THE DEVELOPMENT OF RECOMMENDATIONS FOR THE IMPLEMENTATION OF NUTRITION THERAPY FOR COLOURED WOMEN WITH TYPE 2 DIABETES ATTENDING CHCs IN THE CAPE METROPOLE

by

Catharina Margaretha Meyer, BSc (Hons) Nutrition & Dietetics
THRCAT006

SUBMITTED TO THE UNIVERSITY OF CAPE TOWN
In fulfilment of the requirements for the degree

M Sc in Dietetics

Faculty of Health Sciences
UNIVERSITY OF CAPE TOWN

Date of submission: July 2009

Supervisors: A/Prof M. Senekal, Dr Nelia Steyn and Prof NS Levitt

Name and Department and University: Division of Human Nutrition; Department Human Biology. University of Cape Town.

DECLARATION

I, Catharina Margaretha Meyer, hereby declare that the work on which this dissertation/thesis is based is my original work (except where acknowledgements indicate otherwise) and that neither the whole work nor any part of it has been, is being, or is to be submitted for another degree in this or any other university.

I empower the university to reproduce for the purpose of research either the whole or any portion of the contents in any manner whatsoever.

…….. ……

Signature Date

ABSTRACT

The aim of this study was to develop recommendations for the implementation of nutrition therapy for coloured women with type 2 diabetes attending CHCs in the Cape Metropole. This was accomplished by assessing subjects' weight status; eating pattern; quantity and quality of dietary intake, using dietary guidelines for persons with diabetes, the South African FBDGs, DRIs and the GI as reference standards; as well as their broad understanding of diabetes and the management thereof. A questionnaire was developed to assess socio-demographic background, lifestyle-related factors (physical activity, smoking and drinking habits) and nutrition and diabetes management-related knowledge. For dietary assessment purposes three 24-hour dietary recalls were obtained from each subject using the multiple pass method. A convenience sample of 59 coloured women with type 2 diabetes participated in the study. The data was collected over a period of three months at two community health care centres serving predominantly coloured people.

The results indicate that the study sample had a low socio-economic status, low level of formal education and a strong family history of type 2 diabetes. Most of the subjects were overweight (25%) or obese (62.5%) and had low levels of physical activity. Although low in total energy (±5850kJ) possibly due to underreporting, the subjects' diet was high in energy derived from total fat (±33%) and saturated fat (9.9%), with food products high in trans fats being consumed frequently. The diet was low in fibre (16g), lacking in adequate amounts of vegetables, fruit, legumes and possibly n-3 fatty acids, with a clear preference for refined carbohydrate food items. The majority of the sample did consume breakfast (±77.6%), lunch (±85%) and supper (±86.3%) and had a pattern of snacking between meals.

As far as diabetes knowledge is concerned, the study sample displayed inadequate knowledge in areas relating to the management of hypo and hyperglycaemia as well as the complications of diabetes, specifically the risk of cardiovascular disease. Most of the study sample (67%) had never been counselled by a dietitian and were not clear on the role of diet in diabetes management other than some short-term benefits. Although subjects were able to identify healthy food choices, this was not reflected in actual food choices, specifically in relation to fat, sugar, vegetables and fruit, legume

and refined carbohydrate choices. Expense, followed by taste and the restrictions associated with a 'diabetic' diet were identified as important barriers to following a diet for persons with diabetes.

Recommendations to advise the development of interventions for diabetes education, dietary behaviour change and weight loss at the level of the individual coloured women with diabetes were subsequently developed based on the above-mentioned findings. However, interventions at individual level can only be effective within the context of a supportive framework at other levels, i.e. optimal capacity of health care professionals to implement appropriate interventions and the necessary policies at the different levels of government to support and drive initiatives. Recommendations advising decisions regarding training of the health care professional as well as policy development at government level on diabetes management were therefore also formulated.

ACKNOWLEDGEMENTS

I would not have been able to complete this thesis without the encouragement and practical support from my family, friends and study mentors. I will never be able to name everyone, but would like to thank a few people specifically:

- My **husband Maarten**, thank you for the many sacrifices you made, your encouragement and faith in me.
- **Ma Carina**, thank you for the many hours of practical support, especially with little Amanda.
- **Marjanne Senekal**, you gave much more than your professional expertise- thank you.

I would further like to express my thanks to:

- The UCT staff at the postgraduate office
- Dr Hannelie Nel for her help with the statistics
- The assistance of the staff at Retreat and Heideveld CHCs
- The individuals with diabetes who chose to participate in the project by sharing their experiences and giving their time.

I dedicate this thesis to the staff and women with diabetes at Heideveld and Retreat Community Health Care Centres.

TABLE OF CONTENTS

TABLE OF FIGURES

TABLE OF TABLES

Definitions of terms

Coloured community	For the purposes of this research a *coloured* person is defined as a person of mixed decent (African, European and Malaysian/ Indonesian) with a cultural identity distinct both from Blacks and Whites (Dept of Health et al, 2007; Wikipedia, 2009)
Nutrition therapy	For the purposes of this research, the term *nutrition therapy* is used (unless otherwise specified) to denote the range of nutrition interventions, from basic nutrition education to more in depth nutrition counselling, that forms part of the dietary management of the person with diabetes.

Abbreviations

ADA	American Diabetes Association
CHC	Community health care centre
CHO	Carbohydrate
CRISIC	Coronary Risk Factor Study in Coloureds
CVD	Cardiovascular disease
Dept of Health	Department of Health
DSA	Diabetes South Africa
EASD	European Association for the Study of Diabetes
FAO	Food and Agricultural Organisation
FBDG	Food-based dietary guideline
HbA1c	Glycosylated haemoglobin
IGT	Impaired glucose tolerance
MNT	Medical nutrition therapy
MUFA	Mono-unsaturated fatty acids
NCD	Non-comunicable diseases
PUFA	Poly-unsaturated fatty acids
SADHS	South African Demographic and Health Survey
SEMDSA	Society for Endocrinology, Metabolism and Diabetes of South Africa
SFA	Saturated fatty acids
TF	Transfatty acids
UKPDS	United Kingdom Prospective Diabetes Study
WHO	World Health Organisation

CHAPTER 1: INTRODUCTION AND PROBLEM IDENTIFICATION

1.1 Motivation for the study

Rapid improvement in health and longevity are dramatically changing the burden of illness throughout the world. In developed countries, changes in lifestyle and improvements in the treatment of major causes of mortality have resulted in an aging population with a greater prevalence of non-communicable diseases (NCDs) (Lerman, 2005). Many developing countries are moving through an epidemiological transition with a change in the pattern of health, from communicable diseases and premature deaths to an increase in NCDs (Lerman, 2005) with the main ones being cardiovascular disease (CVD), type 2 diabetes and certain types of cancer (Steyn et al, 2006b). Increasing urbanisation and related lifestyle changes, in particular dietary changes, lower levels of physical activity, higher stress levels, increasing nicotine and alcohol consumption, increase in weight and subsequent obesity, are believed to be responsible for the rise in prevalence of diabetes and other chronic diseases (WHO, 2003).

Type 2 diabetes mellitus (referred to as type 2 diabetes from here onwards) is now one of the most common NCDs globally. The World Health Organisation (WHO) estimates that there are 180 million people with diabetes worldwide, a figure that is expected to double by the year 2030 (WHO, 2006) which is approximately 6.5% of the world's population (Yach et al, 2004). Almost half of diabetes deaths occur in people under the age of 70 years with 55% of diabetes deaths among women. The WHO projects that if urgent action is not taken diabetes deaths will increase by more than 50% in the next 10 years (WHO, 2006). It remains to be seen what effect the ongoing epidemic of HIV disease will have on the epidemiology of such chronic diseases as diabetes.

Available data on the prevalence of diabetes in **Africa** indicate considerable variation in different groups in the same and different countries (Motala, 2002). It was predicted that the prevalence of diabetes in adults in Sub-Saharan Africa would rise by 18% from 1995 to 2025 (King et al, 1998). In South Africa the prevalence of type 2 diabetes mellitus and impaired glucose tolerance (IGT) in all ethnic groups is thought to exceed that of most groups in other African countries (Amos et al, 1997).

It is estimated that there are at least 1 million known diabetics in South Africa (Brown et al, 2005) and possibly up to an equal number who are undiagnosed (Amos et al, 1997). The prevalence of diabetes is estimated to be 10% in the Indian community (Motola et al, 2003), 5-6% in the black community (SEMDSA, 1997) as high as 10.8% in the coloured population in the Cape Town area (Levitt et al, 1999).

Uncontrolled diabetes is not only associated with premature death, disability, coma and decreased quality of life, but also significantly adds to national medical health care expenditures. In a developing country such as South Africa, where chronic care systems are not always well developed (Levitt & Bradshaw, 2006), it is a particularly difficult problem to overcome. Hospital data in South Africa indicate an unacceptably high mortality rate among persons with diabetes, usually due to cardiovascular and renal complications, infection and metabolic emergencies (SEMDSA, 1997). Overall, about 14% of ischaemic heart disease (IHD), 10% of stroke, 12% of hypertensive disease and 12% of the renal disease burden in South African adults were attributable to diabetes (Bradshaw & Steyn, 2001). Diabetes is estimated to have caused 4.3% of all deaths in South Africa in 2000 (Bradshaw & Steyn, 2001). This highlights the need for the implementation of cost effective interventions focused on the prevention and management of diabetes in the country (Unwin et al, 2001; Steyn et al, 2006b).

It is generally accepted that nutrition therapy has the potential to contribute to cost-effective prevention and management of diabetes. To encourage the allocation of resources towards nutrition intervention, it needs to be evidence based, as is the case in pharmacological intervention (Anderson, 2003). In terms of prevention, several studies have demonstrated that the use of structured programs targeted at individuals at high risk for developing type 2 diabetes, which emphasise lifestyle changes, can reduce the risk for developing diabetes. These changes include moderate weight loss and regular physical activity with dietary strategies (such as reduced intake of fat) to reduce energy intake (Bantle et al, 2008; Tuomilehto et al, 2001). In terms of management of diabetes, evidence from randomised controlled trials (UK Prospective Diabetes Study, 1990; Franz et al, 1995a; Delahanty & Halford, 1993), observational studies and meta-analyses (Brown, 1990; Brown et al, 1996) demonstrate that nutrition intervention improves metabolic outcomes, such as blood

glucose and HbA1c levels in individuals with diabetes. These metabolic outcomes were achieved both if delivered as independent nutrition therapy or as part of multidisciplinary diabetes self-management training (Pastors et al, 2002), and at a reasonable cost (Franz et al, 1995b). Cost-effectiveness also improves when dietitians actively participate in the decisions about the patient's nutrition alternatives (Franz et al, 1995b).

Despite recognising that nutrition therapy is an integral and potentially effective component of diabetes management, there are numerous difficulties in the practical application thereof. Within the South African context the national health care system is based on a primary health care (PHC) approach where the chief focus is on community-based facilities delivering a broad range of primary health care services. Patients can then be referred on to primary, secondary and tertiary level hospitals when more specialised services are needed (Benatar, 1997). Within the South African context a large percentage of the population are dependent on facilities such as community health care centres (CHCs) for health care. CHCs provide a range of primary health care services, and some also offer accident, emergency and midwifery services (Health Facility definitions, 2006). Staff in the Cape Metropole typically includes a facility manager, nursing staff, medical doctors, often a physiotherapist and / or an occupational therapist and possibly a rotating dietitian. Although the dietitian is the best person to provide nutrtition therapy in the primary health care (PHC) system such as CHCs, patients may not have the opportunity to be counselled by dietitians because of the limited number of dietitians. Therefore, they are often dependent on the media, a 'diet sheet' or advice by health care providers at CHCs who received little or no formal training in this regard (Nthangeni et al, 2002).

A further factor that limits optimal nutrition therapy for persons with diabetes in the country is the fact that the official South African dietary guidelines for the management of diabetes are outdated, with the last revision published in 1997 by the Association for Dietetics in South Africa (SEMDSA, 1997). The recently published SEMDSA update on the medical management of diabetes mellitus does not include detailed dietary guidelines (Levitt et al, 2009). The 1997 guidelines were based on international consensus guidelines at the time, but there is a paucity of data available on the acceptability and appropriateness of these guidelines in the South African

context. Currently, nutrition therapy for diabetes is based on a combination of points mentioned in international consensus guidelines such as the ADA position statements, the glycaemic index, and the South African Food-Based Dietary guidelines (Blaauw: Personal communication, 2007).

The multi-cultural nature as well as the different socio-economic levels of the South African society represents a further challenge to develop appropriate nutrition guidelines and interventions. Any nutrition guidelines should recognise the importance of adjusting dietary messages according to the needs of the individual's beliefs and lifestyle (Bantle et al, 2007b). However, evidence from work that was undertaken in urban and rural black persons with diabetes in Limpopo Province indicated that they frequently received incorrect and inappropriate dietary advice from health educators (Nthangeni et al, 2002). This illustrates the need for well developed, appropriate diabetes nutrition therapy guidelines in the country.

To ensure optimal program outcomes and cost-effectiveness, interventions should also be based on a profile of the lifestyle and other diabetes-associated factors in particular groups and communities. To date, no research has been conducted to assess the dietary adequacy and adherence of coloured persons with type 2 diabetes to nutrition therapy. One of the very few comprehensive studies that was conducted to assess the dietary intake of coloured people in the Cape Metropole (CRISIC study, n=976), showed that this group consumes a typical Western diet high in fat and low in nutrient density (Steyn et al, 1985). Not only is this type of diet not in line with international diabetes nutrition therapy guidelines (Bantle et al, 2008), but is in actual fact a known risk factor for persons with type 2 diabetes (Steyn et al, 2009) and would thus exacerbate the condition in those diagnosed type 2 diabetes. Other smaller studies in this population group reported similar findings (Langenhoven et al, 1988; Steyn et al, 1986; Charlton et al, 1997). No information is available on the extent to which persons with diabetes in this group are managing their dietary intake and whether the current diabetes guidelines are appropriate for them. Without this information diabetes nutrition therapy targeted at this specific group can not be optimised.

Hence, the purpose of the current study was to investigate the dietary intake, habits and broad knowledge of diabetes and the management thereof in coloured persons

with type 2 diabetes in the Cape Metropole. This will facilitate recommendations for the implementation of nutrition therapy for this community

1.2 Aim of the study

The aim of this research was to develop recommendations for the implementation of nutrition therapy for coloured persons with type 2 diabetes attending CHCs in the Cape Metropole.

1.3 Objectives

To realise this aim, the following objectives were formulated:

A. To develop a profile of coloured persons with type 2 diabetes mellitus in the Cape Metropole that covers the following:

   i. Weight status and energy balance

   ii. Quantity and quality of dietary intake (in terms of prudent and SA diabetes guidelines, the SA Food-based Dietary guidelines, Dietary reference intakes and the glycaemic index).

   iii. Eating pattern with specific focus on the 24-hour carbohydrate distribution.

   iv. Broad understanding of diabetes and the management thereof.

B. To develop recommendations for the implementation of nutrition therapy based on the generated information.

1.4 Outline of the thesis

Chapter 2 covers the literature review that serves as background to the study, and covers aspects of diabetes management in general and, specifically, dietary aspects of diabetes management. The South African scenario in terms of diabetes management, as well as information available on diabetes and dietary aspects of management in the coloured community of the Cape Metropole, are discussed.

Chapter 3 describes the methodology used for selecting the study population, and the data collection. Particular attention is paid to explain the dietary methodology that was chosen, as well as the background for analyses that were performed.

Chapter 4 covers the results of the study. Results are grouped according to objectives. Each group of results is followed up with a discussion, with brief concluding remarks based on the findings of that particular section of results.

Chapter 5 presents the final recommendations based on the results of the study.

Chapter 6 provides the references used in the thesis, followed by Addenda A, B and C.

CHAPTER 2: LITERATURE REVIEW

2.1 Definition and diagnosis of diabetes mellitus

Diabetes mellitus is a group of metabolic disorders characterised by a number of clinical and biochemical abnormalities (primarily an abnormal increase of glucose in the blood). If left untreated, diabetes may result in acute death or premature morbidity and mortality. The hyperglycaemia associated with diabetes results from a defect in insulin secretion, insulin action, or both, and is associated with long-term damage to, dysfunction of, and failure of, various organs, especially the eyes, kidneys, nerves, heart and blood vessels (Franz, 2008:797; Expert Committee, 2000 & 2003; SEMDSA, 1997).

Type 1 diabetes (previously referred to as insulin-dependent or childhood-onset diabetes) is characterised by a lack of insulin production and accounts for 5-10% of all diagnosed cases of diabetes. Without daily administration of insulin, type 1 diabetes is rapidly fatal. Symptoms include excessive excretion of urine (polyuria), thirst (polydipsia), constant hunger, weight loss, vision changes and fatigue (Franz, 2008:798; WHO, 2006). Although type 1 diabetes may occur at any age, most cases are diagnosed in people younger than 30 years of age, with a peak incidence at around ages 10-12 years in girls and 12-14 years in boys. Affected persons are usually lean, have abrupt onset of symptoms, and are dependent on exogenous insulin to prevent keto-acidosis[*] and death (Franz, 2008:795). As the focus of this research is on type 2 diabetes mellitus, the literature review includes no further information on type 1 diabetes.

Type 2 diabetes (formerly referred to as non-insulin-dependent or adult-onset diabetes) accounts for 90-95% of cases (Franz, 2008:797; WHO, 2006). It results from the body's ineffective use of insulin and is largely the result of excess body weight and physical inactivity (WHO, 2006). Most persons with type 2 diabetes are characterised by age of onset over 40 years, obesity and less proneness to keto-acidosis (compared to type 1). They do not, as a rule, require insulin for survival, but often, with the progression of the disease, require insulin to improve clinical

[*] Diabetic keto-acidosis occurs in severe, uncontrolled diabetes, resulting from insufficient insulin, with a ketone body (acid) build up in the blood. If left untreated it can lead to coma and even death (Mahan & Escott-Stump, 2008)

symptoms and metabolic control (SEMDSA, 1997; Nathan et al, 2008). Symptoms may be similar to those of type 1 diabetes, but are often less marked. As a result, the disease may only be diagnosed several years after onset, once complications have already arisen (Campbell & Lebovitz, 2001). Until recently, this type of diabetes was seen only in adults but it is now also occurring in obese children (WHO, 2006).

The diagnosis of type 2 diabetes mellitus is based on the presence of clinical features and an elevated blood glucose concentration. The condition is usually suspected in persons with typical symptoms such as increased thirst (polydipsia) and urination (polyuria), weight loss, fatigue, poor vision, poor wound healing, repeated skin, mucous membrane and genital infections and sometimes coma (SEMDSA, 1997). Other individuals in whom the diagnosis should be suspected, even in the absence of typical symptomatology, include those with a strong family history of diabetes, those of Indian and Malay origin, those who are obese or hypertensive, women who had fertility or obstetric problems or high-birth weight infants and in all with advancing age (SEMDSA, 1997). The criteria for diagnosing diabetes are set out in Table 1. Symptoms must be confirmed biochemically before a diagnosis can be established.

Table 1: Criteria for the diagnosis of prediabetes and diabetes.

Prediabetes:
1.Fasting plasma glucose(FPG) levels ≥5.6 mmol/l but ≤7.0 mmol/l *OR* **2**.2-hr values in the oral glucose tolerance test (OGTT) of ≥7.8 mmol/l but ≤11.1 mmol/l.
Diabetes:
1. FPG ≥ 7.0 mmol/l. Fasting is defined as no caloric intake for at least 8 h.* OR **2**. Symptoms** of hyperglycaemia and a casual*** plasma glucose≥ 11.1mmol/l. OR **3.** 2-h plasma glucose ≥11.1 mmol/l during an OGTT. The test should be performed as described by the World Health Organization, using a glucose load containing the equivalent of 75 g anhydrous glucose dissolved in water.*

*In the absence of unequivocal hyperglycaemia, these criteria should be confirmed by repeat testing on a different day.

**The classic symptoms of hyperglycaemia include polyuria, polydipsia, and unexplained weight loss

*** Casual is defined as any time of day without regard to time since last meal.

Source: (ADA, 2008a: Diagnosis and classification of diabetes mellitus)

'Pre-diabetes' refers to those with impaired fasting glucose (IFG) or who have impaired glucose tolerance (IGT). These persons have glucose levels higher than normal, yet not high enough to be classified as diabetes (Expert Committee, 2003) (Table 1). IFG and IGT are not only risk factors for future diabetes, but also for cardiovascular disease and are associated with the components of the metabolic syndrome (see detailed discussion in section 2.3.3), including central obesity, dyslipidemia and hypertension (ADA, 2008a ; Expert Committee, 2003).

