	3.5	2.6
<b>Mpumalanga</b>	2.1	2.5
<b>Limpopo</b>	3.5	2.4

Table 2.4 indicates the provincial prevalence of diabetes in South Africa, with the Western Cape having the highest prevalence of diabetes amongst both females and males.

### **2.3 TYPES OF DIABETES**

Diabetes can be classified into three main types (Sukha and Rubin, 2007: 120): Type 1, or insulin dependent diabetes (IDDM); Type 2, or non-insulin dependent diabetes (NIDDM) and gestational diabetes, occurring only in pregnancy. Type 1 is divided into idiopathic and autoimmune diabetes mellitus (DM) both resulting in insulin dependence and loss of pancreatic beta cells, while Type 2 diabetes is largely a lifestyle disease, resulting from poor diet, sedentary living and lack of exercise, causing insulin resistance to glucose metabolism. Gestational diabetes is a state of carbohydrate intolerance often caused by hormonal changes during pregnancy affecting 2.5% of all pregnant women (Xiong 2003: 223).

In Type 1, which largely affects younger individuals, low insulin levels result from the destruction of Beta cells in the pancreas due to infiltration of the Islets of Langerhans by lymphocytes with fibrosis and atrophy following later (Rippey 1994: 305). It is further suggested that there is perhaps a genetic basis for the contracting of Type 1 diabetes. The angiotensin I converting enzyme gene was suspected of causing diabetic kidney disease (Dorin *et al.*1994: 690) although this appears to be disputed in a 1998 study by Kimura *et al.* (1998: 1659). Concannon *et al.* (2009:1018) found that five non-HLA chromosome regions showed some evidence of linkage to Type 1 diabetes; whilst Wang *et al.* (2009: 461) suspect that the liver

pyruvate kinase gene is the most likely gene responsible in Type 2 diabetes. Rippey (1994: 305) suggests that the gene responsible may be triggered by exposure to a virus and proposes further that the responsible viruses include the Coxsackie B and Rubella. Whatever the causative gene, however, it is not disputed that there is a definite genetic base in many instances of diabetes mellitus. Abhary *et al.* (2009: 2137) are also of the opinion that variations within the AKR1B1 gene are associated with diabetic retinopathy.

In Type 1 diabetes there is often severe hyperglycaemia due to glucose not entering the cells. This glucose level then exceeds the kidney threshold and spills over into the urine, a condition known as glycosuria. The glycosuria results in an osmotic diuresis causing polyuria (excessive urine production), dehydration and then excessive thirst (polydipsia) (Rippey, 1994: 305). Therefore the presenting symptoms for Type 1 diabetes are often initially excessive thirst and excessive urination.

Weight loss in Type 1 diabetes is a common occurrence. Rippey (1994: 305) describes this phenomenon as happening due to glucose not being able to be utilised in energy production with the result that fat is broken down and free fatty acids are released. These combine with acetylcoenzyme A in the liver but, without insulin, acetylcoenzyme A cannot enter the mitochondria and partake in the Krebs cycle to form ATP and is converted into ketone bodies, a large portion of which is acetone. These ketone bodies also cannot be used in muscle tissues and accumulate causing ketosis and metabolic acidosis (ketoacidosis). Neu *et al.* (2009: 1647) argue that ketoacidosis occurring at diabetes onset is still a major problem. The classic

smell of acetone on the breath of diabetic patients entering into ketoacidosis is indicative of a Type 1 diabetic in severe distress, often resulting in diabetic coma and possible death. Goldberg (2009: 3171) mentions certain biomarkers which are evidence of islet damage resulting from cytokines in autoimmune activation in Type 1 diabetes.

Type 2 diabetes is by far the most commonly found type of diabetes accounting for 80 – 90% of all cases (Rippey, 1994: 305), who suggests further that obesity is associated with the development of insulin resistance. Rheeder (2006: 20) notes that the increase in diabetes worldwide is directly linked to the increase in obesity and that Type 2 diabetes is often associated with obesity and in older persons with a familial history of the disease. Zeitler (2009: 2215), however, has noted that over the last two decades non-autoimmune mediated Type 2 diabetes has increased markedly amongst adolescents and he suggests a unique pathophysiology in this group. Nadeau *et al.* (2009: 3687) insists that the incidence of paediatric Type 2 diabetes is increasing and found that adolescents with Type 2 diabetes had significantly lower  $VO_2$  peak (ability to effectively utilise oxygen intake, or a reduction in oxygen uptake, for ATP production) and decreased insulin sensitivity, amongst other factors, than their leaner counterparts. All these factors indicate decreased cardiopulmonary fitness and are signs of potentially life-threatening challenges.

Omar and Motala (1994: 46) report that there appears to be a definite high familial aggregation of Type 2 diabetes in the South African Indian population making it apparent that genetic factors play an important role in its pathogenesis. This is

supported by the fact that as many as seventeen genetic loci have been convincingly associated with Type 2 diabetes (Florez 2008: 4633). Chung *et al.* (2009: 552) determined the effect of the common adiponectin gene polymorphisms on changes in adiponectin levels due to diet and certain insulin resistance indices. These authors concluded that the genetic variants identified have an effect on insulin resistance and adiponectin levels in those individuals recently diagnosed with impaired fasting glucose or Type 2 diabetes. Further in the genetic field, Swedish researchers Jonsson *et al.* (2009: 2409) have found that a common variant in the KCNQ1 gene is associated with increased risk of future Type 2 diabetes in Scandinavians. However Brito *et al.* (2009: 1411), in their study of 16003 Swedish adults, have suggested that a genetic predisposition to hyperglycaemia is somewhat dependent on personal lifestyle factors. This perhaps indicates a role for both mechanisms in the development of Type 2 diabetes.

In contrast to Type 1 diabetes, Type 2 diabetic beta cells are largely intact and preserved in the pancreatic Islets of Langerhans and insulin is present albeit in a lower quantity than is normally the case. However, the tissues develop a resistance to the action of insulin and there are indeed fewer insulin receptors (Rippey, 1994: 305). This combination has the effect of negating the glucose–insulin relationship and, as a consequence, the same effects of Type 1 diabetes occur with polydipsia and polyuria manifesting as signs and symptoms of the condition.

A third type of diabetes, known as gestational diabetes, occurs during pregnancy and along with obesity is a common metabolic abnormality during this time (Catalano *et al.* 2003: 1674). This form of diabetes is a major risk factor to progress

to Type 2 diabetes after the pregnancy (Buchanan and Xiang 2005: 485). According to these researchers the pathophysiological mechanisms involved are increased insulin resistance and an inadequate insulin response, which affects insulin regulated carbohydrate, lipid and protein metabolism. Reece *et al.* (2009: 1789) state that gestational diabetes is a substantial and growing health concern with certain populations due to environmental, genetic and social factors. Gestational diabetes carries a very high risk of progression to development of postpartum Type 2 diabetes and both intensive lifestyle interventions and hypoglycaemic treatment are effective in delaying or preventing the development of diabetes (Ratner *et al.* 2008: 4774). Gestational diabetes has serious long-term consequences for both baby and mother and Reece *et al.* (2009: 1789) remark on a predisposition of children to obesity, the metabolic syndrome and diabetes. In order to counteract this, Bellamy *et al.* (2009: 1773) recommend increased awareness of the risk factors involved and that clinicians make use of dietary, lifestyle and pharmaceutical methods to try and delay the onset of Type 2 diabetes. Oganowski *et al.* (2009:3 34) have noted that obesity and a higher BMI are strong predictors for gestational diabetes requiring insulin treatment.

Joshi and Joshi (2008: 29) report on other types of diabetes and mention pancreatic disease as a cause of hyperglycaemia together with hormonal disease, drug or chemical exposure, insulin receptor anomalies and certain genetic syndromes.

## **2.4 RISK FACTORS FOR DIABETES**

Risk factors can broadly be seen as modifiable and non-modifiable. Currently, genetic-based diabetes is considered to be caused by non-modifiable factors, while obesity and a sedentary lifestyle are considered modifiable factors which may lead to diabetes. In the case of modifiable factors, lifestyle changes can lead to the prevention of diabetes development. Gudbjörnsdottir *et al.* (2009: 53) examined various risk factors in Type 2 diabetic and coronary heart disease (CHD) patients. They found a high prevalence of adverse lifestyle characteristics including being overweight, obese, smoking and having a large waist circumference. Pierce *et al.* (2009: 679) researched undiagnosed diabetes data in the United Kingdom and found that a quarter of diabetes cases in the United Kingdom were undiagnosed. They found that male sex, high BMI, increased waist circumference, higher systolic blood pressure and high triglycerides were significant risk factors for undiagnosed diabetes. It is evident that risk factors for Type 2 DM are centred on certain largely modifiable elements which are described below.

### **2.4.1 Body Mass Index (BMI)**

The concept of BMI as a measure of fatness or obesity has been in use for many years and has superseded the using of weight alone as an indication of obesity (Cole *et al.* 1990: 25). In the United Kingdom the National Health Service (NHS) uses BMI as a measure of adiposity because it is "an easy, cheap and non-invasive means of assessing excess body fat" (National Obesity Observatory, 2009: 5). It has been mentioned previously that a significant risk factor for Type 2 diabetes is waist circumference; BMI is a valuable description of body shape and mass as the

following examples illustrate. Rolland-Cachera *et al.* (1991: 13) describes the measurement of BMI as weight (kg)/height (metres)<sup>2</sup>. Thus a 1.8 metres tall person weighing 70kg would have a BMI of  $70/1.8^2 = 21.60$  and would be described as relatively slim. If an individual of 1.55 metres weighed 70kg he or she would have a BMI of 29.14, an indication that he or she is shorter and less slim and this would be classified as an 'at risk' BMI. Therefore it can be seen that the higher the BMI the higher the indication of obesity.

#### **2.4.2 Obesity**

Joshi and Joshi (2008: 29) note that, although Type 2 diabetes is typically seen in people aged 40 and older, there appear to be recent trends for the condition to manifest earlier. This, say the authors, is particularly due to increasing obesity and lack of regular exercise. The disease burden associated with obesity is substantial, according to Paeratakul *et al.* (2002: 1205). These authors suggest that the risk of having diabetes, hypertension, heart disease and high cholesterol increase with increased body weight. Gardner and Gabbay (2009: 328) argue that obesity is a challenge for every ophthalmologist while Pierce *et al.* (2009: 679) identified BMI and waist circumference, amongst others, as major risk factors for Type 2 diabetes. Rheeder (2006: 20) is of a similar opinion and a study by Kramer *et al.* (2009: 851) further concluded that increased abdominal obesity and increased BMI are associated with albuminuria, the presence of albumin in the urine, in overweight and obese adults with Type 2 diabetes. Measures of central and overall adiposity were used by Mackay *et al.* (2009: 956) to predict Type 2 diabetes in all patients with the exception of African Americans where central measures were more effective. All of these facts lead to the unavoidable conclusion that obesity is a serious indicator of

potential, even manifest, poor health leading inexorably to poor quality of life, if not to diabetes. This is not limited to adults and Kaufman *et al.* (2009: 953) have identified that children in the sixth grade are exhibiting increased BMI and potential risk factors for the development of Type 2 diabetes. This was especially evident in minority populations, where Hispanic youths had a greater degree of increased BMI and blood glucose levels than blacks and whites. This has further implications for Type 1 diabetes where Viner *et al.* (2008: 1056) found that a higher childhood BMI was an independent risk factor for the development of Type 1 diabetes and supports suggestions that obesity is the link between Type 1 and Type 2 diabetes. Those at risk for type 2 diabetes show systematic activation of proinflammatory and procoagulant pathways due to obesity and insulin resistance (Goldberg 2009: 3171).

To further compound decrease in quality of life with obesity, obese diabetic patients measured by BMI and waist circumference were found by Foster *et al.* (2009: 1017) to have high degrees of obstructive sleep apnoea and recommend that physicians be aware of the potential dangers inherent with this condition. Furthermore, among overweight and obese women with Type 2 diabetes urinary incontinence is highly prevalent and reportedly far exceeds all other complications related to diabetes (Phelan *et al.* 2009: 1391).

It is therefore a well-established concept that obesity is a strong risk factor for Type 2 diabetes and Liese *et al.* (2009: 1434) have researched the so-called DASH diet (Dietary Approaches to Stop Hypertension) and conclude that adherence to this eating pattern involving fruit, vegetables and low fat dairy products may potentially prevent Type 2 diabetes. Nettleton *et al.* (2009: 688), however, have suggested that

the daily intake of diet soda drinks, while not an indication of causality, is associated with significantly greater risks of metabolic syndrome and Type 2 diabetes. Japanese researchers Kodama *et al.* (2009: 959) have concluded that replacing fat with carbohydrates appears to make insulin resistance worse and that if patients want to participate in a Low Fat High Carbohydrate (LFHC) diet they should balance their energy intake to levels sufficient for optimum weight reduction. Too high an intake of carbohydrates is clearly as bad as too much fat, especially if the carbohydrates are not being utilised for energy production. Kuizer *et al.* (2009: 791) have shown that following a diabetes prevention program aimed at lifestyle modification, patients exhibited significant modification of lifestyle factors that are normally associated with elevated diabetes risk. Vegans, according to Tonstad *et al.* (2009: 791), appear to have the lowest mean BMI (23.6 kg/m<sup>2</sup>) and conclude that the five-unit difference between vegetarians and non-vegetarians indicates a strong potential for vegetarianism to protect against obesity and consequent Type 2 diabetes. Danish researchers de Fine *et al.* (2008: 933) studied how the 10 years of weight change preceding diabetes diagnosis varied with weight at age 20 and found that women gained more weight than men and the lower the weight at age twenty the greater the weight gain. Interestingly, the average weight gain in the 10 years preceding diabetes diagnosis was only 1 kg and decreased markedly with age. They contend, however, that it is important to advise young patients in particular and especially females who have gained considerable weight to be attentive to this in order to prevent the development of diabetes.

It is thus apparent that the first steps toward reversal of risk factors associated with obesity are to be found in a healthy diet. The benefits of exercise in terms of a

weight loss programme are clear but importantly are also apposite in terms of reduction of arterial stiffness which has a direct impact on cardiovascular mortality (Madden *et al.* 2009:1531). Furthermore, exercise capacity, or the ability to perform exercise, has been shown by Kokkinos *et al.* (2009: 623) to be a strong predictor of all-purpose mortality in, especially, men with Type 2 diabetes. Physical activity has been shown by Thomas *et al.* (2008: 9) to be positively related to both glucose tolerance and resting energy expenditure. This implies that moderate exercise could be a force for prevention of diabetes in adolescents by promoting glucose disposal efficiently and by increasing "energy expenditure". This would ensure that carbohydrates which would normally remain unused for energy and be stored as fat are indeed used as energy. The importance of moderate exercise such as brisk walking to improve insulin sensitivity and other metabolic risk factors is highlighted by Ekelund *et al.* (2009: 1081), who found that low levels of physical activity were associated with insulin resistance. Ferland *et al.* (2009: 589) discovered that blood glucose is lower in Type 2 diabetic patients when exercise is done after a meal. The importance and beneficial effect of low-Glycaemic Index (GI) food on exercise-induced hypoglycaemia is emphasised in this study.

### **2.4.3 The Metabolic Syndrome**

The term metabolic syndrome refers to a group of, specifically cardiovascular, risk factors whose pathophysiology is related to insulin resistance (Kahn *et al.* 2005: 2289). The prevalence of the metabolic syndrome is significantly higher in Type 2 diabetes than in Type 1 according to Hawa *et al.* (2008: 160). Reaven (2006: 1237) quotes the World Health Organisation (WHO) as defining the metabolic syndrome to be:

The patient must have one of the following:

- Diabetes mellitus: FPG  $\geq 7$  mmol/l or 2 hour postprandial  $\geq 11.1$  mmol/l
- Impaired Glucose Tolerance (IGT): FPG  $< 7$  mmol/l or 2 hour postprandial  $\geq 7.8$  mmol/l but  $< 11.1$  mmol/l
- Impaired Fasting Glucose (IFG):  $\geq 6.1$  mmol/l but  $< 7$  mmol/l and postprandial  $< 7.8$  mmol/l

Plus any two of:

- Waist to hip ratio  $> 0.9$  in men and  $> 0.85$  in women or BMI  $> 30$  or both
- Triglycerides  $\geq 1.7$  mmol/l; HDL cholesterol  $< 0.9$  mmol/l in men or  $< 1.0$  mmol/l in women or both
- Blood pressure  $\geq 140/90$  mmHg
- Microalbuminuria: excretion rate  $\geq 20\mu\text{g}/\text{min}$

From the above it can be seen that the metabolic syndrome and its' components appear to be very close to that of clinical diabetes with upper limits of FPG close to that of diabetes, the presence of obesity, increased BMI and risk factors of hypertension, cholesterol and triglycerides. Thorn *et al.* (2009:950) concluded that the metabolic syndrome is a 2.1 times risk factor for cardiovascular mortality. This becomes even greater in Type 1 diabetes-related mortality when nephropathy becomes a particular challenge, where a risk factor of 2.5 was reported. This is a conclusion in agreement with Bianchi *et al.* (2008: 1412) who maintain there is a close and independent association between the metabolic syndrome and kidney disease and nephropathy prevalence increases with the number of metabolic syndrome components present in patients. Luk *et al.* (2008: 2357), in a Hong Kong

study, have shown that the presence of the metabolic syndrome is an independent predictor of chronic kidney disease in patients with Type 2 diabetes.

#### **2.4.4 Ethnicity**

Numerous studies have associated diabetes with ethnicity, a non-modifiable risk factor in diabetes. In Hawaii, Maskarinec *et al.* (2009: 2563) studied diabetes incidence between Caucasians, Japanese Americans and native Hawaiians and found native Hawaiians (14.4 per 1000 person years) to have the highest incidence, followed by Japanese Americans (12.4) and Caucasians (6.5). They found that BMI was positively associated with incidence and that education was inversely associated with BMI. This high interaction between ethnicity, education and BMI suggests to these authors that significant ethnic differences in diabetes aetiology exist. Herman *et al.* (2009: 1689) found glycolated haemoglobin, using the HbA1c test, to be higher in Hispanics, Asians and Africans than in Caucasians although they mention that, because of inherent biological variations, this higher HbA1c level may not always hold true. Lisabeth *et al.* (2008: 778) concluded that Mexican-American women had an increased risk of stroke at younger ages compared to non-Hispanic white women suggesting that the increased prevalence of hypertension and diabetes could be the reason. In New Zealand, Kenealy *et al.* (2008: 1302) found that in the Maori population diabetics were 30% more likely to have cardiovascular events compared to other groups. Motala *et al.* (2003: 23) established that South African Indians had a particularly high incidence of Type 2 diabetes, a fact borne out by a study done by Oza-Frank *et al.* (2009: 1644) who concluded that Asian Indian ethnicity was strongly associated with diabetes. This is confirmed in a previous study by Davis (2008:52) who studied the ethnic diversity in Type 2 diabetes in the United

Kingdom. He found that Indian Asian patients were younger at onset of diabetes than Afro-Caribbean and Caucasian patients even though they had the lowest prevalence of hypertension and current smoking. Afro-Caribbean patients had the poorest glycaemic control yet they had the best lipid profile and had a 70% lower risk of fatal myocardial infarction than Caucasians and Indian Asian patients had the highest risk for nephropathy. Davis (2008: 52) concludes by stating that there are sustained ethnic differences in the nature of diabetes. A previous South African study by Omar and Motala (1996: 45) found the prevalence amongst South African Indians was as high as 13%. Wang *et al.* (2009: 461) estimated the prevalence of diabetes in rural China to be 21.1 million persons aged 30+ with 9.2 million people having diabetic retinopathy. It would appear that, from the evidence of the studies mentioned, ethnicity, in particular Asian ethnicity, is a major non-modifiable risk factor in contracting Type 2 diabetes.

#### **2.4.5 Age and gender**

Other non-modifiable risk factors for diabetes are age and gender. The use of the terms 'Juvenile Onset' and 'Adult Onset' when describing Type 1 and Type 2 diabetes respectively appear to be losing favour in the light of the increasing numbers of adolescents developing Type 2 diabetes coupled with childhood obesity. Hillier and Peduta (2003: 2999) argue that the earlier onset of Type 2 diabetes results in a more aggressive form of the disease especially from a cardiovascular perspective. These authors state further that although CVD rates are higher in adults with diabetes, young adults with early-onset Type 2 diabetes have a much higher risk of CVD compared to those non-diabetics of a similar age. This was true with microalbuminuria as well. In terms of treatment progression, earlier-onset Type 2

diabetes is associated with earlier onset of insulin therapy than those with usual or later onset diabetes. Although Type 1 diabetes continues to be largely a disease of juvenile onset, Felthower *et al.* (2003: 437) report that in Yorkshire the mean age of onset of Type 1 diabetes has dropped from 9.2 to 8.4 years for children aged 0–14 and from 16.0 to 14.6 for individuals 0–29 over the period 1991–1999. This research agrees with a Finnish study by Karvonen *et al.* (1999: 1066) who found that the greatest incidence in Type 1 diabetes occurred in children under five years of age.

Whilst Choi and Shi (2001:1221) claim that the prevalence of diabetes increases with age and body mass index and increases inversely with energy expenditure in both males and females, the age-adjusted global prevalence of diabetes was 12.7% for males and 8.4% for females (Ohmura *et al.* 1993: 1198). These authors found the impaired glucose tolerance (IGT) between genders to be almost equal (males 19.6%, females 18.4%), yet Omar *et al.* (1993: 641), during the same period, found a marked difference between Zulu men and women with 5.5% of males having IGT compared to 11.5% of females. Conversely, the prevalence of diabetes in Zulu adults was 5.2% for females and 2.3% in males. In the United States of America, Narayan *et al.* (2003: 1884) found the risk of developing diabetes was 32.8% for males and 38.5% for females and, to add emphasis to the risk of mortality of diabetes, these authors have estimated that men will lose 11.6 life-years while women will lose 14.3 life-years. In terms of quality of life (QOL), however, the authors suggest that men will lose 18.6 QOL-years as opposed to 22.0 for women.

#### **2.4.6 Genetics and family**

The association between parental history of Type 2 diabetes, the presence of the metabolic syndrome and diabetic complications in patients with Type 1 diabetes was studied by Thorn *et al.* (2008: 63). They found that Type 1 diabetic patients who had a positive parental history of Type 2 diabetes had a higher prevalence of the metabolic syndrome, higher BMI, larger waist circumference, higher triglycerides and higher HbA1c as well as larger insulin doses. Type 2 diabetes parental history was also associated with a later onset of Type 1 diabetes. A policy of communicating familial risk increased personal control over prevention of diabetes, according to Pijl *et al.* (2009: 597). This positive intervention did not result in fatalism but some evidence exists that it increased healthy behaviour.

#### **2.4.7 Depression**

Depression is a common phenomenon amongst patients with chronic illnesses (Ciechanowski, 2000: 3278). In assessing the relationships between depression scores and diabetes, glucose and insulin, Holt *et al.* (2009: 641), using the Hospital Anxiety and Depression Scale (HADS), found that men with undiagnosed diabetes had significantly higher HADS scores. This supported their hypothesis that depression was a significant risk factor for diabetes and that clinicians should screen all depressive individuals for diabetes. It has been shown by Knol *et al.* (2006: 837) that depressed adults have a 37% increased risk of developing Type 2 diabetes; it is not yet known, however, whether treatment of depression can prevent or reduce this incidence. Other research carried out by Mezuk *et al.* (2008: 2383) claim this

risk figure to be as high as 60%, while Aikens *et al.* (2008: 1324) have found the incidence of depression is higher amongst insulin users.

#### **2.4.8 Hypertension**

Because of the association between lifestyle disease and diabetes, hypertension is frequently found in conjunction with diabetes. There is some debate as to whether hypertension is a direct risk factor for diabetes or whether diabetes is a risk factor for hypertension. That the two conditions are often found together is not in dispute. Repeti *et al.* (1994: 511) studied the link between arterial hypertension and diabetes. They found a 50% increase in the incidence of arterial hypertension in diabetic subjects compared with non-diabetic individuals. Furthermore, retinopathy occurred twice as often in hypertensive diabetic females than non-hypertensive. Izzo *et al.* (2009: 567) suggest that Type 2 diabetes might be associated with pre-existing hypertension and after their study of 1754 patients they conclude that uncontrolled hypertension is associated with a twofold increased risk of incident diabetes which was independent of BMI or age and FPG. Gress *et al.* (2000: 905) mention that prescribing beta-blockers for hypertensive therapy appears to increase the risk of diabetes but show that angiotensin converting enzyme inhibitors (ACE inhibitors) and thiazide diuretics pose no threat in this regard.

#### **2.4.9 Other**

Chronic insomnia rather than poor sleep has been associated with higher risk for diabetes (Vgontzas *et al.* 2009: 1980), who found the highest risk was for persons with insomnia or  $\leq 5$  hours sleep duration.

## **2.5 SYSTEMIC COMPLICATIONS OF DIABETES**

### **2.5.1 Kidney disease (nephropathy)**

Fowler (2008: 77) states that diabetic nephropathy is the leading cause of kidney failure in the United States. Nephropathy is defined as proteinuria of >500mg in 24 hours in diabetic patients which is usually preceded by lower degrees of proteinuria called microalbuminuria, where microalbumin is excreted. In untreated diabetics microalbuminuria rapidly progresses to proteinuria followed by nephropathy (Fowler, 2008: 77). Diabetic retinopathy is a major predictor of nephropathy and is stronger for Type 1 diabetics than Type 2 (El-Asrar *et al.* 2001: 1), especially where there is evidence of proliferative retinopathy. Goldberg (2009: 3171) notes recent developments indicating that an inflammatory cascade results in beta cell damage, insulin resistance and vascular complications in diabetes which are associated with nephropathy. As mentioned in 2.4.1 above, Type 1 diabetic patients with nephropathy and the metabolic syndrome have a 2.5 increased mortality risk factor than those without any of the metabolic syndrome factors (Thorn *et al.* 2009: 950).

### **2.5.2 Diabetic neuropathy**

Amongst the general complications of diabetes is the often painful occurrence of diabetic neuropathy. The American Diabetes Association, in Fowler (2008: 77), defines diabetic neuropathy as "the presence of symptoms and/or signs of peripheral nerve dysfunction in people with diabetes after the exclusion of other causes." Vinik *et al.* (2003: 365) state that diabetic autoimmune neuropathy is the most common and troublesome complication of diabetes mellitus. Symptoms may be diffuse or confined to a single source *i.e.* an organ or organ system. These researchers found

the pathogenesis of these autoimmune diabetic complications to include altered metabolism, vascular insufficiency and loss of growth factor trophism, causing atrophy, and autoimmune destruction of nerves. In a longitudinal study of diabetic neuropathy, Dyck *et al.* (1993: 817) found that 66% of Type 1 diabetics and 59% of Type 2 diabetics had some form of neuropathy. Approximately half of neuropathies reported were polyneuropathies and significant evidence of carpal tunnel syndrome and visceral autonomic neuropathy was also seen. Diabetic neuropathy, along with vasculopathy, is a major contributor to diabetic foot ulcer with impaired cutaneous oxygenation being the strongest risk factor (McNeely *et al.* 1995: 216). Argoff *et al.* (2006: 3) state that half of diabetic patients suffer from some form of diabetic neuropathy and diabetic peripheral neuropathy (DPN) is the leading cause of foot ulcers which are, in turn, a major cause of amputation in the United States.

Other afflictions associated with DPN include chronic pain, insomnia and depression (Wiggin *et al.* 2009: 1634). The link between risk factors for diabetes, manifest diabetes and DPN appear to be elevated triglycerides correlated with myelinated fibre density loss. This appears to support the theory that hyperlipidaemia is instrumental in the progression of diabetic neuropathy in diabetes. Anti-depressant medication is often prescribed to combat the discomfort associated with this condition (Max *et al.* 1992: 1250). Treatment of diabetic neuropathy pain is further examined by Ziegler (2008: 255) who states that increased alcohol consumption, hypertension, smoking and cholesterol all play a role in the development and progression of this condition. Cardiovascular autonomic neuropathy (CAN) is a common form of autoimmune diabetic neuropathy causing anomalies of heart rate control and central and peripheral vasculopathies (Maser and Lenhard, 2005: 5896).

Its clinical manifestations include exercise intolerance, orthostatic hypotension and, sometimes, painless myocardial ischaemia leading to death. Barr *et al.* (2006: 1114) demonstrate that individuals with diabetic neuropathy are nearly four times more likely to have retinopathy and twice as likely to have albuminuria, concluding that neuropathy is associated with other microvascular complications associated with diabetes.

### **2.5.3 Cardiovascular disease (CVD)**

The central pathological mechanism in microvascular disease is atherosclerosis, which, says Fowler (2008: 77), is thought to occur from chronic inflammation and injury to the arterial wall in the peripheral or coronary vascular system. Endothelial injury causes oxidised lipids from Low Density Lipoprotein (LDL) cholesterol to penetrate the arterial wall eventually causing an atherosclerotic lesion with a fibrous cap. Gatti *et al.* (2009: 1550) researched whether the association between poor glycaemic control and lower HDL (high density lipoprotein) cholesterol in Type 2 diabetes was dependent on obesity or a high level of triglycerides. They concluded that poor glycaemic control was an independent risk factor for lower HDL cholesterol, the so-called "good" cholesterol. Japanese researchers Hayashi *et al.* (2009: 1221) have found that lower HDL cholesterol is an important risk factor for both ischaemic heart disease as well as CVD especially in the diabetic elderly. Diabetes has been shown by Giorda *et al.* (2008: 2154) to be a strong predictor of recurrent CVD events, indicating that approximately 6% of diabetics develop a recurrent major CVD event annually, especially myocardial infarction, and those with long-standing previous CVD show a higher incidence of recurrence. Church *et al.* (2009: 1289) concluded that CVD mortality was three times higher in diabetic

compared to non-diabetic males; indeed the presence of both diabetes and the metabolic syndrome substantially increased the mortality risk of CVD. Williams (2008: 13) states that hypertension is established as a major risk factor for premature CVD and death in people with Type 2 diabetes and all modern guidelines now recommend the routine treatment of hypertension in Type 2 diabetes. This study of hypertension in diabetes revealed that hypertension was most common in people with Type 2 diabetes and that the treatment of this hypertension was dramatically beneficial in reducing the risk of major macro- and microvascular complications.

In a study of 106 Type 2 diabetic youths aged 10 – 22, West *et al.* (2008: 175) found that youths with Type 2 diabetes had a higher degree of elevated blood pressure, obesity, larger waist circumference, low HDL cholesterol and high triglycerides. This study concluded that children and young adults with Type 2 diabetes had a much less favourable CVD risk profile than their non-diabetic counterparts. In terms of cholesterol as a risk factor for CVD, the use of statins, the term for HMG Co-A reductase inhibitors, which are used in the treatment of hypercholesterolaemia, have been associated by Yee *et al.* (2004: 962) with a significant delay in the starting of insulin therapy as an adjunct to oral anti-diabetic medications in Type 2 diabetics.

Blood pressure control in diabetes is often difficult to achieve, according to McLean *et al.* (2008: 2355) and often have better results when treated by a team including pharmacists and nursing staff. Wong *et al.* (2009: 34) report that in their study less than one-third of patients with diabetes and hypertension achieved the desired blood

pressure levels and fewer than half were aware of the correct or desired level for their condition. Gudbjörnsdottir *et al.* (2009: 53) found that patients with diabetes and hypertension used an increasing amount of lipid-lowering drugs over time which improved their blood lipid profiles but that their hypertension targets were not being met. Conversely, it has been shown by Wu *et al.* (2008: 69) that diabetic patients suffer more from orthostatic hypotension, rapid drop in blood pressure when standing up from a sitting or supine position, than non-diabetics. In a long-term follow-up study of hypertensive diabetics, Holman *et al.* (2008: 1565) concluded that good blood pressure control was essential in order to ensure that the benefits of this control in diabetic treatment was to be maintained.