2.2 Pathophysiology of type 2 diabetes mellitus

The main underlying defects of type 2 diabetes are **reduced insulin sensitivity** (insulin resistance) and **impaired ß-cell function**, although the relative contribution of these twodefects may differ due to heterogeneity of the disease (Groop, 2000). The majority of persons who will ultimately develop type 2 diabetes have both of the above-mentioned defects; even though it is unclear which one is the primary defect (Campbell & Lebovitz, 2001; Expert Committee, 2003; ADA, 2008a). Together, these defects initiate a sequence of events that leads ultimately to widespread metabolic imbalance and clinical disease (Shaw, 2006; Campbell & Lebovitz, 2001; Expert Committee, 2000). Both reduced ß-cell function and increased insulin resistance are major adverse contributory factors to achieving good therapeutic outcomes (Shaw, 2006).

Loss of ß-cell function is gradual and individuals generally have less than 50% of normal beta-cell function by the time they are diagnosed with diabetes (Wajchenberg, 2007). With the course of time, type 2 diabetes progresses and ß-cell responsiveness diminishes, but at differing rates between individuals (Shaw, 2006). The United Kingdom Prospective Diabetes Study observed an approximate 4-5% per year decline in ß-cell function regardless of the treatment given (UKPDS, 1998).

The capacity of the ß-cell to maintain adequate insulin secretion is fundamental for effective responsiveness to oral hypoglycaemic agents, whereas insulin resistance, usually related to obesity, puts greater demand on ß-cell insulin secretory reserve. Endogenous insulin levels may be normal, depressed, or elevated, but if it is inadequate to overcome simultaneous insulin resistance (decreased tissue sensitivity or responsiveness to insulin), hyperglycaemia results. The net effect of insulin

resistance is a decreased ability of insulin to suppress hepatic glucose production and to increase muscle and adipose tissue glucose uptake (Campbell & Lebovitz, 2001).

Hyperglycaemia first appears as an elevation of postprandial blood glucose caused by insulin resistance at the cellular level. It is followed by an elevation in fasting glucose concentrations. As insulin secretion decreases, hepatic glucose production increases, causing the increase in pre-prandial (fasting) blood glucose levels. Compounding the problem is the deleterious glucotoxic effect of hyperglycaemia itself on both insulin sensitivity and insulin secretion (Yki-Jarvinen, 1992; Franz, 2008:797), hence the importance of achieving near-euglycemia in persons with type 2 diabetes. In persons with manifest diabetes, chronic hyperglycaemia can result in further deterioration of insulin sensitivity and secretion aggravated by elevated free fatty acids (lipotoxicity) (Groop, 2000).

2.3 Etiology of type 2 diabetes mellitus

The etiology of type 2 diabetes is not clearly established, but the following have been identified as possible contributing risk factors: a family history, insulin resistance, obesity (particularly central obesity), diet, older age, physical inactivity, smoking, a prior history of gestational diabetes, impaired glucose homeostasis and race or ethnicity (Franz, 2008:797; Expert Committee, 2000; ADA, 2008a). It also occurs more frequently in individuals with hypertension or dyslipidaemia (Expert Committee, 2000; ADA, 2008a).

2.3.1 Family History (genotype)

Compared with the general population, one first-degree relative with type 2 diabetes increases the relative risk of an individual of developing type 2 diabetes twofold and having two relatives increases the risk fourfold (Campbell & Lebovitz, 2001). Recent genetic association studies have provided convincing evidence that several novel loci are associated with the risk of diabetes (Saxena et al, 2007). In individuals genetically susceptible to type 2 diabetes, the ß-cells cannot compensate and long term and postprandial hyperglycaemia occurs (Campbell & Lebovitz, 2001). However, since population gene pools shift very slowly over time, the current increase in diabetes cannot solely be attributed to genetics and it is more likely to be attributed to changes in lifestyle (ADA, 2008a).

2.3.2 Race/Ethnicity

Certain ethnic groups, such as the Pima Indians of Arizona, have an exceedingly high prevalence of type 2 diabetes. In these populations, type 2 diabetes is associated with obesity, which is presumably the result of a lifestyle change to a western diet, with increased refined carbohydrate and fat intake and a low level of physical activity (Campbell & Lebovitz, 2001). However, although environmental factors such as obesity undoubtedly account for some of the different prevalence of type 2 diabetes, they are likely also to reflect inherent ethnic differences in susceptibility to the disease (Steyn et al, 2004). The South African Indian population have a four times higher risk to develop type 2 diabetes and develop it about 10 years earlier compared to South African whites (Seedat, 1999).

2.3.3 Insulin resistance and the metabolic syndrome

Insulin resistance is one of the key factors responsible for hyperglycaemia in type 2 diabetes and refers to a reduction in the biological effect of insulin on glucose metabolism (Campbell & Lebovitz, 2001).The exact underlying cause of this resistance is unclear, and controversy persists as to whether insulin resistance is itself a primary change in diabetes or whether it is attributable to reduced physical activity, decreased lean body mass and increased adipose tissue (Franz, 2008:797; Kohrt et al, 1993).

Insulin resistance is first demonstrated in target tissues, mainly muscle and the liver, with muscle tissue as the most significant site of insulin resistance. Muscle tissue accounts for approximately 75% of glucose disposal in non-diabetic subjects and insulin resistance in muscle is the major cause of postprandial hyperglycaemia (DeFronzo, 1988). Initially there is a compensatory increase in insulin secretion, which maintains normal glucose concentrations, but as the disease progresses, insulin production gradually decreases. Under most circumstances, insulin resistance is the earliest detectable defect in pre-diabetic individuals, but it is not known whether this is the primary defect or secondary to other abnormalities such as central (abdominal) obesity, with excessive free fatty acid turnover and increased lipid deposits in muscle (Groop, 2000).

However, not all insulin-resistant persons will develop type 2 diabetes (Reaven et al, 1989) and many continue to secrete enough insulin to prevent gross decompensation

of glucose tolerance. Insulin resistance is however associated with a cluster of metabolic abnormalities that together are described as the metabolic syndrome or insulin resistance syndrome. The five criteria selected by the Adult Treatment Panel III (ATP III) of the National Cholesterol Education Program to identify the metabolic syndrome are central obesity, elevated blood pressure, impaired fasting blood glucose, high triglycerides and low HDL-C concentrations (National Cholesterol Education Program Expert Panel, 2001). When any three of the five criteria are satisfied, a person can be identified as having the metabolic syndrome.

The metabolic syndrome is a highly prevalent pre-diabetic state (Krentz, 2006), but as with insulin resistance, not everyone identified with the syndrome will develop type 2 diabetes. The presence of insulin resistance and its associated metabolic abnormalities do, however, put someone at increased risk of cardiovascular disease (Krentz, 2006; Arner, 2002).

2.3.4. Obesity

Obesity is a disease state in which excess fat has accumulated to a degree that health may be adversely affected (WHO, 1998). Overweight and obesity are among the main modifiable risk factors that play an important role in the development of type 2 diabetes. About 65-70% of persons with type 2 diabetes are obese and total adiposity and a longer duration of obesity are established risk factors for type 2 diabetes (Franz, 2008:797; Klein et al, 2004). The risk of co-morbidity associated with excess adipose tissue increases with a body mass index (BMI) in the overweight range and above (Bantle et al, 2008).The relative risk of developing type 2 diabetes is increased 39-fold for people with a BMI of between 30-35kg/m^2, as compared to a BMI of 23kg/m^2 (Colditz et al 1990).

In South Africa, excess body weight is estimated to have caused 7% of all deaths in 2000. The burden in women was approximately double that in males (Joubert et al, 2007). Overall 87% of type 2 diabetes, 68% of hypertensive disease and 45% of ischemic heart disease was attributable to a BMI of more or equal to 21kg/m^2 (Joubert et al, 2007).

Body fat distribution is another important risk factor to consider for type 2 diabetes. The BMI takes no account of the distribution of body fat and serves only as a measure of total body weight and not of body fat, while obesity refers to excess body

fat and not necessarily to total body weight. Some persons with diabetes have an increased amount of intra-abdominal body fat although they are not necessarily obese according to BMI criteria (Ha & Lean, 1998). Obesity combined with abdominal fat distribution (or visceral obesity) rather than gluteal fat accumulation poses the highest risk for insulin resistance, a very atherogenic lipid profile and the other features of the metabolic syndrome (Arner, 2002; Ha & Lean, 1998; Despres et al, 2001; Goldstein, 1992).

Obesity leads to insulin resistance through a variety of mechanisms, with a resulting decrease in glucose transport into cells and defective intracellular glucose metabolism (Campbell & Lebovitz, 2001). The release of free fatty acids from adipocytes can block insulin-signalling pathways and lead to insulin resistance. In addition, recently identified adipocyte-specific chemical messengers, the adipocytokines, such as tumour necrosis factor-alpha, adiponectin, and resistin, appear to modulate the underlying insulin resistance. When insulin resistance is combined with ß-cell defects in glucose-stimulated insulin secretion, impaired glucose tolerance, hyperglycaemia, or type 2 diabetes can result (Goldstein, 1992).

2.3.5 Diet

Many studies have shown a decrease in insulin sensitivity with diets high in fat and positive associations have been found especially between intake of saturated fat and hyperinsulinaemia (Hu et al, 2001b) as well as between trans-fatty acids and development of diabetes (Hu et al, 2001a). Reduced risk of diabetes has also been associated with an increased intake of whole grains and dietary fibre (Meyer et al, 2000; Schulze et al, 2004). Refer to section 2.8 for detail.

2.3.6 Physical inactivity

Physically active subjects are less likely to develop insulin resistance, impaired glucose tolerance, or type 2 diabetes (Helmrich et al, 1991; Eriksson & Lindgarde (1991). Refer to section 2.7 for detail.

2.3.7 Other factors

Older age

The prevalence of type 2 diabetes increases with age. In high incidence populations, the prevalence noticeably increases in the younger adult years (e.g. 20–35 years of

age), while in other populations, the incidence and prevalence increase mainly in older individuals (e.g. 55–74 years of age) (Steyn et al, 2004).

Cigarette smoking

Numerous studies point to the fact that cigarette smoking may increase the risk of diabetes and smokers tend to have a higher HbA1c concentration compared to non-smokers (Bazzano et al, 2005).

A previous history of gestational diabetes

The presence of gestational diabetes identifies women with a defect in ß-cell function, in whom insulin secretion does not increase adequately in response to the insulin-resistant state of pregnancy. The same defect in ß-cell function may therefore predispose some women to overt diabetes in later years (Buchanan, 2001).

Impaired glucose homeostasis

As mentioned earlier, IFG and IGT are risk factors for diabetes as well as for cardiovascular disease (ADA, 2008a; Expert Committee, 2003). IFG is an accepted component of the metabolic syndrome (NCEP-ATP III 2001), and the metabolic syndrome is commonly present in those with IGT and IFG (Hanefeld et al, 2009).

Hypertension and dyslipidaemia

Elevated triglycerides, low levels of HDL-chlolesterol and elevated blood pressure are all components of the metabolic syndrome that individually are significant predictors of diabetes (Hanefeld et al, 2009).

2.4 Clinical course, complications and prognosis of type 2 diabetes mellitus

The clinical course and prognosis for persons with diabetes is influenced primarily by the duration of diabetes and by metabolic control. Poor metabolic control of diabetes results in a variety of acute and chronic complications as are listed in Table 2. These complications of diabetes are very common and persons may initially present with these (SEMDSA, 1997; ADA, 2008b). The overall risk of dying among persons with diabetes is at least double the risk of their peers without diabetes

(WHO, 2006) and most morbidity and mortality associated with diabetes is attributable to its chronic complications (Campbell& Lebovitz, 2001).

Table 2: Complications of diabetes mellitus

Acute
• Hypoglycaemia
• Diabetic Coma
-Keto-acidosis
-Hyperosmolar nonketotic coma
Chronic
Micro vascular disorders
• Retinopathy
• Nephropathy
• Neuropathy
• Foot problems
Macro vascular disorders
• Cardiovascular disease
• Cerebrovascular disease
• Peripheral vascular disease

Source: (Campbell & Lebovitz, 2001)

Micro vascular complications are specific to diabetes mellitus and do not occur in non-diabetic individuals. They involve the small blood vessels and include nephropathy and retinopathy. Diabetic retinopathy is an important cause of blindness and occurs as a result of long-term accumulated damage to the small blood vessels in the retina. After 15 years of diabetes, approximately 2% of people become blind and about 10% develop severe visual impairment. Diabetic neuropathy is damage to the nerves as a result of diabetes and affects up to 50% of persons with diabetes. Although many different problems can occur as a result of diabetic neuropathy, common symptoms are tingling, pain, numbness, or weakness in the feet and hands. Combined with reduced blood flow, neuropathy in the feet increases the chance of foot ulcers and eventual limb amputation. Diabetes is among the leading causes of diabetic nephropathy or kidney failure and 10-20% of persons with diabetes die of kidney failure (WHO, 2006).

Macro vascular complications involve diseases of large blood vessels. They are not specific to diabetes mellitus, but arise at an earlier age in those with diabetes than in non-diabetic individuals (ADA 2001; Campbell& Lebovitz, 2001). Cardiovascular disease (CVD) is the major cause of morbidity and mortality (primarily heart disease and stroke) for individuals with diabetes, and is the largest contributor to the direct and indirect costs of diabetes (ADA, 2008b). Results from a 10-year follow-up in the

UK Prospective Diabetes Study (UKPDS) show a sustained 'legacy' effect of an intensive glucose-control strategy that appears to be longer than previously reported. These observations indicate that intensive glucose control starting at the time of diagnosis is associated with a significantly decreased risk of myocardial infarction and death from any cause, in addition to the well-established reduction in the risk of micro vascular disease (Holman et al, 2008).

Besides glycaemic control the genetic predisposition to type 2 diabetes itself and, in particular, the insulin resistance syndrome with hyperinsulinemia is also involved in the development of macro vascular disease. The interaction of the commonly present cardiovascular risk factors such as hypertension, dyslipidaemia and a procoagulant state together with others such as cigarette smoking, are most likely to initiate and enhance macro vascular disease in persons with type 2 diabetes more than in non-diabetic individuals (Campbell& Lebovitz, 2001).

2.5 Overview of management of type 2 diabetes mellitus

Adequate glycaemic control is a critical component in preventing complications associated with type 2 diabetes. As mentioned, much of the morbidity and financial implications are attributable to long-term diabetes-related complications, particularly cardiovascular disease. The wide spectrum of interrelated variables that influence 'successful' management of diabetes need to be considered in a treatment plan. This ranges from the heterogeneous and progressive nature of type 2 diabetes itself to the many different lifestyle factors, underlying attitudes and belief systems that drive behaviour in everyday living with diabetes (Shaw, 2006). Treatment plans should therefore provide the person with diabetes with the necessary tools to achieve the best possible control of glycaemia, lipidaemia and blood pressure to prevent, delay, or arrest the micro vascular and macro vascular complications of diabetes (Stolar et al, 2008; Campbell & Lebovitz, 2001).

Day-to-day glycaemic control can be assessed by self-monitoring of blood glucose and measurement of urine for ketones. Longer-term glycaemic control is measured by glycated haemoglobin (HbA1c) which is formed when haemoglobin and other proteins are exposed to glucose and the glucose attaches to the protein in a slow, non-enzymatic and concentration-dependent fashion. The higher the blood glucose levels over the previous six to eight weeks, the higher the glycated haemoglobin

(Campbell& Lebovitz, 2001; Franz, 2008:800). Glycated haemoglobin is not used as a diagnostic tool at this stage (ADA, 2008a).

Common therapeutic goals for persons with type 2 diabetes in primary health care in South Africa are listed in Table 3.

Table 3: Recommendations for glycaemic control in type 2 diabetes mellitus*

Biochemical Index	Optimal		Acceptable	Additional Action Suggested [1]
	2002	2009		
Capillary blood glucose values (Finger prick)[2]				
▪ Fasting (mmol/l)	4-7	4-6	6-8	>8
▪ 2-hour post-prandial (mmol/l)	5-8	4-8	8-10	>10
Glycated haemoglobin (HbA1c) (%)	<7	<7	7-8	>8
Weight and Waist				
BMI (kg/m^2)	<25	<25		>27[3]
Waist circumference (cm)	<94	<94		>102
Male:	<80	<82		>88
Female:				

*These values are for non-pregnant adults according to SEMDSA 1997 guidelines unless otherwise specified.

[1] Will depend on individual patient circumstances. Such actions may include enhanced diabetes self-management education, co-management with a diabetes team, referral to an endocrinologist/diabetologist, change in pharmacological therapy, initiation or increased self-monitoring of blood glucose or more frequent contact with the patient. HbA1c is referenced to a nondiabetic range of 4.0-6.0%. Ideally, action should be instituted before these levels are reached.

[2] Preferably assessed over several visits.

[3] In the presence of diabetes mellitus (DM) this level is 27 and 30

Source: (Revised SEMDSA guidelines, 2002; Levitt et al, 2009).

The goals outlines in Table 3 are similar to the most recent glycaemic goals recommended by the ADA (2008b). Less rigorous treatment goals may be appropriate for persons with limited life expectancies and in individuals with co-morbid conditions (ADA, 2008b). The prescribed blood glucose goals are levels that appear to correlate with achievement of an HbA1c of less than 7%. Lowering HbA1c to an average of less than 7% reduces micro vascular and neuropathic complications of diabetes and, possibly, macro vascular disease (ADA, 2008b).

Treatment of type 2 diabetes usually proceeds through different stages. Nutrition therapy to improve insulin sensitivity and improve glycaemic control is initially implemented. This may include weight loss (reducing energy intake) if the person is overweight as well as further dietary adjustments such as monitoring of carbohydrate

servings and distribution through the day, limiting consumption of saturated fats and increasing physical activity (see section 2.7 and 2.8 for further detail). These strategies should be implemented as soon as the diagnosis of diabetes is made (Franz, 2008:803). If they are not adequate, oral medication is added and/or insulin if necessary (refer to section 2.6).

2.6 Medical management of type 2 diabetes mellitus

In the past**, oral antidiabetic** agents were only resorted to in the management of type 2 diabetes when all lifestyle approaches had been adequately tried. However, most persons with diabetes will not sustain an adequate level of glycaemic control using non-drug or even single-drug therapeutic approaches (Nathan et al, 2006). Because of the progressive nature of type 2 diabetes, addition of medications is the rule rather than the exception. Given the loss of 50% of ß-cell function at diagnosis of diabetes (Wajchenberg, 2007) , as well as a 50% prevalence of pre-existing coronary heart disease at diagnosis, a more aggressive approach from the earliest stages of disease is being promoted (Garber, 1998; Gastaldelli, 2004). As a result guidelines from the ADA/EASD now recommend the use of metformin (see Table 4 for clarification) as part of initial therapy, in addition to promoting lifestyle modifications (Nathan et al, 2006). Up to 2008, South African (SEMDSA, 2002) and Canadian diabetes guidelines (Bhattacharyya et al, 2008) for management of type 2 diabetes mellitus still advised lifestyle modification alone as a first-line approach, unless random glucose values are above 15 mmol/L (SEMDSA, 2002) or if a diabetic person's HbA1c is more than 9% (Bhattacharyya et al, 2008). However, very recently updated South African guidelines (Levitt et al, 2009) now also recommend metformin as part of initial therapy.

If the natural history of type 2 diabetes is matched with the pharmacology of antihyperglycaemic agents, a logical step-wise approach to the pharmacological treatment of type 2 diabetes can be derived (Campbell & Lebovitz, 2001; Stolar et al, 2008). Because of the different sites of action, the medications can be used alone or in combination, and be adjusted over time as the disease progresses. Selection of a specific agent is based in part on the existing level of glycaemia, with preferential consideration given to insulin for the diabetic person who is symptomatic or has an HbA1c > 8.5% (Stolar et al, 2008). Other considerations when choosing a specific

agent may include tolerability, nonglycaemic effects, adherence and cost. A list of the different classes of diabetic medications as well as mode of action is presented in Table 4.

Table 4: Glucose-lowering agents used in the management of type 2 diabetes mellitus.