## **2.5.4 Other**

### **2.5.4.1 Sexual dysfunction**

The conclusion of a study by Enzlin *et al.* (2009: 780) was that depression is the major predictor of sexual dysfunction in women with Type 1 diabetes. Amongst Type 1 diabetic women of any age who were still sexually active, up to 35% reported female sexual dysfunction (FSD). Slightly more than half of these subjects reported that loss of libido and problems with orgasm were problematic, while 47% reported a lack of adequate lubrication and more than a third reported lack of arousal. In men, Romeo *et al.* (2000: 788) have stated that the data obtained in their study of sexual function indicates that there is a strong association between glycaemic control and erectile dysfunction (ED) and Jackson (2004: 358) observed that ED is three times more common in men with diabetes. He suspects further that ED most commonly reflects endothelial dysfunction and autonomic neuropathy and might be

a marker for silent occlusive arterial disease but, with sexual dysfunction having multifactorial aetiology, psychological issues appear to predominate. Penson and Wessells (2004: 225) add that ED is one of the most common complications in diabetes and one of the most under-diagnosed, stressing a knowledge of the pathophysiology of the condition in order to successfully address it. Increasing duration of diabetes was positively associated with ED for men over 50, according to Bacon *et al.* (2002: 1458).

#### **2.5.4.2 Thyroidopathy**

The use of metformin as Type 2 diabetes therapy appears to influence thyroid stimulating hormone (TSH) with a drop in TSH being observed in patients with hypothyroidism (Cappelli *et al.* 2009: 1589) and Type 2 diabetics under treatment for hypothyroidism should be re-evaluated after 6 – 12 months of treatment.

Endothelial function is also affected by long-term hyperglycaemia in Type 1 diabetes according to Ceriello *et al.* (2009: 2751). They maintain that this has implications not only for the thyroid gland but for all areas of the body with an endothelial layer, not least important of which is the cornea. This loss of function or dysfunction is only addressed by normalisation of glucose and oxidative stress.

#### **2.5.4.3 Deafness**

Type 2 diabetes has been associated with a prevalent, but not incident, hearing loss in the older population (Mitchell *et al.* 2009: 483). These researchers report that accelerated hearing loss progression over 5 years was more than twice as likely in persons diagnosed with diabetes than in non-diabetic individuals.

#### **2.5.4.4 Mental health complications**

Ciechanowski, (2000: 3278) explored the impact of depression on primary care diabetic patients in terms of their self-care, compliance with treatment, functioning and health care costs. Unsurprisingly, those in the group with medium to high depression scores were significantly less adherent to dietary guidelines. Those in the highest sector of depression also had the highest percentage of oral medication non-adherence, poorer physical and mental functioning and a greater probability of incurring emergency, primary or specialist care and inpatient or mental health costs. Depressed diabetics had total health costs 86% higher than non-depressed diabetics. A further conclusion was that depressive severity was associated with poorer diet and medication compliance, functional incapacity and higher healthcare costs. Ali *et al.* (2006: 1165) found raised rates of depression in patients with Type 2 diabetes although Mezuk *et al.* (2008: 2383) concluded that Type 2 diabetes is associated with only a modest rise in risk of depression. An association, albeit weak, between depression and glycaemic control was found mainly amongst users of insulin (Aikens *et al.* 2008: 1324), where those Type 2 diabetics who made use of insulin might be particularly susceptible; however Makine *et al.* (2009: 28), from their meta-analysis, found depression was associated with poor glycaemic control in Type 2 diabetes and, in poorly controlled Type 2 diabetes, insulin progression is often postponed due to negative beliefs. Egede and Ellis (2008: 213) studied indigent Type 2 diabetic patients and concluded that those patients who were depressed had poorer diabetes self-care and felt less in control of their disease. In a study by Fisher *et al.* (2008: 1096), 506 Type 2 diabetic patients were assessed over 18 months. It was found that diabetics displayed high rates of affective and anxiety

disorders over time relative to community adults, showing 60% higher for Major Depressive Disorder, 123% for General Anxiety Disorder and 85% for Panic disorder. The prevalence of depressive affect and distress was 60 – 73% higher than affective and anxiety disorders. Younger age, female gender and high co-morbidities were related to persistence of all conditions and HbA1c was positively related to depressive effect. This high prevalence of comorbid disorders and the persistence of the depressive effect and distress led these researchers to believe that continued or repeated mental health assessments of diabetic patients should form part of each patient contact. Collins *et al.* (2009: 153) found high levels of anxiety and depression in patients with diabetes with 32% exceeding the 'mild to severe' anxiety scale and 22.4% having 'mild to severe' depression. Risk factors for severity of depression and anxiety were identified as diabetes complications, smoking, being an ex-drinker or heavy drinker and uncertainty about glycaemic controls. Females and those with poor glycaemic control were found to have higher anxiety scores, while those with a higher socio-economic status and older age were found to exhibit the lowest anxiety and depressive signs and symptoms. They concluded that the prevalence of anxiety and depression in diabetics is far higher than in the general population. Canadian researchers Lysy *et al.* (2008: 1133) found that inactive diabetics were 1.75 times more likely to be depressed than those more active. The depressed were almost twice as likely to be more inactive than the non-depressed. Their conclusion was that there is a strong association between depressed mood and physical inactivity in Type 2 diabetics and that this depression may well be modified positively with depression-specific management and exercise encouragement. A study to examine the impact of the diagnosis of Type 2 diabetes on psychological

well-being of Dutch patients was conducted by Adriaanse *et al.* (2004: 992) who concluded that the diagnosis of Type 2 diabetes had no psychological effect, adverse or positive. It was found by Gonzalez *et al.* (2008: 1102), though, that patients with higher levels of depression and depressive symptoms reported significantly lower adherence to general diet recommendations, less exercise and poorer foot care. Moreover, each one-point increase in the depressive score was associated with a 108 fold increase in the chances of non-adherence to prescribed medication, which indicated to them that depressive symptoms predict subsequent non-compliance with important aspects of diabetes self-care in Type 2 diabetic patients.

#### **2.5.4.5 Stress**

Dungan *et al.* (2009: 1798) researched stress hyperglycaemia, raised blood sugar resulting from increased stress levels, and concluded that even those diabetics on tight blood glucose control were susceptible to stress induced hyperglycaemia and that these patients were at greater risk of adverse consequences as were non-diabetic patients with stress hyperglycaemia.

The condition of Diabetes Distress (DD) is raised by Fisher *et al.* (2009: 622) who describe it as distinct from depression and related to diabetes outcomes. The potential for being distressed included female gender, having had a previous major depressive disorder and having poor diet and low exercise. It was found that negative life-events increased the negative effects of higher HbA1c levels.

#### **2.5.4.6 Cognitive function**

Diabetes is associated with cognitive decline and dementia according to Launer *et al.* (2009: 221). These researchers discovered a significant association between HbA1c

levels and cognitive testing scores and concluded that higher HbA1c levels are associated with lower cognitive scores. Similarly, Ruis *et al.* (2009: 1261) noted that Type 2 diabetes is known to be associated with decrements in memory, executive functions and information processing speed. In studying early Type 2 diabetic patients to assess whether cognitive ability had been affected at early stages of the disease, they found that modest cognitive function decrease was already present at early stages of Type 2 diabetes. A history of microvascular disease and smoking exacerbated this state. Researchers van Duinkerken *et al.* (2009: 2335) have ascertained that chronic hyperglycaemia is one of the major factors affecting brain functioning negatively as functional connectivity becomes affected. This occurs even before macrovascular complications are evident. They postulated that hyperglycaemia may underlie cerebral function changes in Type 1 diabetes, as measured by magnetic field fluctuations at the scalp. In their study Type 1 diabetic patients performed worst on general cognitive ability, information processing speed and motor speed. Those Type 1 diabetic patients with diabetic retinopathy had the poorest functional connectivity compared to Type 1 diabetics without microvascular complications. Kim *et al.* (2008: 1440) maintain that poor glycaemic control, central obesity and hypertension all influence cognitive functions like attention and psychomotor speed. Waist circumference was associated with poor performance overall with the problem being most apparent in older Type 2 diabetic patients. Interestingly, studies by Deyore *et al.* (2009: 635) have found that a diet higher in polyunsaturated fats relative to saturated and trans fats has the potential of reducing cognitive decline in, especially older, Type 2 diabetic patients.

It would appear that throughout the literature there exists a common thread regarding the promotion of a healthier lifestyle to prevent and manage diabetes. Due to their primary health role, the optometrist is ideally suited to assist in the education and promotion of lifestyle changes to facilitate blood glucose control.

## **2.6 OCULAR COMPLICATIONS OF DIABETES**

Anecdotal evidence suggests that individuals with diabetes are largely unaware of the possible adverse consequences the disease may bring in terms of their ocular health. Indeed, this is the thrust of this study. There are often vague references to the fact that diabetes 'can affect the eyes' but usually no more than that. Zhang *et al.* (2008: 1421) studied the prevalence of visual impairment among adults in the United States both with and without diabetes and found that approximately 11% of these adults with diabetes had some form of visual impairment. Furthermore, those with diabetes were more likely to have uncorrectable visual impairment which led them to the conclusion that vision loss is more common in people with diabetes than without.

The most common ocular complications associated with diabetes are: cataracts, refractive changes, diabetic retinopathy, secondary glaucoma and ocular neuropathy.

### **2.6.1 Cataract**

The metabolic and intricate biochemical processes involved in growth of the crystalline lens cells is a self-regulating one (Lang, 2000: 167). This metabolic activity is essential for the lens function and the maintenance of clarity. Any

disturbance of this will influence its' optical performance negatively. The lens epithelium maintains equilibrium and transportation of nutrients, minerals and water into and out of the lens. Lang (2000: 167) describes this as a "pump-leak system", which allows active transfer of sodium, potassium, calcium and amino acids from the aqueous humour into the lens. This homeostasis maintenance is closely related to the water balance of the lens, which loses water with age reducing the diluted component of protein within its matrix resulting in insoluble protein accumulation. As a consequence, the lens become harder, less elastic and less transparent with the central portion of the lens (nucleus) becoming sclerosed and yellowish with age (Lang, 2000: 167).

In 1984 Perkins (1984:293) wrote that the diabetic patient required cataract surgery earlier than non-diabetics and, in 1985, Klein *et al.* (1985: 1191) said that persons with diabetes have been found to be at increased risk of developing cataracts compared to non-diabetics. Furthermore, it appeared to these authors that female diabetics had higher rates of cataracts than males. In their study they also found that prevalence of cataract significantly increased in younger persons with longer duration of diabetes, older age at examination, increased severity of retinopathy, use of diuretics and higher HbA1c. In older individuals retinopathy severity, higher HbA1c and diuretic usage, smoking and lower intra-ocular pressure (IOP) were significantly associated with cataract. In 1993, Bron *et al.* (1993: 260) wrote about the changes occurring in the human lens with diabetes, noting *inter alia* refractive changes, cataract, age-related thickening, auto-fluorescence and yellowing. The lens swelling and cataract was ascribed to an accumulation of sorbitol in the cortical fibres of the lens, especially so in adult diabetics whose cataracts resemble those of

older persons with age-related non-diabetic cataracts. Interestingly, these authors note further that the occurrence of cataract is a predictor of mortality in the diabetic. The typical diabetic cataract is rare in younger diabetic patients says Lang (2000: 179). He describes the process as transient metabolic decompensation which causes a radial "snowflake" pattern of cortical cataract and observes that the progress of a diabetic cataract is rapid, occurring two to three years earlier than normal age-related cataracts. Weimer *et al.* (2008: 2017) investigated the effect of diabetes on the internal structure of the crystalline lens and found that the nucleus and different cortical layers of the lens were substantially thicker in Type 1 diabetics than the control group. Furthermore, a significant association was found between the duration of diabetes and the thickening of the lens structures. Importantly, no significant change in thickness was found in the lenses of Type 2 diabetes patients, leading the researchers to conclude that Type 1 diabetes has a significant effect on the internal structures of the lens. This change is probably due to swelling which affects all the components while Weimer *et al.* (2008: 2017) suggest Type 2 diabetic cataract appears to have a different pathogenesis in this regard. In Brazil, Esteves *et al.* (2008: 324) found that there was a high prevalence of cataracts in Brazilian Type 1 diabetics and suggest that the more severe the disease the greater the risk of cataract. Dal Pizzol *et al.* (2008: 564) concluded that the prevalence of cataracts in Type 1 diabetic patients in Brazil was almost 20%, and significantly associated with retinopathy. The influence of diabetes and CVD on cataract formation was researched in the Blue Mountains Eye Study where Tan *et al.* (2008: 317) confirmed that diabetes was a risk factor for age-related cataract and IFG was a possible risk factor for cortical cataract. These authors concluded that a cluster of abnormalities

related to insulin resistance was responsible for cataract formation rather than CVD. In a study on older diabetic patients, Tumosa (2008: 515) found that elderly diabetic persons were 1.5 times more likely to develop vision loss and blindness than non-diabetics of a similar age. The vision loss is due to ocular and periocular conditions including dry eye, cataracts, maculopathy and glaucoma.

Modern treatment for cataract is extra-capsular cataract extraction (ECCE) with phacoemulsification and concurrent intra-ocular lens implants. An Australian study by Hong *et al.* (2009: 1510) concluded that diabetic retinopathy progression was found to be more frequent in patients undergoing phacoemulsification than non-diabetics, although this was still lower than those having either extracapsular or intracapsular procedures.

### **2.6.2 Refractive changes**

Optometric practitioners should be well aware of the refractive changes inherent with prolonged hyperglycaemia. In 1982, Eva *et al.* (1982: 500) wrote that sudden myopic increases in refraction were always associated with elevated blood glucose. But a review of patient records had persuaded the researchers that the changes were not toward myopia rather toward hyperopia. Fledelius (2009: 1987) was equally surprised to observe a hyperopic shift in hyperglycaemia, despite previous teachings that myopic change was the primary refractive manifestation of uncontrolled diabetes. Grosvenor (1996: 141), in contrast, speaks of a bilateral hyperopic change, or increase in hyperopia, due to a decrease in blood sugar. This implies that hyperglycaemia causes a bilateral increase in myopia, termed a myopic shift. Naidoo (1999: 427) comments that several refractions may be needed in order

to obtain the true correction in poorly controlled diabetics and that there may be an earlier onset of Presbyopia with a decrease in accommodative ability.

Jacobsen *et al.* (2007:510) saw that the prevalence of myopia in diabetic patients was considerably higher than in the background Danish population. They suggest that poor blood glucose control is a significant risk factor for myopia and that hyperglycaemia may be a complicating factor in myopia progression. Ebeigbe and Osaiyuwo (2009: 28) considered the influence of sorbitol within the crystalline lens possibly affecting the refractive index and thereby altering the refraction status.

### **2.6.3 Diabetic Retinopathy**

Diabetic Retinopathy (DR) may be the most common microvascular complication of diabetes notes Fowler (2008: 77), who adds that the risk of retinopathy increases with duration and severity of the disease. He observes that retinopathy may develop as early as 7 years before the diagnosis of Type 2 diabetes. Furthermore, Kanski (2003: 439) determined that the prevalence of DR is higher in Type 1 diabetes than in Type 2 and is the most common cause of blindness in the United Kingdom between the ages of 20 and 65. He mentions that duration of diabetes is considered the greatest risk factor of all for DR followed by inadequate blood glucose control. Klein *et al.* (1984: 520) observed that, after ten years of diabetes, males had greater risk of diabetic retinopathy than females and that retinopathy severity was related to longer duration of the disease. Further risk factors included uncontrolled high blood glucose levels, the presence of proteinuria and hypertension.

Whilst good blood glucose control serves mainly to delay the onset of DR, Kanski (2003: 439) is of the opinion that the incidence of DR after 10 years is 50% yet very

rare within 5 years. These statistics are supported by Lang (2000: 314), who maintains that 90% of diabetics will exhibit DR after 20 years and will occur despite optimum therapy. Klein *et al.* (1984: 520), in the Wisconsin Study of Diabetic Retinopathy, found the prevalence of DR varied from 17% in less than five years to 97.5% in persons with diabetes for 15 or more years. Other risk factors for DR are pregnancy, which is occasionally associated with rapid onset proliferative DR; poorly controlled hypertension which is associated with proliferative DR development and kidney disease which is also associated with worsening of DR, although corrective treatment of kidney disease is associated with DR recovery and improvement. Lang (2000: 314) is clear that despite symptoms of keratoconjunctivitis sicca, xanthelasma, infections, refraction changes (often transient), cataract and glaucoma, 90% of all visual impairments are from diabetic retinopathy.

In order to reduce DR there is evidence from Dodson (2009: 997) that would suggest that lipid-modifying therapy with Fenofibrate showing the most beneficial effects reducing the need for laser therapy and progression of pre-existing DR. Treatment for (proliferative) DR is by laser photocoagulation and, if serious enough, by pan-retinal photocoagulation (PRP). Lim *et al.* (2009: 857) have found that in diabetes, those eyes that have been treated by PRP have a far thinner nasal and inferior Retinal Nerve Fibre Layer (RNFL) than in non-diabetic eyes. Other studies, including that of Raymond *et al.* (2009: 410), have found that patients of south Asian ethnicity have a significantly higher prevalence of diabetic retinopathy and maculopathy. Interestingly, they have found that these same patients have significantly higher blood pressure, HbA1c and total cholesterol readings and are far younger at diagnosis than others in the study.

### **2.6.3.1 Causes of diabetic retinopathy**

The pathophysiology and pathogenesis of DR is explained by Kanski (2003: 439) as microangiopathy affecting the retinal precapillary arterioles, capillaries and venules, although larger vessels may also become involved. Features of DR are microvascular occlusion and vascular leakage. Kanski (2003: 439) further describes the pathogenesis as a three-part phenomenon beginning with capillary changes where the basement membrane thickens, endothelial cell damage occurs and proliferation takes place. Secondly, red blood cells become deformed affecting the transport of oxygen negatively and finally platelets become increasingly sticky and aggregate. All of these steps lead to retinal capillary non-perfusion and result in ischaemia causing retinal hypoxia. The conclusion of this physiological cascade of events is arteriovenous shunts, where capillaries running between venules and arterioles become occluded and, ultimately, neovascularisation. Neovascularisation is thought to occur due to a vascular endothelial growth factor (VEG-F) which is released in a hypoxic state in order to revascularise an area of infarction.

Microvascular leakage is thought to occur because the capillary walls lose their mural cells, or pericytes, making them weaker, causing them to distend and become prone to leakage (Kanski 2003: 439 – 440). This distension is also the reason for the presence of microaneurisms, known to be one of the first manifestations of DR. The consequence of this vascular leakage is oedema which can be diffuse from extensive leakage or localised from focal leakage. Chronic leakage results in hard exudates being deposited at the junction of normal and oedematous tissue. These exudates consist of lipoprotein and lipid-filled macrophages and typically manifest in a circular pattern around the site of leakage (Kanski, 2003: 442).

### 2.6.3.1 Classification of diabetic retinopathy

Kanski (2003: 439) classifies diabetic retinopathy as:

- **Background retinopathy** (BDR) which manifests as small round dot microaneurisms located at the inner nuclear layer of the retina, intraretinal haemorrhages originating from the venous end of the capillaries in a 'dot and blot' form and usually found deeper in the retinal layers and superficial flame-shaped haemorrhages which follow the course of the retinal nerve fibre layer (RNFL). There are also hard exudates located between the outer plexiform, or Henle's layer, and inner nuclear layers of the retina, usually arranged in clumps or in a circular pattern around areas of oedema. Finally retinal oedema is often visible also situated between the inner plexiform and RNFL. Further accumulation of fluid gives the fovea a cystoid, or swollen, appearance.
- **Diabetic maculopathy**, which is the most common cause of visual complaint amongst diabetic patients. Indeed, say Yilmaz *et al.* (2009: 902), diabetic macula oedema is the leading cause of visual loss in diabetic retinopathy. This occurs when oedema is present in the macular region and is accompanied by exudates surrounding the macular area. There can also be diffuse maculopathy where there is generalised leakage from the capillaries, which is best diagnosed by fluorescein angiography. Ischaemic maculopathy causes reduction in acuity with a relatively normal macular appearance, although exudates and haemorrhages may be seen elsewhere. This condition may also be manifest as mixed maculopathy where elements of oedema and ischaemia are both present. Finally, Clinically Significant Macular Oedema (CSMO) is defined as the presence of:

retinal oedema or hard exudates within 500µm of the macula and retinal oedema one disc area (approximately 5000µm) from the macula, any part of which is one disc diameter from the macula (Kanski, 2003: 445).

- **Preproliferative DR** where vascular 'beading', looping or segmentation is seen. All the clinical lesions are caused by ischaemic conditions and include cotton wool spots which occur from occlusion of capillaries in the RNFL and axon waste, which is responsible for the white appearance. Darker blot haemorrhages representing haemorrhagic infarcts and intraretinal microvascular abnormalities (IRMA) which are often seen next to areas of capillary closure are also evident. IRMA, however, do not exhibit great leakage with fluorescein angiography (Kanski, 2003:443).
- **Proliferative Diabetic Retinopathy (PDR)**, the hallmark of which is neovascularisation. Klein *et al.* (1984:520), in the Wisconsin Epidemiologic Study of Diabetic Retinopathy, found that PDR varied from 1.2% with diabetes for less than ten years to 67% in persons having diabetes for 35 or more years. New vessels may proliferate at the optic disc (NVD) or elsewhere (NVE) along the course of the major temporal arcades. Non-perfusion of at least one quarter of the retina must be established before NVD is said to develop. The severity of neovascularisation is determined by the area covered by the new vessels as well as their location. Kanski (2003: 447) states that a retina with NVE is less likely to bleed than one with NVD. Fibrotic changes also occur in PDR and this usually happens in conjunction with the neovascularisation and is especially important as it is the cause of tractional retinal detachment which in itself plays an important

part in PDR progression (Kanski, 2003: 453). The fibrous tissue attaches to the posterior interface of the vitreous and contracts pulling the vitreous and detaching it and leaking plasma into the vitreous itself. This traction continues and the detached vitreous is pulled into the vitreous cavity until bleeding occurs in which case symptoms become apparent (Kanski, 2003: 453). Sometimes haemorrhage can occur within the vitreous gel but more often bleeding occurs in the retrohyaloid space, known as a preretinal haemorrhage, manifesting in a crescent shape which is the demarcation of the vitreous detachment.

Lang (2000: 315), in Table 2.4, classifies DR into Nonproliferative and Proliferative and a distinction is made between Nonproliferative stages as mild, moderate and severe. A further distinction is made between proliferative stages as being non-high risk and high risk.

The study by Hong *et al.* (2009: 1510) as mentioned in 2.6.1 is relevant when considering the progression of DR after cataract surgery, which was found to be higher after such procedures. Also relevant in terms of posterior vitreous detachment (PVD) is the research by Kawahara *et al.* (2008: 2784) regarding the use of statins injected into the vitreous to prevent PVD. Statins appear to counter the presence of transforming growth factor (TGF) which is present in higher concentrations in patients with PVD. Interestingly, Shiba *et al.* (2009: 1017) studied the effects of sleep apnoea, or sleep-disordered breathing (SDB), in diabetic patients and found that 29% of those with NPDR and 48% of PDR patients had SDB and conclude that the oxygen stress induced by sleep breathing disorders may promote

the production of vascular endothelial growth factors and promote the development of PDR. Table 2.7 shows a classification of diabetic retinopathy by Lang (2000: 315).

**Table 2.7:** Nonproliferative and proliferative Diabetic Retinopathy (Lang 2000:315)

<b>Nonproliferative DR</b>	<ul style="list-style-type: none"> <li>• Microaneurisms</li> <li>• intraretinal haemorrhages</li> <li>• hard exudates</li> <li>• retinal oedema</li> <li>• venous beading</li> <li>• excessive haemorrhages</li> <li>• cotton wool spots</li> <li>• IRMA</li> </ul>
<b>Proliferative DR</b>	<ul style="list-style-type: none"> <li>• Pre-retinal neovascularisation</li> <li>• Vitreous haemorrhage</li> <li>• Tractional retinal detachment (due to traction of vitreous scarring)</li> <li>• Rubeosis irides</li> </ul>

#### **2.6.4 Secondary glaucoma**

Neovascular glaucoma is one of the serious consequences of PDR and is often a result of rubeosis irides which in itself is a regular sequela of PDR. Kanski (1999: 477) says that rubeosis is especially common in eyes with severe retinal ischaemia or persistent retinal detachment. In rubeosis irides the new vessels block the anterior angle of the eye, drawing the angle together in a zip-like fashion (Lang 2000: 271), causing acute angle closure with a poor prognosis.

#### **2.6.5 Ocular neuropathies**

Eshbaugh *et al.* (1995: 219) established that cranial mononeuropathies are a common occurrence in diabetes, being first reported in 1886 and include facial and ophthalmoplegic neuropathies. In terms of ophthalmic conditions, these researchers cite a Tokyo study which reported a 0.97% incidence of cranial nerve 3<sup>rd</sup>, 4<sup>th</sup>, 6<sup>th</sup> or 7<sup>th</sup> palsies in the diabetic population over a 25-year period. They report further on a Mayo clinic study of over 4000 diabetic patients which concluded that abducens (VI) nerve palsy was by far the most common (44%), followed by oculomotor (III) nerve (28%) and trochlear (IV) nerve (15%). Diabetes and hypertension are regularly associated with ischaemic VI nerve palsy, according to Patel *et al.* (2005:760) who saw the combination of diabetes and hypertension was evident in 18.4% of cases, while in diabetes alone the frequency was 23.7%. These researchers concluded that there is a six-fold risk of having diabetes in cases of VI nerve palsy and an eight-fold risk with co-existing diabetes and hypertension. In their discussion, Eshbaugh *et al.* (1995: 219) found that lesions in diabetic cranial neuropathy can occur anywhere from the brainstem to the orbit. Jacobsen *et al.* (1994: 961) also identified diabetes

as an accepted risk factor for ischaemic III nerve palsy, alongside left ventricular hypertrophy and elevated hematocrit (red blood cell count in the blood). A commonly observed sequela in diabetes-associated III nerve palsy is pupil involvement which is observed as anisocoria (unequal pupil sizes) (Jacobsen, 1998: 723) with the larger pupil being in the involved eye. The degree of anisocoria might only be slight but pupil involvement in this condition occurs more often than was previously recognised. Trochlear nerve lesions are less common than those of the III or VI nerves. Burger *et al.* (1970: 567) reported common risk factors for ocular neuropathies which include diabetes amongst many others.

## **2.7 PATIENT EDUCATION AND KNOWLEDGE OF DIABETES**

Please (2007: 90) reports "knowledge of possible complications associated with disease is generally viewed as a precursor to positive health behaviours." To paraphrase Joshi and Joshi (2008: 29), unless diabetic patients take ownership of the responsibility for their condition they are going to find it difficult to implement the lifestyle interventions necessary to combat the disease. In 1985, researchers Assal *et al.* (1985: 602) stated that it had taken more than 50 years for the beneficial effects of patient education to have been unequivocally proven. They mention further that the widespread failure to acknowledge the impact of patient education is the primary reason for the poor quality of diabetes care.

### **2.7.1 Benefits of patient knowledge of diabetes**

Greenfield *et al.* (1988: 448) developed a programme designed to increase patient involvement in their medical decision making, contending that patients need to

participate actively in their own medical care in order to maximise the control of their condition. They discovered that prior to the intervention programme the mean HbA1c levels were 10.6mmol/l and after the intervention these levels had dropped to 9.1mmol/l. Further analysis showed that those patients in the trial group were far more likely to ask pertinent questions regarding their treatment than the non-trial group and reported fewer functional limitations. This led the authors to conclude that these interventions were positively affecting patient behaviour, improved blood sugar control and decreased functional limitations. In Sri Lanka, Fernando (1993: 18) found similar results in a study of diabetic patients where he noted that it was widely accepted that patient education was essential in the treatment of diabetic patients. The conclusion of the study was that diabetes education improved patient knowledge and, most importantly, diabetes control. An Irish study by Coates and Boore (1996: 99), however, contested this finding and found no relationship between knowledge and glycaemic control. This supports an earlier study by Bloomgarden *et al.* (1987: 263) which concluded that patient education was not necessarily an efficacious intervention in insulin administered diabetes therapy. This premise, however, was effectively refuted by the results obtained by Srinivas *et al.* (2005: 264) who state categorically that an inverse linear relationship exists between performance on a diabetes knowledge test and HbA1c values. It would appear though that literacy levels are significant in obtaining positive results as shown by Hawthorne (2001: 373) who studied British Pakistani diabetic women and found that glycaemic control improved in women receiving culturally-appropriate health education but noted that illiterate women did not do as well as their literate peers in the knowledge skills test and also had a lower glycaemic improvement. This would

seem logical and supports the notion of education levels and diabetic management being linked.

Khan *et al.* (2008: 1108) studied the prevalence and reasons why Bangladeshi patients were reticent to commence insulin therapy in Type 2 diabetes, apparently a frequent problem in their community. Reasons for insulin refusal included perceptions of disease severity increase, insulin leading to premature death, loss of control and the fear of hypoglycaemia. Weight gain, loss of independence and fear of needles was also reported to be influential. The Freemantle diabetes study done by Bruce *et al.* (2003: 82) also found that barriers to diabetes education confronted older people, minority groups and those with language or literacy difficulties. This aspect was already recognised in 1989 when Gildea *et al.* (1989: 1023) enrolled spouses of diabetic patients in a six-week diabetes education programme. It was found that reduction in stress was proportional to their increase in knowledge which was maintained six months after completion of the programme. They suggested that spousal participation and education was an effective intervention and adjunct to conventional therapy. More recent research by Phyllis-Tsimikas *et al.* (2004: 110) found that after a one-year period of participation in a programme to improve patients' clinical diabetes care, knowledge and treatment satisfaction the study group had significant improvements in HbA1c levels (12% to 8.3%), total cholesterol and blood pressure. This nurse-driven or primary care programme, in order to be successful, needs to be culturally aware, sensitive and appropriate and community-based.

Research by Heisler *et al.* (2005: 816) examined the frequency and correlates of knowing one's latest HbA1c result and whether this is associated with a more accurate assessment of diabetes control and self-care and behaviour modification related to diabetes control. Surprisingly, 66% of respondents reported that they did not know their HbA1c results and only a quarter accurately reported them. This led the researchers to conclude that those who knew their HbA1c scores reported better diabetes understanding and assessment of their glycaemic control than those who did not. Unfortunately this knowledge alone was not sufficient to improve self-care of diabetes and glycaemic control, which needed other behavioural strategies to improve diabetic self-management.

The use of electronic communication with healthcare providers by diabetic patients was studied by Harris *et al.* (2009: 1182), who wanted to see whether use of the communication facility improved HbA1c, blood pressure and LDL cholesterol in the group. They found that use of the communication facility resulted in a drop of HbA1c to <7%, although it was also associated with higher frequency of outpatient visits. Their conclusion, however, was that frequent use of the electronic messaging and communication facility improved glycaemic control. In terms of patient communication, Skinner *et al.* (2008: 1117) recommend that educators in diabetic self-management programmes talk less and promote a more facilitative and less didactic approach to achieve optimum results, while Cox *et al.* (2008: 1527) have used the internet as an effective tool for interactive blood glucose awareness training. When examining the communication skills of healthcare professionals in the paediatric diabetes services, Hambly *et al.* (2009: 502) observed that an important component of consultations was addressing psycho-social issues. These researchers

concluded that this represented a key training need within the communication skills framework for healthcare professionals.

### **2.7.2 Lack of patient knowledge of diabetes**

Overall patient education in diabetes is poor according to Moran *et al.* (2005: 267) and there is an urgent need to plan and implement educational programmes to facilitate the treatment of diabetic patients. As long ago as 1978 Miller *et al.* (1978: 275) were concerned with returning war veterans' ability to self-medicate, finding that 35% of these patients lacked any form of formal training in this regard. Of this group 17 patients had been placed on insulin without any instructions on the use thereof. Those who had a form of training were almost equally inept and could not demonstrate adequately the basic skills needed for self-care which included insulin administration, foot care, urine or blood testing and management of hypo- and hyperglycaemia. In 1983 Eastman *et al.* (1983: 229) studied 50 Type 1 diabetic patients and their parents' ability to detect hypo- and hyperglycaemia. They concluded that rigorous interventions were required in order to improve the ability of both patients and their parents to self-manage. In a similar study, Williams *et al.* (1998: 166) studied patients both with diabetes and hypertension and concluded that inadequate functional health literacy levels were a serious impediment to educating patients with chronic diseases like hypertension and diabetes. This was a comparable conclusion to that of Hawthorne (2001: 373) in 2.7.1 above. Of the patients with adequate literacy levels, 92% knew that 160/100 constituted higher than normal blood pressure compared to 55% with inadequate literacy skills. A similar picture emerged with diabetics and their knowledge of hypoglycaemia. Literary skills aside, as mentioned in 2.4.7 above, Wong *et al.* (2009: 34) found that

less than half of hypertensive diabetics were aware of the importance of blood pressure control. In terms of the ocular complications of diabetes, Muñoz *et al.* (2008: 968) found the knowledge of ocular complications in Hispanics to be low and emphasised the use of culturally specific education protocols to address the problem.

## **2.8 SOCIO-ECONOMIC IMPACT OF DIABETES**

Canadian diabetic patients were found to be twice as likely to be unemployed than non-diabetic individuals (Kraut *et al.* 2001: 64). Interestingly, these researchers found that diabetic patients without complications had incomes similar to those non-diabetic counterparts. Those with complications received 72% of the income of the non-diabetic individuals and received 58% more income assistance from social support. In India, Bjorka *et al.* (2003: 61) confirmed that costs of treatment of diabetes amongst all socio-economic groups placed a great financial burden on both patients and state resources. Triomphe (1991: 300) observed that the costs to the French community for diabetic treatment were large. Furthermore, the allocation of resources for the diagnosis, treatment and prevention of diabetes was considerable and impacted indirectly on the economy in terms of loss of working days and deterioration in patient quality of life. The direct economic costs of diabetes were for medical treatment. Skyler (2000: 7) notes that the improvement of blood glucose reduces the costs associated with the treatment and long-term management of diabetes. Estimated costs ranged from \$4000 to \$5800 per patient for intensive glycaemic control, which was approximately three times the cost of conventional therapy (Skyler, 2000: 7). Valdmanis *et al.* (2001: 129) noted in their study that diabetic individuals were economically worse off on all disability measures,

concluding that they had fewer resources to deal with higher levels of disability and poorer health status.

## **2.9 CONCLUSION**

In conclusion, this chapter has undertaken a review of the literature regarding characteristics of diabetes. The description of diabetes and the various types encountered have been highlighted. Furthermore, the global prevalence, causes and risk factors for diabetes have been described. These risk factors include obesity and the concept of BMI to grade obesity, the metabolic syndrome, lack of exercise and proper diet, stress and depression, hypertension and cardiovascular factors. The general complications of diabetes were examined which included nephropathy, diabetic neuropathy, cardiovascular disease, sexual dysfunction, thyroidopathy, depression and loss of cognitive function. Ocular complications of diabetes researched were cataract, refractive changes, diabetic retinopathy, its causes and its various classifications, secondary glaucoma and ocular neuropathies associated with diabetes. Finally, the importance and value of patient education and knowledge, or lack of knowledge of diabetes was examined, concluding that treatment and compliance is vastly improved with greater knowledge and awareness of the condition. The following chapter will describe the research methodology and statistical methods used in the study.

## **CHAPTER 3**

### **RESEARCH METHODOLOGY**

#### **3.1 INTRODUCTION**

In research hypotheses are developed which are tentative explanations accounting for a set of facts, according to Muijs (2004:1). These can be tested by further investigation which is the reason why hypothesis acceptance is always provisional. Upon further investigation the research may provide new and different data or circumstances may change. This chapter contains a rationale and theoretical basis for the research process, followed by an explanation of the research design and methodology used to obtain the data for this study. Reliability, validity and trustworthiness are explained and the chapter concludes with an overview of the ethical considerations for the research.

#### **3.2 THEORETICAL PERSPECTIVES ON THE RESEARCH STUDY**

##### **3.2.1 Theoretical basis for the use of quantitative research**

Predominantly quantitative research approaches were used in this research. Muijs (2004: 1) describes the two main types of research methods as being quantitative and qualitative and uses the definition of quantitative research as given by Aliaga and Gunderson (2004) as "explaining phenomena by collecting numerical data that are analysed by mathematically based methods." Thomas (2003: 2) is of the opinion that researchers using this technique seek explanations and predictions that can be

generalised to other persons and places. Polgar and Thomas (2000: 10) regard quantitative research as viewing our patients objectively, like natural objects, and then attempting to “identify and measure important variables which represent the causes and expressions of a clinical condition.” Certain questions in the research questionnaire had a qualitative element but these were summarized and analysed quantitatively. In quantitative research, phenomena that do not exist in a quantitative form can be converted into quantitative data by means of survey questionnaires. Attitudes, for example, can be quantitatively determined by using a grade, or Likert, scale format (Muijs, 2004: 1).

Researchers use quantitative research designs in the following instances (Muijs, 2004: 2):

- When researchers want a quantitative answer or number to a question. For example: *How many people....*
- To examine numerical change: *By what amount did student numbers increase over the period....*
- When explaining phenomena: *What factors are related to a change in...*
- When testing hypotheses: *Is there a relationship between socio-economic background and low self-esteem?*

Furthermore, quantitative research involves collection of data in units. These units are known as variables and *variable* refers to the fact that data will differ between units (Muijs, 2004: 3).

There are certain problems that are endemic to quantitative research, according to Muijs (2004: 9). These include:

- Exploration of a problem in depth where quantitative research will fail. Although a qualitative design gives a broad overview of information for any in-depth study, they are far superior where specific issues need to be examined.
- Quantitative research cannot develop theories and hypotheses, only test them.
- Complex issues are best examined by qualitative research where unexpected variables may emerge. Unexpected variables do not fit in well with a fixed variable quantitative study.
- While quantitative studies are good for establishing cause and effect, or causality, meanings of events or circumstances need to be examined qualitatively.

Muijs (2004: 9) refers to so-called mixed studies which involve both qualitative and quantitative elements which gives researchers both breadth and depth. In this instance, the use of questionnaires (quantitative) together with case studies (qualitative) would allow both methods to work concurrently. In mixed studies the qualitative and quantitative elements can have equal status or one can hold bias, depending on the research design. Thomas (2003: 6) contends that most modern researchers see the two methods as complimentary rather than antagonistic. This was noted by Jick (1978: 602) as early as 1978 where it was indicated that the two

methods should be regarded as complimentary, endorsing the use of both methods to negate the inherent weaknesses in each.

There are two types of quantitative research: experimental design and non-experimental design. The latter is most popular with survey research in the social sciences (Muijs, 2004: 9). Muijs (2004: 9) defines an experiment as “a test under controlled conditions.” The emphasis in experimental study designs is on “control” which is why they are usually conducted in laboratories. This is in contradistinction to non-experimental design research which is more varied. According to Muijs, (2004: 31) however, the most popular form of non-experimental research is the survey method. Furthermore, a cross-sectional study, where a group is surveyed only once, is often implemented as opposed to a longitudinal study where a group is surveyed over a number of years.

In this research, the quantitative aspect involved the derivation of the data by means of the patient questionnaire. The qualitative research involved a comprehensive literature review and consultations with various colleagues and other experts in the field to check the accuracy, content and relevance of the data obtained. The qualitative aspect of a study involved the determination of what the patient thinks of his or her condition, something not possible in a statistical analysis but rather better suited to an interview research study. This would include his or her family setting and social circumstances (Polgar & Thomas 2000: 10). In the Demographic and Health Survey by the South African Department of Health (Makubalo *et al.* 1998: 206-218), the authors found that those with a lower level of

education were most susceptible to so-called lifestyle diseases, like hypertension and diabetes. It was for this reason that, for this research, the questionnaire contained questions regarding respondents level of education as an important variable to be considered. Other qualitative aspects regarding comments by the participants were assessed, including how they perceived their diabetes and general health.

In order to arrive at the truth or, as Polgar and Thomas (2000: 4) refer to it, "knowledge", one can use various "methods of knowing". These are authority, rationalism and intuition. In the first, knowledge is considered true because of tradition or because experienced researchers or clinicians have said it was true. This method has its problems, not the least of which is what happens if someone of equal academic stature states the exact opposite of what was traditionally believed or taught? Who is, indeed, correct? The scientific method utilised in this study removes all subjective influences and relies on an objective review of the data obtained. Indeed, quantitative analysis is predicated on objectivity where the researcher is encouraged not to become involved in case he or she "contaminates" the data collection process (Kleinbaum *et al.* 1982: 22). It is for this reason that, in this research, there was no attempt made to create an abnormal or unnatural setting while the patient completed the questionnaire like, for example, in an examination or test.

Polgar and Thomas (2000: 4) argue that rationalism relies on logic and reason. Logic guarantees that the conclusion arrived at is true. However, if one of the logical steps proves to be empirically false then the logical "truth" arrived at is incorrect. Scientific

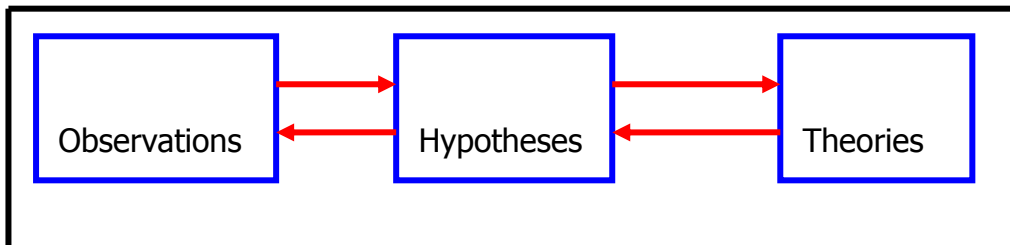
study relies on logic but it requires evidence to be collected to support the logical and mathematical routes taken in the search for the truth.

Polgar & Thomas (2000: 4) refer to the "Eureka moment", when intuition holds sway and truth is judged by the clearness of thought or of the experience, stating that "knowledge is sometimes acquired by sudden insights." Sadly, many an intuitive diagnosis or decision is found wanting when faced with the empirical results. The 19<sup>th</sup> century physician Ignaz Semmelweiss was ostracized and condemned by his fellow practitioners for daring to suggest that doctors themselves were potential carriers of disease which contradicted the intuitions of his colleagues and incurred their wrath (Polgar and Thomas 2000: 4).

Scientific method is based on three elements (Durward and Baer, 1995: 436), namely skepticism, determinism and empiricism. Skepticism implies that all thought or statement is open to doubt and analysis. Determinism means that all events occur because of certain physical laws and causes and not because of luck, demons or evil spirits, while empiricism extols the notion that enquiry be conducted through observation and verified through experience. In this study these three concepts were utilised in the development of the research instrument. The various statements that respondents were asked about contained elements that they were unlikely to have knowledge of in order to ascertain their level of knowledge. The patients in the study were all diabetic as a result of physiological events and the observations elicited from the questionnaire gave empirical credence to the study.

An illustration of the scientific method, consistent with the methodology of 'positivism' (Polgar and Thomas 2000: 5) is seen in figure 3.1 below:

**Figure 3.1:** Scientific Method (Polgar and Thomas 2000:5)



In the above figure, it appears that observations describes the precise, unbiased recording of observations, aspects of persons, objects and events which forms the empirical basis of all science. These can be verbal descriptions or sets of measurements, both of which must be formulated so that they can be replicated and repeated by others. These observations may be used to develop scientific hypotheses which are "statements which specify the nature of the relationship between two or more sets of observations." (Polgar and Thomas 2000: 5-6). These hypotheses, according to these authors must have clear-cut, observable referents so that, when the hypotheses are confirmed by empirical means, they become laws.

Furthermore, theories or, more precisely, scientific theories, are speculations representing current knowledge of the subject. These result from evidence derived from scientific research and from which hypotheses can be converted into theories, which are more general systems of explanation. (Polgar and Thomas 2000: 6). From scientific theory one can then utilise the empirical data and formulate a deduction

which is verifiable from the data that, in turn, must be trustworthy, valid and reliable. These latter concepts will be dealt with in greater detail in section 3.8.

### **3.2.1 Theoretical basis for the use of Health Research**

Research is defined by Polgar and Thomas (2000: 3) as being a systematic and principled way of providing evidence in order to solve health care problems, while Bowling (2002: 1) defines it as “the systematic and rigorous process of inquiry which aims to describe phenomena.” Furthermore, research methods refers to the practices and techniques used to collect, process and analyse the data, the sample size and methods of sampling and how the data will be collected. It also refers to the choice of measurement instrument and how the data is to be processed and analysed (Bowling 2002: 143).

In this study an attempt has been made to examine the state of diabetes knowledge of private patients. In order to do this a population based cross-sectional study design using purposive accidental random sampling was undertaken. Health research is closely linked to health systems research and often the line between the two is blurred. Firstly, Hunter and Long (in Bowling 2002: 3) explain health research as being in relation to health generally and playing an important role in the planning and operation of health services aiming to achieve health. Secondly, health systems research strives to improve the health of the community by enhancing the efficiency and effectiveness of the health system “as an integrated part of the overall process of socio-economic development” (Bowling 2002: 3).

In this research both concepts appear to be appropriate because, as Bowling (2002: 3) indicates, the process for obtaining systematic knowledge and technology which can be used for the improvement of the health of individual groups is, effectively, health research. This, in turn, provides the basic information on the health and disease of a certain population, which is the essence of this study. The results obtained with this research are aimed at contributing to the improvement of the health of the community which then substantiates the two definitions previously described.

The definitions of the two research types further emphasises the need for a multidisciplinary approach to health in general. According to Pope, in Bowling (2002: 4), there are no boundaries in health research as it is all somehow interconnected and all health research is a place "within which disciplines can meet". In this instance optometry proposes to play a more participative role in primary health care, which is traditionally the domain of the district health personnel and larger hospitals. This would be similar to Pharmacy which has also begun to play an increasing role in primary health care offering blood pressure monitoring as well as cholesterol and diabetes blood tests on their premises.

Health research is essentially broader than health systems or health services research, which aims rather to target cost-effective and appropriate treatment for a specific condition or group of conditions that health research has uncovered (Bowling 2002:51). Broadly speaking, the aim of health research is to understand how people become ill, their perceptions and experiences in relation to (their) health

and the effects of the illness. It can also encompass the experience of healthcare, how society reacts to (their) illness and the functioning of health services in relation to their effects on people.

This study, therefore, is a health research study utilising questionnaires. It utilises a descriptive research method involving the comparison of the characteristics of a variable with that of another variable. In this instance consideration is made between variables relating to, *inter alia*, demographics (patient age, race, gender, and education), clinical data and knowledge of diabetes, diabetes management and its general and ocular complications.

### **3.2.2 Theoretical basis for population-based research**

Population-based research is defined by the Robert W Johnson Research Foundation (2005: 1) as another term for epidemiology or the study of disease in populations. Whilst this study is not an epidemiological study, it will compliment current understanding of the disease and patient management. The use of populations distinguishes epidemiological studies from clinical medicine and other biomedical research (Kleinbaum *et al.* 1982: 20). Epidemiology, in turn, focuses on combining results from many subjects which, according to Kleinbaum *et al.* (2004: 20), ties in with its primary and ultimate goal: the improvement of the health status of populations. Polgar and Thomas (2000: 295) refer to population-based research as “the study of the distribution and determinants of disease within a community.”

Kleinbaum *et al.* (2004: 20) lists the aims of epidemiological research as:

- Describing the health status of the population
- Explaining aetiologies
- Predicting occurrences
- Controlling distributions of diseases by preventing new occurrences, eradication of existing occurrences, prolonging life with disease or improving health status of the afflicted

They mention further two different goals or levels at which epidemiological research is conducted, namely *understanding* and *intervention*.

Understanding is concerned with observations and inferences leading to accumulation of knowledge about disease occurrence and aetiology, while intervention involves collecting information which can be used to make informed public health decisions. The objective of research at intervention level is to evaluate health practices, programs and policies to prevent disease and promote good health (Kleinbaum *et al.* 2004: 22).

Study populations may be classified by racial, ethnic, age cohort or by geographic cohort. In this study the cohort is specifically the diabetic patient who privately funds his or her treatment. This is different to community-based research which is focused on all people in a defined geographic community. Although, that being said, this study is confined to the geographical area of the Western Cape Province and so one could possibly consider this study to be a combination of the two forms where the population base or epidemiology is concerned with a single geographical area.

Although this study is population-based it is not intended to be an epidemiological study.

### **3.2.3 Theoretical basis for questionnaire based research**

Muijs (2004: 9) has referred to survey methods as the most popular form of quantitative research in the social sciences. Survey methods include the use of questionnaires which have both advantages and disadvantages. The advantages are listed as follows by Muijs (2004: 44):

- They are easy to use and most people are familiar with them
- Participants can sit and think about their answers
- They are flexible and can contain a wide range of questions
- It is easy to generalise findings to real world settings
- Can gather large amounts of data at relatively low cost

The disadvantages are:

- Low response rates, with non-return rates often lower than 50%
- Time-consuming follow up and data entry

When considering response rate in questionnaire research, Babbie (1992: 267) considers a 50% return rate as "adequate", while a 60% return is rated "good". In order to increase the return rate and minimise the problems, Muijs (2004: 44) recommends the following steps:

- Keep questionnaires short
- Telephone/contact participants to arrange completion of the questionnaires
- Promise and provide feedback to respondents

- Provide a reward for completion of questionnaires
- Follow up calls
- Maintain credibility. This can be done by keeping promises made in respect of, especially, confidentiality.

In order to as far as possible align these principles in this research, respondents were assured of confidentiality and were promised feedback on the results once published. Respondents were invited to return to discuss any aspect of the study, including the results, at any time.

### **3.3 REVIEW OF METHODS AND PROCEDURES**

#### **3.3.1 Research design**

Research design refers to the overall structure or plan of the research. In this study, the research involved the collection of data from questionnaires which were completed by the patients at their attending optometric practice. This data was then captured, collated and statistically analysed.

A population-based cross-sectional study design, using purposive accidental random sampling, was used for this research. The study consisted of questionnaires completed by diabetic patients who fund their condition privately, that is outside of the South African Public Health sector. The patients were from mixed socio-economic backgrounds. The quantitative aspect of the study involved the analysis and synthesis of the data collected together with the statistical analysis of the overall responses obtained from the questionnaire. The qualitative aspect utilised certain

questions within the questionnaire which allowed for an assessment of the patients own perceptions of his or her diabetes and general health status.

### **3.3.2 Literature review**

The research process was initiated with an extensive literature review encompassing the field of diabetes, its clinical presentation and causes, prevalence, risk factors, general complications, ocular complications and patient knowledge of their condition (Chapter 2). The literature was obtained from text books, publications, journal articles and the internet. Further information for the study was also gained from personal correspondence with experts in the field.

### **3.3.3 Research instrument – patient questionnaire**

From the literature review, it became evident that certain variables are significant in diabetes. Using the evidence from the literature review and previous studies in this field, notably Clarke-Farr *et al.* (2006: 134) and Mashige *et al.* (2008: 95), a questionnaire was designed to compile data for each patient. Such data included:

**Section A:** Biographical details. There were 10 questions in this section including location (rural or urban), age, gender, ethnic group, language, occupation, education details, weight, height and a Body Mass Index calculation for each participant. Patient heights were measured on a wall-mounted tape measure and they were requested to indicate their weight on the questionnaire.

**Section B:** Medical history. This section included details of the health status of respondents where 12 questions were asked including description of their own

health, pregnancy status and whether they suffered from hypertension, heart disease, hypercholesterolaemia, tuberculosis or other lung disease. The participants were asked to identify the type of diabetes they had, what their latest blood glucose measurement was, when it was taken and for how long had they been treated for diabetes. Respondents then had to identify who had diagnosed their diabetes and whether, at the time of diagnosis, patients were told about the importance of regular eye examinations. Finally in this section they were asked which other family members, if any, had diabetes.

**Section C:** Eye care. Fourteen questions related to eye care and diabetes were included in this section. This section also dealt with access to eye and health care services. Questions included details of when the participants previous eye examination occurred, at which practice this took place and the distance they needed to travel for an eye test. Respondents were then asked the reason for attendance at the practice, whether it was for new spectacles, a diabetic eye examination or any other reason. The following questions related to their knowledge of where to go for their first diabetic eye examination, whether the costs of an examination made it difficult to attend for one and whether they could take time off work to have an eye examination. Patients were then asked whether they felt that they had received adequate information regarding the possible ocular complications of diabetes when they were first diagnosed and whether they found it expensive to test their blood glucose. Lastly questions about the type of additional information they would like to receive about diabetes, the format this information should take and from whom they would like to receive this information were asked.

**Section D:** Knowledge of diabetes. In this part of the questionnaire an attempt was made to determine the knowledge of diabetes of the participants. Seven questions regarding the types of diabetes, whether there is a heredity factor involved and whether pregnancy could cause diabetes were asked. The involvement of depression and anxiety in diabetes was explored as was some common blood tests used in the diagnosis and management of diabetes.

**Section E:** General diabetes management. Participants were asked eleven questions in this section concerning the importance of a healthy diet and lifestyle and regular exercise. Thereafter, participants were asked about the importance of daily blood sugar testing, effective weight management and medication compliance. Respondents were questioned about their attendance to regular medical and eye examinations, the importance of smoking cessation and whether they, as patients, knew enough about diabetes to manage their own condition. Lastly, they were asked the rate the benefits of certain foodstuffs and supplements as part of a diabetic-oriented diet plan and to indicate certain conditions that were associated with diabetes.

**Section F:** Ocular complications of diabetes. This section questioned the participants' knowledge of ocular conditions associated with diabetes. Eleven questions regarding vision, colour vision, glaucoma and cataracts were asked. Wound healing and retinopathy, described as bleeding and damage inside the eye, were explored as was their opinion on the importance of an eye examination if they

could still see clearly or if their blood glucose was well controlled. Finally participants were asked whether they knew about laser treatment for diabetic eye disease.

**Section G:** Management of diabetes. In the penultimate section patients were asked ten appropriate questions regarding their management of diabetes including whether they felt their diabetes was under control. Next they were asked whether they had a glucometer, how often they measured their blood glucose and what their usual blood glucose level was when tested. Respondents then answered questions on how their diabetes was being treated, whether they exercised and, if so, the frequency and quality of the exercise. Finally in this section patients were asked whether they had received lifestyle advice for the better control of diabetes and from whom this advice was obtained.

**Section H:** General management of diabetes. In the final section of the questionnaire participants were asked seven questions relating to their diet, weight and whether they knew what their Body Mass Index (BMI) was. To conclude the questionnaire they were asked other questions regarding compliance and about the frequency and regularity of medical check-ups and annual eye examinations.

#### **3.3.4 The questionnaire procedure**

In order to ensure accuracy, reliability and validity, the questionnaires were administered by the researcher and also by appointed researchers who had been appropriately trained in order to ensure standardisation of results. Each participant was given an information sheet detailing the nature of the research, its title, the researcher and contact details of both the researcher and the supervisor as well as

the office of the UKZN Biomedical Research Ethics Committee (BREC). The information sheet also certified that the anonymity of the participants was guaranteed and that no-one would be identified in the final writing of the thesis and analysis of results. This form was signed by each participant prior to participating in the study indicating his or her understanding of the research and its implications. In order to prevent contamination of the results, the participants were left in private to complete the questionnaire with a research assistant available for any assistance if needed.

### **3.4 PARTICIPANTS IN THE RESEARCH**

Random privately-funded or medically insured diabetic patients attending the designated optometric practices were examined. The designated optometric practices were situated in the following locations in the Western Cape region:

- Malmesbury
- Milnerton

Diabetic patients who attended the practices were asked to voluntarily participate in the study. They were asked to sign a consent form in English, Afrikaans or isiXhosa. Once their permission had been obtained and after being informed about the nature of the study, the study questionnaire was completed. They were given instructions by the attending optometrist or trained research assistant and allowed as much time as needed to complete the questionnaire. This data was then captured using Microsoft Excel 2007 for further data analysis.

### **3.4.1 Sample selection**

#### **3.4.1.1 Target population**

The target population included all privately-funded, self-funded or medically insured diabetic patients attending optometric practices in the designated areas of the Western Cape Province of South Africa. After an optometric examination the participating diabetic patients were given a questionnaire to complete by the researcher or by appointed researchers/research assistants who were trained in the methodology of the study in order to ensure standardisation of results.

#### **3.4.1.2 Survey population**

The survey population consisted of all privately-funded diabetic patients attending a private optometric practice in Milnerton and Malmesbury and who were prepared to participate in the research study after completion of the consent form.

#### **3.4.1.3 Sample size**

Sample size is normally arrived at by means of the estimated sampling error, where the sampling error is inversely proportional to the square root of the sample size, which means that the greater the sample size the smaller the sampling error (Polgar and Thomas 2000: 39).

The sample size consisted of 120 patients who were privately-funded, self-funded or medically insured. In order to provide a statistically valid sample a minimum of 122 patients were included in the study. (Clinical<sub>sample</sub>  $n_{CS} = 1$ ; patients  $n_p = 122$ ).

To obtain a 95% confidence level at a confidence interval of 3, the minimum sample needed for all nine provinces of South Africa needed to be 1077 (Creative Research Systems, 2009) and, using the formula provided by Creative Research Systems (2009), for the same level in the Western Cape the minimum sample was  $0.101 \times 1077 = 108$ . The final sample size for the study consisted of 122 [ $n_{\text{sample}} = 122$ ] patients seen in the selected private practices.

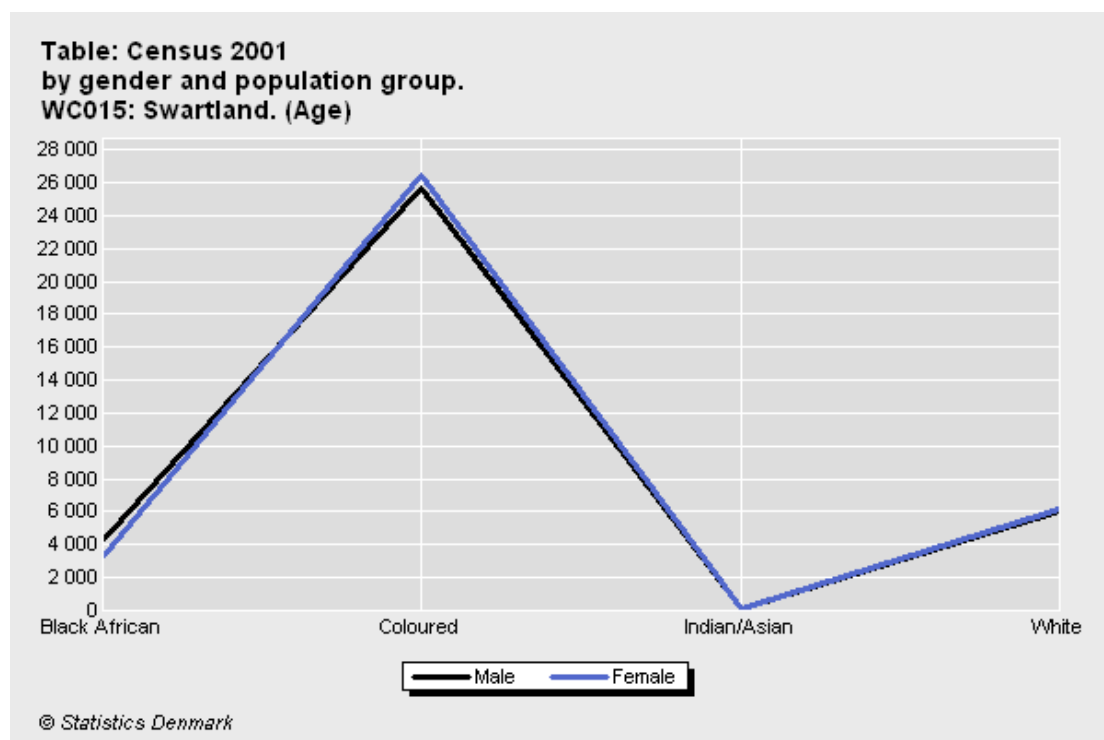
Convenience sampling was employed in patient selection. Random selection was assured as all diabetic patients attending the designated optometric practices were invited to participate in the research. This would be considered to be statistically random as they attended the practice with an equal chance of being selected for participation in the study. Therefore no bias was evident in determining which patients presented at the practices for examination, provided that all participants met the inclusion criteria of being a previously diagnosed diabetic patient on health insurance or privately funded.

#### **3.4.1.4 Description of the sample**

The study population consisted of patients who during the case history section of a routine optometric examination were found to be diabetic and who privately funded their treatment or were medically insured. Patients making use of the Public Health Service for their diabetes treatment were excluded. The practices were located in Malmesbury, a town approximately 65 kilometres north of Cape Town, representing a rural population mix and Milnerton, a suburb of Cape Town representing the Atlantic seaboard. These designated practices reflected a mixture of urban and rural residents with patients chosen according to the selection criteria.

The population of the Swartland, the region of the Western Cape Province wherein Malmesbury is found, was 72099 in 2001 (Census 2001: Statistics South Africa). Figure 3.2 illustrates the population of the Swartland region by gender and population group.

**Figure 3.2:** The population of the Swartland (Statistics South Africa, 2001)

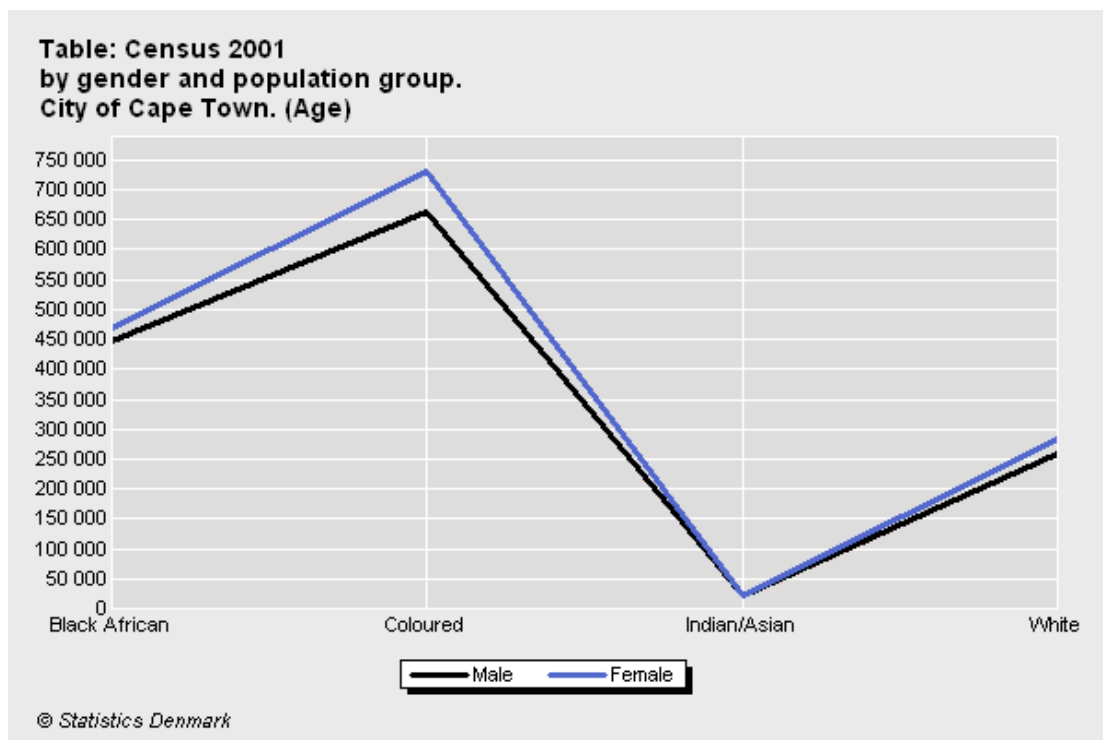


The urban area in the research was Milnerton which falls within the City of Cape Town. In the 2001 Census this region had a population of 2 893 232 (Statistics South Africa, 2001).

In both the urban and rural sectors of this study the majority of the population are from the coloured group, while in the rural area the white and black African numbers

are similar. The black African population proportion rises markedly in the urban area where it is second only to the coloured group and almost twice the size of the white population. Figure 3.3 illustrates the population of the City of Cape Town by gender and population group.

**Figure 3.3:** The population of the City of Cape Town (Statistics South Africa, 2001)



### 3.5 THE PILOT STUDY

The research study was preceded by a pilot study which van Teijlingen and Hundley (2001: 1) consider as crucial to a good study design and define them as mini versions of a full-scale study. The pilot study involved the use of a preliminary questionnaire that had been developed by the researcher and from this study the

final patient questionnaire evolved, which formed the basis of the quantitative data gathering process.