Medication Class	Example	Primary mode of action	Route of glycaemic control	Adverse events
Alpha-glucosidase inhibitors	Acarbose, Miglitol	Inhibit enzyme central to digestion of carbohydrate	Postprandial glucose	Diarrhoea, abdominal pain, flatulence, ↑transaminases
Biguanides	Metformin	↓Hepatic glucose production;↑ muscle sensitivity to insulin	Fasting glucose, insulin sensitivity	Diarrhoea, nausea, lactic acidosis
DPP-4inhibitors	Sitagliptin	Inhibition of DPP-4 results in ↑GLP-1	Postprandial glucose	Upper respiratory infection, nasopharyngitis, headache
Meglitinides	Nateglinide, Repaglinide	Beta-cell secretagogue	Postprandial glucose	Hypoglycaemia,
Sulphonylureas	Glimepiride, Glipizide, Glyburide , Glibenclamide, Glyclizide	Beta-cell secretagogue	Fasting and postprandial glucose	Hypoglycaemia, weight gain
Thiazolidinodiones (*Glitazone)*	Pioglitazone, Rosiglitazone	Enhanced peripheral insulin sensitivity, improved hepatic insulin sensitivity	Insulin sensitivity; postprandial and fasting glucose	Fluid retention, weight gain, heart failure
Amylin analogues	Pramlintide	↓Glucagon secretion, gastric emptying, and food intake	Postprandial glucose	Nausea, hypoglycaemia
Incretin mimetics	Exanitide	↓Glucagon secretion, gastric emptying, and food intake;↑insulin secretion	Postprandial glucose	Nausea, diarrhoea, hypoglycaemia, pancreatititis
Insulin	-	-	Fasting and postprandial glucose	Hypoglycaemia, weight gain

Source: Adopted from Stolar et al (2008)

As the disease progresses, the pancreas fails to secrete enough insulin to maintain adequate glucose control and additional medications are required over time if treatment goals are to be met (Nathan et al, 2008). Metformin is the recommended initial drug therapy for most persons with type 2 diabetes, but a second drug should be added within two to three months for those who fail to reach or maintain the target HbA1c. Consequently, insulin, a sulfonylurea, and/or a thiazolidinodione(TZD) should be added within two to three months when more intensive therapy is required due to either failure of maximally tolerated doses of metformin, or at any time when

goal HbA1c is not reached, although incretin-based therapies could also be considered (Stolar et al, 2008; Nathan et al, 2008).

In the past insulin was often seen as a last resort, but as part of aggressively treating diabetes, it is now being used more frequently in the earlier stages of the disease. The American Diabetes Association and European Association for the Study of Diabetes (ADA-EASD) guidelines recommend addition of insulin as a second-step option for persons with diabetes who are inadequately controlled on metformin alone or as a third-step option for those who still do not reach the HbA1c target goal on oral combination therapy. Insulin is also the treatment of choice for persons with severely uncontrolled or symptomatic diabetes (Nathan et al, 2006 & 2008). Figure 1 illustrates an algorithm for the medical management of type 2 diabetes.

However, as is the case in developed countries (Brown et al, 2004), in South Africa in actual practice there is likely to be a delay before the next step is implemented in the persons with diabetes showing progressive hyperglycaemia on one agent (monotherapy). This may result in significant periods of inadequately controlled glycaemia before adjustments are made to the treatment regimen (Stolar et al, 2008). Clearly, for optimal outcomes in the treatment of persons with diabetes, they should regularly be followed up.

Over and above the administration of medication to lower and improve blood glucose, attention needs to be given to the prevention of macro vascular complications. If lipid levels remains high despite adequate glycaemic control and following dietary advice, raised LDL cholesterol and triglycerides are treated with a statin (e.g. simvastatin). If triglycerides remain persistently high (>4mmol/l) a fibrate is considered, especially if the HDL cholesterol is below 0.9mmol/l (SEMDSA, 2002). Supplementation with fish oils may benefit those with resistant hypertriglyceridaemia (Franz et al, 2002). The recently updated SEMDSA guidelines further recommends statin therapy regardless of baseline lipid levels, for all persons with type 2 diabetes with existing cardiovascular disease and those who are older than 40 years of age and who have one or more additional cardiovascular risk factor (Levitt et al, 2009). Furthermore, aspirin therapy should be used in all adult persons with diabetes and macro vascular disease, as well as for primary prevention in persons 40 years of age or older with diabetes and one or more cardiovascular risk factors (ADA, 2008b; SEMDSA, 2002; Levitt et al, 2009).

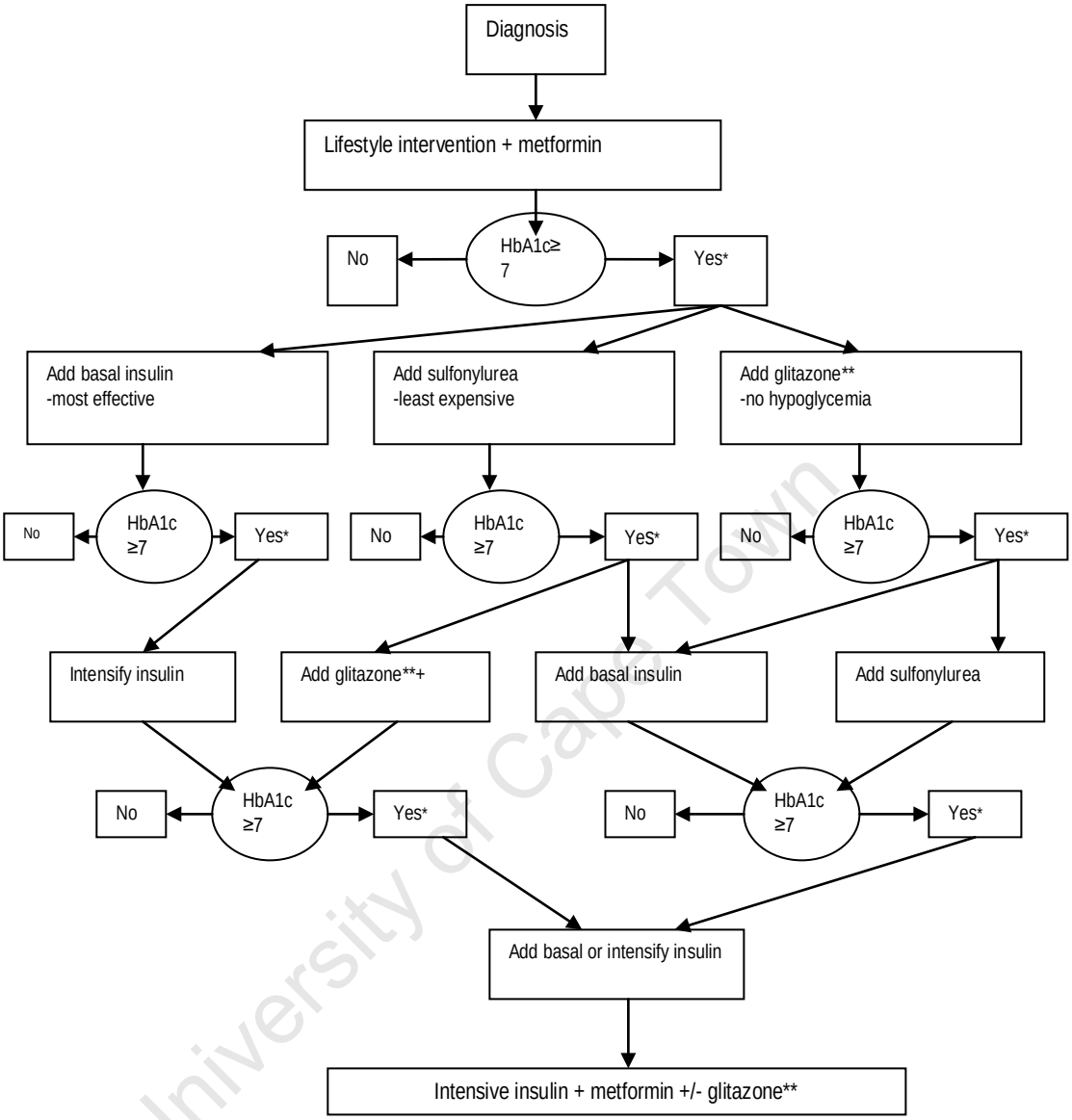

Figure 1: An Algorithm for the medical management of type 2 diabetes mellitus[++]

*Check HbA1c every 3 months until≤7% and then at least every 6 months.
**Associated with increased risk of fluid retention, congestive heart failure (CHF) and fractures
+Although 3 oral agents can be used, initiation and intensification of insulin therapy is preferred based on effectiveness and lower expense.
++ In South Africa, similar guidelines and therapeutic strategies at each health care level have been proposed (Levitt et al, 2009).
Source :(Nathan et al, 2008)

Hypertension, a common co-morbidity of diabetes, should receive vigorous treatment to reduce the risk of both macro vascular and micro vascular disease. Blood pressure should be monitored at every routine visit and drug therapy along with lifestyle modification should be instituted at the outset (Levitt et al, 2009). Initial drug therapy

may involve angiotensin-converting enzyme (ACE) inhibition, angiotensin receptor blockers, calcium channel blockers, ß-blockers (only if co-existing coronary heart disease is present) or diuretics (ADA, 2008b; Levitt et al, 2009). Most persons with diabetes will require at least two agents to control blood pressure (SEMDSA, 2002; Levitt et al, 2009).

The more aggressive approach in management of diabetes and administration of drugs could be misunderstood as a substitute for proper dietary regulation (Campbell & Lebovitz, 2001). However, throughout the process of pharmacotherapy, it should be emphasised to persons with diabetes that these agents are one aspect of the overall management of diabetes. Lifestyle modification (including nutrition therapy) remains a necessary and ongoing component to ensure the success of drug therapy (Campbell & Lebovitz, 2001; Levitt et al, 2009).

Interventions also need to be cost saving and feasible, particularly in developing countries. Moderate blood glucose control, treatment with oral diabetic medication and insulin when required, blood pressure control and foot care are among the measures considered as cost-effective and feasible in developing countries (WHO, 2006). Other cost saving interventions include the screening for retinopathy (which causes blindness), blood lipid control (to regulate cholesterol levels) as well as screening for early signs of diabetes-related kidney disease. A healthy diet, regular physical activity, maintaining a normal body weight and avoiding tobacco use support these measures by lowering insulin resistance in particular.

Currently, there is not yet sufficient evaluation of alternative remedies such as herbs, vitamins, and mineral supplements and its role in glucose control to recommend the use of any particular supplement (Yeh et al, 2003). However, preliminary evidence of several herbs and supplements suggest that further randomised control trials may be warranted. The seven most promising supplements identified in a systematic review by Yeh et al (2003) on the efficacy and safety of herbal therapies and vitamin/mineral supplements for glucose control in persons with diabetes were *Coccinia indica*, American ginseng, *Momordicacharantia,* nopal, L-carnitine,*Gymnema sylvestre, Aloe vera*, and vanadium (Yeh et al, 2003). The ADA has also published practical guidelines for persons with diabetes on choosing alternative supplements with a particular emphasis on safety (ADA, 2001b; ADA,

2001c). Guidelines include avoiding companies that make sensational claims or have misleading labels and warn against combining alternative therapies and prescription drugs or stopping prescribed medication without the medical doctor's knowledge. However, more research and communication is needed regarding the safety of products since in South Asian communities in the United Kingdom some persons with diabetes were using preparations containing active ingredients that may potentially be dangerous (Hill, 2006). It must also be borne in mind that any herb or herbal mixture that can potentially act as a laxative (such as extracts from the aloe leaf) or bulk-forming agent, which will decrease intestinal transit time, may interfere with the absorption of almost any intestinally absorbed drug (Fugh-Berman, 2000).

2.7 The role of physical activity in the management of type 2 diabetes mellitus

Exercise gains more and more credit in both prevention and management strategies for type 2 diabetes. It is considered by some to be the easier lifestyle change to implement and maintain compared to dietary changes (Ha & Lean, 1998). Exercise improves blood glucose levels mainly by decreasing insulin resistance and enhancing insulin sensitivity, which in turn result in increased peripheral use of glucose during and after the activity. Exercise at the appropriate intensity can result in a 10-20% baseline improvement in HbA1c **(**Boule et al, 2001). This is most beneficial in persons with mild type 2 diabetes and those who are the most insulin resistant.

Regular exercise (moderate activity of 30 minutes on most days) have also consistently demonstrated to reduce cardiovascular risk factors in persons with type 2 diabetes by reducing triglyceride levels, reducing blood pressure and improving impaired fibrinolysis (Ha & Lean, 1998; Bantle et al, 2007b).

In terms of weight loss, moderate exercise has only a modest direct effect on excessive body weight for most middle aged or elderly people. Longer periods of moderate exercise (such as one hour per day of walking) or more vigorous activity (such as 30 min per day of jogging) may be needed for successful long-term weight loss (Klein et al, 2004; Franz et al, 2002; Bantle et al, 2007b).

When promoting exercise as a management strategy for persons with diabetes, it must be borne in mind that many of them may need to start a training program gradually. Initial physical activity recommendations should thus be simple, based on the willingness and ability of the person with diabetes and adjusted for age and fitness. Blood pressure may also increase more during exercise in persons with diabetes than in those without diabetes and exercise should not be undertaken if systolic blood pressure is greater than 180 to 200mm Hg (Franz, 2008:809). At least 150 min/week of moderate-intensity aerobic physical activity, distributed over at least three days and with no more than two consecutive days without physical activity is recommended (Sigal et al, 2004). However, even three sessions of 10 minutes activity during the day can improve physical fitness, and rest periods do not impair the training effect from physical activity (Pate et al, 1995). Muscle-strengthening exercises (resistance training) such as lifting light weights are also an important component of an exercise regime. Because muscles dispose of glucose, this type of exercise can also improve glucose control (Franz, 2008:809) and, in the absence of medical concerns, persons with type 2 diabetes can be encouraged to perform resistance exercise three times a week (Sigal et al, 2004).

2.8 Nutrition therapy in type 2 diabetes mellitus

In light of the more 'aggressive' medical approach to reach adequate glycaemic control (Nathan et al, 2006; Stolar et al, 2008), the question might well be asked whether nutrition intervention may still have an impact on the management of diabetes. Although South African guidelines for diabetes management in primary health care until very recently still subscribed to lifestyle modification alone (mainly nutrition therapy and physical exercise) as initial therapy, the most recent guidelines (Levitt et al, 2009) follow the example of the United States and Europe (Nathan et al, 2006; Stolar et al, 2008). The simultaneous initiation of drug therapy together with nutrition therapy as initial approach may minimise the role of nutrition therapy in the mind of both the person with diabetes and the medical practitioner. It is therefore necessary to be clear on the benefits of nutrition intervention, its cost-effectiveness and the scientific evidence on which recommendations are based.

2.8.1. A historical overview of developments in the nutritional management of type 2 diabetes mellitus

The optimal diet for persons with diabetes is continuously revised as new evidence is published. It is evident that these recommendations have changed markedly over the past decades (Table 5).

Table 5: Historical perspective on nutrition recommendations for diabetes mellitus

Year	Distribution of energy from CHO (%)	Distribution of energy from Protein (%)	Distribution of energy from Fat (%)
Before 1921	Starvation Diets		
1921	20	10	70
1950	40	20	40
1971	45	20	35
1986	Up to 60	12-20	<30
1994	Based on nutrition assessment and treatment goals (Medical Nutrition therapy).	10-20	<10 (saturated fat)
2000+	Glycaemic index and glycaemic load of carbohydrates. Relaxed sucrose restriction.	10-20 Exploring the role of higher protein diets.	Emphasis on mono-unsaturated fats. <7 (saturated fat)

Source: Adopted from ADA (1999)

Since carbohydrate has a much greater impact on blood glucose levels than protein or fat, considerable attention has always been given to the amounts and types of carbohydrate in the diets of persons with diabetes (Lee & Nieman, 2003). Historically, before 1921 or the 'pre-insulin era', persons with diabetes were placed on near-starvation diets, with a maximum allowance of 10g carbohydrate per day and minimum intake of protein and fat (Richardson, 1929-quoted by Leeds, 1979). This recommendation for a high fat, high-protein and low-carbohydrate diet persisted for a long time, even after insulin was made available. However, as insulin became available a gradual liberation of carbohydrate intake was seen and it was reported that changing the diet to one with a greater percentage of carbohydrate resulted in no increase of insulin requirement and an improvement of the patient's well-being (Richardson, 1929- quoted by Leeds, 1979). However, despite these 'positive

reports' on carbohydrates, diets were still low in carbohydrate, ranging from 32 to 48% in the 1950's to the 1970's (Truswell et al,1975; Leeds, 1979).

When atherosclerosis research in the mid 1960's highlighted the fact that diets were too high in fat, further emphasis was put on a lower fat intake and an increase in carbohydrate intake. Raising the carbohydrate content of the diet also led to a subsequent increase in fibre intake (from 5 to 14 g/d) (Truswell et al. 1975). Despite the availability of this information, most clinics in Great Britain were still recommending a relatively low carbohydrate (46-50% of total energy) diet for both type 1 and type 2 diabetes in 1973. It was only in the late 1970's and early 1980's that the high carbohydrate, high fibre and low fat diabetic diet really started to take effect in the management of diabetes (Leeds, 1979; Love, 2003; Blades et al, 1997). In the 1980s, there was a growing awareness that carbohydrate restriction was both unnecessary and counter-productive, as it tended to result in an increased consumption of fat (Connor et al, 2003). The term "medical nutrition therapy" (MNT) was introduced in 1994 by the American Dietetic Association to better define the nutrition therapy process (Pastors et al, 2002; Franz, 2008:802) and is explained in Box 1. Current medical nutrition therapy goals also address management of cardiovascular complications, especially lipid and lipoprotein profiles, because of the increased associated risk in persons with diabetes (Choudhary, 2004).

Box 1: Medical Nutrition Therapy for diabetes describes a process that includes the following aspects: *1*) an *assessment* of the patient's nutrition and diabetes self-management knowledge and skills; *2*) identification and negotiation of individually designed nutrition *goals*; *3*) nutrition *intervention* involving a careful match of both a meal-planning approach and educational materials to the patient's needs, with flexibility in mind to have the plan implemented by the patient; and 4) *evaluation* of outcomes and ongoing monitoring. These four steps have been identified as necessary to assist patients in acquiring and maintaining the knowledge, skills, attitudes, behaviours, and commitment, to successfully meet the challenges of daily diabetes self-management. Medical nutrition therapy will therefore include nutrition education, but is by far a more thorough and in-depth approach to assist the individual in reaching his/her treatment goals.

Source: (Pastors et al, 2002; Franz, 2008:802)

It is evident that the major change in thinking about nutrition therapy over the last decade has been a switching of focus between fats and carbohydrates (Choudhary,

2004). Both macronutrients are now recognised as including better and poorer types. Saturated fats can be replaced by either carbohydrate or monounsaturated fats, with the choice determined by personal preferences and weight management goals (Choudhary, 2004). This has led to a greater flexibility in the proportion of energy derived from carbohydrate and mono-unsaturated fat. Research also began to focus more on the carbohydrate source and the glycaemic effect of different sources on blood glucose levels. This has altered attitudes and practices concerning sugar intake (sucrose), which is now permitted as part of a balanced diet for persons with diabetes (Bantle et al, 2008).

Nutritional therapy of diabetes has undergone further shifts over the past decade towards being more focussed on addressing individual nutritional needs. Emphasis moved away from a 'diabetic diet' with preplanned diabetic diet sheets to meal plans compiled with the individual to suit daily lifestyle activities, customary eating habits and medication regimes (Franz et al, 2002; Choudhary, 2004). The recent 2008 ADA nutrition recommendations depart from previous guidelines in not setting optimal levels for macronutrients, but instead recommending that macronutrient intake is based on a nutrition assessment, modification of usual eating habits, treatment goals, and monitoring of desired metabolic outcomes (Bantle et al, 2008).

Furthermore, the role of protein has received more attention over the past years, especially in substituting carbohydrates in the diabetic diet and in this way achieving a lower glycaemic index and glycaemic load (see sections 8.4.2c and 8.5 for more details of these concepts). At this stage, evidence is insufficient to formulate new recommendations regarding protein's contribution to total energy, although its importance beyond mere adequacy is being recognised and researched.

In summary, in the 21st century the most notable change in dietary issues is the greater flexibility in the proportion of energy derived from carbohydrate and mono-unsaturated fat, more relaxed sucrose restriction, a greater consideration of the glycaemic index and an emphasis on individualised dietary recommendations (Connor et al, 2003).

2.8.2 Aims of nutrition therapy in type 2 diabetes mellitus

As was stated in previous sections, dietary guidelines, ideally in the format of medical nutrition therapy (MNT), remain a cornerstone in the management of type 2 diabetes and are complementary to the aims of medical treatment for diabetes. Not only does it play a key role in glycaemic control, but also in the management of body weight, hypertension, serum lipid levels and diabetic nephropathy, as well as in delaying the onset of these diabetes-related complications (Bantle et al, 2008).

The actual implementation of dietary recommendations varies according to different groups and circumstances and different tools are used to best bring across these recommendations. MNT as outlined in section 2.8.1 can take place even in primary health care settings, although the tools that are used may be simpler and less intensive than those used in settings where resources are ample and literacy levels of patients are generally higher. The public health sector does however often lack the necessary resources (staff and time) to fully complete the process of MNT as described earlier (refer to section 2.8.1, Box 1). Hence, for the purposes of the discussion from here forward, the term *nutrition therapy* will be used, unless specified to include the range of nutrition interventions that are taking place, even though it often does not reach the full extent of MNT. Irrespective of the mode of delivery, the dietary objectives stay the same, apply to all settings and are internationally and locally accepted. These guidelines aim to:

• Maintain blood glucose levels within/ as close to the normal range as is safely possible in order to reduce or prevent the risk of diabetic complications, together with optimal nutrition, activity and appropriate medication;

• Minimise the risk of hypoglycaemia for those taking insulin or oral hypoglycaemic agents;

• Adjust energy intake to achieve and maintain reasonable weight and normal growth and development;

• Achieve blood pressure and lipid levels that reduce the risk for micro- and macro vascular disease or complications;

• Reduce the risk of and treating long-term complications (obesity, dyslipidaemia, cardiovascular disease, hypertension and nephropathy);

• Maintain quality of life;

• Address individual nutritional needs, taking into consideration personal, ethnic and cultural preferences and lifestyle while respecting the individual's wishes and willingness to change.

(Bantle et al, 2008; Connor et al, 2003; SEMDSA, 1997).

2.8.3 Development of dietary guidelines for the treatment of type 2 diabetes mellitus

Guidelines and recommendations for nutrition therapy in diabetes that have been developed in the United Kingdom, Europe, USA and Canada (Connor et al, 2003; Bantle et al, 2008; Canadian Diabetes Association, 2003) are often adopted by other countries. The evidence base for these dietary guidelines has been extensively reviewed on behalf of the European Association for the Study of Diabetes and the ADA (Bantle et al, 2008). The newest position statement of the ADA (Bantle et al, 2008) provides evidence-based recommendations and interventions for diabetes MNT, and updates previous position statements with the accompanying technical review published in 2002 and modified slightly in 2004 and 2007 (Bantle et al, 2007b; Franz et al, 2004). It focuses on key references published since the year 2000 and uses grading according to the level of evidence available based on the ADA's evidence-grading system.

In South Africa, there are limited published data for many of the above recommendations as they apply to our situation today (SEMDSA, 1997). The last official South African dietary guidelines for diabetes management were published in 1997 by the Association for Dietetics in South Africa. It generally followed the guidelines of the ADA and other international consensus guidelines. The latest SEMDSA guidelines (Levitt et al, 2009) on the diagnosis and management of diabetes do not include detailed dietary recommendations. In the absence of of South African guidelines many dietitians make use of the position statement of the ADA on which to base their nutrition advice (Blaauw: Personal communication, 2007). Although the 1997 South African guideline "is intended to be adaptable to both

optimal and minimal health care settings and to individual patient differences" (SEMDSA, 1997), these guidelines and their feasibility in different communities of the South African population have not been evaluated. The fact that nutrition therapy guidelines frequently originate in the United States or Europe and are thus constructed around typical Western food and meal patterns is one of the main barriers to nutrition therapy in Sub Saharan Africa (Steyn & Levitt, 2004).

A comparison of guidelines from South Africa, the United States and Europe are presented in Table 6.

Table 6: Comparison of nutritional recommendations for type 2 diabetes mellitus

Advice	RSA *	United States**	Europe ***
Energy	Achieve and maintain a reasonable weight	Weight loss recommended for all overweight/obese	Aim for BMI 19-25kg/m^2
Protein	10-20% TE, from a variety of foods (0.8g/kg/day if any nephropathy present)	15-20% TE, from a variety of foods (0.8g/kg/day if any nephropathy present)	Not more than 1g/kg (0.7-0.9g/kg/day if any nephropathy present)
Total fat	<30% TE (adults)	+	<35% TE
Saturated fat and trans-unsaturated fat	<10% TE	<7% TE; Intake of transfatty acids should be minimised	<10% TE (Saturated fat *and* transfatty acids)
Mono-unsaturated fats	-	-	10–20% (together with 45-60%TE from CHO a total of 60-70% of energy intake)
Cholesterol	<300mg	<200mg Plant sterols 2g/day can be considered	Plant sterols 2g/day can be considered
Polyunsaturated fatty acids	-	≈10% of energy intake (Franz et al, 2004+)	>10% of energy intake
Omega-3 polyunsaturated fatty acids	-	≥2 servings of fish/wk	Eat fish, especially oily fish, once or twice weekly
Carbohydrate	50-65% TE, from a variety of foods	Choose fruit, vegetables, whole grains, legumes & low fat milk +	45-60% TE, especially those in rich in soluble fibre or with a low GI (60–70% together with MUFAs)
Sucrose	Limited amounts, as part of a balanced diet	To be substituted for other carbohydrate sources-avoid excess energy intake	Up to 10% TE; in the context of a healthy diet.
Glycaemic Index and load	-	"May provide a modest additional benefit "	"Have value as a broad guide to good CHO food choices"
Fibre	6-8g/1000 kJ from a variety of foods	A variety of fibre-rich foods as for the general population	Emphasis on sources of soluble fibre for glycaemic & lipid metabolism, insoluble fibre for increased satiety and gastro-intestinal health
Sodium	-	'Look at strategies to reduce intake'	<6g NaCl/ day
Alcohol	10% TE, ingested with a meal (unless contraindicated)	≤1 alcoholic beverages/day for women; ≤2 for men	1-2 alcoholic beverages/day ingested with carbohydrate-rich foods
Vitamin & Mineral supplementation	Advised for 'at risk' groups	No clear benefit/not advised routinely	Not needed with adequate diet intake. Encourage foods naturally rich in vitamins and anti-oxidants
Herbal preparations	-	-	No convincing evidence of benefits
Non-nutritive sweeteners	Limited amounts allowed, but more research needed to determine long-term effects	Approved by FDA; saccharin, aspartame, acesulfame-K, sucralose	Saccharin, cyclamate, aspartame, alitame, sucralose
'Diabetic' products	Not essential and to be used with discretion		Not essential and to be used with discretion
Exercise	Regular; monitor blood glucose levels before, during and after	An increase in physical activity is recommended	Physical activity may be needed to achieve acceptable BMI
Meals	Minimum 3/ day; must correlate with peak action of medication	Eat at consistent times synchronised with medication	-

TE=total energy; BMI=body mass index; GI=glycaemic index; FDA=Food and Drug Administration

* Source: (SEMDSA, 1997) ** Source: (Bantle et al, 2008) unless otherwise specified *** Source: (Connor et al, 2003)

+ No optimal mix of macronutrients is specified in the 2008 ADA guidelines (Bantle et al, 2008).

When considering dietary guidelines for diabetes mellitus as summarised in Table 6, it becomes clear that public health messages aimed at the person with diabetes are also suitable for the non-diabetic individual. The non-diabetic individual also needs to prevent the NCDs of lifestyle such as overweight, obesity and cardiovascular disease. Furthermore, the majority of persons with hyperlipidaemia, hypertension and obesity today have dietary habits similar to persons with diabetes and will benefit from the same type of changes (Vessby, 1994). Therefore, from both a scientific and a practical point of view, the concept of a ‘‘common diet”, will benefit most people. A number of countries have subsequently developed dietary guidelines that are aimed at the public but simultaneously aim to address the massive global burden of diet-related diseases. These guidelines are ‘food-based’ as opposed to being ‘nutrient-based’ due to a growing perception that the latter are not effective in promoting appropriate diets and healthy lifestyles (Gibney & Vorster, 2001). ‘Food-based’ dietary guidelines provide qualitative or descriptive statements that provide dietary guidance in terms of *foods*, rather than numerical quantities of nutrients (e.g. 30% fat) as recommended in dietary guidelines. Advice is presented as simple, practical and action-orientated but still reflects the most current scientific understanding of the role of nutrition in health (Love, 2003).

South Africa has developed its own set of Food-Based Dietary Guidelines (FBDGs) for use as the basis for a healthy eating plan and to address the double burden of disease that the country is facing, namely the growing burden of NCDs (cardiovascular diseases, certain cancers, diabetes and dental caries) as well as existing nutritional disorders associated with poverty and under nutrition. Technical support papers provide the background and evidence for the formulation of each guideline to address existing under- and over nutrition in different communities. The guidelines were tested for comprehension, appropriateness and applicability in consumer groups of different communities (Gibney & Vorster, 2001). The Department of Health have officially approved the South African FBDGs in 2003 (Table 7).

Table 7: The Food Based Dietary Guidelines for healthy eating for South Africans older than 7 years.

Guideline	Specific messages
Enjoy a variety of foods	No single food or meal can provide all the nutrients we need. Different foods contribute different nutrients
Be active	Aim for 30-45 minute physical activity sessions every day or three short 10-minute sessions.
Drink lots of clean safe water	6-8 glasses of clean safe water
Make starchy foods the basis of most meals	To be eaten in larger amounts than the other foods at a meal. 6-8 servings per day
Eat plenty of vegetables and fruits every day	At least 5 portions of vegetables and fruits
Eat dry beans, peas, lentils and Soya regularly	At least three times a week. One serving = 1 cup cooked
Chicken, fish, meat, milk or eggs can be eaten daily	Small portions can be eaten every day but need not be eaten daily. Low fat choices and cooking. 1 serving 75-100g cooked chicken, fish, and meat. Try to have 2-3 meatless days/wk. Increase fish consumption to 2/wk. 3 eggs /wk
Eat fats sparingly	Emphasis on mono- and poly-unsaturated fats: Vegetable oils, soft tub margarine, oily fish, nuts, peanuts, and avocado.
Use salt sparingly	Use very little at a time-limit use in cooking or added at the table.
Use food and drinks containing sugar sparingly and not between meals	A little at a time and only a few times per day, preferably with meals. Limit foods with added sugar e.g. cold drinks, cakes and sweets.
If you drink alcohol, drink sensibly	≤3 standard drinks/day for men ≤2 standard drinks/day for women

Source: (Dept of Health, 2004)

The FBDGs are intended to form the core of the Government's nutrition education messages and aim to promote healthy life styles among all South Africans. It is also in line with the recommendations of the World Health Organisation (WHO) and the Food and Agriculture Organisation (FAO) (Dept of Health, 2004). Throughout the process of developing the South African FBDGs as core nutrition messages for the promotion of health to South Africans, the intention was to consider them also for people with special dietary needs, such as infants, young children, the elderly,

pregnant and lactating women, and those with NCDs and HIV/AIDS. The rationale is that consistent nutrition messages are easier to implement and individualise within a household (Love, 2003) than giving conflicting and confusing messages for different groups of people.

A great educational advantage of the FBDGs is that it serves to reinforce the message that instead of a separate 'diet' persons with diabetes can enjoy most foods and need not feel isolated by their diets. However, it still needs to be borne in mind that some points need to receive more emphasis (e.g. types of fat), since it is especially important for persons with diabetes mellitus to change their food habits in accordance with these recommendations because of the increased risk for secondary complications (Vessby, 1994).

In the light of the above, as well as the lack of updated guidelines appropriate for South African diabetic populations, the FBDGs could serve as a basis for the nutrition education of type 2 diabetes in South Africa, bearing in mind points that need special emphasis. Dietitians have already received training in the FBDGs and have been encouraged to use this tool in diabetic nutrition education in order to provide messages consistent with those for the public. Furthermore, more and more printed material on diabetes are now based on the FBDGs.

2.8.4 Energy and macro and micronutrient composition of the diet for the management of type 2 diabetes mellitus

Although numerous studies have attempted to identify the optimal mix of macronutrients for the diabetic diet, it is unlikely that one such combination of macronutrients exists (Bantle et al, 2008). The best mix of carbohydrate, protein and fat appears to vary depending on individual circumstances. This is also reflected in current dietary guidelines for diabetes. Methods used for determining energy requirements, and thus macronutrient ratios, are only approximate and provide a starting point to evaluate adequacy (Franz, 2008:822). The discussion that follows covers the essential aspects of the diabetic diet and nutrient-based guidelines, based on the best evidence available. This information forms the backbone of food-based guidelines, messages and modifications that are made to individualise meal recommendations**.**

2.8.4.1 Energy intake

Control of energy intake and body weight is important in most persons with type 2 diabetes, as ±90% of them are overweight or obese (Franz, 2008:806). Because of the effects of obesity on insulin resistance, weight loss is an important therapeutic objective for persons with type 2 diabetes. Research indicates that weight loss of 5–10% of initial body weight can lead to substantial improvement in risk factors for diabetes and heart disease, resulting in a decreased insulin resistance, improved measures of glycaemia and dyslipidaemia and reduced blood pressure. It can also lead to reductions in or discontinuations of medications for these conditions (Goldstein, 1992; Pi-Sunyer, 1993; Franz et al, 2002). For these reasons, most type 2 diabetic guidelines include a guideline on energy intake control.

Recommendations for actual **weight loss** generally focus on the following (Bantle et al, 2008; Klein et al, 2004):

- Decreased total energy-intake by 2100-4200 kilojoules, supplying at least 4200-5000 kilojoules/day for women and 5000-6700 kilojoules/day for men.
- Low-fat intake (25-30% of total energy)
- Emphasis on lifestyle changes, including regular physical activity, to ensure weight maintenance after weight loss.

In context of the above-mentioned health benefits following 5-10% weight loss, achieving and maintaining a 10% weight loss should be considered successful, even though for many obese individuals this weight loss may not return them to a non-obese state (Wing & Hill, 2001). Research by Wing and Hill (2001) on a registry of individuals (n >4000) who have been successful at weight loss and maintenance, suggests that the following are associated with weight loss **and long-term weight maintenance** (defined as maintaining a loss of 5-10% of initial weight for 2-5 years):

- A low fat diet (avoiding fried foods, substitution of low-fat for high-fat foods);
- Frequent self-monitoring of body weight and food intake;
- High levels of physical activity;

- Eating breakfast regularly;
- Maintaining a consistent eating pattern across weekdays and weekends;
- Catching "slips" before they turn into larger regains.

Initiating weight loss after a medical event may also help facilitate long-term weight control. Furthermore, it appears that the first few years after weight loss is the most vulnerable period for weight regains (Wing & Hill, 2001). Once successful maintainers have maintained a weight loss for two to five years, the chances of longer-term success are greatly increased.

However, despite the success achieved by certain individuals, weight loss and control in the long term is difficult for adults with type 2 diabetes to achieve by employing currently used lifestyle and behavioural strategies (Norris et al, 2005). Other strategies can also be considered for weight loss or control. Pharmacotherapy achieves modest, but statistically significant, weight loss over 26 to 52 weeks in general populations (Norris et al, 2005). Surgical interventions can produce substantial weight loss at up to 10 years of follow-up in general populations (Pories et al, 1992; Sjostrom et al, 1999) and among persons with diabetes (Pories et al, 1992). However, these strategies are costly and not feasible in the public health sector.

Much remains to be learned about how to implement dietary, physical activity and behavioural interventions designed to achieve weight loss and weight control in the long term. However, a specific weight loss of 5-10% of baseline weight should receive more emphasis due to the associated health benefits. Effective interventions to focus on weight maintenance after initial weight loss may need further attention in order to prevent future weight gain. Furthermore, weight maintenance in those not currently overweight needs to be promoted to prevent future weight gain (Norris et al, 2005).

2.8.4.2 Carbohydrate intake

The amount of carbohydrate consumed is the component of the diet that has the greatest influence on blood glucose levels and primarily determines the insulin needed to cover meals and snacks (Sheard et al, 2004). Although carbohydrate

restriction might therefore seems like a logical approach to manage postprandial glucose, there are good reasons why this is neither recommended nor necessary. The specific benefits of a high (60% of total energy) carbohydrate, high fibre and modified fat diet compared to a low (34% of energy) carbohydrate intake were already reported in the 1970's when it was found that basal plasma glucose concentrations fell and the percentage of HbA1c was reduced after a 6-week high-carbohydrate diet. No hypertriglyceridaemia occurred and plasma cholesterol levels also decreased (Simpson et al, 1979). Furthermore, carbohydrate is an important source of energy, provides water-soluble vitamins, minerals and fibre and is important in dietary palatability. The brain and central nervous system have an absolute requirement for glucose as an energy source, and for this reason, it is not recommended or justifiable that total carbohydrate should be restricted below 130 g/day (Sheard et al, 2004).

In light of the emphasis on prevention of macro- and micro vascular disease, diets containing a lower proportion of energy derived from fat (especially saturated fat) and a constant protein content (because of possible negative effects on renal function) will have to result in a corresponding increase of the carbohydrate content to meet the dietary energy needs (Wiseman et al, 1987). In addition, an increased content of fibre-rich, carbohydrate-containing foods may also promote satiety and increase the volume of the food, thereby reducing energy density and assisting in body weight reduction in the overweight individual (Garrow et al, 1990). Carbohydrate food sources rich in soluble fibre also contribute to improved glucose control (Chandalia, 2000).

Thus, carbohydrate intake remains a key strategy in achieving glycaemic control, but not by simply restricting the intake thereof. Distribution, quality and quantity of carbohydrates consumed are all aspects that need to be considered for optimal management of glucose levels.

a) Quantity of carbohydrates

A carbohydrate intake of 45%-65% of total energy forming the basis of most meals has generally been recommended throughout the years. Current guidelines (Bantle et al, 2007b; Bantle et al, 2008) place more emphasis on what is most appropriate for

the individual without specifying a ratio. A dietary pattern that includes carbohydrates from fruits, vegetables, whole grains, legumes and low-fat milk is encouraged (Bantle et al, 2008). This is in line with the much more flexible approach of recent years without the rigid recommendations of the past. Carbohydrate restrictions in the past have often been counter-productive, as it tended to result in an increased consumption of fat (Connor et al, 2003).

A further point to consider when deciding on the carbohydrate percentage in the diet is the fact that it has been found that replacing carbohydrates with monounsaturated fat (MUFA) can be beneficial, as it reduces postprandial glycaemia and triglyceridaemia. High carbohydrate diets (>55% of total energy from carbohydrate) have been found to increase postprandial plasma glucose, insulin and triglycerides when compared with high–MUFA diets (Bantle et al, 2008). Consequently, current European guidelines and earlier ADA guidelines recommend a carbohydrate intake of 45-60% of total energy along with an intake of mono unsaturated fat that together provides 60-70% of energy intake (Connor et al, 2003; Franz et al, 2004). This could translate into a carbohydrate intake as low as 45% of total energy intake and MUFA intake between 15-25% of total energy intake. However, due to concerns that increased fat intake in ad libitum diets may promote weight gain (Franz et al, 2004, Bantle et al, 2007b; Bantle et al, 2008), it has been recommended that the carbohydrate and MUFA contribution in the diet be individualised and would thus more likely be implemented for those on weight maintenance diets. A certain restriction of the fat content of the diet remains one of the main strategies for achieving a sustained body weight reduction in overweight subjects (Vessby, 1994).

Furthermore, when considering substituting carbohydrates for monounsaturated fatty acids, it must be borne in mind that when total energy intake is reduced, the adverse effects of high-carbohydrate diets are not observed (Heilbronn et al, 1999; Parker et al, 2002). The remaining capacity for insulin secretion may also influence advice on carbohydrate intake. A person with diabetes with a poor remaining capacity for glucose-stimulated insulin secretion and a high degree of peripheral insulin resistance may have a lower capacity to handle a high-carbohydrate diet than would a person with newly detected diabetes mellitus, good glycaemic control and a better preserved early response to glucose (Vessby, 1994).