The major advantage of a pilot study is that it might give advance warning about where the main research could fail or whether proposed instruments or methods are inappropriate or too complicated (Van Teijlingen and Hundley 2001: 1). Also of great importance is the fact that a successful pilot study can help convince other stakeholders that the main study is worth pursuing and supporting. Pilot studies do have their limitations, especially if they are based on relatively small numbers and as a consequence do not have any real statistical foundation. There is also the concern of contamination which, according to Van Teijlingen and Hundley (2001: 2), could arise in two ways namely where data from the pilot study could be included in the main results and where pilot participants are included in the main study but new data is collected from these people. The chief concern in this instance is that the participant has been exposed to an intervention and may therefore respond differently to one who has not previously experienced it. For this reason those involved in the pilot study were excluded from this research.

### **3.6 DATA COLLECTION**

Data was collected from the study questionnaire. This data was obtained during a routine optometric examination and involved the participant completing a questionnaire containing the variables to be utilised in the study. Once a study

questionnaire had been completed the data was captured using Microsoft Excel for statistical analysis.

### **3.7 DATA ANALYSIS**

Data utilised for the statistical analysis of the results were derived from information obtained by the following procedures:

1. Patient questionnaire completed by each participant with the assistance of trained research assistants or the researcher.
2. The weight and height of the subjects in order to determine the body mass index (BMI) as an associated risk factor for diabetes.

The data was analysed using the statistical analysis software of Microsoft Excel in Office 2007. The data analysis of the study elicited the central tendency, including the mean (average), median (midpoint) and mode (most common value). Dispersion factors measured where appropriate were the range (gap between largest and smallest values), and standard deviation.

### **3.8 RELIABILITY, VALIDITY AND TRUSTWORTHINESS**

When establishing reliability in research, an instrument is considered reliable if it consistently gives the same results (Goddard and Melville, 2001). Babbie (1992: 132) remarks that the term refers to whether the study results adequately reflect the true meaning of the concept under consideration. Bowling (2002: 147) refers to the reproducibility and consistency of the instrument, where it is free from random error

and is homogenous. In order to facilitate the reliability of this study, a copy of the same questionnaire was used for each patient. The same procedures and instructions were utilised in each instance.

In order for a study to have validity it needs to measure what it intends to measure (Bowling 2002: 147). To evaluate the validity of the instrument, a pilot study was undertaken by the researcher which reinforced the internal validity, especially in terms of the questions asked in the questionnaire.

The major threat to the validity of the instrument is observer bias, whereby participant's answers could possibly be influenced by the researcher or research assistant. This was largely overcome by the use of the research instrument the results of which could be analysed or checked by an external observer. In addition, participants were left to privately complete the questionnaire with a research assistant available if necessary. The validity of the instrument, for concurrent validity (diagnosis), in respect of the questionnaire, is established by the nature of the questions which were unambiguous, referring to defined medical conditions and treatment modes. In addition, the questions were modified to be more applicable to the private optometric environment.

All research, to be credible, is predicated on its trustworthiness. Lyon (2000) mentions the two elements of trustworthiness as being (a) the suitability of the research design or methodology used for the particular study and (b) the scientific rigour of the methodology. The latter statement infers that the data collected and

collated is true and not fabricated in any way. In this study the former is ensured by the appropriate questions to be asked in the patient questionnaire and the latter by use of the statistical analysis of the results so obtained and the role of the researcher or research assistants to ensure the questionnaire responses are not fabricated.

Denzin (in Bowling 2002: 202) emphasises the use of triangulated research methods in order to elevate the researcher above the personal biases that occur with the use of single methods. His proposal was that the data is triangulated by being collected at different times and by different people and that the methodology also is triangulated by using multiple methods to collect the data.

In order to triangulate results of this study a thorough literature review was conducted by the researcher, a pilot study was undertaken in consultation with experts in the field and the study questionnaire was drafted. Furthermore, diagnosis of diabetes had been previously made by a medical practitioner. The nature of the statistical analysis and wording of the questionnaire also aimed to ensure such triangulation.

### **3.9 ETHICAL CONSIDERATIONS**

McKinney, in Babbie (1992: 470-71), is of the opinion that ethics in research is of paramount concern. In health research this is especially important as certain personal and often highly confidential issues are examined. Ethics in research is based on three major considerations according to McKinney (Babbie, 1992: 470-71).

These are informed consent, the right to privacy and protection from harm. Bowling (2002: 156) endorses this view stating that the ethical principle governing research is that respondents should not be harmed in any way. The South African Medical Research Council states that "research involving a human subject ... is based on a moral commitment to advancing human welfare, knowledge and understanding." (SA Health Info 2005: 1). Patients should also give their informed consent to participate in a study after they have been made fully aware of the nature of the study both verbally and in writing.

Ethical approval for the research was obtained from the UKZN BREC. The Medical Research Council of South Africa (MRC) (Benatar *et al.* 2000: 8) mentions the four principles of biomedical ethics as being:

- Autonomy – respect for the person and human dignity
- Beneficence – benefit to the participant
- Non-maleficence, meaning no harm must come to the participant and
- Justice where the concept of equal distribution of risks and benefits between communities is recognised.

In this study all respondents were informed of the nature of the research, their voluntary participation was emphasised and their anonymity and withdrawal at any time was assured. All patients in this study were given a fact sheet explaining the study and were all invited to sign a consent document. In this document their right to privacy and confidentiality of results was emphasised. They were also informed that there was no coercion involved in their participation and that it was entirely

voluntary. To this end all patients completed a consent form either in English, Afrikaans or isiXhosa. The questionnaire was also available in either English/Afrikaans format or English/isiXhosa format.

All participants were assured that they could withdraw from the study at any time and that there would be no consequences for them should they so decide. All patients were attendees of an optometric practice in the designated areas, usually where they routinely received eyecare services. There was no discrimination on any basis other than that listed in the inclusion and exclusion criteria, i.e. diabetic patients under treatment outside of the public health system or non-diabetics. This study conforms to internationally accepted ethical norms and practices in research.

All completed questionnaires were stored in the locked office of the researcher and were only accessible in his presence. Anonymity was ensured as there were no personal identifying details on the questionnaire and the consent forms were kept separately, ensuring that no match could be made between them and the completed questionnaire. All electronic data was anonymous and password protected.

Benatar *et al.* (2000: 8 – 9), remark that ethics is the science of criteria, norms and values for human action and conduct. Ethics apply when one reflects on one's moral analysis of actions or decisions. The appropriateness of an action whether is it good or bad and how it possibly affects others is weighed by our ethical judgement and consideration. In terms of ethics for health research, these authors maintain that this kind of research should exist solely to benefit patients, to alleviate pain and to

prevent suffering. It is thus incumbent on researchers to recognise the boundaries of their professional expertise and not undertake research that they are not qualified to carry out. The researcher and the appointed research assistants were at all times fully cognisant of this and at all times adhered strictly to the parameters of the study.

### **3.10 CONCLUSION**

In this chapter the theoretical basis for health research was described together with an overview of its relevance to the study. This involved the study of quantitative and qualitative phenomena, population based research as opposed to community-based research, questionnaires and the scientific method and why it is important. Secondly, the methodology and procedures of the research were described in detail. This included a description of the topics covered in the literature review, the study questionnaire as well as a concise description of the participants in the research. The latter included a description of the study area and of the target population. The pilot study was explained, the theoretical basis for pilot studies as well as the various research techniques that were employed. Finally the validity, reliability and trustworthiness of the study were highlighted as were the ethical considerations of research in general and of this study in particular. In the following chapter, Chapter 4, the results of the study will be presented and the analysis thereof will be explored in depth.

## **CHAPTER 4**

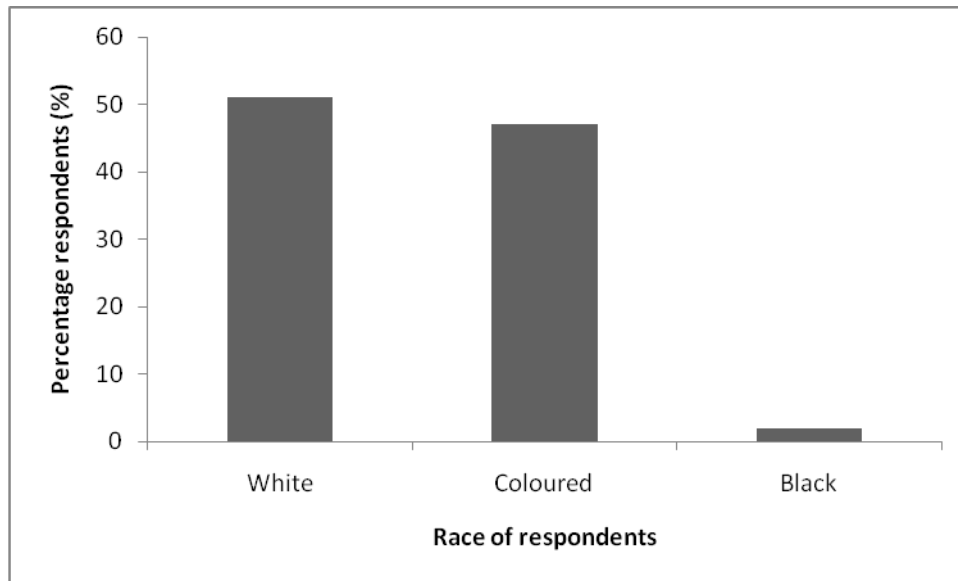
### **RESULTS**

#### **4.1 INTRODUCTION**

In this chapter the results of the study will be presented. Firstly the overall results are expounded, wherafter the results are separated into responses from the rural group, represented by those patients attending the Malmesbury practice (n=73) and the urban group, represented by those patients attending the Milnerton (n=49) practice.

##### **4.1.1 Biographical information**

Of the 122 respondents, 73 (60%) were from rural areas and 49 (40%) were from urban areas. Of the total sample, 121 indicated their ages which ranged from 33 to 80 years with a mean of 58.6 and standard deviation ( $\sigma$ ) of  $\pm 11.24$  years (mode = 54 and median = 56.5 years) and included 66 (54%) males and 56 (46%) females. The overall ethnicity of the respondents included 62 (51%) Whites, 57 (49%) Coloureds and 3 (2%) isiXhosa (cf. Figure 4.1).

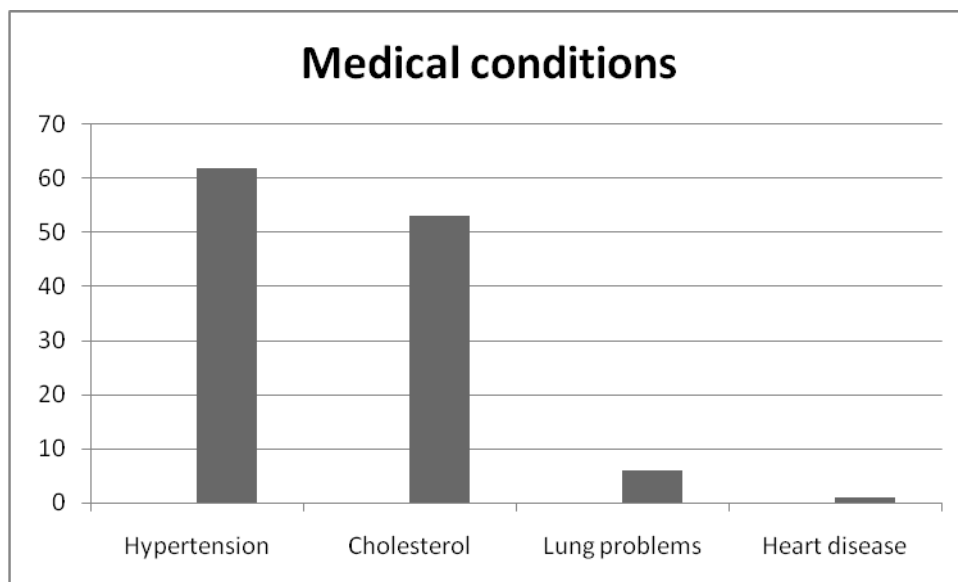


**Figure 4.1:** The ethnic distribution of respondents.

Seventy-six (62%) respondents indicated that their language preference was Afrikaans and 44 (36%) preferred English while 1 (1%) preferred isiXhosa. The average number of successful years of study was 11.88 years, with a range of 5 to 18 years (12 years being taken as successful matriculation). The mean weight of the respondents was 87.7 kg ( $\sigma = \pm 20.6$  kg) (range = 49 to 150 kg) and their mean height was 1.69 metres ( $\sigma = \pm 0.106$  metres) (range = 1.49 metres to 1.98 metres). From the measured heights and weight information, the Body Mass Index (BMI) of each participant/respondent was calculated. Their calculated BMI ranged from 20 kg/m<sup>2</sup> to 58 kg/m<sup>2</sup> with a mean BMI of 30.7 ( $\sigma = \pm 6.8$  kg/m<sup>2</sup>).

### 4.1.2 Medical history

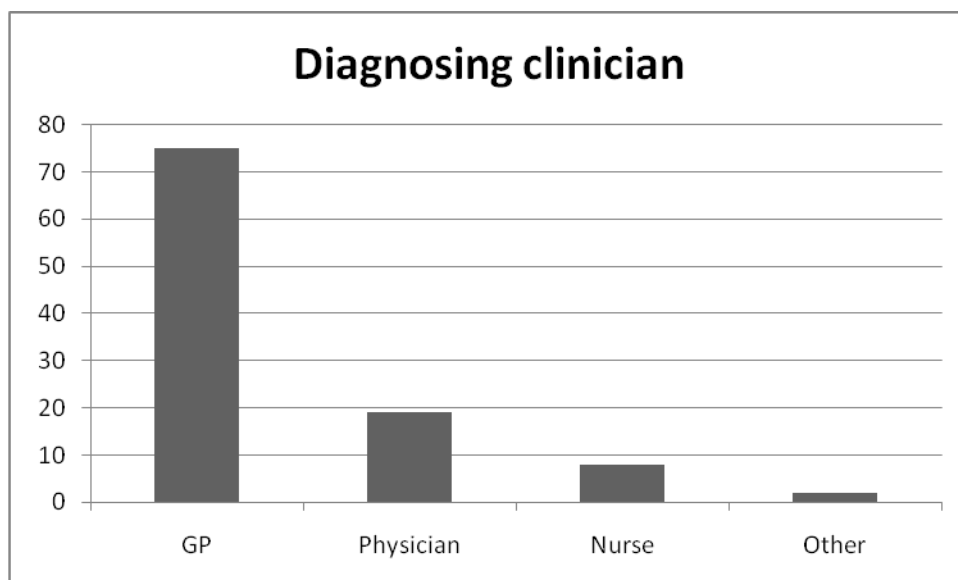
Seventy-three (60%) respondents rated their current health status as good, 46 (38%) as average and three (2%) as poor. No respondents reported being pregnant. Seventy-six (62%) respondents reported that they had hypertension, 65 (53%) had elevated cholesterol levels, none of the respondents reported having tuberculosis (TB), six (5%) had unspecified lung problems, one (1%) reported having heart disease (cf. Figure 4.2).



**Figure 4.2:** The overall percentage respondents regarding medical conditions.

When asked to indicate what type of diabetes they had, 64 (53%) respondents indicated that they had Type 2 diabetes (T2DM), 5 (4%) had Type 1 diabetes (T1DM) and 53 (43%) reported that they did not know what type of diabetes they had. One hundred and fourteen (93%) respondents did not know or recall their latest blood glucose reading while eight (7%) respondents knew their blood glucose

level. Of those who knew their blood glucose level, the reported range was 2.7 mmol/l to 19.2 mmol/l with a mean of 8.25 mmol/l ( $\sigma = \pm 3.25$  mmol/l), and a mode of 7 mmol/l. Forty-nine (40%) respondents indicated that their blood glucose levels were measured on the same day, 17 (14%) indicated that it was done the previous day, 18 (15%) had their blood glucose levels measured within the same week, 20 (16%) in the previous month and 18 (15%) could not recall when they had last taken a blood glucose test. The duration of treatment ranged from 6 months to 40 years, with a mean duration of 7.2 years ( $\sigma = \pm 7.41$ ), a median of 4.5 years and a mode of 1 year. Ninety three (75%) of respondents reported that their diabetes was diagnosed by a General Practitioner (GP), 19 (%) were diagnosed by a physician, 8 (%) by a nurse and 2 (%) reported other (cf. Figure 4.3). In Figure 4.3, other refers to medical professionals such as pharmacists and nursing sisters.

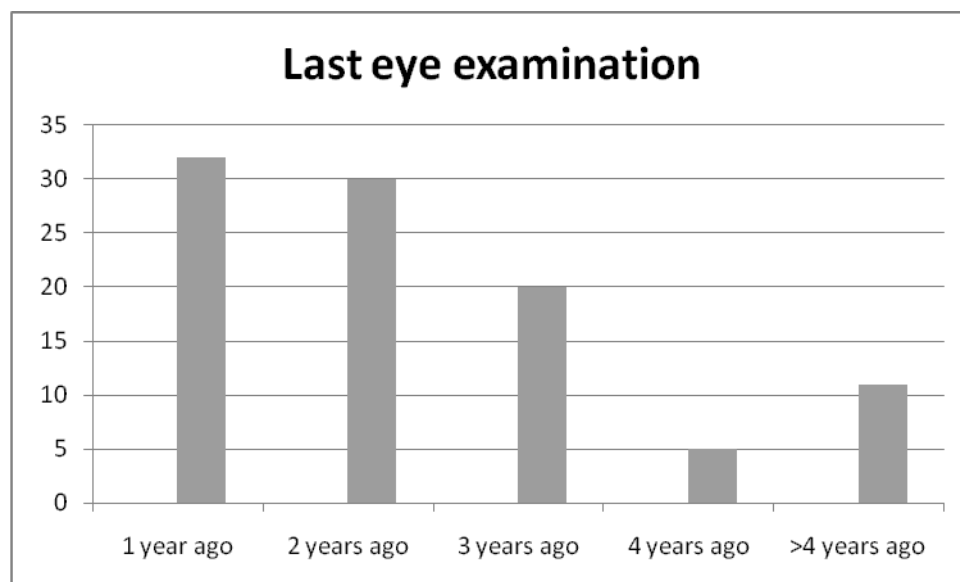


**Figure 4.3:** The percentage distribution of diagnosing clinicians in total sample.

When asked whether they were told about the importance of regular eye examinations by the diagnosing clinician, 73 (60%) respondents indicated that they were informed and 49 (40%) reported that they were not. Forty (33%) of the respondents indicated that their mothers were diabetic, 32 (26%) indicated that their brothers were diabetic, 28 (23%) and 28 (23%) respectively indicated that their fathers and sisters were diabetic while 40 (33%) reported no family history of diabetes.

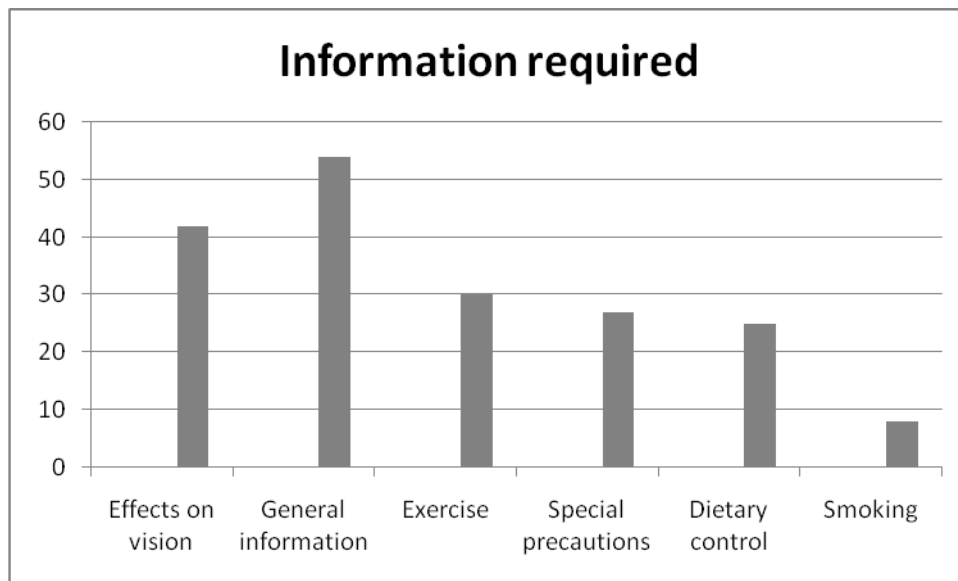
#### 4.1.3 Knowledge about eye care

Of the respondents who answered this question, thirty-nine (32%) reported that their last eye examination was done one year ago, 36 (30%) two years ago, 24 (20%) three years ago, nine (5%) four years ago and 13 (11%) respondents indicated that it was more than four years ago (cf. Figure 4.4).



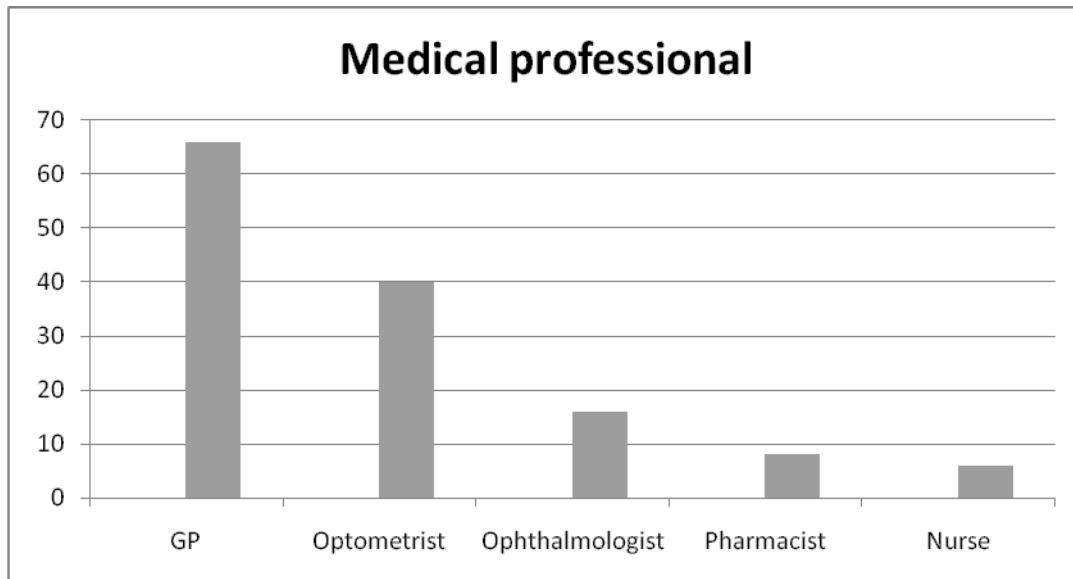
**Figure 4.4:** The overall percentage respondents showing the last time they had an eye examination.

The majority, 64 (52%), of respondents had their previous eye examination in the same optometric practice where this study was conducted, 41 (34%) were examined at another practice and 16 (13%) had their last ophthalmic examination with an ophthalmologist. Seventy-two (59%) of the respondents reported that their main reason for the eye test was to obtain new glasses, 59 (48%) had their eye test because they were diabetic, 17 (14%) tested their eyes because they had optical benefits available on their medical aid, four (3%) were referred for an eye examination by their GP and eight (7%) reported that they had their eyes examined for no particular reason. Seventy-eight (64%) of the patients knew where to go for a diabetic eye examination and 44 (36%) did not know. Ninety-eight (80%) respondents reported that the cost of an eye test was not an important consideration to having their eyes examined but 24 (20%) indicated that it was. Similarly, 114 (93%) of respondents indicated that they had no problem taking time off work to have an eye examination while eight (7%) reported the contrary. Although 72 (59%) respondents felt that they had received adequate information regarding diabetic eye disease when they were first diagnosed with diabetes, the remaining 50 (41%) respondents reported that they did not receive adequate information.



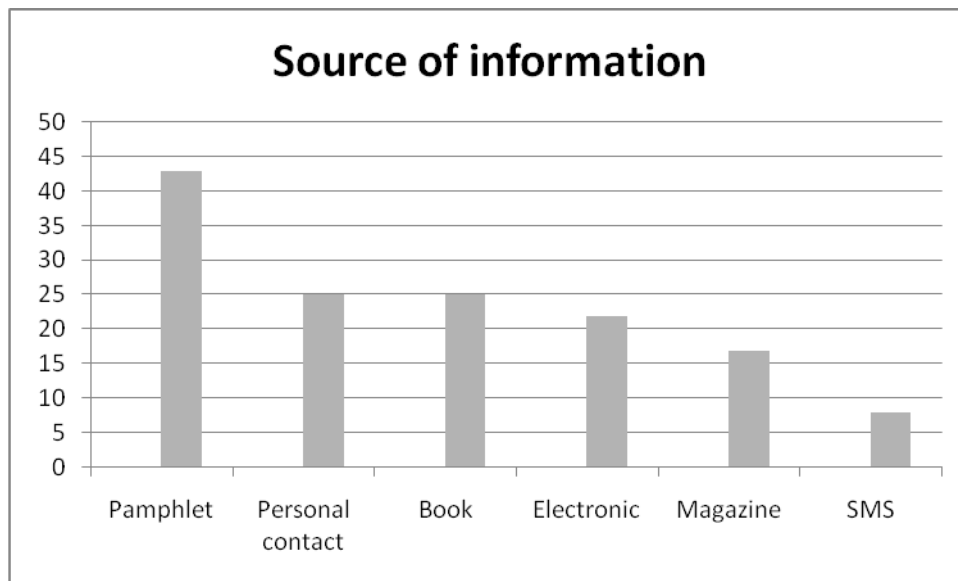
**Figure 4.5:** Percentage distribution of information required by respondents in the sample.

Eighty-four (71%) respondents indicated that checking their own blood glucose levels was not expensive, 33 (28%) said it was while five of the 122 respondents (4%) did not respond to this question. Sixty-seven (54%) respondents indicated that they would have liked to receive general information on diabetes (cf. Figure 4.5).



**Figure 4.6:** The overall percentage respondents regarding the medical professional from whom they would like to receive information on diabetes.

In response to how often they would like to receive information about diabetes, 82 (67%) said on a continuous basis, 32 (26%) said once, while eight (7%) wanted to receive it twice. Eighty-one (66%) respondents preferred receiving information about diabetes from their GP and 53 (43%) preferred this information to be provided in pamphlet form. The preferred medical professional from whom respondents would like to obtain information on diabetes and the format in which they prefer the information to be provided are illustrated in Figures 4.6 and 4.7 respectively.

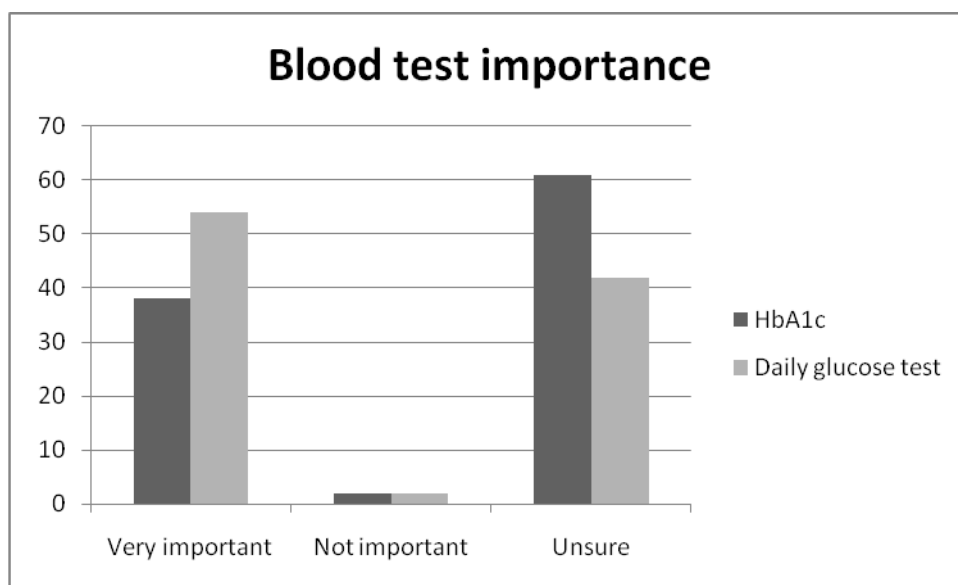


**Figure 4.7:** The preferred source of information of total sample.

#### **4.1.4 Overall patients' knowledge of diabetes mellitus**

Seventy-five (61%) of the respondents knew that there are two main types of diabetes, 17 (14%) reported that there were more than two types and 15 (12%) reported either that there was only one type or did not know. Seventy-three (60%) of the respondents thought diabetes was a hereditary disease and 48 (40%) thought otherwise. Seventy-six (62%) felt that pregnancy could not cause diabetes while 46 (38%) felt it could. One hundred and nineteen (98%) respondents agreed that the control of blood sugar levels reduces the complications of diabetes although three (2%) disagreed. Seventy-two (59%) respondents agreed that diabetes could cause depression and/or anxiety, 10 (8%) disagreed while 40 (33%) were unsure. As regards the converse question, fifty (41%) respondents agreed that depression and/or anxiety could cause diabetes and 21 (17%) disagreed while 51 (42%) did not know.

When questioned about the importance of certain blood tests in the management of diabetes, 46 (38%) respondents considered the HbA1c glycolated haemoglobin test to be very important, two (2%) felt it was not important while the remainder 74 (61%) were unsure. Sixty-six (54%) of respondents felt that the daily blood glucose test was very important, three (2%) felt it was of no importance while 52 (42%) were unsure (cf. Figure 4.8).

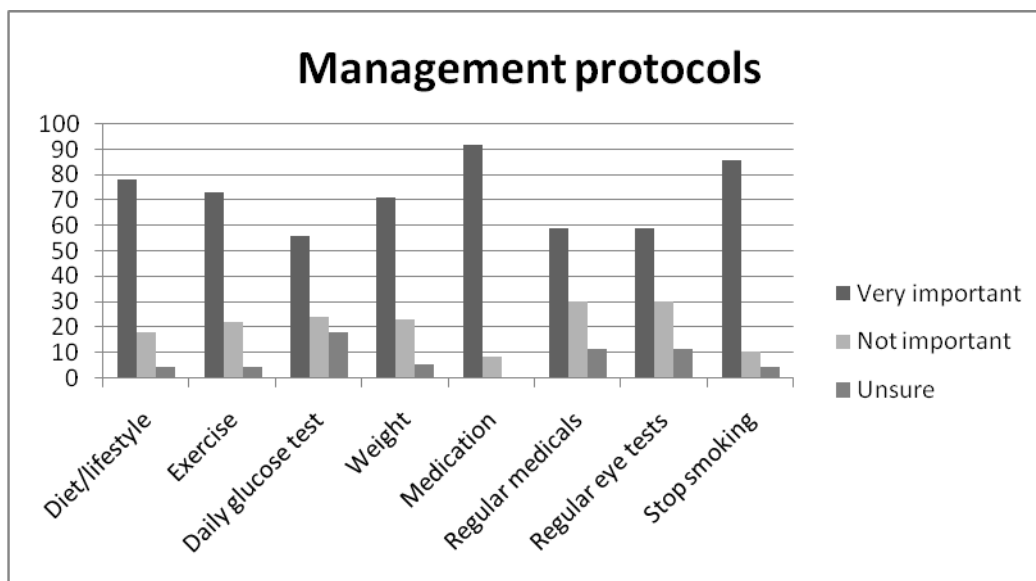


**Figure 4.8:** Ratings of the importance of different blood tests in diabetes management.

#### 4.1.5 Overall knowledge about management of diabetes mellitus

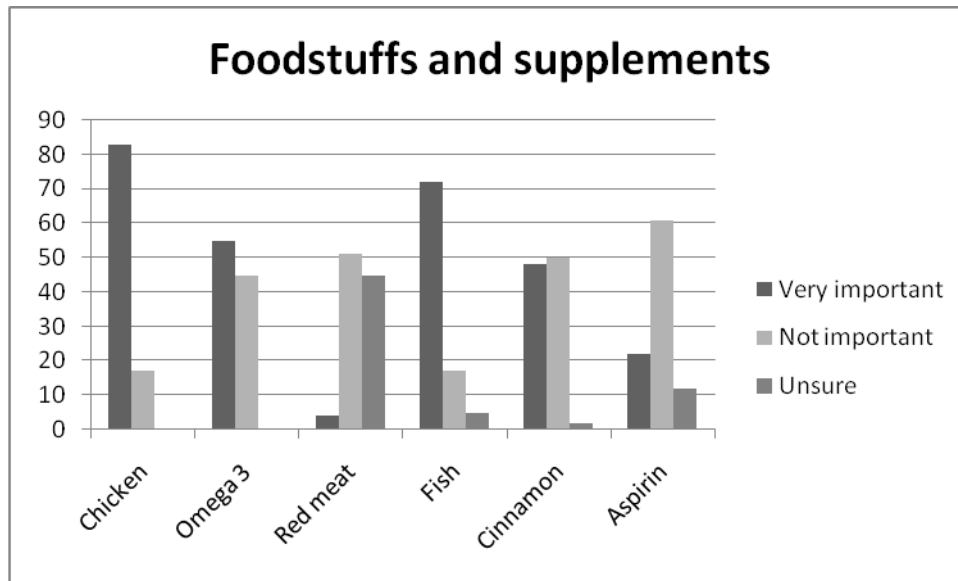
The maintenance of a healthy lifestyle and diet was considered to be very important by the majority 95 (78%) of respondents. Twenty-two (18%) respondents felt this aspect of diabetes management was important while five (4%) deemed this to be slightly important. Regular exercise was considered to be very important by 89

(73%) of patients while 27 (22%) respondents felt it was important and five (4%) as only slightly important. Of those respondents who completed this question, slightly more than half, 68 (56%), rated the daily testing of blood glucose as very important while 32 (24%) patients considered daily testing to be important and 22 (18%) as slightly important. The effective weight management question was answered by 120 respondents and was considered to be very important by the vast majority, 86 (70%), while 28 (23%) of respondents found this element to be important and six (5%) only slightly important. There were no respondents who determined that taking their medication regularly and as directed was only slightly important and 112 (92%) considered this to be very important while ten (8%) patients thought this to be important. The majority 72 (59%) of respondents felt that regular medical checkups were very important, 42 (34%) regarded this as important while 14 (11%) thought this to be slightly important. A similar pattern emerged with regard to regular eye examinations where 72 (59%) of respondents determined this to be very important, 36 (30%) of respondents felt it was important while 14 (11%) thought regular eye examinations to be slightly important. In terms of cessation of smoking, 105 (86%) of respondents considered this to be very important, 12 (10%) felt this was important while a minority 5 (4%) regarded smoking cessation as slightly important. The ratings of relative importance of various factors in relation to managing diabetes mellitus are illustrated in Figure 4.9.



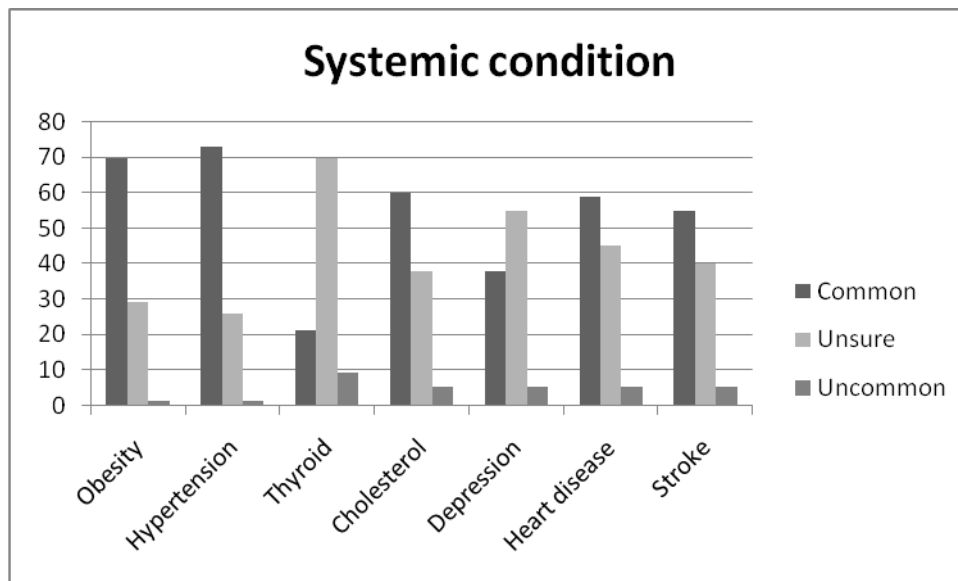
**Figure 4.9:** The percentage ratings of factors that are involved in the management of diabetes for total sample.

Eighty-two (67%) respondents reported that they knew enough about diabetes to manage their own condition while 40 (33%) reported they did not. When asked to rate certain food, supplements or medication in terms of their beneficial effects on diabetes control, 83% rated chicken as very beneficial and, of the 114 respondents that answered regarding fish, 72% rated it very beneficial. Of the 95 respondents answering the question related to aspirin, Seventy-six (62%) respondents indicated that they were unsure of the benefits of aspirin in diabetes. Also, a significant proportion of the respondents were unsure of the beneficial effects of Omega 3 (45%) and Cinnamon (50%) (cf. Figure 4.10).



**Figure 4.10:** Respondents' ratings regarding the benefits of various foodstuffs, supplements and over the counter medication.

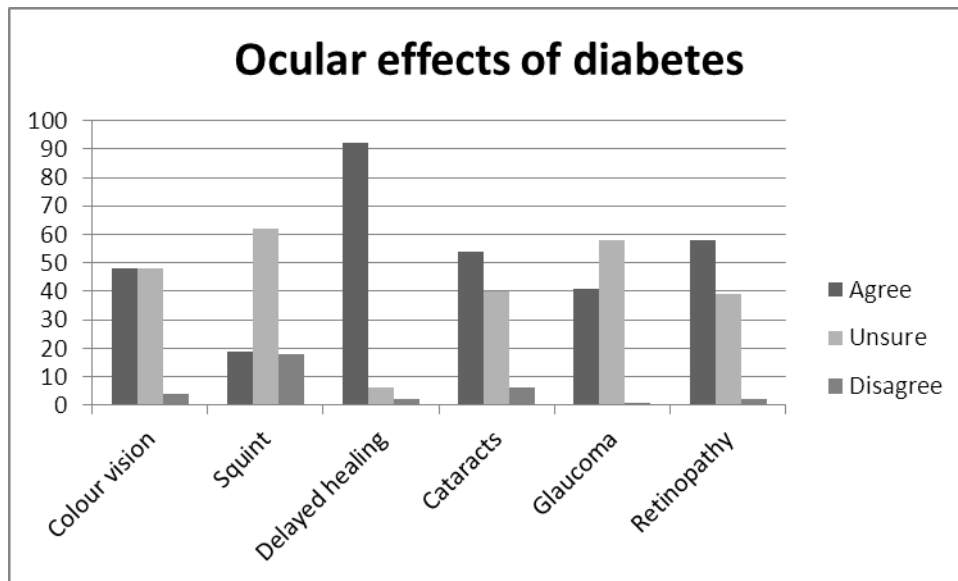
Eighty-five (70%) of 121 respondents felt that obesity was commonly encountered in diabetes, 35 (30%) were not sure and 1 (1%) felt that it was not a common occurrence. Ninety (73%) respondents considered hypertension to be commonly associated with diabetes while 32 (26%) were unsure. In terms of cholesterol as a commonly encountered factor with diabetes, 71 (58%) of the respondents agreed that this was true. The responses to the questions on the association between diabetes and other systemic conditions are shown in Figure 4.11.



**Figure 4.11:** Respondents' ratings of association between systemic conditions and diabetes.

#### 4.1.6 Knowledge of ocular complications of diabetes

One hundred and nineteen (98%) respondents agreed that diabetes could lead to visual problems, 1 (1%) did not agree and 2 (2%) were not sure. Many, (62%) respondents were also unsure that diabetes could cause squints or glaucoma (58%). Less than half of the respondents, 58 (48%) and 50 (41%) respectively agreed that diabetes could affect colour vision and may lead to glaucoma (cf. Figure 4.12).



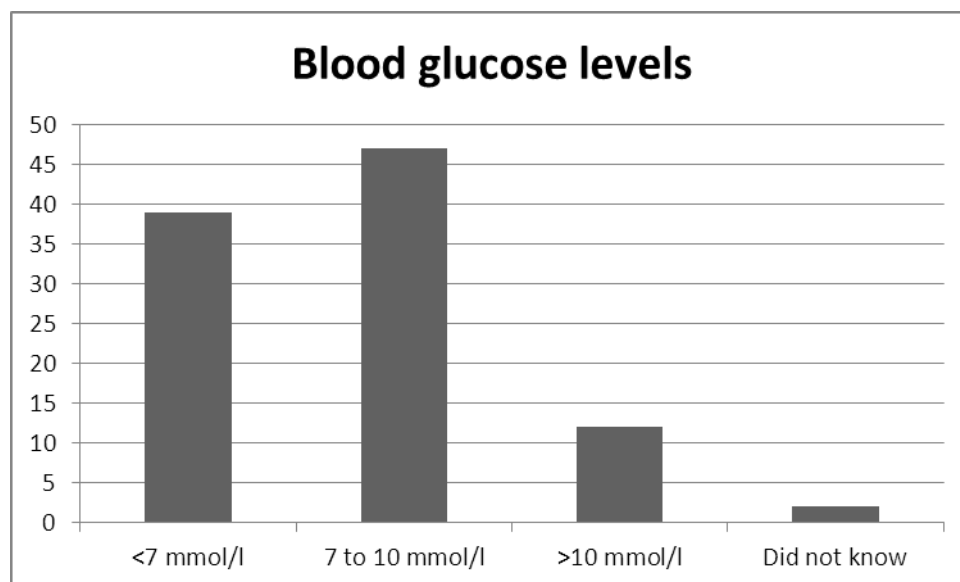
**Figure 4.12:** Percentages of respondents' knowledge regarding the ocular complications of diabetes.

Eighty-eight (72%) respondents felt it was very important for diabetic patients to have an eye examination even if they could still see clearly. Twenty-four (20%) felt it was important while 10 (8%) said it was slightly important. Similarly, the majority 91 (75%) of respondents reported that it was very important to have an eye examination even if their blood glucose levels were well controlled, 24 (20%) felt it was important while six (5%) felt it was slightly important. When asked if they knew about laser treatment for diabetic eye disease, 38 (31%) responded "yes" and 84 (69%) reported "no".

#### 4.1.7 Knowledge about management of diabetes

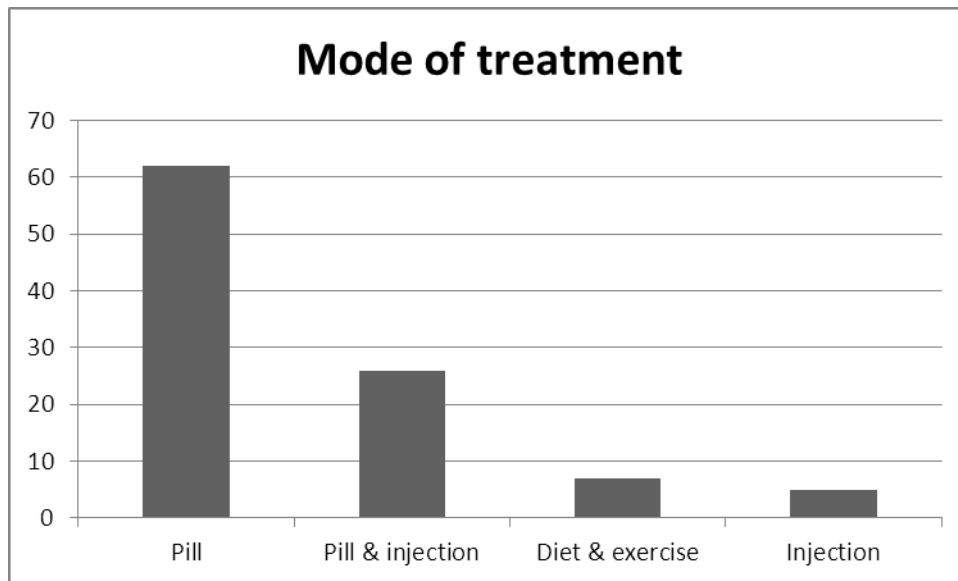
The majority, 91 (75%), of respondents felt that their diabetes was under control and 31 (25%) felt it was not. Many, 100 (82%), respondents reported having a

glucometer to check their blood sugar/glucose levels while 22 (18%) reported not having one. In response to how often respondents checked their blood sugar levels, 40 (33%) reported daily, 28 (23%) reported every second day, 35 (29%) less than weekly and 20 (16%) reported that they only checked their sugar/glucose levels when they visit their doctor. Almost half of respondents, 57 (47%), reported that their blood glucose levels were between 7 and 10 mmol/l when they last checked. The reported usual levels of blood sugar levels are shown in Figure 4.13.



**Figure 4.13:** Last tested blood glucose levels of respondents

With regards to the treatment of diabetes, the majority 78 (62%) of the respondents used oral medication (pills/tablets), 33 (26%) used both pills and injection and eight (7%) reported treating their condition through diet and exercise (cf. Figure 4.14).



**Figure 4.14:** Respondents' different modes of diabetes treatment

When asked whether they exercised, 59% of respondents reported "yes" and 41% reported "no". Of those who reported "yes", 38% exercised daily while 20% respectively reported exercising 1-2 times per week and 3-4 times per week. Sixty-two percent reported that they performed light exercise, 33% exercised moderately (light sweat) and 4% engaged in heavy exercise (out of breath).

The majority 79 (65%) of respondents indicated that they had received lifestyle advice for their diabetic condition and 42 (35%) reported that they had not. Those who received this lifestyle modification advice reported getting it from their GP (35%), dietician (21%), articles (14%), nursing sister (8%), optometrist (6%), family or friend with diabetes (5%), ophthalmologist (4%) and the internet (4%).

Eighty-six (70%) respondents indicated that they usually followed a healthy diet for the control of their diabetes, 15% reported either always following a healthy diet or

that they never followed a healthy diet. Sixty-two (51%) respondents felt that their weight was acceptable for good diabetes control and 60 (48%) felt that it was not. The majority, 100 (82%), of the respondents did not know their Body Mass Index (BMI) and 22 (18%) did. Many, 109 (90%), indicated that they took their medication regularly and as prescribed and 13 (10%) did not. Similarly, 100 (82%) respondents indicated that they went for regular medical check-ups and 22 (18%) did not. When asked whether the control of diabetes may help in preventing eye problems, 109 (89%) participants agreed, one (1%) disagreed and 12 (10%) were unsure. Many, 74 (61%), reported not having annual eye examinations and 48 (39%) respondents reported having them.

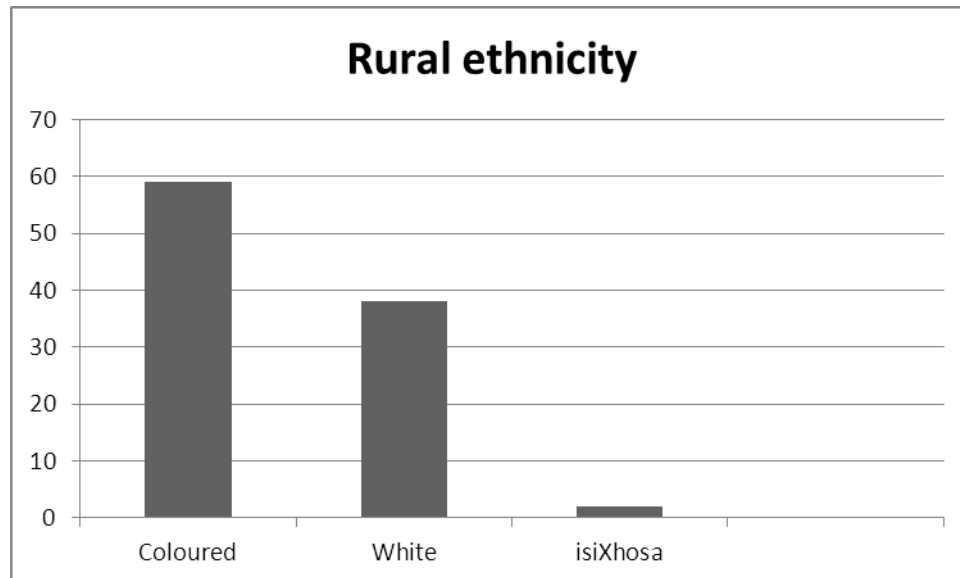
## **4.2 RESULTS FROM RURAL RESPONDENTS**

### **4.2.1 Biographical information**

The rural sample comprised seventy-three subjects ( $n = 73$ ), of these 43 (61%) were males and 30 (42%) females. The age range was 33 to 80 years with a mean of 57 and a mode of 54 years with a median of 56.5 years. The majority 63 (86%) preferred Afrikaans, 9 (12%) preferred English and only one (1%) preferred isiXhosa. The majority of respondents, 43 (59%), were Coloured, 28 (38%) were White and 2 (3%) respondents indicated they were isiXhosa (cf. Figure 4.15).

The average number of successful schooling was 11.99 years (range = 5 years to 12 years), with the median and mode of 12 years. The average height of the rural participants was 1.71 metres (range = 1.5 to 1.98 metres) and their average weight

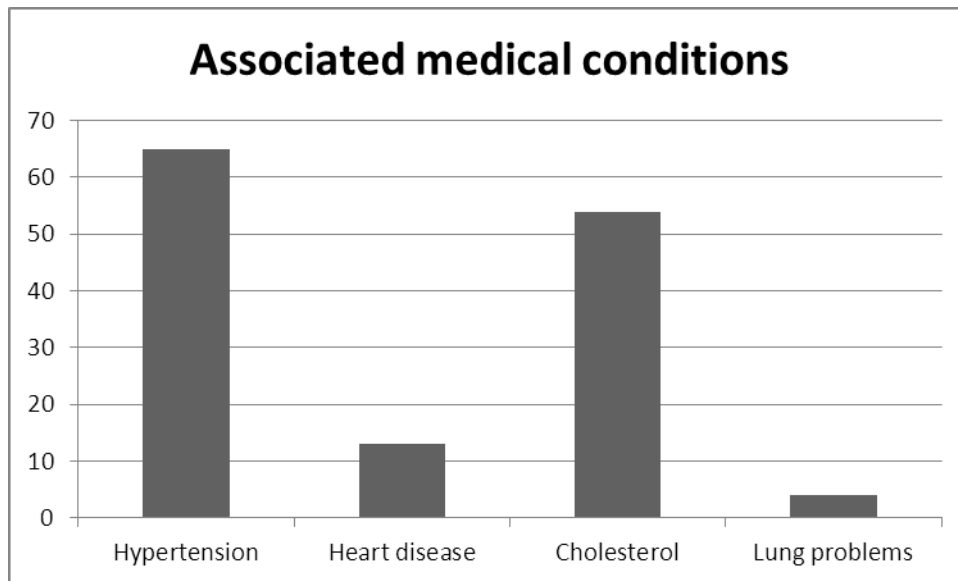
was 91.1 kilograms (range = 54 to 150 kg). The reported average BMI was 31 kg/m<sup>2</sup> with a median and mode of 31 kg/m<sup>2</sup> ( $\sigma = \pm 7.223$ ).



**Figure 4.15:** The ethnic distribution of rural respondents.

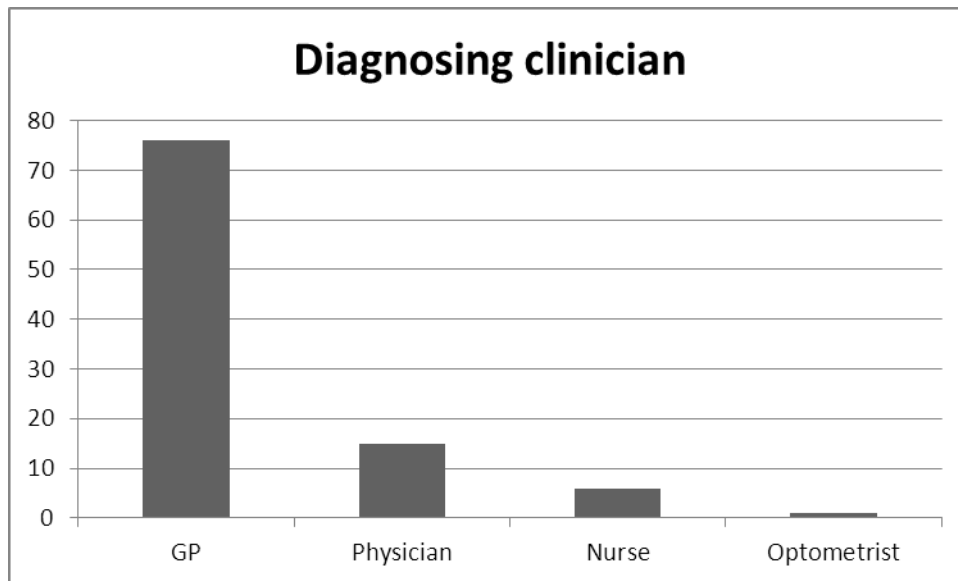
#### **4.2.2 Medical history**

Most respondents, 46 (63%), reported to be in good health, 26 (35%) reported their health to be average and only one respondent reported poor general health. Forty-eight (65%) respondents reported having hypertension, ten (13%) had heart disease, 41 (54%) cholesterol and two (4%) reported having lung problems. The percentage of respondents regarding the specific health conditions reported by the rural participants is shown in Figure 4.16.



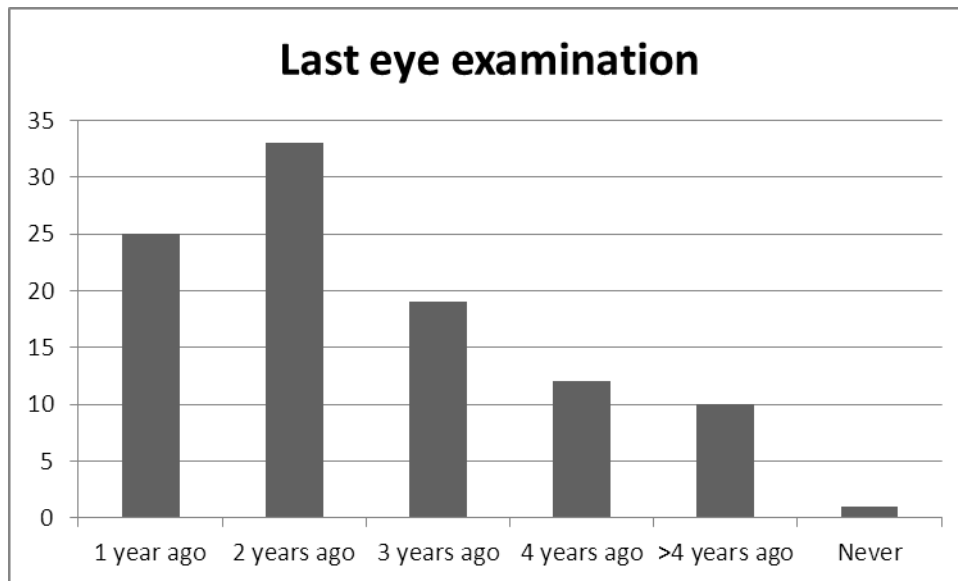
**Figure 4.16:** Rural respondents' associated medical conditions.

Nearly half, 34 (46%), of the respondents reported that they had Type 2 diabetes, three (4%) reported having Type 1 diabetes and a significant proportion, 36 (49%), of respondents did not know what type of diabetes they had. The reported average/mean fasting blood glucose reading was 8.67 mmol/l, with the median of 7.8 mmol/l, mode of 7 mmol/l and range = 2.7 mmol/l to 19.2 mmol/l ( $\sigma = \pm 3.85\text{mmol/l}$ ). Thirty-three respondents reported performing a daily blood glucose test while the majority 40 (55%) of rural participants did not. Of those respondents who performed blood glucose testing, 13% did it the day before, 12% within the week, 16% within the previous month and 12% could not remember. The average duration for rural subjects/patients was 6.64 years ( $\sigma = \pm 6.85$ ), with a median of 4 years and a mode of 1 year. The GP far outnumbered other health professionals in the diagnosis of diabetes among the rural participants (cf. Figure 4.17).



**Figure 4.17:** Rural participants' diagnosing clinician.

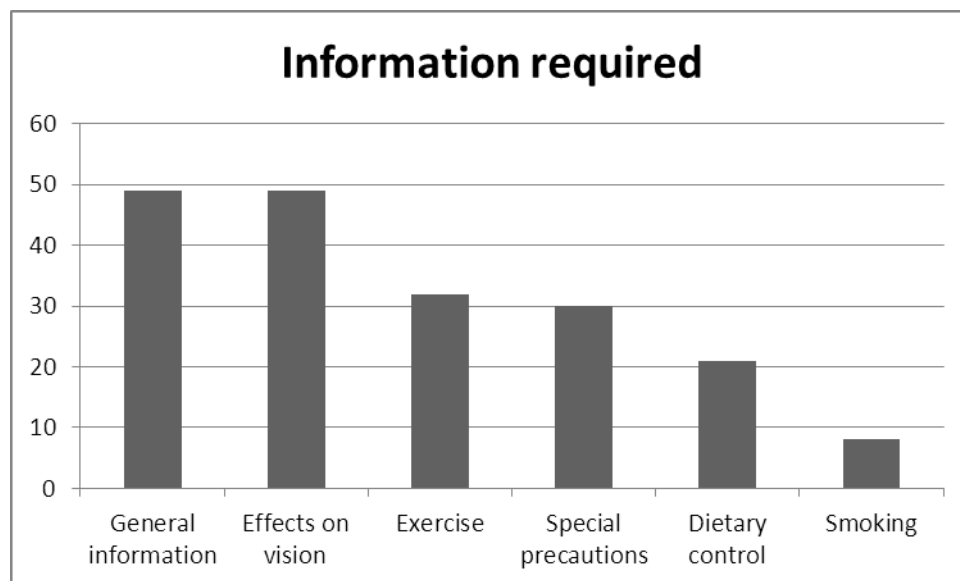
Many, 46 (63%), respondents from the rural area reported that they had been advised on the need for regular eye examinations and 27 (36%) reported that they did not receive such advice. Less than one quarter 25 (23%) of respondents reported that their mothers were diabetic, 22 (21%) reported that their brothers were diabetic, 20 (19%) had diabetic fathers, 19 (18%) reported having diabetic sisters and 20 (19%) had no diabetic family members. One quarter, 18 (25%), of respondents reported having their last eye examination a year previously and seven (10%) more than four years previously. Other responses to the question on the last eye examination are shown in Figure 4.18.



**Figure 4.18:** Rural respondents' period since previous eye examination.

The majority 40 (54%) of respondents had their previous/last eye examination at the practice where they completed the questionnaire, 23 (31%) at another practice and 10 (13%) at an ophthalmologist. Among the respondents who had their eyes tested, 49 (67%) and 38 (52%) respectively indicated it was because they needed new glasses or were diabetic, 10 (14%) reported that it was because their medical aid would pay, one (1%) indicated that they were either referred by their GP or there was no particular reason for undergoing an eye examination. Almost two-thirds 47 (64%) reported that they knew where to go for an eye test/examination while 26 (36%) reported that they did not know. The cost of an eye test/examination was not a barrier for an eye examination for the majority, 57 (72%), of the respondents from the rural area while 16 (22%) cited cost as a barrier. Similarly, 50 (68%) respondents reported that the cost of checking their blood sugar levels was not a barrier to doing so while 18 (32%) reported that it was.

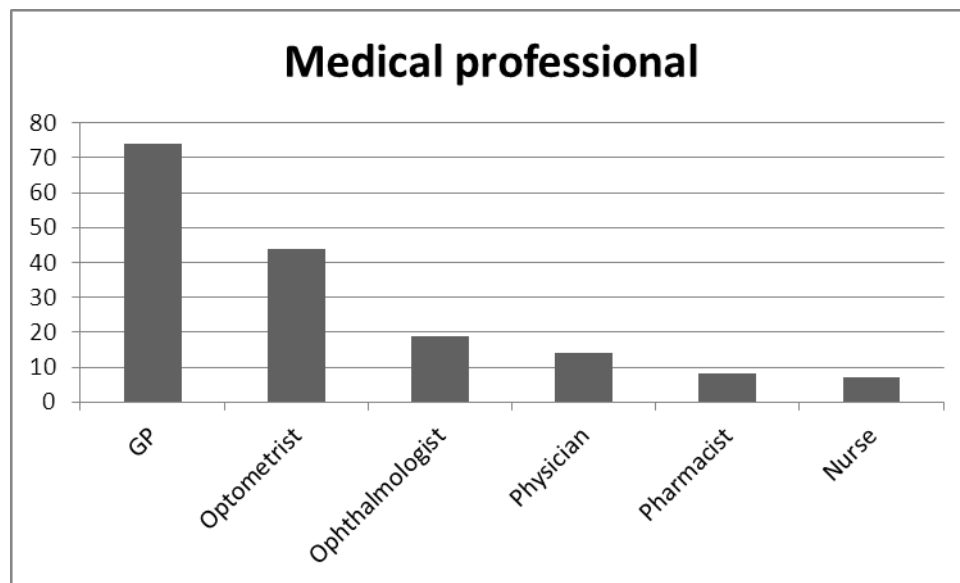
Also, 68 (93%) respondents reported that taking time off work to go for an eye examination was not a problem for them while five (7%) indicated that this was a problem. The majority, 44 (60%), of participants felt that they were provided with adequate information about possible diabetic eye disease when they were diagnosed with their condition while 29 (40%) felt that this information was inadequate. With regards to the type of information they would like to receive, 49% of respondents reported that they would general information on diabetes and its effects on vision respectively. Smaller percentages reported that they would like information on special precautions to take as a diabetic (30%), exercise (32%) and the effects of smoking (8%) on their diabetic condition (cf. Figure 4.19).



**Figure 4.19:** Diabetic information rural respondents would like to receive.

The majority, 50 (68%), preferred this information to be provided to them on a continuous basis, 17 (23%) preferred to be provided once and six (8%) preferred it

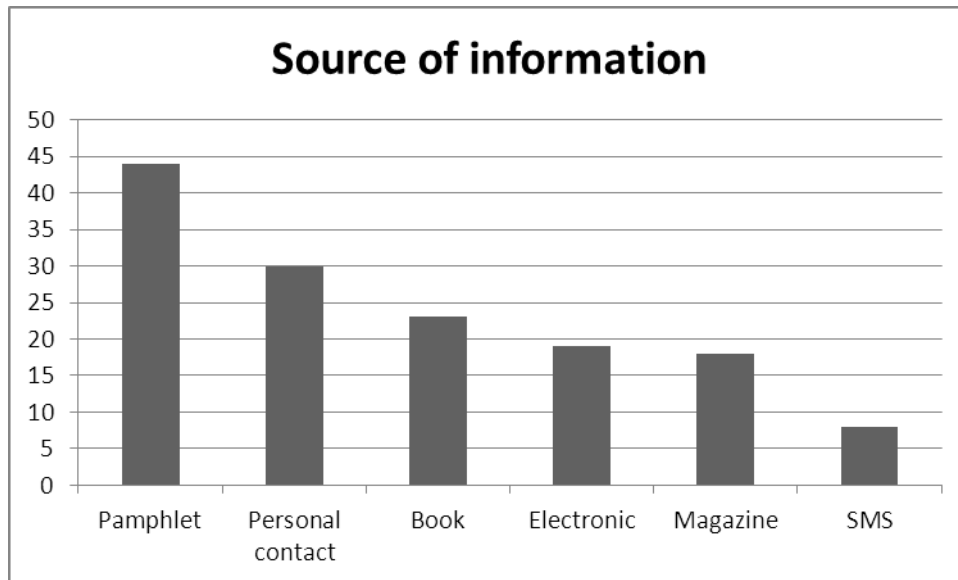
twice. Most, 54 (74%), respondents reported that they wanted information on diabetes to be given to them by their GP, 32 (44%) from their optometrist, 14 (19%) from an ophthalmologist, 10 (14%) wanted their physicians to provide them with this information, eight (10%) from a pharmacist and five (7%) from a nursing sister (cf. Figure 4.20).



**Figure 4.20:** The medical professional from whom rural respondents would like the information about diabetes.

Regarding the source of information preferred, where respondents were invited to mark more than one possibility, 32 (44%), of the rural respondents reported pamphlets as the most convenient source, 22 (30%) preferred personal contact, 17 (23%) wanted book-based information regarding diabetes, 14 (19%) and 13 (18%) of respondents preferred information from the internet or magazines respectively,

while six (8%) preferred SMS. Preferred sources of information from rural respondents are illustrated in Figure 4.21.