Although recommendations regarding the total carbohydrate content of the diet are more flexible, the amount of carbohydrate eaten is still primarily what determines the insulin needed to cover meals and snacks (Sheard et al, 2004; Bantle et al, 2007b). If a large quantity of carbohydrate-containing food is eaten, it will result in a greater glycaemic load and a greater need for insulin secretion. Due to the ineffective use of insulin (due to impaired ß-cell function and /or insulin resistance) by the person with type 2 diabetes, this will result in hyperglycaemia with the associated short and long-term complications, depending on the frequency of such an occurrence. Thus, the rationale for regulating the amount of carbohydrate in meals and snacks and the distribution thereof throughout the day, is based on the goal to achieve near normal blood glucose levels and minimise the need for insulin secretion. In type 2 diabetes management it is also important to match doses of insulin and insulin secretagogues to the carbohydrate content of meals (Franz, 2008:822).

A variety of methods, most involving monitoring or regulating carbohydrate consumption, have been developed for use in diabetic nutrition education. Data from the United Kingdom indicates that most dietitians use a combination of methods when advising persons with diabetes on how to regulate their carbohydrate consumption (Nelson et al, 2000). The most common methods are qualitative advice, semi quantitative (portions) and the use of carbohydrate exchanges or carbohydrate counting in which the person with diabetes is encouraged to eat a consistent amount of carbohydrate at meals and snacks (Warshaw, 1997). Although no official data is available on the use of different dietary tools by South African dietitians, the situation in South Africa is likely to be similar to that found in the United Kingdom. South African dietitians are trained in all the different methods and they are expected to adjust their methods and tools according to the situation and their patient's needs and literacy level.

A popular tool and an example of a qualitative method is the 'plate model', which, although primarily a tool for encouraging healthy eating practices, is suitable for most non-insulin treated persons with diabetes and for some on fixed insulin doses. In this simple visual method, the dinner plate serves as a pie chart to show the proportions of the plate that should be covered by the various food groups (Karlstrom et al, 1989). There are different versions of the plate model, but emphasis is placed on vegetables and controlled portions of carbohydrates and protein. The advantages

of this qualitative model are that it is simple, adaptable, incorporating all the principles of healthy eating while the visual image promotes memory and understanding (Camelon et al, 1998). Figure 2 illustrates an example of the plate model.

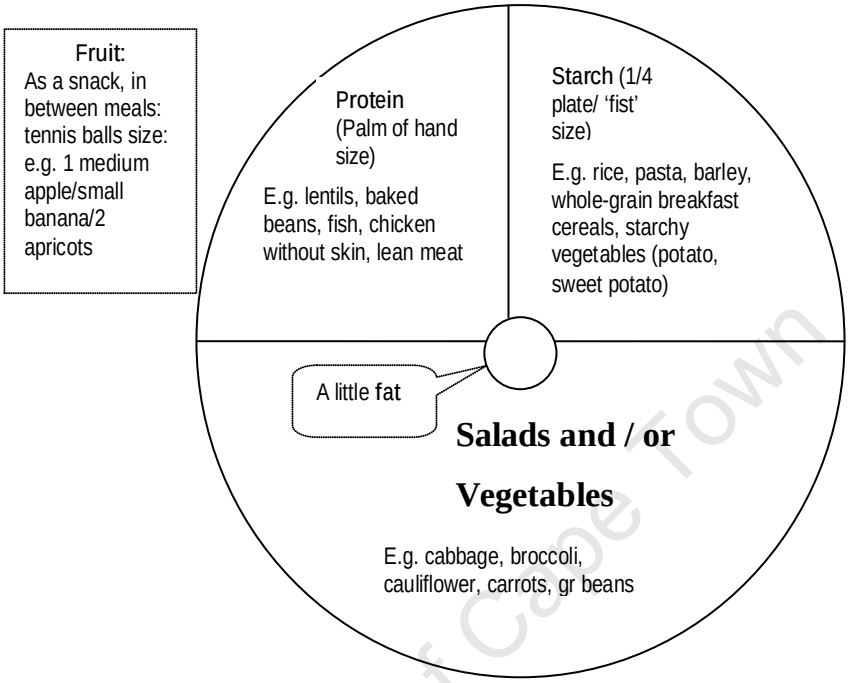

Figure 2: The plate model as a tool to illustrate healthy eating practices.

b) Distribution of carbohydrates

One of the earliest known dietary principles for the management of type 2 diabetes is the advantage of frequent small feedings rather than several large meals (Link, 1999). Persons with diabetes who may benefit most from a recommendation to have frequent small meals (instead of a few larger meals), include those on insulin or insulin secretagogues, as they may otherwise experience hypoglycaemic incidents (Franz, 2008:822). Diabetic persons on other medications or those receiving only nutrition therapy are not prone to hypoglycaemic incidents and thus do not need to follow this recommendation, unless it is their choice. The South African dietary guidelines (SEMDSA, 1997) advise at least three equal-sized meals every day with snacks determined by the type and time of medication. More current guidelines of the United States state that distribution of meals, division of food intake, three meals,

or smaller meals and snacks, should be based on individual preference (Franz et al, 2004).

However, it can also be argued that all persons with diabetes may benefit from eating small frequent meals, including carbohydrates, based on the principle that those with type 2 diabetes may retain an adequate insulin response to a modest carbohydrate load but are unable to cope with intakes above a certain threshold (Link, 1999). A comparison of two versus six meals per day indicated that the more frequent feedings reduced the daily amplitude of glucose swings (between highest and lowest) from 6.1mmol/L to 3.3mml/L and decreased the peak glucose by about 2.2mmol/L (Bertelsen et al, 1993). The chief advantage of this practice may therefore be to moderate blood glucose extremes and thus reduce insulin secretion (Link, 1999; Wolever, 1990; Bertelsen et al, 1993).

At this point the nature of the relationship between the frequency of meals and the development of overweight is unclear. Many anecdotal reports argue that overweight persons eat less often than normal weight persons do, but published reports in this regard are lacking. Spreading the nutrient load into equal amounts and consuming it evenly through the day may contribute to enhanced control of appetite (Speechly & Buffenstein, 1999). This greater control of satiety when consuming smaller and more frequent meals may possibly be linked to an attenuation in insulin response although other physical (gastric stretch) and physiological (release of gastric hormones) factors may also be affected by the frequency of eating (Speechly & Buffenstein, 1999). Frequency of eating may also change lipid metabolism although not all findings are in agreement (Jenkins et al, 1989; Murphy et al, 1996).

Possible limitations associated with the concept of frequent feedings include the potential for weight gain and difficulty with compliance. Furthermore, the principle of frequent small feedings has never been tested in a large randomised trial to assess effectiveness and social acceptability (Link, 1999). Therefore, specific recommendations regarding frequency of eating should be based on the individual's dietary habits and weight status. Overweight persons with type 2 diabetes who choose to have snacks should not do so in addition to their usual meals. A portion of the meal could rather be saved to be eaten as a snack between meals (Franz, 2008:822).

c) Quality of carbohydrates: The glycaemic index

It is generally accepted that the amount of carbohydrate ingested is usually the primary determinant of postprandial response (Sheard et al, 2004). However, the impact of the type and source of carbohydrate on postprandial glucose levels has received more attention in recent years and has continued to be an area of controversy (Franz, 2003a; Franz, 2003b; Coulston & Reaven, 1997, Sheard et al, 2004).

In the past, advice concerning carbohydrate sources was based on the assumption that all 'simple' carbohydrates (sugars) were more rapidly absorbed compared to 'complex' carbohydrates (starches). 'Simple' sugars would consequently result in relatively larger surges in blood glucose and insulin levels compared to the more 'complex' carbohydrates. However, it is known now that the complexity of the carbohydrate (e.g. starch versus sucrose) present in a particular food does not necessarily predict its effect on blood glucose (Foster-Powell & Brand Miller, 1995; Wolever et al, 1994). In recent years, research has focused on the glycaemic index (GI) to resolve this phenomenon.

The GI index is a means of quantifying the relative blood glucose response to carbohydrates in individual foods, comparing them on a weight-for-weight basis (i.e., per gram of carbohydrate) (Sheard et al, 2004). It is defined as '*The incremental area under the blood glucose response curve of a 50g carbohydrate portion of a test food expressed as a percent of the response to the same amount of carbohydrate from a standard food (either glucose or white bread) taken by the same subject*'(Guy, 2003). The GI therefore classifies carbohydrate-containing foods based on their acute glycaemic response with the view that the slower flatter response may facilitate better glycaemic control in persons with diabetes (Perlstein & Wilcox, 1997). Foods that are mainly sources of protein and fat, such as meat, fish; chicken, eggs, cheese, nuts, and margarine do not have GI values since they contain negligible amounts of carbohydrate. It is only carbohydrate-rich foods that have GI-values because they have an immediate effect on blood glucose levels (Steenkamp & Delport, 2007).

Inherent variables that influence the effect of carbohydrate-containing foods on blood glucose response include the specific type of food ingested, type of starch (amylose versus amylopectin), variety (e.g. long grain versus white rice) of the food,

style of preparation (cooking method and time, amount of heat or moisture used), ripeness, and degree of processing (Bantle et al, 2008). Many common starchy foods, including potatoes, bread, processed cereal products, and many varieties of rice, produce high postprandial glycaemic responses (Foster-Powell et al, 2002). The foods with the lowest GI values include legumes, semolina-based pastas, dairy products, and temperate fruits such as apples and oranges (Brand-Miller, 2003).

Extrinsic variables that may influence glucose response include fasting or pre-prandial blood glucose levels, macronutrient distribution of the meal in which the food is consumed, available insulin and degree of insulin resistance (Bantle et al, 2007b). Prior food intake and the co-ingestion of protein and fat can also alter the effect of a specific carbohydrate-containing food on blood glucose concentration (Nuttall et al, 1984; Collier & O'Dea 1983; Gulliford, 1989). Fat and protein may significantly alter the GI of carbohydrate foods if present in relatively large quantities (Nuttall et al, 1984; Collier & O'Dea 1983; Gulliford, 1989). Fat reduces gastric emptying as well as motility and postprandial flow rates in the intestine. Together with a potentiation of insulin secretion these factors may all contribute to a decreased glycaemic response (Collier & O'Dea 1983**;** Welch et al, 1987). The moderate glycaemic responses of many foods high in sugar, such as ice cream, cakes, cookies and chocolates can be attributed in part to the high fat content of these products (Brand-Miller, 2003). Protein appears to reduce the glycaemic response through an increase in insulin secretion, and may also increase the osmolarity of stomach contents, thereby reducing the rate of gastric emptying (Nuttall et al, 1984). However, the presence of fat and /or protein in a mixed meal with carbohydrates is unlikely to influence the clinical utility of the GI, since the amounts eaten in a normal meal are usually less than the amounts eaten under experimental conditions to achieve the effects described above (Wolever et al, 1991). Studies show that fat and protein generally only alter the GI of foods containing carbohydrate when present in quantities greater than 25g per 50g carbohydrate serving (Nuttall et al, 1984; Collier & O'Dea 1983).

When a mixed meal consists of several carbohydrate sources, the effect of the lower GI component is diluted in proportion to the amount of higher GI-carbohydrate from other foods (Wolever et al, 1985). The GI of a mixed meal can be calculated and be predicted by summing up the glycaemic index of the component foods (Wolever et

al, 1985; Wolever & Jenkins, 1986; Wolever et al, 1990; Collier et al, 1986; Chew et al, 1988; Gulliford et al, 1989). Although not all studies have found a direct relationship between the calculated and measured glycaemic index of mixed meals (Coulston et al, 1984; Hollenbeck et al, 1986; Laine et al, 1987) the GI concept still seems to remain discriminating (Bornet et al, 1987) in that a meal calculated to have a lower GI compared to another, will in actual fact be lower in GI.

Other issues that have been raised regarding the GI are that it is highly variable for any particular food item (Xavier & Pi-Sunyer, 2002; Brand-Miller et al, 2003; Frost & Dornhorst, 2000; Wolever, 1985), it only measures the response to an individual food consumed in isolation, and it does not predict postprandial blood glucose response as accurately in individuals with diabetes as it does in healthy persons (summarised by Sheard et al, 2004). Although the glycaemic response following carbohydrate ingestion is higher in individuals with diabetes, the *relative response* to foods and mixed meals that vary in GI index is similar in individuals with diabetes and healthy subjects (Wolever et al, 1990; Jenkins et al, 1983; Coulston et al, 1987; Laine et al, 1987; Wolever et al, 1987). Some foods continue to show wide variation in response secondary to botanical differences (Foster-Powell et al, 2002), but variability in GI findings can be limited if methodology is standardised (Wolever et al, 2003);

A shortcoming in the practical application of the glycaemic index has been the fact that it does not take into account the effect of a typical amount of carbohydrate in a food portion on glycaemia. Concerns have been raised that foods will be rated suitable or unsuitable solely based on their glycaemic index. The concept of **glycaemic load** (GL) has thus been suggested to improve the reliability of predicting the glycaemic response of a given diet (Salmeron et al, 1997). The GL concept incorporates the **quantity** *and* the **quality** of the dietary carbohydrates consumed. The GL is defined as the product of the glycaemic index of the food and the amount of carbohydrate in a serving. E.g., although the GI for carrots is high, the GL for one serving is small because the amount of carbohydrate in one serving is minimal. There would therefore be no need to exclude a nutrient-rich vegetable solely on the basis of its GI value. A diet with a low glycaemic load can therefore be a high carbohydrate diet based on low-GI foods, or it can be obtained by lowering the intake of carbohydrates. Benefits of reduction in available carbohydrate intake would be

expected only in a context of no increase in total or saturated fat intake (Livesey et al, 2008). The GL of foods, meals and diets are calculated by multiplying the GI of individual foods by the amounts of carbohydrate in each food and then totalling the values for all foods (Salmeron et al, 1997; Bantle et al, 2008).

A large number of studies have reported positive effects of low GI and/or low GL meals and diets in persons with diabetes compared to the few with negative outcomes (Colombani, 2004). Evidence suggests that diets based on foods with a low GI and/or low GL improve glycaemic control, insulin resistance, lipid profiles and blood clotting (Livesey et al, 2008; Wolever, 1997; Frost et al, 1998; Frost & Dornhorst, 2000; Järvi, 1999; Brand-Miller et al, 2003b). A meta-analysis of the randomised controlled trials that have examined the efficacy of the GI index on overall blood glucose control indicates that the use of this concept can provide an additional benefit over that observed when total carbohydrate is considered alone (Brand-Miller et al, 2003). Furthermore, a systematic review by Opperman et al (2005) presented convincing evidence to recommend the use of the GI as a scientifically based tool when choosing carbohydrate-containing foods to improve overall metabolic control of diabetes as well as to reduce total cholesterol (TC) and LDL-cholesterol (LDL-C) concentrations.

Besides glycaemic control, two further features of low GI foods are potentially beneficial for the **overweight person with diabetes**. A diet low in GI (as opposed to a higher GI diet) promotes fat oxidation at the expense of carbohydrate oxidation (McMillan-Price & Brand-Miller, 2004) and seems to provide greater levels of satiety and fullness (Raben et al, 1996; Ludwig, 2000; Pawlak et al, 2002). Both of these characteristics may stem from the slower rates of digestion and absorption of low GI carbohydrates and subsequent effects on postprandial glycaemia and hyperinsulinemia. Mixed meals with low GI values have also been found to induce greater levels of cholecystokinin (CCK) secretion, a hormone involved in appetite regulation, as well as more fullness over a 180-minute period (Holt et al, 1992). Consumption of high CHO (high in GI) diets may therefore interfere with weight control compliance (Febbraio et al, 2000; Febbraio & Stewart , 1996) and in part explain rising figures in obesity and overweight during the last decade despite declines in fat intake in both an individual and population basis (Brand-Miller, 2003). It has been suggested that the decrease in dietary fat intake has led to a

compensatory increase in consumption of carbohydrates, in particular carbohydrate foods high in GI (Pawlak et al, 2002).

Thus a diet low in GI and GL may be particularly beneficial to persons with diabetes who are prone to insulin resistance and who are often overweight and sedentary (Brand-Miller, 2003). Figure 3 illustrates ways in which a low GI diet may play a role in the management of diabetes and other NCDs.

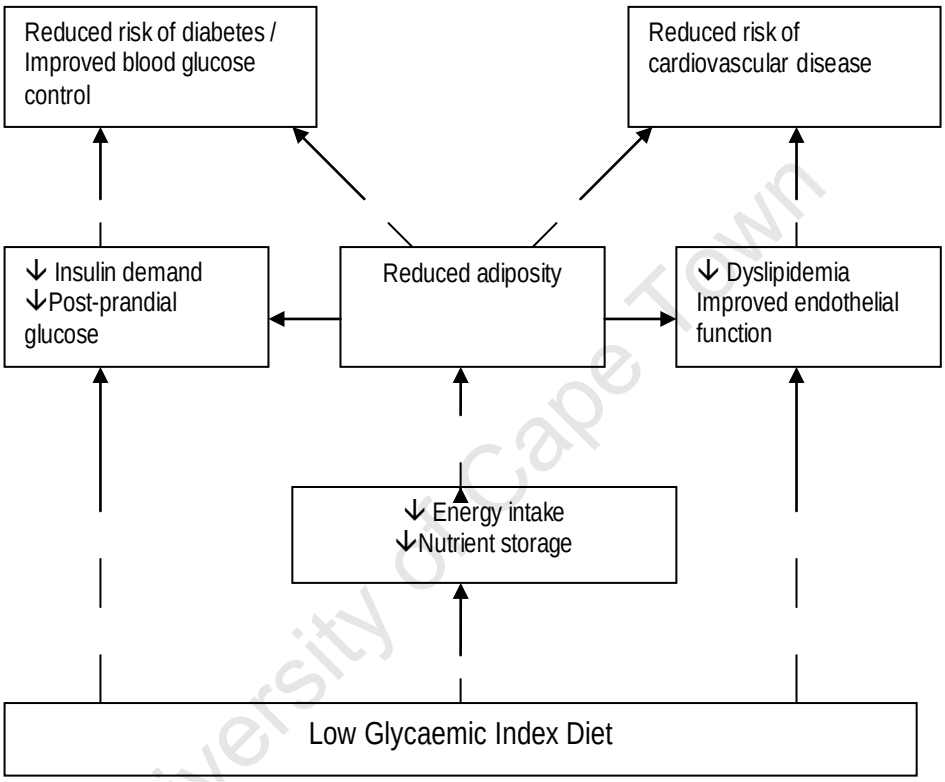

Figure 3: Pathways by which a low glycaemic index diet might positively play a role in the management and risk reduction of obesity, diabetes and cardiovascular disease (Source: Adopted from Pawlak et al (2002))

Although evidence has been disputed and controversy exists regarding the extent of its application in practice (Franz, 2003a; Franz, 2003b; Coulston & Reaven, 1997; Pi-Sunyer, 2002), the GI concept has been endorsed by various expert groups, such as the European Dietetic Association, (Diabetes and Nutrition Study group, 2004) the British Dietetic Association (Connor et al, 2003), the Canadian Diabetes Association (2000), as well as the Joint Food and Agriculture Organization/World Health Organization (FAO/WHO, 1998).

Official dietary guidelines for healthy consumers as well as a GI trademark certification programme for food labelling have been developed in Australia, considered the leading country in terms of knowledge of the GI of foods (Venter, Slabber & Vorster, 2003). Contrary to previous guidelines (Franz et al, 2002) the ADA now recognises the role of low–glycaemic index diets for individuals consuming a high– glycaemic index diet in controlling postprandial hyperglycaemia (Bantle et al, 2007b; Bantle et al, 2008).

Locally, the GI concept is acknowledged in the South African Food-Based Dietary Guidelines (FBDGs), and reference is made to the beneficial effects of low-GI foods in the context of preventing chronic diseases (Vorster & Nell, 2001). A group consensus statement by South African dietitians acknowledged the GI as a useful concept and a scientifically based tool to choose carbohydrate-containing foods (Vorster, 2005). The group also supported GI-labelling of South African food products as a way to create a mechanism to inform and educate the public towards responsible use of the concept. More research on the GI of typical South African foods, knowledge and attitudes of consumers, as well as the development of suitable teaching aids were identified as necessary for optimal implementation of the concept in a South African context (Vorster, 2005).