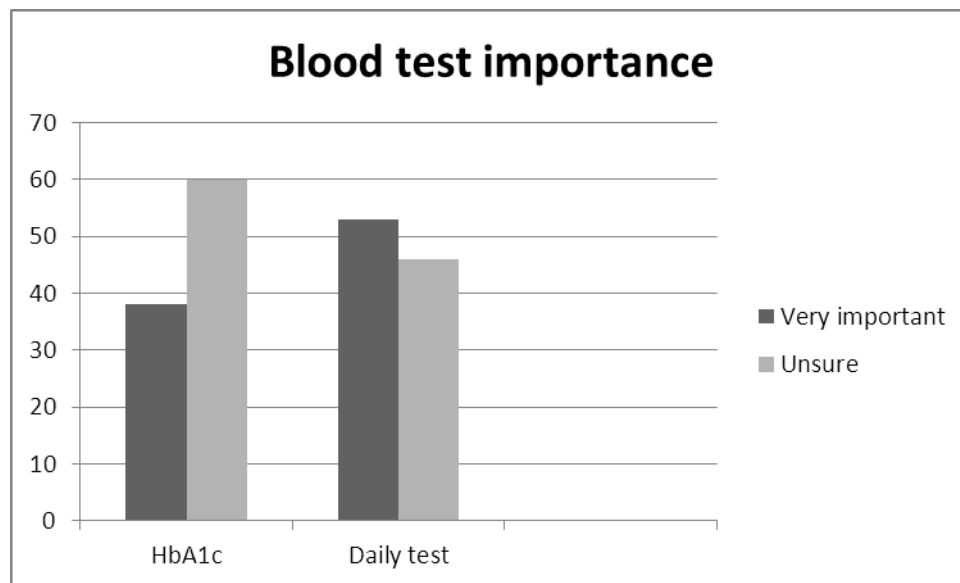


**Figure 4.21:** The source of diabetes information preferred by rural respondents.

### 4.2.3 Rural respondents' knowledge of diabetes

The majority, 41 (56%), of rural respondents were aware that there are two main types of diabetes, 11 (15%) knew of one type only or did not know how many types of diabetes there were while 10 (14%) reported that there were more than two types of diabetes. Many, 44 (61%) respondents knew that diabetes was a hereditary condition while 28 (39%) did not know. Most, 48 (65%), respondents reported that pregnancy was not a potential risk factor for the development of diabetes while the remainder, 25 (34%), reported that pregnancy was a risk factor. More than half, 44 (60%), of respondents agreed that diabetes could lead to depression and/or anxiety, 23 (32%) were unsure while six (8%) respondents disagreed. In response to

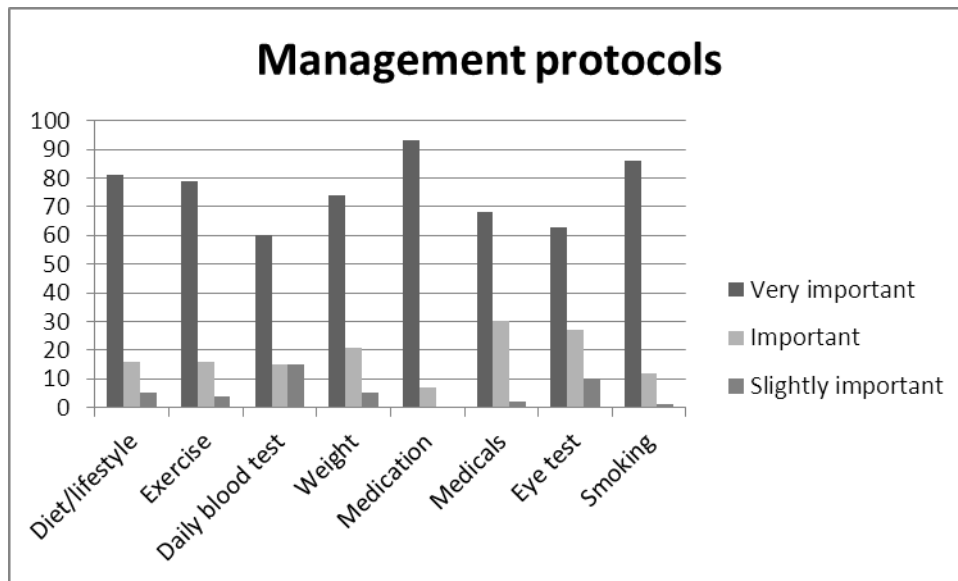
whether depression and/or anxiety could cause diabetes, 34 (47%) agreed, 30 (41%) were unsure and nine (12%) disagreed. With regard to diabetic blood tests, the majority, 44 (60%), of rural respondents were unsure whether glycosylated haemoglobin (HbA1c) was important while 38 (53%) felt that daily blood glucose testing was very important (cf. Figure 4.22).



**Figure 4.22:** Rural respondents' opinion on the importance of blood tests for diabetes

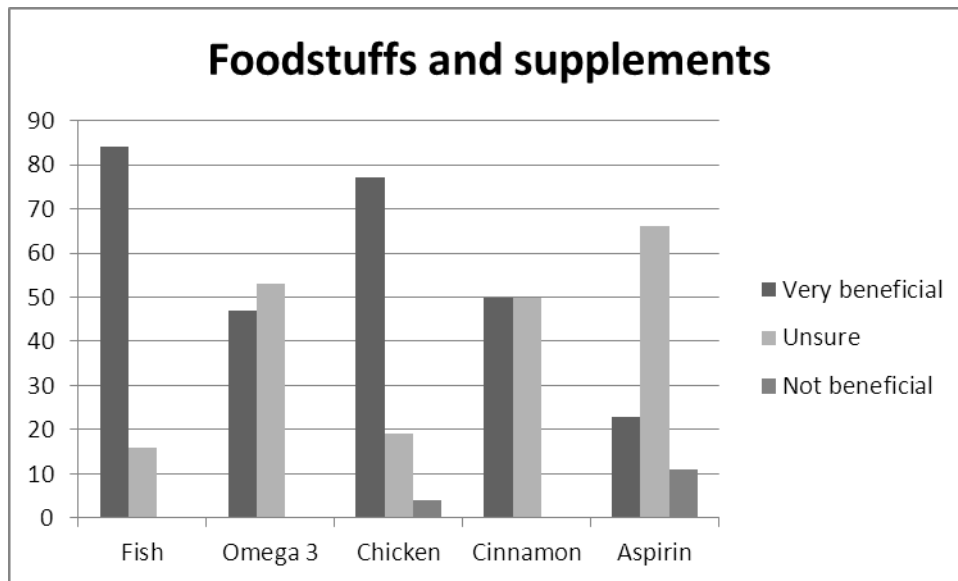
#### 4.2.4 Diabetes management of rural respondents

The majority of rural respondents felt that maintaining a healthy diet and lifestyle (81%), regular exercises (79%), checking blood sugar daily (60%), weight management (73%), regular medication (93%), regular medical check-ups (68%), regular eye examinations (63%) and smoking cessation (86%) were very important factors in the management of diabetes (cf. Figure 4.23).



**Figure 4.23:** Rural respondents value of the various protocols in diabetes management.

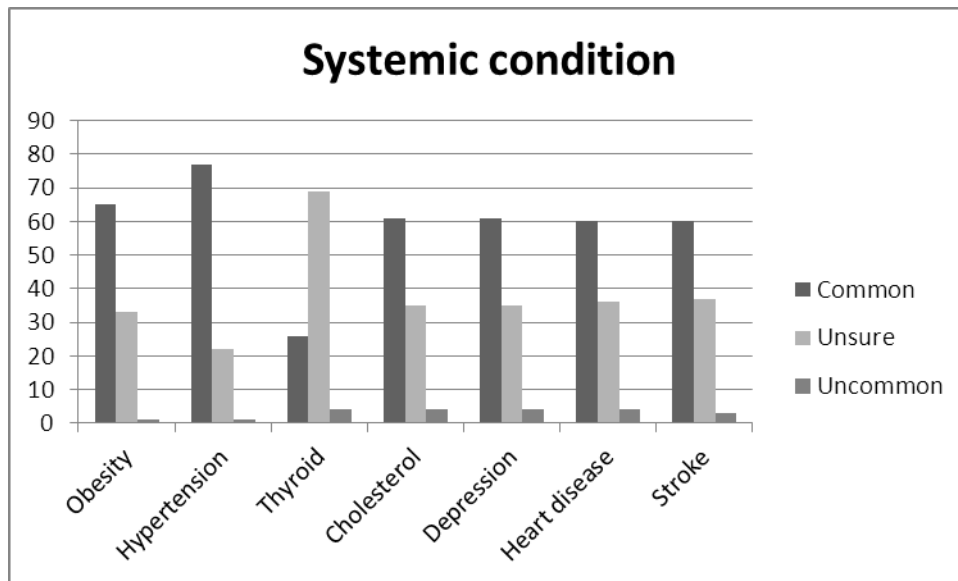
The majority, 51 (70%), of rural respondents considered that they knew enough about diabetes to manage the condition themselves while 22 (30%) reported to the contrary. The majority (84%) of rural respondents felt that fish and chicken (77%) were very beneficial in the management of their condition although a significant proportion were unsure of the benefits of Omega 3 (53%), Aspirin (66%) and Cinnamon (50%) (cf. Figure 4.24).



**Figure 4.24:** Rural respondents opinion of the benefits of foodstuffs and supplements

#### 4.2.5 Rural respondents' knowledge of associated health conditions

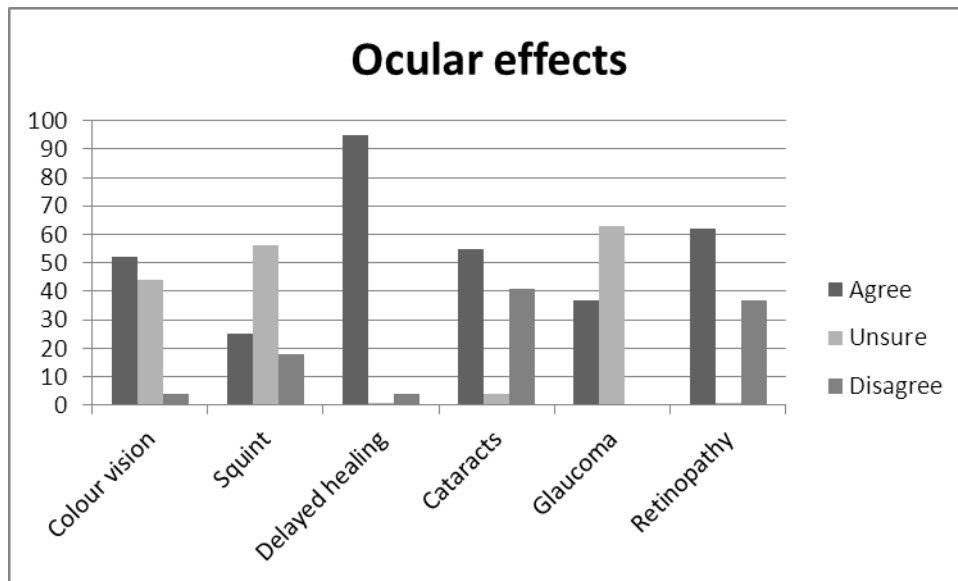
Most, 56 (77%), of the respondents from the rural area identified hypertension as commonly associated with diabetes. Forty-seven (65%) recognised obesity, 43 (59%) equally identified cholesterol, heart disease and stroke as significant co-morbidities. A significant proportion, 29 (40%), of the rural respondents were unsure or disagreed with the association between depression and diabetes, 27 (37%) were unsure of stroke and diabetes association, 26 (36%) heart disease and diabetes and 24 (33%) obesity and diabetes (cf. Figure 4.25).



**Figure 4.25:** Knowledge of the association of various health conditions with diabetes among the rural respondents.

#### 4.2.6 Rural respondents' knowledge of ocular complications

The majority, 71 (97%), of the respondents from the rural areas agreed that diabetes could affect vision while two (3%) disagreed or were unsure that diabetes could affect their vision. Many, 69 (95%), respondents agreed that diabetes could affect wound healing after injury, 45 (62%) agreed that diabetes could cause bleeding within the eye, 40 (55%) that diabetes could cause cataracts and 38 (52%) agreed that colour vision could be affected. Significantly, a high proportion, 46 (63%), of rural respondents reported that they were not sure that diabetes could cause glaucoma, 42 (57%) were unsure of diabetes related squints, 32 (44%) that diabetes could affect colour vision, 30 (41%) that diabetes could cause cataracts and 27 (37%) of rural respondents were unsure whether diabetes could cause bleeding within the eye (cf. Figure 4.26).



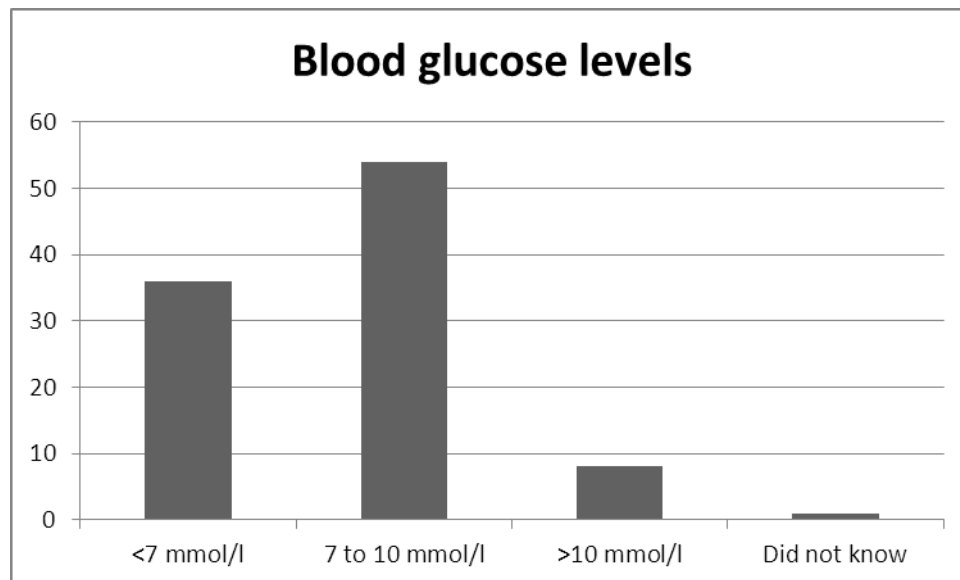
**Figure 4.26:** Rural respondents knowledge of the ocular complications of diabetes.

When rural patients were asked how important it was to have an eye examination even if they could still see clearly, 53 (73%) felt it was very important, 13 (18%) said it was important and seven (9%) felt that it was slightly important. Similarly, 55 (76%) rural respondents felt it was very important to to have an eye examination even if their diabetes was well controlled, 14 (19%) felt it was slightly important and three (4%) indicated that it was not important. The majority, 48 (66%) of rural respondents did not know about laser treatment for diabetic eye disease while 25 (34%) reported that they did.

#### **4.2.7 Rural respondents' knowledge of management of diabetes**

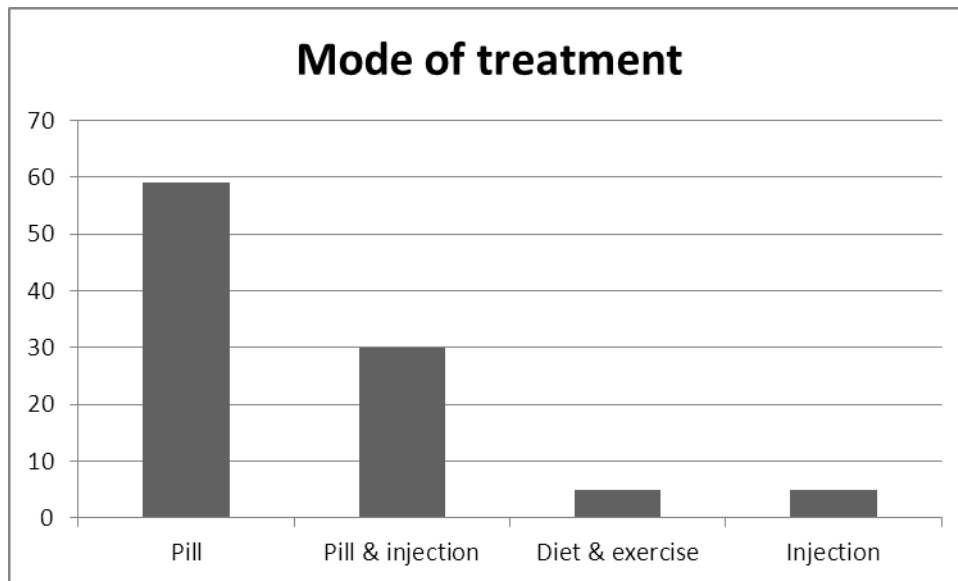
The majority, 56 (77%), of rural respondents felt that their diabetes was under control while 17 (23%) felt that their condition was not. However, more than half, 39 (54%), of respondents reported blood sugar levels of 7 – 10 mmol/l, six (8%)

reported that their sugar levels were in excess of 10 mmol/l while 26 (36%) reported normal sugar levels of less than 7 mmol/l. One respondent (1%) did not know what their previous blood glucose reading was (cf. Figure 4.27).



**Figure 4.27:** Rural respondents usual blood glucose level.

Most, 59 (82%), respondents from the rural area had a glucometer while 13 (18%) did not. More than one quarter of the rural respondents, 21 (29%), reported that they measured their blood sugar daily, 20 (27%) measured it every second day, 21 (29%) less than weekly and 12 (16%) measured their glucose levels only when they went to the doctor. The majority, 44 (60%), of respondents reported that they were treating their condition by oral medication, 22 (30%) by insulin injection and pills while 4 (5%) respondents treated their diabetes either by insulin alone or by diet and exercise (cf. Figure 4.28).



**Figure 4.28:** The diabetes treatment modality of rural respondents.

Many respondents, 44 (61%), from the rural area admitted that they did not exercise regularly while 28 (39%) reported that they did. Of those who reported exercising regularly, 36% reported exercising daily, 25% exercised 3-4 times per week and 39% 1-2 times per week. The majority, (61%), of these respondents admitted to doing light exercises, 32% moderate (light sweat) exercise and 7% reported did heavy exercise, defined as out of breath. Most, 44 (61%), rural diabetic patients had received lifestyle advice for their diabetic condition. The advice on lifestyle was received from their GP (82%), dietician (41%), articles (27%), optometrist (16%), nurse (16%), ophthalmologist (5%), family or friend with diabetes (5%).

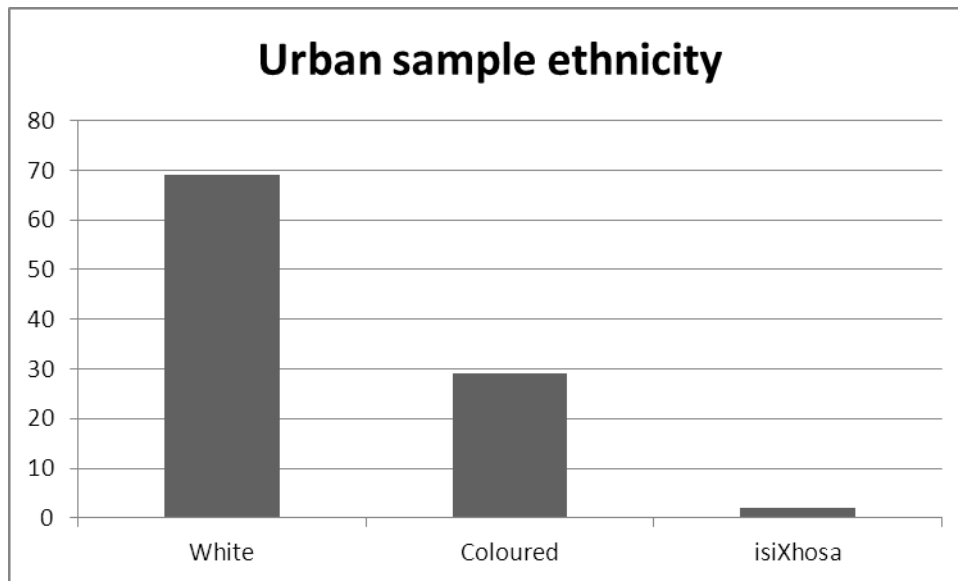
#### **4.2.8 Rural respondents' general diabetes management**

The majority, 52 (71%), of rural respondents stated that they usually followed a healthy diet aimed at better controlling their diabetes, 12 (17%) reported always following a healthy diet while nine (12%) respondents reported never following a healthy diet. Half, 36 (50%), of the respondents felt that their weight was acceptable for good control of the disease while the other half (50%) felt it was not. A high proportion, 61 (84%), of the respondents reported not knowing their Body Mass Index (BMI) with only 12 (16%) knowing what their BMI was. The majority, 64 (89%), of rural respondents took their medication as prescribed while eight (11%) did not. Similarly, 59 (82%) reported going for regular medical check-ups and 13 (18%) did not. Also, 63 (86%) of rural respondents agreed that controlling their blood glucose levels may help prevent eye problems, nine (12%) were unsure and only one (2%) disagreed. About one third 27 (37%) of rural respondents reported having annual eye examinations while 46 (63%) reported not having them.

### **4.3 RESULTS FOR THE URBAN RESPONDENTS**

#### **4.3.1 Biographical information**

Of the sample total of 122, 49 (40%) were urban respondents. Their ages ranged from 33 to 80 years with a mean and median of 60 years ( $\sigma = \pm 27.29$  years) and a mode of 63. Their gender distribution was 47% males and 53% females. There were 71% Whites, 27% Coloureds and 2% isiXhosa in the sample (cf. Figure 4.29). There were no Indians represented in the sample from the urban respondents.



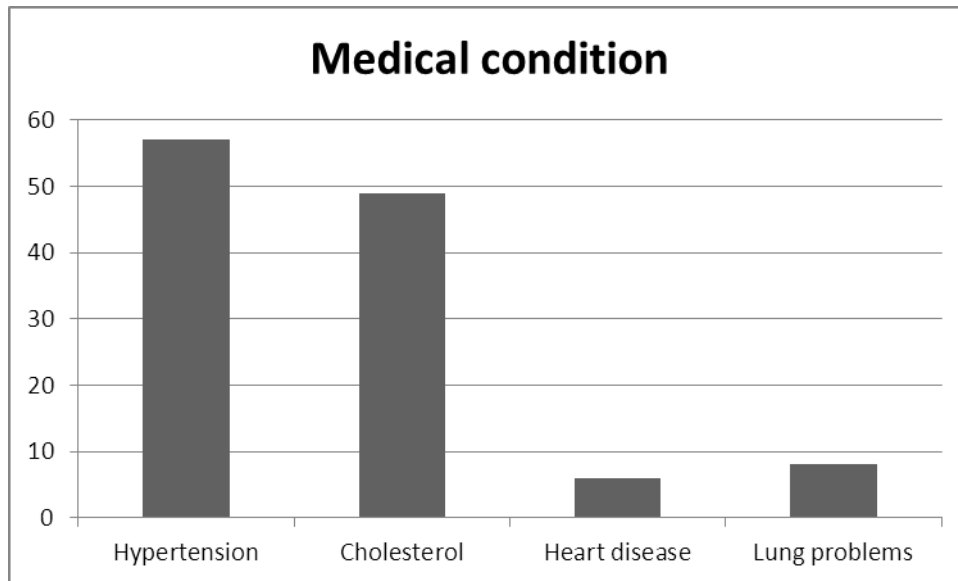
**Figure 4.29:** The ethnic distribution of urban respondents.

The majority, 35 (71%), of the subjects stated that they were English-speaking followed by Afrikaans, 14 (29%). There were no other languages indicated in the sample. The highest level of education in the sample ranged from 8 to 17 years of successful schooling, with a mean of 11.7 years ( $\sigma = \pm 5.41$ ) and median and mode of 12 years. Their weight ranged from 49 to 130 kilograms, with a mean of 82.7 ( $\sigma = \pm 39.4$ ) and median and mode of 80 kilograms. The height of the urban respondents ranged from 1.49 to 1.87 metres, with a mean of 1.76 metres ( $\sigma = \pm 5.01$ ) a median of 1.7 metres and a mode of 1.6 metres. The mean of their Body Mass Index (BMI) was 29.9 ( $\sigma = \pm 13.0$ ) and median 28 and mode 27.

#### **4.3.2 Medical history**

The majority, 27 (55%), of the respondents stated that their general health was good, 20 (41%) considered their health to be average and two (4%) felt that their

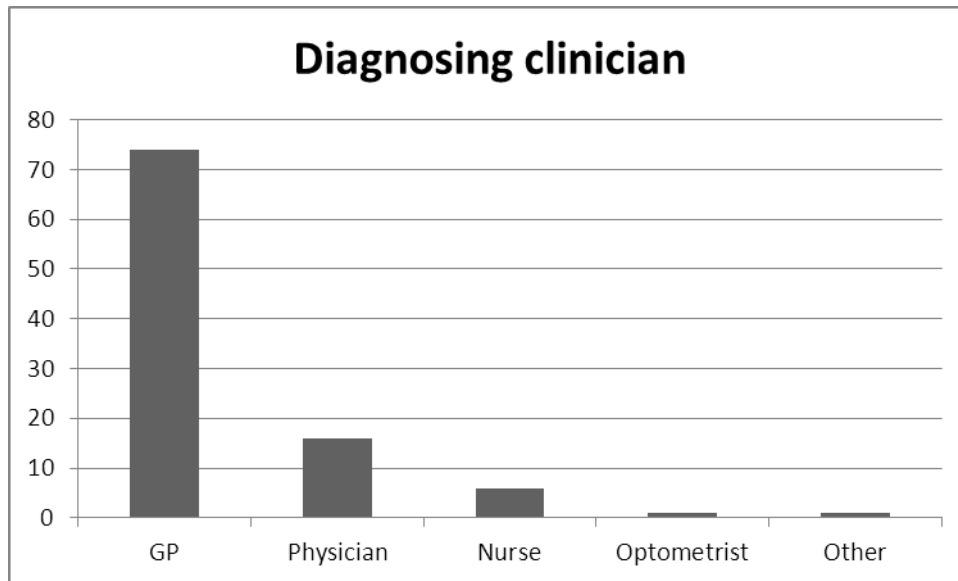
health was poor. A significant proportion, 28 (57%) and 24 (49%) respectively reported that they were treated for hypertension and cholesterol problems while four (8%) and three (6%) respectively were treated for lung problems and heart disease (cf. Figure 4.30).



**Figure 4.30:** Associated medical conditions of urban respondents.

The majority, 30 (61%), of the urban respondents reported having Type 2 diabetes, two (4%) reported having Type 1 diabetes and 17 (35%) did not know what type of diabetes they had. The urban respondents' latest blood glucose levels ranged from 4 mmol/l to 17.5 mmol/l, with a mean of 7.65 ( $\sigma = \pm 5.21$ ) a median of 6.5 mmol/l and a mode of 8 mmol/l. One third, 16 (33%), of the respondents reported that they had their blood sugar reading taken the same day they completed the survey, seven (14%) the previous day, nine (18%) within the previous week, eight (16%) within the previous month and nine (18%) indicated that they could not remember when they had last measured their blood glucose levels. The mean duration of

diabetes treatment in the urban respondents was 8.04 years, with a median of 5 years and a mode of 4 years. The majority, 37 (74%), of patients were diagnosed with diabetes by their GP, eight (16%) by specialist physicians, three (6%) by nurses and one (2%) each by an optometrist and unspecified other (cf. Figure 4.31).

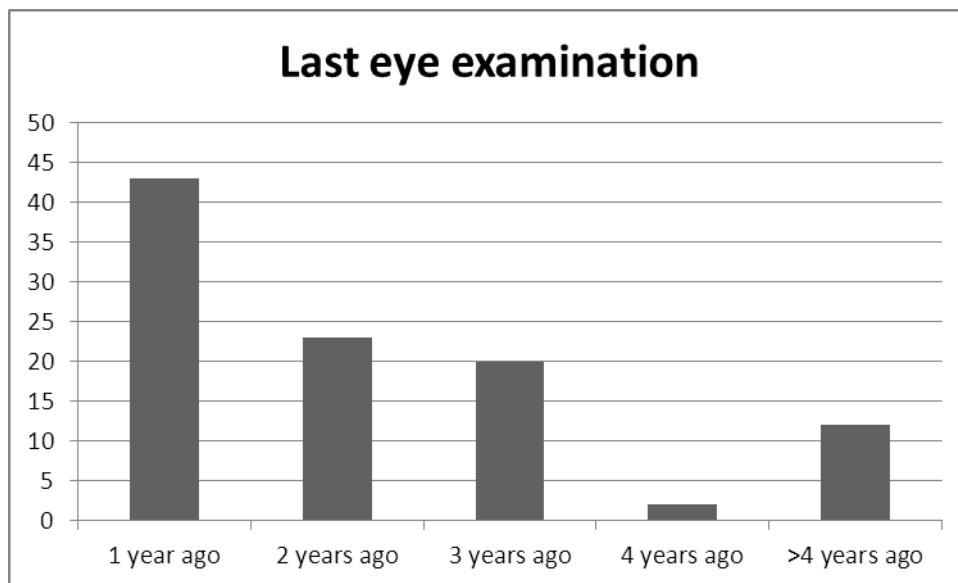


**Figure 4.31:** Diagnosis of diabetes in urban respondents.

More than half, 27 (55%), of respondents reported that they were told about the importance of regular eye examinations when they were diagnosed with diabetes while 22 (45%) reported that they were not told. A significant proportion, 20 (41%), reported no immediate family members with diabetes, 15 (31%) had mothers with the disease, 10 (20%) brothers (20%), nine (18%) sisters and eight (16%) respondents had diabetic fathers.

### 4.3.3 Eye care

Less than half, 21 (43%), indicated that they had an annual eye examination, 11 (23%) reported that they had it two years previously, 10 (20%) three years prior, one (2%) four years ago and six (12%) were last examined more than four years ago (cf. Figure 4.32).



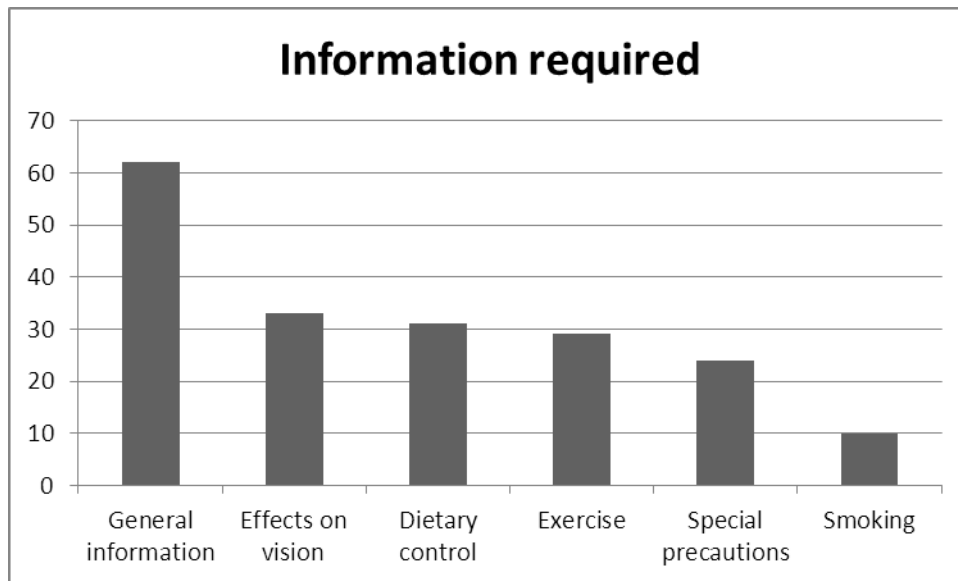
**Figure 4.32:** Urban respondents previous eye examination.

Nealy half, 24 (49%), of the urban respondents indicated that they had their last eye examination at the same practice, 18 (37%) were examined at another practice and six (13%) indicated that they were last seen by an ophthalmologist. In response to why they came to have their eyes tested, 23 (47%) respondents indicated that it was for new glasses, 21 (43%) said it was because they were diabetic, seven (14%) reported that it was because their medical aid would pay, three (6%) said it was because they were referred by their GP and seven (12%) came for no particular

reason. Of the urban respondents, 31 (63%) knew where to go for their diabetic eye examination and 18 (37%) reported that they did not know.

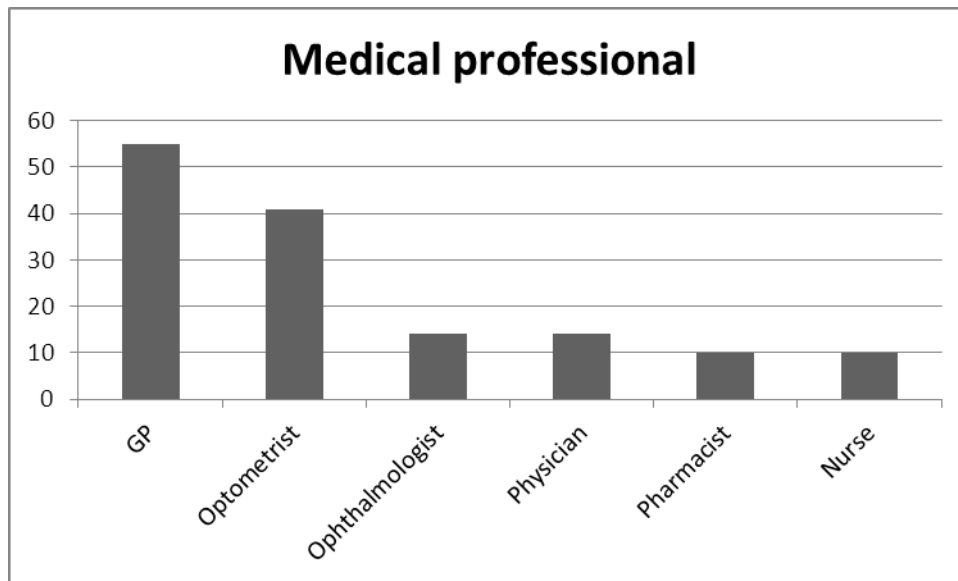
An overwhelming majority, 41 (84%), of urban respondents reported that cost was not a barrier to having their eyes examined with only 8 (16%) citing cost as a barrier. Similarly, 46 (94%) urban respondents indicated that taking time off work in order to have an eye examination was not a problem with only three (6%) reporting difficulty. Furthermore, 34 (69%) respondents reported that the cost of blood sugar testing was not a barrier to doing it while 15 (31%) indicated that it was. Just above half, 28 (57%), of urban respondents indicated that they had received adequate information about how diabetes could affect their eyes while a significant proportion, 21 (43%), reported not receiving such information.

The majority (63%) of urban respondents were interested in receiving general information about diabetes, followed by the effects of diabetes on vision (35%), dietary control (33%), exercise (29%), special precautions (26%) and the effects of smoking on diabetes (12%) (cf. Figure 4.33)



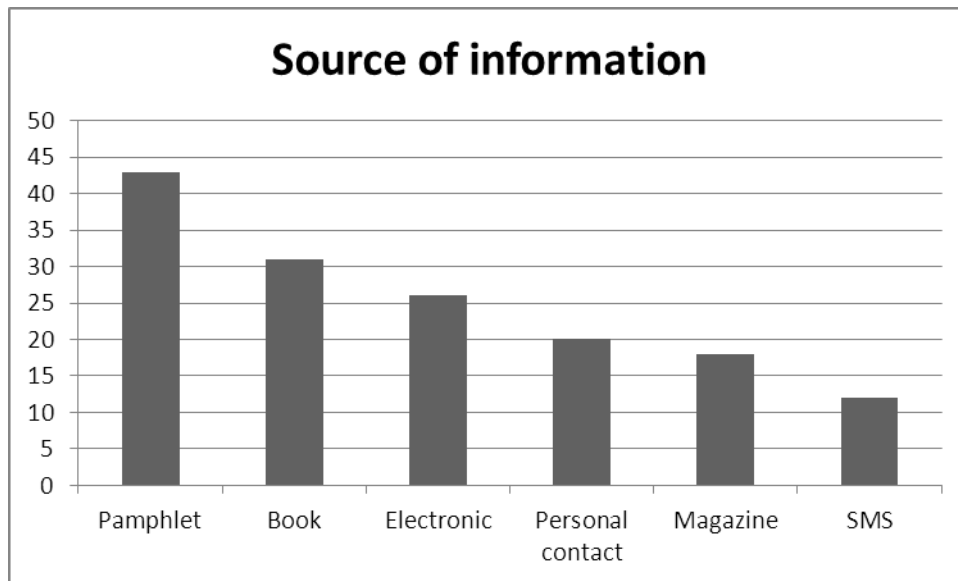
**Figure 4.33:** Urban respondents information requirements

Almost two-thirds, 32 (65%), of urban respondents would prefer to be given information about diabetes on a continuous basis, 15 (31%) preferred to be given information once while two (4%) respondents chose twice. When asked from which medical professional they would prefer to receive diabetic information, 27 (55%) respondents preferred the information on diabetes to be provided to them by their GP, 20 (41%) indicated the optometrist, 7 (14%) preferred their ophthalmologist and specialist physician and 10% each preferred a nurse or pharmacist. In some instances more than one option was chosen. (cf. Figure 4.34).



**Figure 4.34:** The medical professional from whom urban respondents preferred to receive diabetes information

A significant proportion, (43%), of the urban respondents indicated pamphlets as the best source of information about diabetes, (31%) indicated books, (26%) electronic media, personal contact (20%), magazines (18%) and SMS (12%) (cf. Figure 4.35).

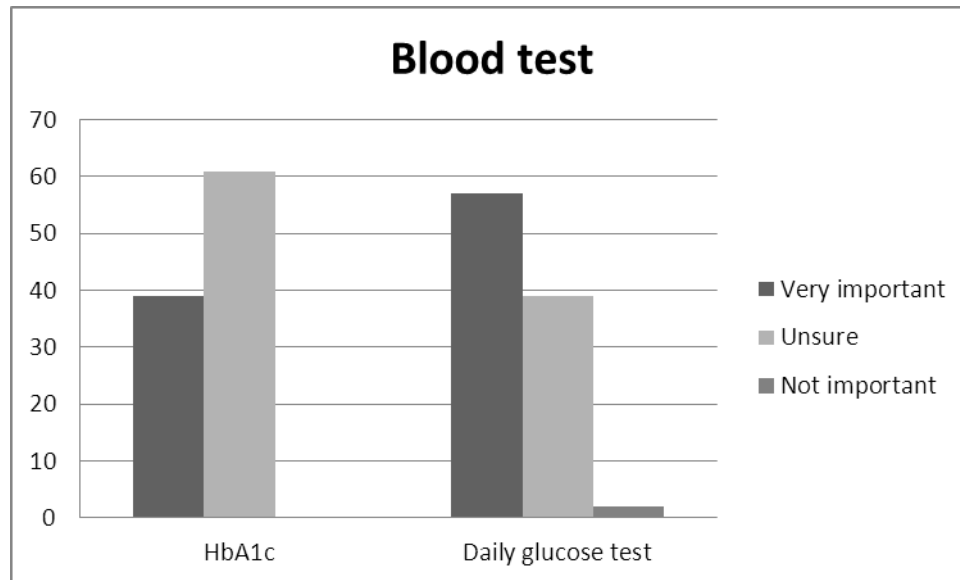


**Figure 4.35:** The source of diabetic information preferred by urban respondents.

#### 4.3.4 Knowledge of diabetes

Many, 34 (69%), of the urban respondents indicated there were two main types of diabetes, four (8%) thought there was only one type, seven (14%) thought there were more than two types and four (8%) did not know how many types of diabetes there were. Twenty-nine (59%) respondents thought that the disease was hereditary while 20 (41%) thought it was not. More than one-third, 21 (43%), of respondents felt that pregnancy could cause diabetes while 28 (57%) thought otherwise. The majority, 28 (57%), of the urban respondents agreed that diabetes could cause depression and/or anxiety while 17 (35%) were unsure and four (8%) disagreed. However, only one-third, 16 (33%), agreed depression and/or anxiety could lead to diabetes, while 21 (43%) were unsure and 12 (24%) disagreed. The majority, 30 (61%), of respondents were unsure that HbA1c was a very important test for diabetes while 19 (39%) thought it was very important. Significantly, 28

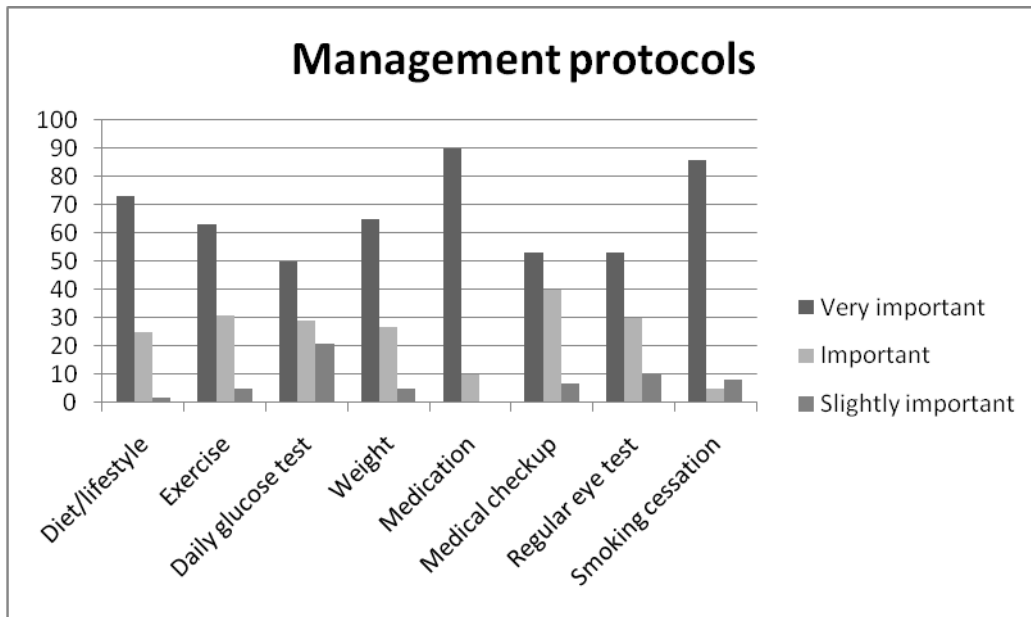
(57%) reported that daily blood glucose was a very important test, 19 (39%) were unsure and two (4%) said it was not important (cf. Figure 4.36).



**Figure 4.36:** Urban respondents value of diabetic blood tests.

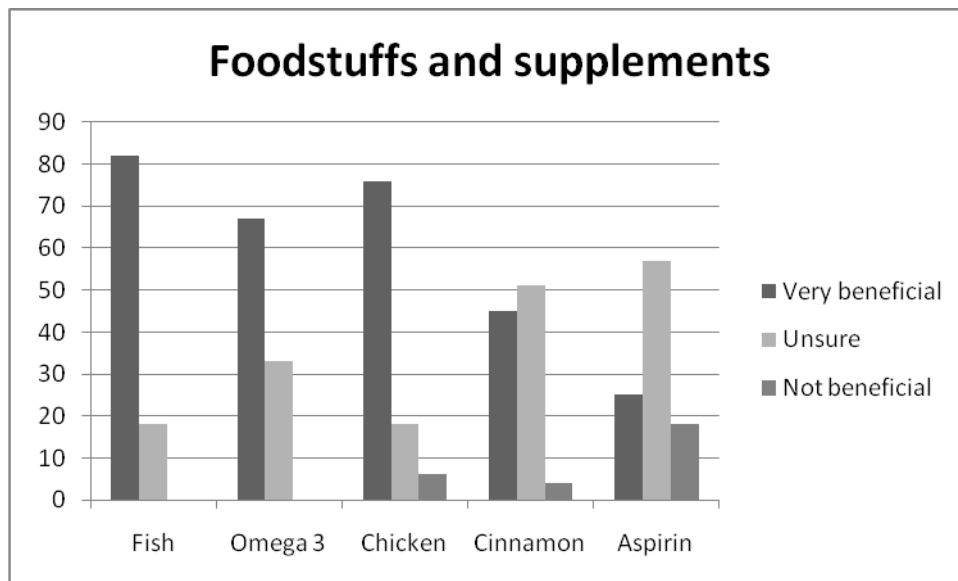
#### 4.3.5 Knowledge of diabetes management

The majority, 44 (90%), of urban respondents felt that taking their medication regularly and as prescribed was a very important factor in the management of their condition, 42 (86%) agreed cessation of smoking was important, 36 (73%) maintaining a healthy diet and lifestyle, 32 (65%) effective weight management, 31 (63%) felt regular exercise was important, 26 (53%) regarded regular medical check-ups and eye examinations as important while half, 24 (50%) felt checking blood sugar on a daily basis was important (cf. Figure 4.37).



**Figure 4.37:** Urban respondents' ratings of importance to the various management protocols for diabetes.

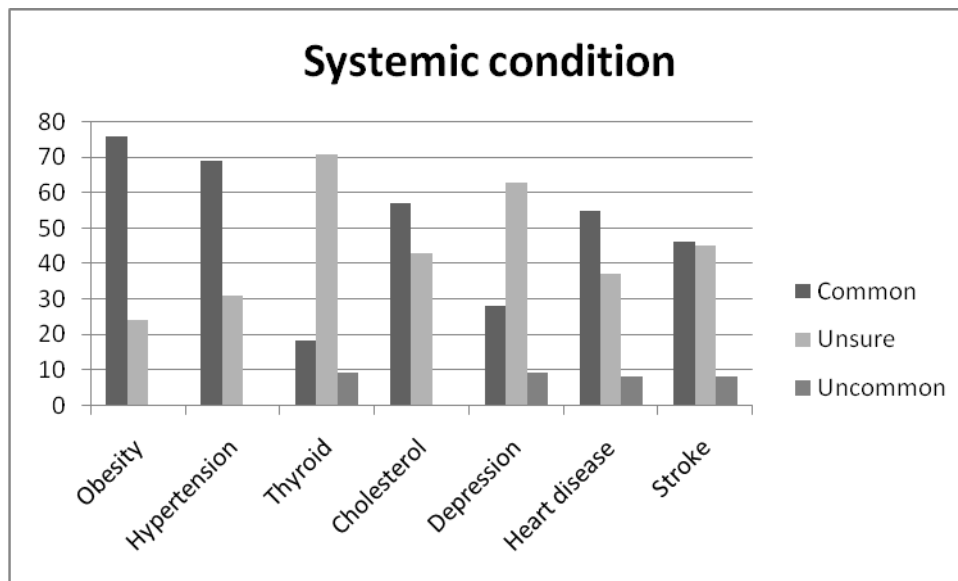
When asked whether they knew enough about their condition to manage it themselves, 31 (63%) of the urban respondents replied in the affirmative and 18 (37%) said they did not know enough about diabetes to manage it properly. The majority (82%) of urban respondents agreed that fish was a very beneficial part of a diabetes-orientated diet, followed by chicken (76%), Omega 3 (67%). In terms of Aspirin use 28 (57%) were unsure of the benefits followed by Cinnamon where 25 (51%) were unsure (cf. Figure 4.38).



**Figure 4.38:** Urban respondents' opinion of the benefits of Omega 3, aspirin and cinnamon.

#### 4.3.6 Associated health conditions

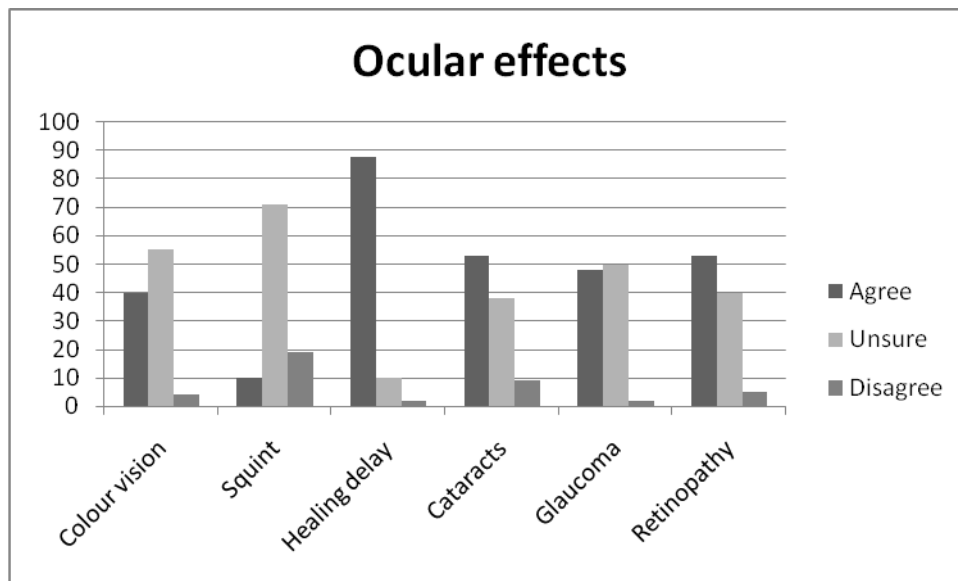
Most, 37 (76%), of the urban respondents reported obesity as commonly associated with diabetes, 34 (69%) associated hypertension, 28 (57%) cholesterol and 27 (55%) heart disease. Significantly, less than half, 23 (46%), of urban respondents felt that stroke was commonly associated with diabetes while 22 (45%) were unsure of the association. Many, 35 (71%), were unsure of the association between thyroid disease and diabetes. Also, 31 (63%) of urban respondents were unsure of the association between depression and diabetes (cf. Figure 4.39).



**Figure 4.39:** Urban respondents' knowledge regarding the association between diabetes and other conditions.

#### 4.3.7 Ocular complications of diabetes

Almost all, 48 (98%), urban respondents agreed that diabetes may affect vision and only one (2%) did not know. Many, 34 (71%) and 27 (55%) respectively, were unsure that diabetes may cause a squint and could affect colour vision. The majority, 43 (88%), agreed that diabetes may affect wound healing after injury and 26 (53%) each agreed that it may cause cataracts and bleeding and damage inside the eye (cf. Figure 4.40).



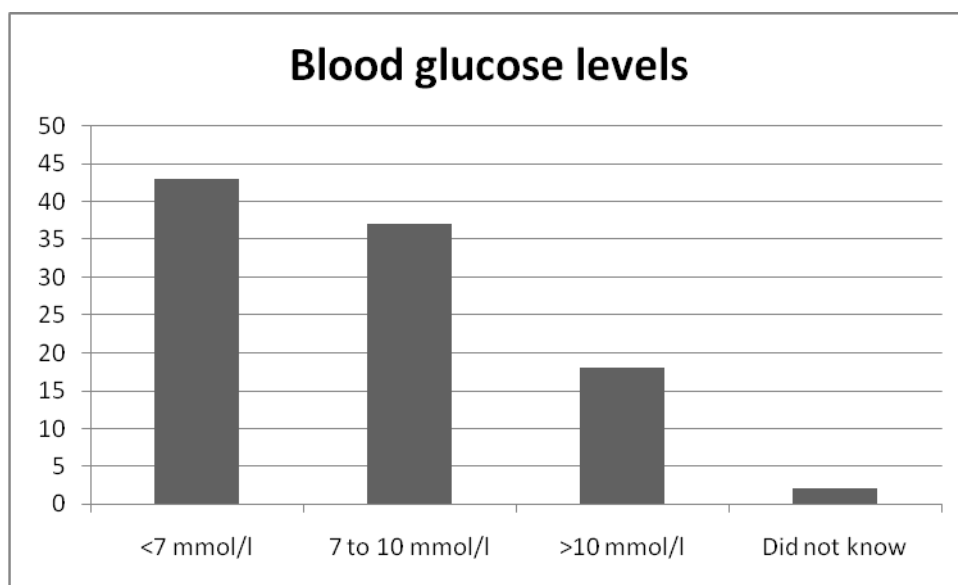
**Figure 4.40:** Urban respondents' knowledge of the ocular complications of diabetes.

The majority, 35 (74%), of the urban respondents reported that it was important to have an eye test even if they could still see clearly, 11 (22%) felt it was slightly important while three (6%) felt it was not important. Similarly, 36 (73%) respondents reported that an eye examination was important even if their blood glucose levels were well controlled, 10 (20%) felt it was slightly important while three (6%) felt it was not important. Most, 36 (73%), urban respondents did not know about laser treatment for diabetic eye disease while 13 (27%) did.

#### 4.3.8 Management of diabetes

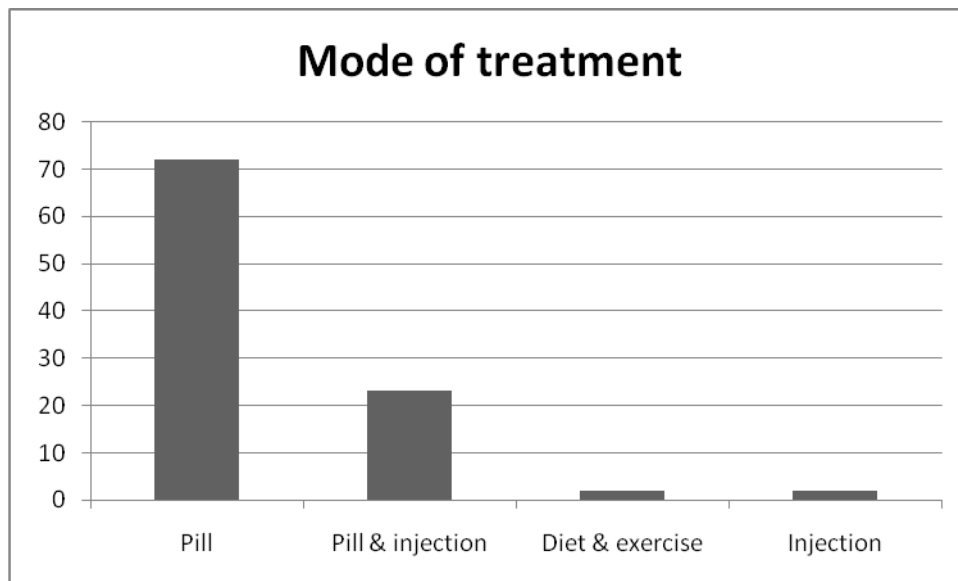
Thirty-five (71%), of urban respondents reported that they felt their diabetes was under control while 14 (29%) reported that it was not. Most, 41 (84%), of the urban respondents had a glucometer while eight (16%) reported not having one to test

their own blood glucose levels. However, only 19 (39%) reported testing their blood sugar levels daily and 14 (16%) respondents tested less than once a week. Less than half, 21 (43%), reported having blood sugar levels of less than 7 mmol/l, 18 (37%) reported between 7 to 10 mmol/l, nine (18%) reported more than 10 mmol/l and one (2%) respondent reported not knowing their blood sugar reading (cf. Figure 4.41).



**Figure 4.41:** Usual urban blood glucose levels.

Of the 47 respondents who answered this question most, 34 (72%), urban respondents were being treated by oral medication, 11 (23%) by both oral medication and insulin injection and one (2%) each were being treated by insulin or by lifestyle modification (diet and exercise) (cf. Figure 4.42).



**Figure 4.42:** Urban respondents diabetes treatment modalities.

More than half, 27 (55%), of urban respondents reported not having regular exercise while 22 (45%) did. Of the 23 respondents who reported that they undertook some exercise, 26% exercised daily, 48% exercised 3-4 times per week and 26% reported exercising 1-2 times per week. The majority (64%) of those who exercised did light exercise while 36% did moderate exercise. None reported doing heavy exercise, defined as out of breath. Many, 35 (71%), respondents had received lifestyle advice for diabetes control while 14 (29%) had not. Of those who reported receiving this advice, 69% received it from their GP, 51% from a dietician, 37% from articles, 20% from nurses, 14% from family or friend, 11% from an optometrist, 9% from an ophthalmologist and 6% from the internet.

#### **4.3.9 General diabetes management**

Of the urban respondents, 34 (69%) reported usually following a diet specifically tailored for diabetes, six (12%) reported always managing to follow a diabetic-oriented diet while nine (18%) never did. Slightly more than half, 26 (54%), of respondents felt that their weight was about right for optimum diabetic control with 23 (46%) reporting their weight was not optimal. The majority, 39 (80%), admitted to not knowing their BMI as opposed to 10 (20%) reporting that they knew what it was. The overwhelming majority, 46 (94%), took their medication regularly and as prescribed while three (6%) reported not adhering to instructions. Similarly, 42 (86%) of the urban respondents went for regular medical check-ups and seven (14%) did not. A vast majority 46 (94%) of urban participants agreed that controlling their blood glucose levels would help prevent eye problems while three (6%) were unsure. Less than half, 21 (43%), of urban respondents reported that they had annual eye examinations as opposed to the 28 (57%) that did not.

## **CHAPTER 5**

### **DISCUSSION AND RECOMMENDATIONS**

#### **5.1 INTRODUCTION**

Diabetes is characterised by hyperglycaemia and the main treatment objective is the reversal of hyperglycaemia to blood glucose levels found in non-diabetic individuals. Alwan (1994: 2) notes that the aim of this treatment is to reduce the possible complications of diabetes. How to maintain normal levels of blood glucose is often dependent on the knowledge that diabetic patients have about the disease. The lack of knowledge about the disease can lead to possible systemic and ocular complications and can influence the overall treatment goal (Please 2007: 90 and Joshi & Joshi 2008:29). In this chapter the results of the research study will be discussed. This includes trends derived from the qualitative and quantitative findings. Key comparisons will be made between those patients in the rural area represented by Malmesbury and those urban patients represented by the metropolitan areas of Milnerton and Claremont. These comparisons will provide an indication of the knowledge of diabetes, its ocular complications and the management protocols in these groups. The chapter will conclude with limitations of the study and recommendations.

The primary objectives of the study have been met. These were to determine the level of knowledge of diabetes and its' ocular complications in private sector patients, their management and treatment protocols and whether there was a difference in rural and urban results. The majority of respondents correctly identified

regular eye examinations as necessary but only one third actually adhered to this regimen. Despite the majority of respondents stating that they felt they knew enough about diabetes to manage their own condition, the results appear to indicate the contrary. The majority of patients reported their fasting plasma glucose levels to be above the WHO recommendation of  $\leq 7$  mmol/l. Patients' knowledge of the management and treatment protocols appeared also to be sub-optimal. There were differences between rural and urban respondents' knowledge and management protocols. Examples of the difference are that significantly more rural patients than urban were aware of the risk of stroke with diabetes, whilst average BMI and average weight was slightly higher in rural respondents than urban. Rural respondents were also more likely to be treated for hypertension than their urban counterparts and less likely to attend an annual eye examination.

### **5.1.1 Biographical comparisons**

The overall average schooling was 11.88 years. The mean schooling (11.7 years) of the urban cohort was almost similar to that of the rural cohort (11.88 years). In terms of weight, the urban group had an average weight of 82.7 kg and an average Body Mass Index (BMI) of 29.9 kg/m<sup>2</sup>. In comparison, the rural average weight was 91.14 kg with an average BMI of 31.26 kg/m<sup>2</sup> and overall the average weight was 87.74 kg with an average BMI of 30.7 kg/m<sup>2</sup>. This contrasts with previous studies by Shaper *et al.* (1997: 1311) who recommended that the optimum BMI for British men be 22 kg/m<sup>2</sup>, while James *et al.* (2001: 228) advocated a limited range of healthy BMI to be between 18.5 and 22.9 kg/m<sup>2</sup>. The figures in the current study indicate that the BMI's of the diabetic patients were significantly above the recommended levels which raises concern for their overall health in both the short and medium

term. This strengthens conventional policy that raised BMI is indicative of obesity which is associated with diabetes. Medical professionals who diagnose patients with diabetes should inform and educate them about the significance of Body Mass Index and health care professionals managing diabetic patients should stress weight management as part of a continuous education programme for the patient.

### **5.1.2 Medical history**

The overall percentage of those who reported having hypertension was 62%. Sixty-six per cent of rural respondents reported having hypertension compared to the 57% of their urban counterparts. Patients were on treatment for high cholesterol in 53% of the total respondents with rural respondents being higher with 56% and urban at 49%. One possible explanation for this resides in a study by Steyn *et al.* (1996: 479-484) who examined three founder-related LDL (Low Density Lipoprotein) cholesterol receptor gene mutations causing familial hypercholesterolaemia in Afrikaners. Since 86% of the rural sample indicated that Afrikaans was their preferred language the inference is that they could have higher cholesterol levels. Further research needs to be conducted to determine the reason for a higher prevalence of these conditions in rural areas than urban. Fifty three per cent of the total sample reported having Type 2 diabetes. Forty seven per cent of the rural respondents indicated that they had Type 2 diabetes while 61% of the urban group reported having Type 2 diabetes. Of concern is the significant amount (43%) of respondents who reported that they were uncertain of the type of diabetes they had. This was more evident in the rural group where many (49%) did not know the type of diabetes they had. While many of the urban group knew their type of diabetes (65%), a significant proportion (35%) was unsure which type of diabetes they had.

These results have serious implications for long term management of the condition which would be challenging if the diabetic patient did not know what type of diabetes they had. Similarly, one wonders how diabetic patients seek advice and information about their condition when they do not know exactly what their condition is. The Freemantle Study by Bruce *et al.* (2003: 82-89) observed that those diabetics who were better informed were most likely to visit dieticians and maintain self-monitoring programs. It is therefore recommended that once patients are diagnosed with diabetes, their condition should be explained to them in lay terms so that it is clearly understood. In doing so, health professionals need to take cognisance of cultural and language differences. During follow-up visits this information needs to be reinforced.

The WHO criterion for the diagnosis of clinical diabetes is fasting plasma glucose of  $\geq 7.0$  mmol/l (Alberti and Zimmert, 1998: 539). The majority (47%) of patients overall reported that their usual blood glucose measurement was between 7 and 10 mmol/l which is higher than the WHO recommendations. A further 12% were higher than 10 mmol/l, resulting in a total of 59% of patients with less than optimally controlled blood glucose levels overall. Fifty-four per cent of the rural group measured between 7 and 10 mmol/l, with a further 8% above 10mmol/l indicating that 62% of patients had habitual measurements of greater than 7 mmol/l. Of the urban group, 37% had a habitual measurement between 7 and 10 mmol/l with an additional 9% measuring above 10mmol/l resulting in 46% being over the 7 mmol/l limit. The results of this study indicate that the urban group had a lower average blood glucose reading than their rural counterparts (7.65 mmol/l for the urban respondents versus 8.67 mmol/l for the rural respondents). Although the urban

cohort had lower average blood glucose levels than the rural cohort, both groups had levels above those recommended for optimum blood glucose control. It would thus appear that, notwithstanding the lower mode (7mmol/l) in rural participants, the rural patient was less than optimally compliant or managed in order to keep their blood glucose levels within the recommended levels. This implies that rural patients would be more at risk for long term complications of diabetes than their urban counterparts. A possible explanation for the disparity between the rural and urban average blood glucose levels is that the average weight of the rural participants was 91 kilograms as opposed to the average weight of the urban respondents of 82 kilograms. Furthermore, the difference in BMI (31.2 for rural and 29.9 for urban respondents) is an additional explanation for the disparity and may be indicative of a different diet philosophy between the two groups. The high averages could be linked to the frequency of blood glucose measurement, where an overall low proportion (33%) of patients tested their blood glucose on a daily basis. Twenty-nine per cent of rural patients tested their blood sugar daily as opposed to 38% of urban patients. Irregular or not testing can mask rises in blood sugar purely because the patient is unaware of their blood glucose levels, allowing the diabetic patient to continue with an unabated incorrect eating plan or lifestyle. This could possibly be due to apathy or ignorance as almost 82% of the respondents reported having a glucometer and 69% did not think the cost of measuring blood glucose levels was a barrier to testing. It is therefore recommended that diabetic patients should be advised to visit their medical professionals on a more regular basis and that regular blood glucose monitoring should occur and results reviewed with the health care practitioner at

each visit. Reinforcement of the importance of regular blood sugar testing should be done at each visit to their medical professionals.

The study demonstrated that seventy-five per cent of all diabetes diagnoses were done by their general practitioners (GP). The GP was also rated as the most preferred health care practitioner from whom diabetic information should be received. The GP therefore carries more responsibility with regard to the dissemination of information and continued management of the diabetic patient. Overall, 40% of patients reported that they were not informed about the need for regular eye examinations when they were first diagnosed with diabetes. Of these, many (45%) were urban respondents while 27% were rural respondents. A possible explanation for this is the anecdotal evidence that in busy urban medical practices most general practitioners see a patient every 15 minutes, a situation not unique to the South African medical fraternity (Ogden *et al.* 2004: 479-483). This affords the GP little time to carefully explain important concepts such as presenting for annual eye examinations. The pace of practice in the rural areas is possibly a little slower which allows for better patient communication. This concept becomes more important when patient knowledge about the ocular complications of diabetes is examined. The health care practitioner responsible for the diagnosis of diabetes should ensure that patients are advised about the need and reasons for regular eye examinations. The potential ocular complications should be explained to the patients and reinforced at each subsequent visit.