Thus, the GI has value as a broad guide to ensure good carbohydrate food choices, by grouping foods into low, medium and high GI categories. The concept of GL address the concern about rating foods as suitable or unsuitable solely on the basis of their glycaemic index by incorporating both the quantity and the quality of the dietary carbohydrates consumed. Experts further agree that the GI and GL are not intended to be used in isolation, but should be used in the context of other food and nutrition strategies such as portion control, dietary fibre intake, total amount of carbohydrate as well as modification of dietary fat intake (Diabetes and Nutrition Study group, 2004; Connor et al, 2003; Sheard et al, 2004).

d) Dietary fibre (non-glycaemic carbohydrate)

Data suggests that consuming a high-fibre diet (>50 g fibre/ day) reduces blood glucose, blood cholesterol and hyperinsulinemia in persons with type 2 diabetes (Chandalia et al, 2000). However, it is not known whether free-living individuals can

maintain such a high dietary fibre intake without consuming foods or supplements fortified with fibre (Franz et al, 2002). Thus, as a first priority, current ADA guidelines recommend a fibre intake similar to what is recommended for the general population (20-35g of dietary fibre per day) from a wide range of carbohydrate containing foods from cereals, vegetables, legumes and fruits (Bantle et al, 2007b; Bantle et al, 2008). This is in line with the message that a 'diabetic diet' is a healthy way of eating for everyone to follow. Given the epidemic nature of type 2 diabetes it is even more important to emphasise that the recommended intake of dietary fibre is appropriate for the general population as well as for high-risk families and individuals with diabetes (Venn & Mann 2004).

Although fibre and GI values are not linearly related (McMillan-Price & Brand-Miller, 2004), soluble dietary fibres and foods in which the natural cell wall architecture remains intact (e.g. legumes) are associated with lower GI scores (Jenkins et al, 2000). The results of dietary intervention studies have found improvements in glycaemic control after increasing the dietary intake of whole grain foods, legumes, vegetables and fruit (Venn & Mann 2004). The specific benefits of an increased fibre intake results primarily from the greater consumption of soluble fibre forms (Mann, 2001). The gel-forming capacity of soluble fibre is believed to be the mechanism by which it slows gastric emptying, accelerates small intestinal transit and slows absorption of nutrients such as glucose from the small intestine. It is for this reason that foods containing soluble fibres have a major impact on the glycaemic index (GI) of foods (James et al, 2003). Although insoluble fibres themselves do not generally affect the GI, the physical properties of food containing insoluble fibre may have an impact; for instance, the starch in coarsely ground grains is more slowly digested and absorbed in the small intestine, thereby reducing the GI (James et al, 2003).

Furthermore, soluble fibres, especially oat fibre, also lower serum cholesterol in several ways by reducing absorption of cholesterol, fat and bile acids from the small intestine. Short-chain fatty acids (SCFA) produced by the fermentation of dietary fibres can also directly inhibit hepatic cholesterol synthesis (Spiller, 1999). Increasing fibre intake also has other general dietary benefits, such as increasing the intake of vitamins, minerals, antioxidants and other substances important for good health (James et al, 2003; Franz et al, 2002).

Since fibre-rich foods are easy to identify, a message to increase dietary fibre should in theory be easier to implement compared to many other dietary adjustments (James et al, 2003). Unfortunately, this is not the case and substantial barriers to achieving an increased consumption of fibre-rich foods exist (Venn & Mann, 2004). Among these are palatability, gastrointestinal side effects, consumer preference for refined products, lack of availability of whole grains and whole grain products in supermarkets, limited choice, price, lack of knowledge of health benefit, product labelling, unfamiliarity with cooking techniques, lack of recipes, familial and cultural eating habits and reluctance to change (Venn & Mann, 2004).

e) Nutritive and non-nutritive sweeteners

Nutritive sweeteners refer to a variety of sweetening agents that provide energy, such as sugar (or sucrose), fructose and sugar alcohols. Sucrose and fructose provide 16.8 kilojoules per gram (4kcal/g). Sugar alcohols or polyols sweeten with less energy per gram, averaging 8.4 kilojoules per gram (2 kcal/g), because they are not fully absorbed from the gut and thus less available for energy metabolism. Non-nutritive sweeteners provide no energy (or insignificant energy in the case of aspartame), and, because they sweeten with little volume, they can be referred to as high-intensity sweeteners (American Dietetic Association, 2004).

In the past sugar was either eliminated or severely restricted in the diet of persons with diabetes based on the premise that it causes rapid increases in blood glucose. However, it has now been well established that dietary sucrose does not increase glycaemia more than isocaloric amounts of starch (Connor et al, 2003; American Dietetic Association, 2004, Bantle et al, 2007b; Bantle et al, 2008). Therefore, nutritive sweeteners such as sugar need not necessarily be restricted, but if consumed, should be substituted for other carbohydrate sources rather than added. Intakes as high as 60 g sucrose per day may not adversely affect glycaemic response in persons with type 2 diabetes (Malerbi et al, 1996; Bantle et al, 2008).

However, even if rather large amounts of sucrose can theoretically be substituted for higher GI carbohydrates without any negative impact on metabolic control, in practice it is likely that sugar allowed in 'free' amounts, may be taken *in addition* to other food (Vessby, 1994). Sugar-rich foods are also often energy dense and may

contain significant amounts of fat. This might contribute to a deterioration of glycaemic control as well as to an increase in energy content and ultimately, weight gain (Vessby, 1994). Therefore, even though sugar can now be part of a balanced diet for persons with diabetes, it is still good advice to be careful in the consumption of foods containing large amounts of sucrose (Slabber, 2005; Franz, 2008:804; Vessby, 1994). It should be consumed in a context of a healthy diet, in small amounts and not replacing food rich in fibre. The addition of fructose as a sweetening agent is not recommended for persons with diabetes, despite its lower GI value (compared to sugar) due to concerns for increased blood triglyceride levels with high intakes of fructose (Franz et al, 2002).

Sugar alcohols produce a lower glycaemic response than fructose, glucose, or sucrose and can be used safely in the diets of persons with diabetes. However, because of the laxative effect of these compounds, the amount consumed may need to be limited (American Dietetic Association, 2004). Furthermore, even though sugar alcohols have lower energy content than sucrose and other carbohydrates, they are not water soluble and often combined with fat in food items. Food sweetened with sugar alcohols may end up with energy content similar to that of foods they are replacing (Franz, 2008:804) and should be used with care.

The non–nutritive sweeteners such as saccharin, aspartame, acesulfame potassium, and sucralose have proven to be safe substitutes for nutritive sweeteners (American Dietetic Association, 2004). They are also appropriate as part of nutrition therapy for persons with diabetes and may help control energy intake in individuals who wish to lose weight (Franz, 2008:804; American Dietetic Association, 2004). They should ideally be used within the context of a sensible weight management program including a balanced diet and exercise (American Dietetic Association, 2004).

2.8.5 Protein

Guidelines from across the world have generally only considered protein in the context of that necessary for maintenance of lean body mass, i.e. that needed to maintain nitrogen balance, whether people have diabetes or not (Gannon et al, 2003). There is general agreement that protein can provide 10-20% of total energy from a variety of foods, with more emphasis placed on plant protein sources such as legumes (which are also low in GI and high in soluble fibre), as well as oily fish (see

section 5.7.4) and low fat animal protein sources (Dept of Health, 2004). Persons with diabetes may have an increased need for protein due to moderate hyperglycaemia contributing to an increased turnover of protein. However, since most people eat more protein than required, persons with diabetes who consume a usual diet are not at risk for protein malnutrition (Bantle et al, 2008).

Protein intake has been linked to the occurrence of diabetic nephropathy as a micro vascular complication of diabetes. However, intakes in the usual range (not exceeding 20% of energy intake) do not appear to be associated with the development of diabetic nephropathy (Bantle et al, 2008). Thus, for individuals with diabetes and normal renal function, there is insufficient evidence to suggest that usual protein should be modified for the prevention of micro vascular complications (Bantle et al, 2008). Reduction of protein intake in individuals with diabetic chronic kidney disease may improve measures of renal function and is recommended (Bantle et al, 2008).

A role for protein in the management of hyperglycaemia has also been investigated since glucose can be derived from the constituent amino acids through gluconeogenesis (Gannon et al, 2003). Furthermore, protein does not have a GI and in those with controlled type 2 diabetes, dietary protein does not raise plasma glucose concentration right after a meal (Franz e al, 2004; Bantle et al, 2007; Gannon et al, 2003; Nuttall et al, 1984). Including protein as part of a mixed meal may however have an impact on the glycaemic effect of the meal since amino acids promote insulin release when ingested with carbohydrate, thereby increasing the clearance of glucose from the blood (Nuttall & Gannon, 1991). It has therefore frequently been recommended that protein be combined with carbohydrate as a way to lower the GI of a meal. However, it is unlikely to influence the GI significantly, since the amounts eaten in a normal meal are usually less than the amounts eaten under experimental conditions to achieve these effects (Wolever et al, 1991).

Finally, protein has received attention, especially in the popular media, for its role in lowering the GL when substituted for carbohydrate. Short-term studies suggest that a higher protein diet and subsequent lower carbohydrate intake may improve blood glucose control in persons with type 2 diabetes (Bantle et al, 2008). However, long-term studies are necessary to determine potential long-term acceptability and benefits

as well as adverse effects of such a diet (Bantle et al, 2008) and research in this regard conducted over the past two decades is limited by flaws in experimental design, small sample sizes and insufficient short-term and long-term data (Eckel, 2003). Intakes above 20% of total daily energy are therefore not recommended at this point in time.

2.8.6 Fat

Fat is energy dense, provides double the amount of energy compared to carbohydrate or protein and over consumption is therefore easier to achieve (Bray, 2007). Foods combining fat and sugar may be a particular problem because they are often very palatable and usually inexpensive (Drewnowski and Spector, 2004). Thus when weight loss is a goal in diabetes management, fat is probably the most important nutrient to restrict (Franz et al, 2002) as spontaneous food consumption and total energy intake are increased when the diet is high in fat and decreased when the diet is low in fat.

Apart from reducing energy, the primary goal with respect to dietary fat restriction in individuals with diabetes is to manage and reduce the risk for CVD. Diabetes in all its forms is one of the main cardiovascular risk factors, two of three persons with diabetes will die as a result of cardiovascular complications and approximately 30% of patients treated in cardiovascular intensive care units have diabetes (Kengne et al, 2005). As for prudent guidelines for healthy adults, a total fat intake of less than 30% of total energy intake has traditionally been recommended (SEMDSA, 1997). However, during the last two decades emphasis, based on several lines of evidence, have shifted from simply promoting a low-fat diet to a greater recognition of the types of fat and its important role in determining risk for various NCDs (Hu et al, 2001b). Refer back to section 2.8.1 for more detail. Prominence is now given to limiting saturated fatty acids (SFA), trans fatty acids (TFA), and cholesterol intakes so as to reduce risk for cardiovascular disease (CVD) (Bantle et al, 2008). A food-based approach for achieving these fatty acid goals is recommended, namely a dietary pattern high in fruits and vegetables, whole grains, legumes, nuts and seeds, lean protein, fish and the use of non-hydrogenated margarines and oils (Bantle et al, 2008; Bantle et al, 2007a; Dept of Health, 2004).

Saturated and trans fatty acids are the main dietary determinants of plasma low-density (LDL) cholesterol. Saturated fats are generally found in foods of animal origin and plant products but also in coconut and palm kernel oils, often found in biscuits and energy bars (American Dietetic Association, 2005). A saturated fat intake of less than 10% of total energy (TE) has generally been recommended (Bantle et al, 2007b), although more recently the ADA have been recommending an intake of less than 7% for all persons with diabetes (Bantle et al, 2008). Simply reducing intake of saturated fatty acids (SFAs) can be useful if weight loss is desirable, but it can also be replaced with either carbohydrate or monounsaturated fat (Connor et al, 2003; Franz et al, 2004; Bantle et al, 2008) if weight loss is not a goal.

Trans fatty acids or trans fats occur naturally in foods such as beef, pork, lamb and butter, but can also be formed when unsaturated fats are hydrogenated. The latter is a manufacturing process that is used to solidify liquid oils e.g. brick margarines (American Dietetic Association, 2005). High intakes of trans fats (TFAs) have been associated with an increase in the relative risk of coronary artery disease, CVD death rate, and risk of fatal and nonfatal myocardial infarction, and sudden death (Hu, 1997; Baylin et al, 2003; Lemaitre et al, 2002; Pietinen et al, 1997; Sun et al, 2007). In addition to raising plasma LDL cholesterol, TFAs lower high density lipoprotein (HDL) cholesterol and increase the total cholesterol (TC)-to-HDL cholesterol as well as LDL-to-HDL cholesterol ratios (Mensink et al, 2003). This is significant as evidence strongly suggests that the ratio of TC to HDL cholesterol is a better predictor of cardiovascular disease risk than either total cholesterol or low density lipoprotein cholesterol alone (Castelli et al 1983; Kinosian et al 1994). TFAs also increase other coronary artery disease risk factors, such as small dense LDL, postprandial lipids, endothelial function, and systemic inflammatory mediators (Mozaffarian et al, 2004; Gatto et al, 2003; Mauger et al, 2003). Intake of trans fats should therefore be kept to a minimum in the diet of persons with type 2 diabetes.

Monounsaturated fats (MUFAs) decrease total and LDL cholesterol when substituted for saturated fat. When compared to carbohydrate, MUFAs decrease triglycerides, increase HDL cholesterol and are inversely related to total-to-HDL cholesterol ratio (Garg, 1998). MUFAs have a lower susceptibility to lipid peroxidation and consequent lower atherogenic potential (Kratz et al, 2002) and are

now promoted as the main source of dietary fat. Olive and canola oil, avocado and many nuts are all good sources of monounsaturated fats (Connor, 2003).

Due to concerns that diets high in MUFAs eaten ad libitum may result in increased energy intake and weight gain (Franz et al, 2004), recommendations should rather be based on an individual's metabolic profile and need to lose weight, as well as cultural or ethnic preferences when determining whether saturated fats should be replaced with carbohydrates or monounsaturated fats.

The two major dietary **poly-unsaturated fatty acids** (PUFAs) are **linoleic acid** (LA) as the parent fatty acid of the n-6 series, and **linolenic** acid (ALA) as the parent fatty acid of the n-3 series. LA is elongated to arachidonic acid (ARA), and ALA is converted to eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA) in animal cells (Bantle et al, 2007a). The n-6 component of PUFAs or linoleic acid is found in vegetable oils, nuts and seed oils and the n-3 component is found in substantial amounts in oily fish such as mackerel, herring, salmon, tuna, and trout, as well as oysters (Connor et al, 2003).

As is the case with MUFA, evidence suggests that replacing saturated fats and trans fats with unsaturated n-6 PUFAs may have beneficial effects on insulin sensitivity and is likely to reduce risk of type 2 diabetes (Lovejoy, 1999; Risérus et al, 2009; Hu et al, 2001b). In terms of CVD, when saturated fat is replaced by linoleic acid, LDL and HDL are lowered (Bantle et al, 2007a). When carbohydrate is replaced by linoleic acid LDL is lowered, but HDL raised.

Long-chain n-3 fatty acids (ALA, EPA, and DHA) do not appear to improve insulin sensitivity or glucose metabolism (Risérus et al, 2009), but there is growing evidence to support its role in reducing CVD risk (Bantle et al, 2007a), by reducing overall mortality, mortality due to myocardial infarction and sudden death in patients with coronary heart disease (Heiner et al, 2002). Increased dietary consumption of ALA may decrease platelet aggregation and reduce formation of pro-aggregatory thromboxane A2 by inhibiting the conversion of linoleic acid to arachidonic acid (Adam et al, 1986). Omega-3 polyunsaturated supplements have been shown to lower plasma triglyceride levels in persons with type 2 diabetes, although LDL may also be raised.

Internationally it is recommended that the intake of PUFA should be limited to a maximum of 10% of total energy intake, although consensus on the optimal intake of LA and ALA, EPA and DHA has not been reached. Recommendations for lowering the intake of n-6 PUFA have centered on concerns that high intakes may antagonise n-3 PUFA metabolism and contribute to various disorders associated with an excess production of n-6 fatty acids such as a susceptibility of tissue and plasma lipids to oxidative modification (Reaven et al, 1994; Calder, 2005).

Updated diabetes guidelines for both the United Kingdom and United States now recommend the intake of oily fish two to three times a week (Connor et al, 2003; Franz et al, 2004, Bantle et al, 2008). Persons with CVD may benefit from 1g of EPA and DHA per day, ideally from oily fish, although supplementation may be necessary to achieve this intake (Kris-Etherton et al, 2002). Those needing triglyceride lowering may benefit from 2-4 grams of EPA and DHA per day, as a supplement under a physician's care (Kris-Etherton et al, 2002).

Dietary cholesterol raises blood cholesterol levels although not to the same extent as saturated fat (Clark et al, 1997; Howell et al, 1997). Because of a lack of specific information, it is recommended that the dietary goals regarding cholesterol intake for individuals with diabetes be the same as for individuals with pre-existing CVD, since the two groups appear to have equivalent cardiovascular risk (Bantle et al, 2008). Previous guidelines (SEMDSA, 1997; Franz et al, 2004) generally recommended an intake less than 300mg/day, although an intake of less than 200mg/day is now recommended for all persons with diabetes by the ADA (Bantle et al, 2008). Dietary cholesterol is only found in foods of animal origin and in foods containing such ingredients. Foods high in cholesterol include egg yolk and dishes made with egg yolk, organ meats, caviar, prawns, shrimps and calamari as well as butter, cream, full cream dairy products (milk, cheese), beef, mutton, lamb, pork, tongue, duck, chicken and turkey (FoodFinder^{TM}3, 2002).

Plant sterols and stanol esters block intestinal absorption of dietary and biliary cholesterol. Amounts of 2g/day have been shown to lower total and LDL cholesterol (Franz et al, 2004). In South Africa a few products have been fortified with plant sterols such as a soft margarine and yoghurt (Lee et al, 2003). If these products are

used, they should displace rather than be added to the diet to avoid weight gain (Bantle et al, 2008).

2.8.7 Micronutrient intake

The micronutrient intake recommended for persons with diabetes is the same as that for the general population and supplementation guidelines for at risk groups such as the elderly, pregnant women and those with HIV also apply to them (Bantle et al, 2007b; Bantle et al, 2008).

A growing interest in the possible role of chromium, magnesium, vitamin E , vanadium and L-carnitine in contributing to metabolic control and to preventing chronic complications in persons with diabetes is apparent from the literature (Guerrero-Romero & Rodríguez-Morán, 2005; Yeh et al, 2003). However, to date there is insufficient clinical evidence to recommend the routine use of such supplements in the treatment of type 2 diabetes.

Since an inadequate diet is a frequent reason for micronutrient deficiencies, appropriate nutrition counselling should be the basis of advice on micronutrients instead of a focus on micronutrient supplementation in order to reach metabolic control (Guerrero-Romero & Rodríguez-Morán, 2005).

2.8.8 Alcohol intake

In individuals with diabetes moderate alcohol consumption (when ingested alone) has no acute effect on glucose and insulin concentrations, but carbohydrate co-ingested with alcohol (as in a mixed drink) may raise blood glucose levels (Bantle et al, 2008). If adults with diabetes choose to use alcohol, it is generally recommended that daily intake be limited to a moderate amount (one drink per day or less for women and two drinks per day or less for men). This is the same advice as for the general population (Dept of Health, 2004; SEMDSA, 1997; Bantle et al, 2008).

Alcohol should be consumed with food in individuals using insulin or insulin secretagogues to reduce risk of nocturnal hypoglycaemia (Bantle et al, 2008). Although chronic excessive alcohol intake is associated with an increased risk of hypertension, light to moderate alcohol consumption is associated with reductions in blood pressure (Bantle et al, 2008). Contraindications would include pregnancy,

hypertriglyceridemia, obesity, neuropathy, and poor glycaemic control (Bantle et al, 2008).

2.8.9 Diabetic Products

Foods containing fructose, sugar alcohols and non-nutritive sweeteners are sometimes marketed as 'diabetic foods'. Professional guidelines do not recommend any of these foods, as no clinical advantage of the use of these products has been documented (Choudhary, 2004). These products are not essential to health and the decrease in focus on the products is in line with a move away from a special 'diabetic' diet to a healthy one suitable for most people.