### 5.1.3 Eyecare

Overall, only 32% of participants reported that they had an eye examination during the previous year. This figure was 24% for rural respondents and 43% for urban. This was despite 88% of participants indicating that regular eye examinations were either 'very important' or 'important' and 97% of patients reporting that diabetes could affect their vision. More significantly was that all the participants agreed that diabetes could affect their eyes and 89% of the total group agreed that controlling diabetes could help prevent eye problems. Although Brechner *et al.* (1993: 1714) recommends that all diabetic patients should have an annual dilated fundus examination, in the South African context the normal allowance/dispensation for those on medical insurance is one eye examination every two years. Considering that the study sample consisted of those who were on medical insurance or privately funded their medical treatment it was expected that the rate of eye examinations would be greatest after two years in order to be in line with health insurance guidelines. This, however, was not the case as fewer patients presented after two years than those that had annual eye examinations (30%). Of note was that 68% of patients had eye examinations at greater than annual intervals. The inference is that either apathy or ignorance, perhaps through a lack of diabetic counselling, is responsible for this phenomenon as 80% of respondents reported that cost was not a barrier to having an eye test. This is reasonable given that their health insurance would pay for an examination. The fact that 40% of the respondents were not informed about the need for regular eye examinations could have contributed to this result. Medical professionals and other health care practitioners should therefore emphasise the importance of annual eye examinations. Secondly, health insurance

companies should be advised to apportion appropriate funding to provide annual eye examinations specifically for diabetic members. This would benefit the medical insurance companies as ocular and systemic complications would be managed more cost effectively if identified and treated at an earlier stage.

#### **5.1.4 Knowledge of diabetes and its systemic complications**

The majority (61%) of respondents knew of only two types of diabetes. In this study there were no respondents who had gestational diabetes or were pregnant, which is a possible explanation for their lack of knowledge regarding this form of diabetes. More than 62% of participants felt that pregnancy was not associated with diabetes indicating that very few patients knew about gestational diabetes. The recommendation is that all pregnant patients should be counselled regarding the potential for gestational diabetes. Whilst a pregnant patient's weight is normally constantly monitored the reasons for this should be elucidated in prenatal consultations. Those who do contract gestational diabetes should be counselled further that they are at high risk for developing Type 2 diabetes and possibly at an earlier age than expected and that those at risk should be observant for signs and symptoms of the disease. This has long term dietary implications and BMI awareness is therefore essential.

Overall, 60% of patients felt that diabetes was linked to heredity factors. This is important as those with diabetic family members need to be made aware of the potential for diabetes and manage their lifestyles accordingly. Health practitioners should counsel their diabetic patients about this important concept.

Studies have shown that diabetes has the potential to cause significant mental health problems, including depression (Ciechanowski, 2000: 3278 and Mezuk *et al.* 2008: 2383). A recent study by Pan *et al.* (2010: 1884 – 1891) provides compelling evidence of the bidirectional association of diabetes and depression. Fifty-nine per cent of the overall respondents agreed that diabetes could cause depression and/or anxiety leaving a significant proportion (41%) that disagreed or were unsure. A general depressive state will leave diabetic patients unmotivated to maintain and closely follow treatment regimens as prescribed by their medical practitioners. Symptoms of depression include lethargy (Rodin and Voshart, 1986: 696 – 705) and consequently patients are reluctant to exercise and have sub-optimal self-care which includes eating and taking their medication (Lin *et al.* 2004: 2154 – 2160). All members of the health care team should be aware of the potential for depression associated with diabetes and close relatives should be counselled accordingly. Health care providers should be cautious with their patients on depression treatment and a careful ocular case-history should be taken. When examining patients already diagnosed with diabetes, health practitioners should be aware of the signs of depression and refer appropriately.

The test for glycolated haemoglobin, also known as the HbA1c test, has become more significant in recent times (Sato *et al.* 2009: 644). Many clinicians have been using this test as a diagnostic tool for clinical diabetes as opposed to the random instant blood glucose test (Inoue *et al.* (2008: 1157). The majority of participants in this study were not familiar with the test and 62% were unsure of its importance. The implication of this finding is that diabetic patients are not informed as to the value of the HbA1c test as a measure of their disease progression and their blood

glucose control. This in turn has treatment implications where a delay in the utilisation of insulin as a means of tighter blood glucose control could result in diabetic eye disease, nephropathy or neuropathy. Heisler *et al.* (2005: 816 – 822) reported a marked improvement in self-management of diabetes when patients knew their HbA1c. Forty-three per cent of the urban participants were either unsure of the importance of daily fasting blood glucose test or disagreed that it was important with urban candidates marginally more certain of the importance than their rural counterparts. Also, when patients were asked how important it was to check blood sugar on a daily basis, 54% thought it to be 'very important'. This, nevertheless, represents only slightly more than half of all participants. A possible explanation for this is that many patients are afraid to monitor their blood glucose readings for fear that they may be too high. This would then imply that their treatment should be intensified and that their condition had worsened. There is, furthermore, a possible psychological impact involved with the advent, or worsening of, depression (Mezuk *et al.* (2008: 2383). Notwithstanding the low numbers who tested daily, many respondents (82%) reported owning a glucometer. Diabetic patients should be encouraged to use their glucometers on a daily basis which will enable patients to monitor their blood glucose levels and to keep a diligent record of their readings. This is important in the management of their diabetic condition and should be emphasised by health care practitioners in their dealings with diabetic patients. Health insurance companies should be advised to provide glucometers and measuring sticks to their members as part of their health benefit package along with the necessary medication. Furthermore, all members should be encouraged to have a 3-monthly HbA1c blood test in order to properly monitor their glycolated

haemoglobin levels and endeavour to maintain this at  $\leq 6.5\%$ . This would improve the knowledge base of diabetic patients, 62% of whom in this study were unaware of the importance of the HbA1c test.

The majority of participants in this study recognise the importance of regular exercise. More than 95% rated this factor as very important or important, however only 41% of the respondents reported that they exercised regularly. The benefits of exercise in terms of weight and BMI management as well as for the general circulation have been reported in several publications (Joshi and Joshi (2008: 22, Mozaffarian *et al.* (2009: 798). Health care workers should be advised to make every effort to encourage their patients to exercise to the best of their abilities. For example, simple exercises such as brisk walking for 30 – 40 minutes three to four times a week should be advised as they do not have a cost factor compared to monthly gym subscriptions.

### **5.1.5 Health management**

Despite their reported average blood glucose levels, 67% of all respondents felt that they knew enough about diabetes to manage their own condition. Abram (1972:659) has reported that regression, denial, and intellectualisation, (along with projection, displacement and introjection) are part of the coping mechanisms of chronic illnesses. These typically lead to depression which has strong links to diabetes (Ciechanowski, 2000: 3278 and Mezuk *et al.* (2008: 2383). The results of this study suggest that these patients may be incorrect in the assumption that they knew enough about diabetes in order to manage their own diabetic condition. Health care practitioners should be aware of this and reinforce knowledge-empowerment

whereby patients are given facts in a way that they are comfortable with. In this manner existing knowledge can be used as a foundation for increasing knowledge through information.

The benefits of Omega 3 fatty acids on general health have been reported in several studies (Hu *et al.* 2003: 1852). These benefits should be considered alongside the study by Glauber *et al.* (1988: 663 – 668) which cautioned that Omega 3 may give rise to hyperglycaemia. Two-thirds (67%) of those in the urban areas were aware of the benefits of Omega 3 fatty acids while approximately half (53%) of the rural patients were unsure. One possible explanation is that the majority of health magazines and articles are written in English. With the high proportion (86%) of the rural respondents being Afrikaans, fewer are likely to choose an English magazine to obtain health information. Moreover, 76% of the overall respondents were unsure or indicated that there was no benefit of aspirin use in diabetes management. A possible explanation is that this may not have been discussed with them by their GP due to the limited time at his or her disposal. Many patients are therefore not exposed to the possible beneficial effects of regular aspirin use, especially in terms of coronary heart disease prevention. Hennekens *et al.* (2004: 2752) recommend that clinicians follow the guidelines of the American Diabetes Association to reduce the risks of cardiovascular disease in patients with diabetes by making use of low dose aspirin. With regard to nutritional supplementation, fifty-two per cent of all respondents were unaware of the benefits of cinnamon as a supplement in the diabetic diet. A possible explanation for this may be that many GP's and health care practitioners are possibly unaware of the benefits of cinnamon and/or are reluctant to advocate the use of so-called "natural" supplements. Furthermore, diabetic

patients may not have read about it in the various articles on the subject that appear in magazines or not have been to a dietician who could have advised them accordingly. Khan *et al.* (2003: 3215) demonstrated that the regular intake of 1 – 6 grams of cinnamon each day reduced the risk factors associated with diabetes and cardiovascular diseases. More recently, Akilen *et al.* (2010: 1159) have shown that the daily intake of just 2 grams of cinnamon for 12 weeks significantly lowered HbA1c levels as well as reducing BMI and blood pressure.

In terms of general health management issues in this study, the results suggest that there are areas where patients are lacking in knowledge to optimally manage their own condition. This is despite the fact that many patients reported that they are knowledgeable enough about their condition. This study therefore supports the recommendation that health care practitioners should recommend the use of supplements such as cinnamon and Omega 3 as part of a healthy diet and anti-platelet medications such as aspirin where appropriate. These products have been reported to improve the cardiovascular prognosis of the diabetic patient (Akilen *et al.* 2010: 1159; Hu *et al.* 2003: 1852 and Hennekens *et al.* 2004: 2752).

#### **5.1.6 Associated health conditions**

In general the participants in the study had adequate knowledge of obesity and hypertension associated with diabetes. The hypertension knowledge is reflected in the total number (62%) of respondents indicating that they were being treated for this condition. A possible explanation for knowledge of obesity association with diabetes can be found in the average weight and BMI of the respondents which was well above the optimum. This would have made the majority of respondents aware

of their adiposity and a weight loss programme may possibly have been suggested to them by their GP. With regard to thyroidopathy, the use of the drug metformin in Type 2 diabetes has been reported to result in a drop in thyroid stimulating hormone production. (Cappelli *et al.* 2009: 1589). Eighty-five per cent of participants in this study were either unsure or reported that thyroidopathy was uncommon in diabetes. Fifty-three per cent of urban respondents thought that stroke was uncommon in diabetes or were unsure while 59% of their rural counterparts thought it was a common occurrence. This is in conflict with studies by Barrett-Conner and Khaw (1988: 116) who reported that diabetes may confer excess risk of stroke independent of blood pressure. The results of this study indicate that many diabetic patients were unsure of the association between these systemic conditions and diabetes. This suggests a need for health care practitioners to be proactive and observant to ensure that appropriate clinical tests are carried out along with risk-appropriate counselling to advise patients about the potential systemic health threats of diabetes. Furthermore, diabetic patients and their family members should be counselled to recognize the signs and symptoms of stroke in order to act immediately if these manifest.

#### **5.1.7 Knowledge of the ocular complications of diabetes**

With regard to the ocular complications of diabetes, three-quarters (75%) of patients regarded having an eye examination as very important even if they could still see clearly or their diabetes was well-controlled. However, only one third indicated that they had undergone an eye examination within the previous year. This could indicate that diabetic patients are not adhering to the recommendations for annual eye examinations even though they are aware of their importance, or

patients are not being adequately advised in this regard. This suggests that the diagnosing clinicians should advise their patients on the need for regular examination. It could also suggest that the GP's (who were the majority clinicians in terms of diagnosing diabetes) were not informing them about the ocular complications of diabetes and therefore the need for regular eye examinations.

Almost all (97%) participants thought that diabetes could affect their eyes. An explanation for this could be that often diabetic patients hear non-specific references to the effect of diabetes on the eyes. This might be from their GP, an optometrist, a fellow diabetic or an article in a magazine. With regards to the exact effects of diabetes on the eyes, a large proportion of respondents were less certain of the specific effects. Lakowski *et al.* (1972: 145) demonstrated that colour vision testing was useful in predicting minor retinopathies in diabetic patients under 30 and over 60 years of age. In 1987, Daley *et al.* (1987: 777) showed that there existed an early loss of blue-sensitive vision in Type 1 diabetes, due to nerve fibre layer degeneration specific to the blue-yellow colour sensitivity. Overall, 47% indicated that diabetes could affect colour vision, with 52% being from the rural group and 41% from the urban group. A possible explanation for this is that, in this study, the optometrist in the rural area has a keen interest in the diabetic condition and conducts regular colour vision testing and explains the reason for this. The neurological effect of diabetes has ocular manifestations when cranial nerves III, IV and VI are affected, resulting in a strabismus-induced diplopia (Sukha and Rubin, 2007: 120 and Records, 1970: 709). In terms of the effects of diabetes on extra-ocular muscle innervation, eighty per cent of the overall respondents either disagreed or were unsure that diabetes could lead to a squint. Only one quarter

(25%) from the rural group and 10% of the urban group were of the opinion that diabetes could cause a squint, indicating further evidence of lack of knowledge of the ocular consequences of uncontrolled diabetes. A possible explanation of this is that those diabetic patients presenting to an optometric practice are not generally seen by ophthalmologists until such time as they have been referred. In an ophthalmology practice, diabetic-induced strabismus would be more readily seen and consequently more patients would be aware of the occurrence.

Just over half of the total sample (54%) agreed that diabetic patients were likely to develop cataracts although a significant proportion of patients were either unsure or disagreed. Cataracts are commonly encountered in diabetes and represent a significant cause of vision loss which is relatively easily corrected (Lang, 2000: 167). Sixty three per cent and 53% respectively, of the rural group and urban group were unsure of the possibility of diabetes-related glaucoma. One possible explanation for this is that an ophthalmology practice is more likely to see more diabetes-related glaucoma than an optometric practice and patients attending are therefore more likely to be aware of the relationship between diabetes and glaucoma. The Beaver Dam Study showed that the presence of open angle glaucoma is increased in older-onset diabetes (Klein *et al.*: 1994: 1173 – 1177) however it is unlikely that lay persons would be aware of this unless specifically informed by a health care practitioner. Diabetic patients visiting an optometric practice should therefore be carefully screened for any signs of glaucoma and GP's should recommend that their diabetic patients be screened for the condition.

Diabetic retinopathy, described as 'bleeding and damage inside the eyes' in the questionnaire, was understood to be a danger by many respondents. In total 58% agreed that diabetes could lead to retinopathy, with 62% of the urban cohort in agreement. Significantly, more than two-thirds (69 %) of the overall respondents did not know about laser treatment for diabetic eye disease, with 73% of the urban group reporting that they did not know.

It is incumbent upon the health care practitioner that diabetic patients should be extensively informed about the ocular risks of diabetes and the importance of an annual eye examination. Furthermore, when presenting for an eye examination diabetic patients should be carefully monitored for colour vision defects, optic nerve head damage, intra-ocular pressure, retinopathy and oculomotor function. Fundus photography should be employed as it provides a permanent record to track progress and for interdisciplinary referral. It is also an invaluable teaching tool for diabetic patients.

#### **5.1.8 Management of diabetes**

The majority of respondents (75%) felt their diabetes was under control. This contradicts the results on the average blood glucose levels, where the average blood glucose of the total group was above 8 mmol/l. This is an indication that the knowledge of diabetes of the group is sub-optimal and contradicts the 67% of respondents who felt that they knew enough about their condition to manage it on their own. The results of this study show that 27% of the overall group were being treated by insulin injection and pill. A possible explanation for this is that oral medication alone was not sufficient to control their blood glucose levels. Nathan *et*

*al.* (2006: 1963 – 1972) report that when tight blood glucose control is lacking, insulin as an adjunct therapy is the most effective form of diabetes medication that lowers glycaemia. Initially in their disease, Type 2 diabetic patients compensate for increased insulin resistance by increasing pancreatic beta-cell insulin secretion. When this compensation is no longer adequate to overcome the insulin resistance, blood glucose escalates progressively. As the disease progresses, insulin levels slowly become reduced with the result that most patients with Type 2 diabetes are unable to achieve optimal glycaemic control with oral agents alone. This is a process taking, on average, up to 15 years (Mudaliar and Edelman, 2001: 1 – 2). Insulin can, when used in adequate doses, decrease any level of hyperglycaemia to, or close to, the therapeutic goal. This inexorable progression notwithstanding, tight initial glycaemic control and later insulin therapy contributes to fewer long-term side effects due to prolonged hyperglycaemia.

The beneficial effects of exercise have been reported in studies conducted by, amongst others, Nadeau *et al.* (2009: 3687 – 3695) and Madden *et al.* (2009: 1531). Fifty-eight per cent of total respondents indicated that they did not exercise regularly. This figure rose to 61% in the rural group, whose average blood glucose and BMI were also greater, indicating an apparent correlation between exercise and blood glucose levels. Health care practitioners need to consider the effects of depression in diabetes and consider whether this may contribute to the lack of exercise due to lethargy, poor eating habits and feelings of inadequacy. Almost 75% of the respondents reported having had lifestyle advice for diabetes control, the majority of which advice was from their general practitioner and dietician. GP's were almost twice more likely, though, to be consulted for this advice than dieticians.

Given the constraints on the time of general practitioners, it is hardly likely that the dietary advice received from them would be at the same level as that from a dietician. Therefore, diabetic patients should be encouraged to seek lifestyle advice from as broad a field as possible and that this advice include dietary recommendations from a dietician. Dieticians should form a more significant part of the diabetes team and health insurance providers should take cognisance of their value in the management of the condition.

When asked whether they followed a diet aimed at controlling their diabetes, the majority (70%) of the overall patients reported 'usually'. This is a positive aspect and implies that diabetic patients are taking the dietary advice from their GP and dietician seriously. However, almost half (49%) of the respondents felt their weight was not ideal for the effective control of diabetes. This appears to tie in with the 82% of respondents that did not know their BMI. The importance of Body Mass Index (BMI) in diabetes control has been reported in several studies (Cole *et al.* 1990:25 and National Obesity Observatory, 2009:5). The average BMI of all respondents in this study ( $30.7 \text{ kg/m}^2$ ) is far higher than the recommended  $22 \text{ kg/m}^2$  (Shaper *et al.* 1997:1311) which correlates with the average fasting plasma glucose of the total group (8 mmol/l). GP's and other diabetes health care practitioners should inform their patients of the importance of BMI awareness and educate their patients about the value of observing their BMI status and using it as a valuable tool for monitoring their condition. Patients should be encouraged to know their weight and height and calculate their BMI by dividing their weight by the square of their height in metres.

Many of both the urban and rural patients agreed that controlling their diabetes would help to prevent eye problems. It raises the question, however, why only one-third of participants presented for an annual eye examination? This could, perhaps, be due in part to the high proportion of patients who feel that their diabetes is under control and therefore did not go for regular eye examinations. Also, many felt that they knew enough about diabetes to manage their own condition. However, this could indicate that the patient is in the denial phase of the disease and that diabetic patients should move beyond this phase of the disease and make use of the advice given by their health care practitioner. This includes annual eye examinations and regular medical check-ups.

It must be stressed that the role of the optometrist is particularly important in the management of the diabetic patient. Optometrists are ideally positioned to counsel diabetic patients and to educate them regarding the potential ocular damage resulting from diabetes. Optometric training institutions should provide further education in the form of continuous professional development programmes for existing practitioners to empower them with the knowledge about ocular complications of the disease. The United Kingdom has extensive programmes to facilitate the up-skilling of their optometric practitioners and one such programme is designed to enable the optometrist to be registered as a diabetes co-management practitioner. If implemented in South Africa, such a programme will enable optometrists to co-manage diabetic patients with other health care professionals on a more formal basis.

## **5.2 SUMMARY OF RECOMMENDATIONS**

The aim of this study was to determine the management regimens and level of knowledge of diabetes and its' ocular complications among private sector diabetic patients. The overall goal of the study was to enhance the role of the Primary Care Practitioner, including the optometrist, in performing a constructive supporting service in the overall management and care of the diabetic patient in private practice. From data derived from the study and in order to fully achieve these goals the following recommendations arose from the study:

### **5.2.1 Health Care Practitioners**

The following recommendations pertain to the various health care practitioners involved in the management of the diabetic patient:

- Medical practitioners, when diagnosing diabetes, should inform and educate their patients about the significance of Body Mass Index. When the diagnosis of diabetes is made, the condition needs to be explained to patients in simple/lay terms so that they can understand their condition better. Health care professionals need to take cognisance of cultural and language differences. During follow-up visits this information about diabetes needs to be reinforced.
- The health care practitioner who diagnoses the diabetes needs to ensure the patient is informed of the need for regular eye examinations and, secondly, the reasons for this need. The potential ocular complications should be explained to the patient and reinforced at each subsequent visit. At diagnosis

patients should be extensively informed about the ocular risks of diabetes and that annual dilated eye examinations or fundus photography was essential.

- Health care practitioners should be advised to recommend the use of supplements like cinnamon and Omega 3 as part of a healthy diet and, where appropriate, anti-platelet medications like aspirin to improve the cardiovascular prognosis of the patient.
- All members of the health team should be aware of the potential for depression-linked diabetes and diabetes-linked depression. Health practitioners should be cautious with their patients on depression treatment and careful ocular case history should be taken. When examining those patients already diagnosed as diabetic, health practitioners should be aware of the signs of depression and refer appropriately.
- Diabetic patients who have glucometers should be encouraged to use them. Those diabetic patients without glucometers should be advised to obtain one. Most pharmacies supply glucometers either free or at a low cost and the patient merely has to purchase the measuring sticks. Patients should be educated in the use of these instruments and the monitoring of the results.
- Health care workers should make every effort to encourage their patients to exercise to the best of their individual ability, with brisk walking 3 – 4 times per week for 30 – 40 minutes the preferred mode.
- Health practitioners should ensure that appropriate clinical tests are carried out along with appropriate counselling to advise patients about the potential

systemic health conditions associated with diabetes. Practitioners should utilise a process of knowledge-empowerment whereby patients are given enough information about their condition in a way that they understand and are comfortable with.

- Diabetic patients should be encouraged to seek lifestyle advice from as broad a field as possible and that this advice include dietary recommendations from a dietician.
- Diabetic patients should be encouraged to join support groups and mailing lists where information about diabetes can be shared in order to effectively manage their condition. In this regard, health care practitioners should emphasise the role of Diabetes SA, a non-governmental organisation, as a valuable information source.
- When presenting for an eye examination patients should be carefully monitored for colour vision defects, optic nerve head damage, intra-ocular pressure, diabetic retinopathy and oculomotor function. Fundus photography should be employed by practitioners as it provides a permanent record and is an invaluable teaching tool for diabetic patients.
- Optometrists are ideally placed to counsel diabetic patients and to educate them regarding the potential ocular damage resulting from diabetes. In this regard Optometric training institutions should provide further education for existing practitioners to become diabetes co-management practitioners. This could also form part of an on-going Continuing Professional Development

(CPD) programme, where accreditation is achieved, or as a post-graduate diploma.

### **5.2.2 Institutional Bodies**

The following recommendations pertain to the institutional bodies involved in diabetes care and include Health Insurance companies and statutory bodies like the Health Professions Council of South Africa, the Board of Healthcare Funders and the South African Optometric Association:

- Health insurance companies should recognise the importance and benefits of annual eye examinations and apportion appropriate funding to provide annual eye examinations for all diabetic members, based on sound cost-benefit analysis of the effects of diabetes.
- Health insurance companies should be advised to provide glucometers and measuring sticks to their members as part of their health benefit package along with the necessary medication as Prescribed Minimum Benefits.
- Health insurance companies should require of and reward members to undergo a 3-monthly HbA1c blood test in order to properly monitor glycolated haemoglobin levels and endeavour to maintain this at  $\leq 6.5\%$ .
- Dieticians should play a more significant role in the diabetes team and that health insurance providers take cognisance of their value in the management of the condition. The cost-benefit to health insurance companies of diet-compliant diabetic patients is something that the Professional Board for Dieticians should be highlighting.

- The Health Professions Council of South Africa (HPCSA) via the Professional Board for Optometry and Dispensing Opticians (PBODO) should invite optometric training institutions to offer advanced studies in diabetes co-management in co-operation with ophthalmology and departments of internal medicine and the PBODO should compile minimum standard guidelines for optometric co-management of diabetic patients.
- The Department of Health should utilise the positive role optometry could play in diabetes management and facilitate programmes in this regard. These programmes should be informative for the public at large. Secondly, the Department of Health should make funding available for the further training of optometrists to become diabetes co-management practitioners.
- The South African Optometric Association (SAOA) needs to lobby at statutory level and act as liaison between the Ophthalmological Association of South Africa (OSSA) and the PBODO in order to facilitate progress on the role of optometrists in diabetes co-management. The SAOA should also launch a public awareness campaign to educate diabetic patients on the advantages of an annual eye examination.

It is proposed that the recommendations of this study will be disseminated by means of journal articles, lectures and direct approaches to the PBODO, SAOA and Western Cape Department of Health.

### **5.3 LIMITATIONS OF THE STUDY**

The study is limited to two main areas in the Western Cape and it is acknowledged that this narrow band of sample selection renders the results ungeneralisable to the wider population. It does however indicate certain statistical trends which are important and worthy of further and deeper investigation.

Many respondents appeared unfamiliar with certain phraseology in the questionnaire. While some terminology was deliberately used in order to test the knowledge of the respondent in respect of diabetes management and ocular complications of diabetes, certain concepts like Body Mass Index (BMI) were sometimes confused with Body Mass.

Whilst this was essentially a quantitative study, certain qualitative measures may have been beneficial in order to obtain a wider perspective. These include interviews with GP's and other health care practitioners involved in the care of the diabetic patient.

### **5.4 RECOMMENDATIONS FOR FUTURE STUDY**

A similar study to this involving a broader regional base and thereafter on a national scale will make findings more generalisable to the wider diabetic community.

A qualitative study involving all members of the health care team involved in diabetic patient management would provide a valuable augmentation to this study. Such study would ideally involve input from, *inter alia*, GP's, dieticians, physicians, ophthalmologists and optometrists.

## 5.5 CONCLUSION

This research commenced with a comprehensive literature review followed by development of the patient questionnaire and the analysis of the data. The aims and objectives of the study were subsequently realised and based on these recommendations have been made. In conclusion, the following can be highlighted:

The results of this study indicate a clear trend where diabetic patients are not well-informed or knowledgeable about the disease of diabetes as well as the possible consequences of the condition. This appears true for both the management of the disease as well as the ocular complications, despite many respondents feeling that they knew enough about their condition to self-manage.

The literature provides clear evidence that increased, or enhanced, knowledge of diabetes facilitates greater compliance with management of the disease (Assal *et al.* (1985: 602). This results in potentially tighter blood glucose control with the associated long term benefits. Patient education and knowledge reinforcement is an essential part of diabetes care and management and, in the South African context, is particularly culturally sensitive. Furthermore, cognitive decline in the ageing population is exacerbated by uncontrolled plasma glucose levels. In this regard the importance of diet, exercise and the selective and judicious use of certain supplements are of vital importance.

The importance of a team-oriented approach to diabetes management has become apparent during this study. The General Practitioner is clearly the health care provider who is most intimately involved with the private diabetic patient. It is evident that GP's are under severe time constraints and consultations are often

limited to 15 minutes. In such a limited time only the primary complaint can be adequately addressed, leaving little time for patient education and counselling. It is unreasonable to expect of a GP to be able to cater to all the needs of a diabetic patient in so short a time and use must be made of optometrists and dieticians as part of the health care team. Optometrists are ideally placed to add value to diabetes treatment in a co-management role, where microvascular abnormalities may be detected by fundoscopy and appropriate referrals can be made. Suitably trained optometrists are able to recommend certain lifestyle interventions, educate patients and obtain random blood glucose measurements. To facilitate this, the Professional Board for Optometry and Dispensing Opticians (PBODO) should provide guidelines for the management of diabetic patients in optometric practice. The PBODO should furthermore accredit education programs for optometrists to become diabetes co-management practitioners. The role of the South African Optometric Association should be to highlight the benefits of a comprehensive optometric examination for all diabetic patients and emphasise the role of the optometrist as a primary health care provider in this regard.

It is clear from the literature that diabetes is a global concern and its prevalence is escalating to pandemic levels. There are vast socio-economic implications to this phenomenon and governments need to take cognisance of this as a matter of urgency. In South Africa, emphatic policy framework decisions must be taken and appropriate funding allocated in order to raise awareness amongst the population. Diabetes Mellitus is a major pandemic involving ever-greater numbers of the population. While the prognosis of well-managed diabetes is generally excellent, the

journey to optimal management is one that needs to be taken as a matter of urgency.

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## ANNEXURE A: Introduction letter and questionnaire



### Consent to participate in research

**Study title: PATIENTS' KNOWLEDGE OF DIABETES, ITS OCULAR COMPLICATIONS AND MANAGEMENT IN PRIVATE SECTOR POPULATION SAMPLE IN THE WESTERN CAPE, SOUTH AFRICA.**

I ..... hereby confirm that I have been requested to participate in a research study on the knowledge of diabetes, its ocular complications and management. I have read the briefing document provided and the contents thereof.

I confirm that I am voluntarily participating in the study and understand that all information will be kept confidential and that at no time will I be identified in the presentation of the results. Furthermore, I am aware that I have the right to refuse to participate or terminate my participation at any point. I am aware that should I have any queries, or if I have questions about my rights as a research participant, I may contact Mr K.C. Phillips at 022 4821900 (o/h), Mr K.P.Mashige at 031- 260 7352 or the Research Ethics Committee at 031-260 3587.

\_\_\_\_\_  
Signature of Participant

\_\_\_\_\_  
Date

## Toestemming om deel te neem in die navorsing

**Studietitel: "PATIENTS' KNOWLEDGE OF DIABETES, ITS OCULAR COMPLICATIONS AND MANAGEMENT IN PRIVATE SECTOR POPULATION SAMPLE IN THE WESTERN CAPE, SOUTH AFRICA."**

Ek ..... bevestig hiermee dat ek gevra is om deel te neem in 'n navorsingsstudie i.v.m. die kennis van diabetes, die okulêre komplikasies en die behandeling daarvan. Ek het die verduidelikingsbrief gelees en verstaan die inhoud daarvan.

Ek bevestig dat ek vrywillig in hierdie studie deelneem en verstaan dat alle inligting vertroulik is en dat ek op geen wyse geïdentifiseer word in die voorlegging van die resultate sal wees nie. Ek is verder bewus dat ek te enige tyd die reg het om deelname aan hierdie studie te ontkom. Ek is ook bewus daarvan dat, sou ek enige navrae oor my regte as navorsingsdeelnemer het, ek die volgende kan kontak: Mnr KC Phillips by 022 4821900 (k/u), Mnr KP Mashige by 031- 260 7352 of die Navorsings Etiek Komitee by 031-260 3587.

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Handtekening van Deelnemer

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Datum

**Isihloko: ULWAZI OLUPHANGALELEYO NGESIFO SESWEKILE NENDLELA  
ESIBANGELA INGXAKI NGAYO NESINGALAWULEKA NGASO  
EMEHLWENI KWISEBE ELIZIMELEYO LABEMI ABATHILE KWI  
BANDLA LASENTSHONA KOLONI EMZANTSI AFRIKA**

Mna ..... ndiyavuma ukuba yinxalenye ngokwesicelo kwizifundo eziphanda ngolwazi ngesifo seswekile futhi nangendlela esibangela ingxaki ngayo nesingalawuleka ngaso emehlweni. Ndiwafumene ndawafunda onke amaphepha acacisayo nanikeza ulwazi oluthe vetshe ngesisifo.

Ndiyanguqina ukuba ndizithandele ngokwam ukuba yinxalenye koluphando futhi ndiyaqonda ukuba lonke ulwazi oluqokelelweyo luyakugcinwa luyimfihlakalo negama lam alisayi kupapashwa kwiziphumo ezothi zivezwe. Ndiyazi ukuba ndinalo ilungelo lokwala okanye lokuzikhupha kwezizifundo zophando nangaliphi na ixesha endithanda ngalo. Ndiyazi ukuba nangaliphi na ixesha ndinemibuzo okanye ndinesikrokro ngamalungelo am okuba yinxalenye, ndingaqhakamshelana noMnumzana u K.C. Phillips ku 022 482 1900 (ngexesha lomsebenzi), Mnumzana K.P. Mashige ku 031 260 7325 okanye abe komiti ephanda ngokomgaqo ku 031-260 3587.

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Ilungu elityikityayo

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Umhla