2.8.10 Sodium intake

Recommendations on sodium intake for the person with diabetes are the same as for the general public, namely limiting sodium chloride to less than 6g/day or sodium to less than 2300mg/day (Connor et al, 2003). To achieve such a level of intake, no salt should be added to cooking or at the table and processed foods limited (Charlton & Jooste, 2001). For persons with diabetes and symptomatic heart failure, dietary sodium intake of less than 2000 mg/day may reduce symptoms (Bantle et al, 2007b). In normotensive and hypertensive individuals, a reduced sodium intake (e.g. 2300 mg/day) with a diet high in fruits, vegetables, and low-fat dairy products lowers blood pressure (Sacks et al, 2001).

2.8.11 In summary

Healthy lifestyle nutrition recommendations for the general public are also appropriate for individuals with type 2 diabetes. Reducing total energy intake as well as intakes of saturated and trans fats, cholesterol, and sodium are especially desirable since many individuals with type 2 diabetes are overweight and insulin resistant and suffer from the associated metabolic abnormalities such as dyslipidemia and hypertension. An emphasis on good quality carbohydrates high in fibre and low in GI as well as good quality fats such as mono-unsaturated fats and omega-3 fats can be of further benefit.

2.9 Cost-effectiveness of nutrition therapy for type 2 diabetes mellitus

Assessment of the cost-effectiveness of nutrition therapy as an intervention is limited as there are only a few randomised controlled trials in which nutrition was the only variable and not combined with exercise and other lifestyle management programmes. Randomised controlled nutrition therapy outcome studies have documented decreases in HbA1c in those with newly diagnosed type 2 diabetes as well as those with a disease duration of four years (UKPDS, 1990; Franz et al, 1995a). In the UK Prospective Diabetes Study (UKPDS) trial, nutritional advice given by registered dietitians was an integral component of management (Delahanty & Halford, 1993; UKPDS, 1990). During the initial period of the UKPDS trial study nutrition counselling was the primary intervention and the mean HbA1c decreased by 1.9% (from 9 to 7%), fasting plasma glucose was reduced by 46 mg/dl, and there were average weight losses of 5 kg after three months.

Furthermore, in a meta-analysis of 89 studies of educational interventions and outcomes specific to weight loss in diabetes care (Brown, 1990; Brown et al, 1996), nutrition therapy had the largest statistically significant impact on weight loss and metabolic control. Combined strategies of nutrition and behavioural therapy plus exercise had a small effect on body weight, but a very significant impact on HbA1c (Pastors et al, 2002).

Evidence also suggests that the amount of weight loss and improvement in glycaemic control in persons with type 2 diabetes is related to the amount of time spent on dietary aspects and to how often they are seen by a dietitian (UKPDS, 1990; Franz et al, 1995a; Jones et al, 1989; Matthews & Hayes, 1987). In persons with established diabetes who were attending a hospital clinic and who received no input from a registered dietitian, HbA1c decreased in 68% of them when a registered dietitian became available (Matthews & Hayes, 1987).

Cost-effectiveness also improves when dietitians actively participate in the decisions about the person with diabetes' nutrition alternatives (Franz et al, 1995b). Nutrition interventions that followed medical nutrition (MNT) practice guidelines lead to substantial improvements in metabolic control, as well as savings in drug therapy

(Franz et al, 1995b) and a reduction in utilisation of medical services (Sheils et al, 1999), which were achieved with a reasonable economic investment.

Thus, overall, evidence-based research strongly suggests that nutrition therapy is clinically effective when provided by a registered dietitian who is experienced in the management of diabetes. There is evidence from randomised controlled trials, observational studies and meta-analyses that nutrition intervention (both as independent MNT and as part of overall diabetes self-management training) improves metabolic outcomes, such as blood glucose and HbA1c levels in individuals with diabetes (Pastors et al, 2002). Based on the cost of providing nutrition care to persons with diabetes and the cost of care for diabetes-related complications, the beneficial medical outcomes from nutrition therapy outweighs the economic investment (Franz et al, 1995b).

It should however be noted that successful nutrition interventions mentioned in most of the available research, for both prevention and management, are considerably time and labour-intensive. Research on cost-effectiveness of nutrition interventions has often focused on medical nutrition therapy, a thorough and in-depth process to comprehensively manage dietary aspects of diabetes in the individual with diabetes. It is unlikely that such in-depth nutrition therapy is consistently taking place at this point in time in the public health sector of South Africa with its huge burden of disease and limited resources (Parker, 2008; Nthangeni et al, 2002; van de Sande et al, 2007). However, this should rather be a motivating factor to evaluate the effectiveness of current nutrition strategies used to ensure that nutrition therapy is evidence-based, effective and cost-effective within the existing constraints. 'A lack of resources' should not be used to justify lack of taking action to implement effective nutrition strategies in the treatment of diabetes.

2.10 Diabetes education in the management of type 2 diabetes mellitus:

2.10.1 General Overview

Diabetes is a self-managed condition and therefore it is vital for persons with diabetes to have the necessary knowledge, skills and attitudes to enable them to establish self-care and self-referral (SEMDSA, 1997). Acute complications

(hypoglycaemia and hyperglycaemia) and most other complications such as foot injury or infection can be prevented or limited by the diabetic person's alertness to the warning signs and appropriate reaction to it (SEMDSA, 1997). However, approximately 50-80% of persons diagnosed with diabetes mellitus lack significant knowledge and skills to manage the condition effectively (Clement, 1995). Therefore, the goal of diabetes education is to enable individuals to incorporate core principles of diabetes management into their daily life-styles. It is an individualised and planned process that requires time, materials, space and professional expertise (Franz, 2008:833).

2.10.2 Core messages to be included in diabetes education.

Optimal management of diabetes requires changes in existing behaviours in addition to the adoption of new ones. For newly diagnosed persons a staged approach to education is advised in which initial education focuses on the most essential skills and behaviours needed for survival. The 1997 SEMDSA Consensus Document outlines the education of patient and family at three levels, namely at primary level, secondary level and tertiary level.

Education at **primary** level should include:

a) Knowledge of diabetes and its management

- Diagnosis, explanation and recognition of diabetes symptoms
- Glycaemic targets
- Blood glucose and /urine monitoring and appropriate action to take
- Dietary principles and guidelines
- Exercise guidelines
- Weight control
- Medication

b) Survival skills

- Home monitoring and recording
- Symptoms and prevention of hyperglycaemia
- Symptoms and prevention of hypoglycaemia

- Treatment of hypoglycaemia
- Urgent self-referral

c) Health promotion

- Good nutrition
- General hygiene
- Dental care
- Active lifestyle
- Contraception
- Specific Counselling when pregnant
- Preventative foot care
- Awareness of complications

d) Counselling (motivational interviewing)

- Disease acceptance
- Reassurance of continuity of care
- Value of compliance
- Dependence and independence conflict
- Introduction to self-care

Clearly, in the public health sector with a lack of resources, even conveying only the most essential diabetic skills (primary level) will not be easy to achieve. A lack of a systematic approach and clearly defined programme to incorporate all the above aspects will complicate and hinder effective education.

2.10.3 Diabetes education in South Africa

The development of a systematic approach towards diabetes management and education is currently under way in the Metro District Health Services (MDHS) in the Western Cape. It will entail a group education programme for the newly diagnosed person with diabetes that focuses on generic issues of self-esteem, self-efficacy and self-management. According to the model proposed there are two different options (Mash: Personal communication, 2009):

- In CHCs with support groups (SG), the routine education would be done by a facilitator from a nongovernmental organisation (NGO) as part of the activities of the support group. Persons with diabetes would come for review every 6-months and good communication between the SG and CHC would be essential.

- In CHCs without SGs, the routine education must still happen in the CHC, primarily provided by the health promoter. Basic messages need to be standardised between all involved in routine education.

Diabetes South Africa (DSA) is an example of an NGO that has had a partnership with the local Western Cape Department of Health for the past four years to train, monitor and supply feedback on four to five groups in the Cape Metropole area. These groups each have two facilitators who have been trained in the basics of diabetes management and who send in reports to the NGO on a monthly basis. The groups meet regularly and provide education and support to persons with diabetes on diet, foot care, eye care, exercise, blood glucose monitoring and many other aspects of diabetes management (McCumisky: Personal communication, 2009).

These developments are very promising as strategies to improve the quality of care of persons with diabetes attending CHCs in the Metropole. Active and intensive strategies are certainly justified by the large burden of illness borne by groups with diabetes, their greater need for health care services and the demonstrated efficacy of diabetes control in reducing adverse outcomes (Banister et al, 2004; Glazier et al, 2006). Dietary aspects of diabetes management will form part of the proposed group educational programmes for diabetes, although more in-depth education and practical application might be necessary in addition to what is currently being proposed**.** These developments and proposals are also in line with the recently updated SEMDSA guidelines (Levitt et al, 2009) on diagnosis and management of type 2 diabetes for primary health care that recognise small group education as the most cost-effective option for patient education. The guidelines also emphasise that education programmes should be evidence –based and not only offered at the time of diagnosis. Regular auditing of the programme and its effect on outcomes is further advised (Levitt et al, 2009).

2.10.4 Nutritional aspects of diabetes education

As for general diabetes education, the knowledge and skills needed to implement

nutritional recommendations cannot be acquired in one session, as people may be able to assimilate only a very limited amount of information at the initial stages after diagnosis (Connor et al, 2003). Table 8 presents initial self-management education (survival skills) that specifically covers aspects important to nutrition education for persons with diabetes.

Table 8: Basic survival skills for medical nutrition therapy for all persons with diabetes

- Basic food/meal plan guidelines
- Exercise guidelines
- Signs, symptoms, treatment, and prevention of hypoglycaemia
- Nutritional management during short-term illness
- Self-monitoring of blood glucose levels
- Plan for continuing care

Source: (Monk et al, 1995)

Following the initial education regarding survival skills, energy restriction and weight loss are two of the key dietary behaviour changes expected of most persons with type 2 diabetes and should be foremost in, and underly all, specific dietary advice. Knowledge of which food components provide energy and which ones more directly influence blood glucose levels would further be essential to cover in nutrition education of persons with diabetes (Maldonato et al, 1995). Nutrition education should be an ongoing component of diabetes care and be individualised, not merely be included as part of a standard package. It is best accomplished through a coordinated team effort in which the dietitian must be an active subject (Franz, 2008:833).

In developed countries, there is a growing recognition for the need for nutrition education to be more comprehensive, to enable persons with diabetes to take effective control of their chronic condition. Both the United States and United Kingdom have developed and proposed programmes that require much more intensive input from both dietitians and persons with diabetes than traditional methods of providing dietary advice (Doherty et al, 2000). These types of interventions are, however, considerably time and labour-intensive and would require additional resources for needs assessment, leader training, community outreach and

follow-up (Glazier et al, 2006). The appropriateness of such interventions in developing countries may well be questioned, but should provide more reason to ensure that interventions that are implemented are the most effective, given financial and other constraints.

2.10.5. The need for appropriate diabetes education-with an emphasis on nutritional aspects

It is well recognised that nutrition therapy will be unsuccessful if the diet prescription does not take the individual's culture, language, usual eating pattern and economic status and health literacy level into consideration (Gohdes, 1988; Nthangeni et al, 2002; Schillinger, 2002).

Health literacy is a measure of patients' ability to read, comprehend and act on medical instructions. Poor health literacy is common among patients who have low educational training and among patients with chronic medical conditions, such as type 2 diabetes (Williams et al, 1998). Inadequate health literacy has been associated with worse glycaemic control (Schillinger, 2002). Findings from black and coloured persons with diabetes in a SA township showed that those with a higher educational level and those who received diabetes education tended to have a better glycaemic control (van de Sande et al, 2007). However, even in persons with diabetes who received information and seemed to know how they should live with their disease, implementation of the received information remained doubtful (van de Sande et al, 2007). Therefore, although diabetes education could be a tool to achieve better glycaemic control, it is important to understand that education should be adjusted to a person's literacy, cultural environment and economic status (Nthangeni et al, 2002; Williams et al, 1998; Schillinger, 2002; Gohdes, 1988).

Language barriers may make both dietary assessment and dietary guidance more difficult. Social problems such as poor housing, unemployment and poverty may also have significant nutritional implications (Connor et al, 2003). A diet prescription that is unrelated to a person's cultural and economic status is an important barrier in the nutrition therapy of persons with diabetes (Gohdes, 1988). Nutrition therapy guidelines frequently originate in the United States or Europe and thus constructed around typical Western food and meal patterns (Steyn and Levitt, 2004). The 1997 South African guidelines for the nutrition therapy of diabetes illustrate the point.

Because of a lack of updated guidelines, most South African-based dietitians follow international recommendations (Blaauw: Personal communication, 2007). Although dietitians are trained to adopt guidelines to suit the individual needs of their clients, the burden in the public sector is overwhelming and it is often left to other health professionals to do nutrition education in the form of 'blanket ' messages, which again often originate from a typical western meal pattern.

No set of tested and adjusted diabetic dietary guidelines exist for specific groups within the South African population. Findings of a study done in urban and rural black persons with type 2 diabetes in Limpopo Province indicated that they frequently received incorrect and inappropriate dietary advice from health educators (Nthangeni et al, 2002). It is not known whether the situation is any different in the South African coloured diabetic population compared to findings in urban and black persons with type 2 diabetes. The dietary intake of the diabetic subgroup of the coloured population has not been studied in any depth. Although dietary advice is being given to coloured persons with diabetes at health care centres in Cape Town, no data is available to evaluate whether they are actually making changes to their diet or whether these guidelines are appropriate.

For many generations the coloured population of South Africa has lived in distinct residential areas mainly in the Cape Peninsula, but there are also small communities living in relatively distinct residential areas scattered throughout South Africa (Labadarios et al, 1996). Very little information is available on the dietary habits of the Cape Town urban coloured community of South Africa. One of the few studies evaluating the diet of adults in this community was undertaken in 1982 (Steyn et al, 1985). This cross-sectional study of 976 coloured subjects, aged 15-64 years, identified a population consuming a typical Western diet, reflecting a diet high in fat (37% of total energy intake) and low in nutrient density. Only 32.2% of men and 27.5% of women consumed a prudent diet consistent with nutrition recommendations for the general population. Major risk factors for coronary heart disease, namely hypercholesterolemia, hypertension, obesity, low physical activity levels and tobacco use, were found to be common.

In 1988 similar data on meals and nutritional intakes of adult coloured people in the Western Cape was reported (Langenhoven et al, 1988a). The mean pattern indicated

very little or no breakfast, a midday meal consisting mainly of bread, a cooked supper, and heavy snacking between meals, which frequently tended to supply large quantities of sugar and fat together with more nutrient-rich foods. Animal protein, fat and sugar consumption was high and fibre intake low, reflecting a typical western diet.

Other studies in this population group are limited to children or the elderly, but report similar findings, such as a too high fat intake and low intake of fruit and vegetables. In a study of 255 12-year old children in Cape Town, the fat intake (36%) exceeded that of a prudent diet (Steyn et al, 1986). A more recent study in older coloured South Africans in Cape Town indicated a fat intake of 32.4% of total energy intake (Charlton et al, 1997). In the latter study a low fibre intake (17g/day), attributed to the low consumption of fruit and vegetables, was also found. Over half of the daily fat intake was supplied from hard fat sources with high saturated fat content.

A diagnosis of diabetes for someone following a typical western diet as described above will imply major dietary adjustments. It is not known to what extent the coloured person with diabetes is making these dietary adjustments and whether appropriate messages are provided.

2.11. Diabetes educators and their role as nutrition educators

2.11.1 General overview

Diabetes education delivered by a team of educators, with some degree of reinforcement of that education made at additional points of contact, may provide the best opportunity for improvements in patient outcomes (Loveman et al, 2008). The South African Department of Health has compiled a document, "The Primary Health Care Package for South Africa", which included a set of norms and standards to be used by provinces to provide health services at acceptable levels of service to all people, help the process of redistribution and reduce inequalities (Dept of Health, 2000). Under the 'Patient Education ' section of the document it is advised that patients are supported after diagnosis and that their capacity are developed regarding self-care, self-monitoring, compliance, prevention of complications and management of the disease. Education activities that are sensitive to the cultural and economic realities of the person with diabetes should be emphasised (Dept of Health, 2000).

However, in actual practice in the South African public health sector nutrition education for diabetes is seldom practiced as a staged approach. Nutrition education by a dietitian often happens once off, if at all. Study findings in persons with diabetes managed in the South African public health sector all point to the fact that most of them have not been seen by a dietitian (Nthangeni et al, 2002; van de Sande et al, 2007) due to the small numbers employed in the public health sector. This is confirmed by a recent review on the public health workforce in South Africa (Steyn & Mbhenyane, 2008). There are less than 2000 registered dietitians in South Africa and less than 600 of them work in the public health sector.

It is unlikely that proper and thorough nutrition education is being delivered by other health care professionals in light of the heavy burden of disease and patient numbers (Parker, 2008) and the current lack of a systemic approach to general diabetes education. In the experience of the author nutrition education in CHCs might be done by doctors as part of a consultation where many other factors need to be looked at or, it might be included as part of general diabetes education by health promoters or nursing staff while patients are waiting for doctor's appointments in a busy 'weighing' room where blood sugars, urine samples and weight measurements are done simultaneously. However, professional nurses who are the backbone of the primary health-care system and often deliver the basic elements of nutritional care, are not being trained in sufficient numbers to meet population growth either (Steyn & Mbhenyane, 2008). This situation is aggravated by the growing burden of conditions associated with over nutrition and under nutrition, as well as the enormous demands of the HIV/AIDS epidemic. The South African Department of Health is striving to meet these increasing needs by means of the Integrated Nutrition Programme (INP) as well as strategies to improve the quality of training and the number of health professionals, including dietitians and nutritionists. This plan includes the objective of increasing the public health nutrition workforce to more than 250 newly trained dietitians and nutritionists per annum by 2010 (Steyn & Mbhenyane, 2008).

Even if these targets are achieved, a lack of a comprehensive strategy to make nutrition education available to all persons with diabetes as an integral part of management will still lead to suboptimal nutritional management of those with diabetes in the public health sector. Staff responsible for diabetes care at the CHCs often work in isolation and have a heavy workload (Mash et al, 2008). The fact that

most CHC staff involved in diabetic care continuously rotates into and out of the diabetic clubs where persons with diabetes are followed up, results in a lack of continuity. At a recent inquiry, involving CHCs in the Cape Metropole, a need to create facility-based chronic care teams with long-term and specific leadership was identified to improve quality of care in diabetes management (Mash et al, 2008). CHC staff further reported that it was best to use multiple opportunities, methods and people to educate and interact with patients (Mash et al, 2008) e.g. waiting times could be used more constructively for this purpose, using group methods of health education in light of heavy staff workloads. Some CHCs also introduced structured programmes so that different topics were addressed at consecutive visits. Support groups were also recognised as an ally in this goal.

Furthermore, it is essential that all team members involved in diabetes treatment be knowledgeable about nutrition therapy (Franz et al, 2002) since many misconceptions exist concerning nutrition and diabetes. In clinical practice, nutrition recommendations that have little or no supporting evidence have been and are still being given to persons with diabetes (Nthangeni et al, 2002). Misconceptions held about diet and diabetes, such as that sugar is a forbidden food and special diabetic foods are essential in a healthy diet, can only be erased when accurate and consistent dietary messages are promoted by all members of a diabetes care team (Opperman, 2005; Connor et al 2003). When these messages are 'packaged' by health care providers with special training in health education and cultural sensitivity, patients are more likely to show greater improvements in health (Lerman, 2005).

Although not all will be equally involved in aspects of nutrition education, consistency in the type of nutrition information given is essential. Everyone involved in diabetes education should to some degree be involved in nutrition education, although the registered dietitian should be the team member providing the more in depth nutrition therapy.

2.11.2 The dietitian

It takes considerable skill to apply the nutritional objectives of diabetes management in a way that is realistic and practical. The dietitian is uniquely qualified to be the primary facilitator in the implementation of nutrition therapy. The dietitian's role is to translate nutrition therapy goals for the person with diabetes into practical

messages that can be implemented as part of their daily living. A thorough assessment of an individual's background and eating habits is made while the nature of recommended dietary changes will vary according to individual nutritional and clinical priorities, habitual diet and lifestyle as well as the prevalence of risk factors. Cultural and individual misconceptions held about diet and diabetes are also identified and clarified (Opperman, 2005; Connor et al, 2003).

However, as mentioned previously, due to a general shortage of dietitians in the public sector, access to dietitians at CHCs in South Africa have been found to be variable (Mash et al, 2008; Parker, 2008). Parker (2008) found that only 39% of health professionals dealing with NCDs in CHCs in the Western Cape indicated that they often have access to dietitians. The situation in other parts of the country may be worse. A study in black persons with type 2 diabetes attending primary health-care services indicated that only 4-16% had been counselled by a dietitian (Nthangeni et al, 2002). Most had had a 'diabetic' diet explained to them by either a doctor or a nurse (Nthangeni et al, 2002).

There clearly is a need for sound nutrition information. In a questionnaire and focus group survey of the Needs of the Recently Diagnosed Person with Diabetes undertaken by Diabetes UK (Care Interventions Team, 2001), patients ranked the need for information about diet and eating more highly than any other requirement. Those who reported meeting with a dietitian at or near to the time of diagnosis rated this as the most useful aspect of a multidisciplinary service. There was an expressed need for earlier referral to a dietitian and for more information about diet.

Besides a shortage of dietitians there is also a limit to how much facilitation any one specialist can really undertake. This state of affairs only highlights the need for close liaison with other members of the diabetes care team.

2.11.3 Other health professionals

The majority of health professionals interviewed at CHCs in the Western Cape were found to be promoting the most important lifestyle modification messages, including limiting fat intake, decreasing the consumption of sugar and salt, increasing the consumption of foods high in fibre, increasing physical activity and promoting weight loss. Although these messages were being promoted, these health

professionals seemed to experience difficulty in providing their patients with practical information and examples of how to do so (Parker, 2008).

What is concerning is that only a few health care professionals mentioned a lack of knowledge as a barrier preventing them from counselling patients on lifestyle modification, although only 6% achieved the desired knowledge scores (Parker, 2008). This implicates that they may be involved in 'confidently providing incorrect information' on lifestyle modification to their patients.

Doctors appeared to be more knowledgeable about lifestyle modification than nursing staff (Parker, 2008). However, barriers such as lack of time or language, limited the amount of education and counselling that doctors were able to render to patients. Therefore, nursing staff have to conduct the majority of patient education and counselling. All nursing staff in the above-mentioned survey performed poorly in knowledge scores on weight loss (Parker, 2008).These findings are not unexpected and only highlight the lack of clear protocol to follow regarding aspects such as weight loss, which is relevant in all the NCDs, but in particular for diabetes management.

Besides doctors and nursing staff, health promoting officers and/or nutrition advisors play an important role in diabetes education, specifically in the Cape Metropole Area. However, many CHC's do not have access to nutrition advisors nor health promoting officers (HPOs). Nutrition advisors are trained by and work under the supervision of dietitians, often in CHCs *and* local authority baby clinics. Health promoters are responsible for all health promoting activities in the CHC and often in the community as well. However, although they do receive training in aspects of nutrition, there is often not a systematic way or program in which information is delivered to ensure that the basic nutrition-related messages are covered and delivered to the person with diabetes (Mash et al, 2008).

2.11.4 Community health workers and community-based support groups

Community health workers differ from health care professionals in that they have no formal professional or paraprofessional tertiary education, but usually are provided with informal job-related training and can be involved in either paid or voluntary

care (Lewin et al, 2005). These workers are used to perform diverse functions related to health care delivery.

A culturally tailored diabetes lifestyle intervention among African Americans and Latinos with type 2 diabetes delivered by trained community workers produced significant improvements in dietary and diabetes self-care related knowledge and behaviours and improved metabolic outcomes (Two Feathers et al, 2005). This is similar to the findings of a recent systematic review where one of the key intervention features that appeared to have the most consistent positive effects in diabetes management was the involvement of community educators or lay people in leading the intervention (Glazier et al, 2006).

Success was also reported for those CHCs in the Cape Metropole that collaborated with community-based organisations (Mash et al, 2008). These CHCs were involved with local non-profit organisations to set up support groups for persons with diabetes in the community. The health promoter at the facility was seen as a key link in setting up and facilitating these support groups that are also seen as a way in which the CHC workload could be reduced while increasing quality of care, adherence and self-management (Mash et al, 2008).

In a community-based nutrition education programme in low-income coloured communities in the Free State and Northern Cape a positive impact of the nutrition education programme was observed on many aspects of dietary knowledge and practices, such as a significant improvement in vegetable and fruit intake, milk intake as well as a more balanced meal intake. Local nutrition advisors trained by dietitians were used as community health workers (Walsh et al, 2003). Use was made of creative techniques to convey health information in communities as was advocated by the World Health Organisation (WHO, 1991). Methods of instruction included role-play, singing, demonstrations, workshops, discussions, home visits and puppet shows.

However, a study conducted in Khayelitsha, Cape Town, found that community health workers (CHWs) did not have the necessary knowledge, attitudes and beliefs to make a positive impact on prevention and management of diabetes (Hughes et al, 2006). Obesity was not considered an important risk factor, eating sugar was cited as

a cause of diabetes and folk remedies were advised that supposedly diluted the blood sugar. The patients also took prescribed medication irregularly (Hughes et al, 2006).

CHWs clearly have an important role to play in diabetes education. However, there is a need for proper training. This is an area where dietitians can be of assistance to ensure the integration of accurate and consistent dietary messages for persons with diabetes.

2.11.5 Summary and Conclusion

Diabetes education delivered by a team of educators, with some degree of reinforcement of that education made at additional points of contact, may provide the best opportunity for improvements in patient outcomes (Loveman et al, 2008). Improvement in aspects of diabetes management have been reported in CHCs where chronic care teams met regularly, developed more structured and systematic approaches to care, including the creation of special clubs and appointed specific 'champions' who would not rotate to other duties and who could provide continuity of leadership (Mash et al, 2008). An improvement in the continuity and consistency of diabetes management in general can also benefit nutrition education and should be supported. Ideally, dietitians and nutrition advisors should form part of such a team.

CHAPTER 3: METHODS AND PROCEDURES

3.1 The study design

The research was executed as an adjusted descriptive cross-sectional study (Figure 4).

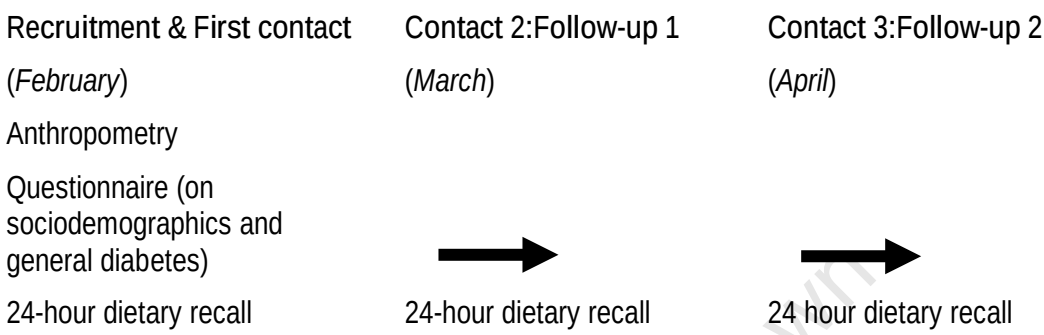

Figure 4: The adjusted cross-sectional study design of the research project

3.2 The Study Sample

3.2.1 The target population

The health care system in South Africa is based on a primary health care approach in which CHCs serve large segments of the population. The Cape Metropole includes 45 CHCs which, depending on the area where they are situated, are attended by either a mixture of ethnic groups, or mainly by coloured individuals or mainly by black individuals. As the aim of this study was to investigate the dietary intake of coloured persons with type 2 diabetes in the Cape Metropole, CHCs serving predominantly lower socio-economic coloured communities were targeted. Heideveld and Retreat CHCs were chosen for this purpose. Retreat CHC serves the surrounding communities of Retreat, Lavender Hill, Seawinds, Heathfield and Muizenberg. Heideveld CHC serves the Heideveld community as well as Manenburg, Vanguard and Sherwood Park, all predominantly coloured communities. Table 9 provides information on the general and diabetic patient load of each CHC.

Table 9: Numbers of patients attending Retreat and Heideveld CHCs (Total number of patients and diabetic patients)

2008 average monthly figures	Heideveld CHC	Retreat CHC
Number of patients	8,540	12,762
Number of newly diagnosed diabetic patients	15	67
Number of diabetic patients for follow-up	580	516

Source: (Hendricks: Personal communication, 2009)

3.2.2 Sample

A convenience sample was drawn on days that persons with diabetes attended the CHCs to be seen by a doctor or to fetch medication. Those persons that were available and willing on the days of recruitment were approached for participation. The target of 60 was originally set to ensure a sufficiently large number of 24-hour recalls (n>50) to provide a reasonable estimate of the mean nutrient intake of a group.

Convenience sampling may cause bias in relation to the general population because their characteristics could differ in important ways from the general population. Extrapolations from convenience samples to the general population must therefore be made cautiously (Lunsford & Lunsford, 1996) and the study results will only apply to the populations resembling the sample. However, the fact that a 24-hour dietary recall method was chosen to assess dietary intake places a relatively small burden on respondents and those who agree may be more likely to be representative of the population compared to a longer and more respondent-intensive procedure, such as keeping food records (Thompson & Byers, 1994).

The following **inclusion criteria** were set for recruitment of subjects:

- Patients who were attending CHCs in the Cape Town Metropole;
- Patients who belonged to the coloured ethnic group in South Africa (by self-identification);
- Patients who were between 35-65 years old (*Type 2 diabetes typically occurs in persons older than 30 years (Franz, 2008:795), and 65 years was used as a cut-off*

point to limit other dietary factors due to older age that might influence dietary intake);

- Patients who had been diagnosed with type 2 diabetes for at least 3 months;
- Patients who were being managed on diet and/or oral agents or a combination of oral agents and insulin.

Patients were **excluded** if they were known to have any of the following:

- Renal failure;
- Conditions that might affect eating (e.g. dysphagia, cancer);
- An inability to communicate and respond to questions e.g. mental impairment
- Evidence of mental disturbance;
- Type 1 diabetes or those managed on insulin therapy only.

3.2.3 Recruitment

Recruitment took place at the two designated CHCs. The primary researcher, a registered dietitian with work experience in the specific communities and community nutrition and twelve first year postgraduate BSc Honours in Nutrition and Dietetics students conducted the recruiting process. Recruitment took place on diabetic 'club' days, which are specific days on which persons with diabetes come and see a doctor or collect medicine.

The researcher or research assistants informed patients of the study in the general reception area or the diabetic clubroom of the CHC. Patients could also indicate to the nursing staff or approach the research team if they were interested in participating. Thereafter the volunteers were individually informed about the details of the study and procedures to be undertaken. Patients who met the criteria and agreed to the procedures gave written consent.

3.2.4 Final sample

Seventy-four subjects were recruited, 63 women and 11 men. Sixty-nine completed the study and 67 were included in the initial data analysis. Due to the small number of men the final analysis was limited to the 59 women.

Reasons for non-completion:

One subject became ill while being interviewed and had to go home. Since one 24-hour recall per person is not considered a reflection of usual dietary intake, four subjects who could only give one 24-hour dietary recall were excluded from the dietary analysis. Reasons for not completing the full number of 24-hour dietary recalls were: One subject suffered a stroke and subsequently died; two subjects could not be contacted again due to defaulting from treatment and/or a change in contact details; one subject was at sea during the subsequent months of follow-up interviews.

Two more subjects were excluded from the analysis as a review of their clinic records indicated that they had type 1 diabetes. One type 2 diabetic person who was on insulin only due to a negative reaction to oral agents, was included in the sample.

A total of 55 female subjects completed all three interviews and thus three dietary recalls and four subjects completed two recalls each. In total 173 24-hour dietary recalls were taken into account for analyses.

3.3. Anthropometric measurements:

3.3.1 Measurements and techniques

The following anthropometric measurements were taken during the first contact:

- **Weight and height** were measured using Masskot scales and Leicester height measures. Height was measured without shoes to the nearest 0.1cm. Weight was taken in light clothing and to the nearest 0.1 kilogram. Measurements were taken twice and the average used.

- **Waist-Hip-Ratio (WHR**): Waist measurements were taken at the slimmest area between the chest and hips (Hammond, 2008: 372), or at the level of the umbilicus. Hip measurements were measured at the largest diameter between the waist and the knees (Hammond, 2008: 372). Measurements were taken twice and the average used.

3.3.2 Operational definitions

- **Body mass index** (BMI) was calculated as weight (in kg) divided by height (in square metres). BMI was categorised according to age-adjusted standards (James et al, 2001) to define cut-off values for underweight, overweight and the obese (Underweight: BMI<18.5kg/m^2; Desirable weight: BMI=18.5-24.9kg/m^2; Overweight: BMI=25-29.5kg/m^2; Obese: BMI≥30 kg/m^2). It was further defined according to the revised SEMDSA guidelines for diagnosis and management of type 2 diabetes mellitus for primary health care in 2002. An optimal BMI is defined as less than 25kg/m^2; an acceptable BMI is less than 27kg/m^2 and additional action is suggested when the BMI exceeds 27kg/m^2 (SEMDSA, 2002).

- The w**aist circumference (WC)** was used in the final analysis since the WHR is known to underestimate central adiposity in individuals who also have a degree of gluteal obesity. WC is also considered to be a better criterion of central adiposity, particularly for long-term follow-up (Despres et al, 2001) and waist circumference is one of the ATP III criteria for identifying individuals with the metabolic syndrome. In Caucasian populations a waist circumference ≥88 cm in women predicts risk of diseases associated with obesity, whereas in Asian populations the figures are≥90 and ≥80 cm, respectively (International Diabetes Institute, 2000). Cut-off values for this study were defined based on the revised SEMDSA guidelines for diagnosis and management of type 2 diabetes mellitus for primary health care in 2002, and were as follows: Optimal: < 82cm; Additional action suggested: >88cm (SEMDSA, 2002). (Refer to section 2.5, table 3).

3.4 The General diabetes questionnaire

An interviewer-administered questionnaire to assess socio-economic status, life-style factors, medical history and diabetes as well as dietary and general knowledge on diabetes management was developed (see addendum B).

3.4.1 Development

The **first step** in the development of the questionnaire involved constructing a theoretical framework (dendogram) on the aspects to be covered in the questionnaire (Figure 5). The **second** step involved developing the framework of the questionnaire

based on the dendogram. The **final step** involved the generation of questions to cover each concept included in the dendogram and the construction of the first draft of questions. In the first stage of development, questions were based on that of a questionnaire used in a similar study in black persons with type 2 diabetes (Nthangeni et al, 2002). Questions on sociodemographics were adjusted from the National Food Consumption Survey (Labadarios et al, 1999) and questions concerning lifestyle factors (physical activity, smoking, usual eating pattern) were adjusted from the Nutrition Monitor questionnaire (Senekal et al, 2009). Some questions were pre-coded and others were left open-ended and coded afterwards. The draft questionnaire was then submitted for feedback to two dietitians experienced in research and questionnaire development. Table 10 gives an outline of the different aspects covered in the questionnaire.

Table 10: Outline of the different aspects that were covered in the general diabetes questionnaire

Section	Aspects covered	Type of questions
Section A	General and Demographic Information	Religion, Housing, Rooms in house, access to electricity, main fuel for cooking, electrical equipment, schooling, source of income and money spent on food.
Section B	Lifestyle factors: Physical activity levels, smoking and alcohol use.	Physical activity: At a screening level only, self-reported and not quantified. Perception of exercise and barriers to exercise. Smoking: Present smoking habits, attempts and barriers to stop smoking. Alcohol: Consumption of alcohol, differentiating between weekdays and weekends.
Section C:	Medical History:	Duration of diabetes, co-morbidities, use of other remedies. Family history of other NCDs.
Section D:	Knowledge of diabetes:	General understanding of aspects that should form part of diabetes education: Symptoms and management of hyper- and hypoglycaemia, and long-term complications.
Section E:	Diet, role of diet and source of dietary information:	Primary source of dietary information, a dietitian's input and the role of diet in the management of their diabetes. Difficulties about the diet were also explored.
Section F:	Dietary Practices and Perceptions:	Usual eating pattern (meals per day); how it differed from family, whether a diabetic diet was adhered to. The difference between a 'diabetic' diet and a 'normal' diet. Views on suitability of specific food items
Section G:	Information obtained from medical folder:	Medication for diabetes. Fasting blood sugar values, cholesterol and HbA1c. Confirmation of date of diagnosis

Socio-Demographic

Day Hospital

Age

Sex

Religion

Housing (type & no of rooms)

Amenities

Employed/Income

Education

Medical

History:

- Co-morbidity
- Diabetes Diagnosis

Family History

Management:

- Medication
- Remedies
- Acute complications
- Long term complications

Knowledge:

- Diabetes
- Management
- Hypo/Hyper
- Long-term complications

Lifestyle

Smoking

Activity & barriers

Alcohol

Stress

Diet

Information:

- **Source** of information
- **Type** of information
- **Appropriateness** of information

Understanding

- Role of diet in diabetes
- Misconceptions

Knowledge :

- Appropriate foods
- Inappropriate foods

Practices:

- Meal frequency
- Following diet?
- Social / family
- Perceived Barriers

Actual intake: (24-hour recall)

- Macronutrients
- Micronutrients
- Compared to guidelines
- Commonly eaten foods
- Staple foods
- Main sources of E, CHO
- GI of foods eaten

Figure 5: A theoretical framework (dendogram) of the aspects to be covered in the general diabetes questionnaire

3.4.2 Piloting

The questionnaire was pilot-tested in persons with type 2 diabetes on three occasions at CHCs in the Cape Town area that also serve predominantly coloured people of low socio-economic background. It was first piloted at Grassy Park CHC in three diabetic persons and after adjustments were made, again at Kensington CHC in six diabetic persons. Thereafter questions were rephrased to improve clarity and the overall questionnaire was shortened. After a full final pilot of three type 2 diabetic persons at a third CHC who were taken through the whole interview procedure to streamline the process and identify potential pitfalls, the questionnaire was adjusted slightly and finalised. Questionnaires were available in English and Afrikaans.

3.5. Dietary assessment

3.5.1 Choice of dietary methodology

The four dietary assessment methods most relevant to epidemiological methodology or clinical trials that could be considered were the 24-hour dietary recall, the diet record, the food frequency questionnaire and the diet history method (Block, 1989). The strengths and limitations of each method are summarised in Table 11.

Table 11: Comparison of four dietary assessment methods for dietary research

Method	Strengths	Limitations
The 24-hour recall Detailed report of all food and drink consumed during previous 24-hour period	-Generally brief to administer -Inexpensive -Low respondent burden -No literacy required on the side of respondent -Do not alter usual diet -Can provide detailed information on types of food consumed -Can be used to estimate nutrient intakes of groups	-1 recall not representative of usual intake of an *individual* -Recall relies on memory -Underreporting/over reporting occurs -Focus on current behaviour; not suitable for retrospective/case-control studies. -Detailed information on foods necessary -Omissions of dressings, sauces and beverages can lead to low estimates of energy intake
Diet Records 3-days' record is kept of all food and drink consumed	-Not dependent on memory -Provide detailed food and food pattern information	-Requires high degree of cooperation -Requires good literacy level -Recording diet may alter diet -High respondent burden can result in low response rates -Takes more time to collect data -Analysis is labour intensive & expensive

Table 11 continued….

Method	Strengths	Limitations
Food frequency questionnaire (FFQ) Subjects report how frequently they consume specific foods on a list during a specified time limit	-Can be self-administered -Modest demand on respondents -More representative of usual intake (vs. a few days of diet records) -Useful in large scale studies -Considered by some as the method of choice for research on diet-disease relationships	-Food lists may not represent usual foods or portion sizes consumed by respondents -Grouping of foods may compromise data e.g. "yellow vegetables" -Relies on memory -Not appropriate for determining absolute nutrient intake -Foods and portion sizes in OFF may not coincide with self-selected portions. -Over/ under estimation occurs
Diet History Assessment of an individual's intake over an extended period of time.	-Assess usual intake -Can detect seasonal changes -Data on all nutrients can be obtained -Data correlate well with biochemical measures	-Lengthy interview process -Requires highly trained interviewers -Difficult and costly coding process -May overestimate nutrient intake -Requires cooperative respondents with ability to recall usual diet.

Source :(Block, 1989; Lee & Nieman, 2003)

The most suitable of the above four methods for a particular study will ultimately depend on the aim and scope of the research and the population that will be involved. Questions and aspects considered for the identification of the most appropriate method for this study are presented in Table 12.

Table 12: Questions that were considered to identify the most appropriate dietary assessment method for the present study.

Question	Present study
What is to be measured? *Entire diet in detail/ single nutrients /other food constituents, or specific foods/ food groups or dietary behaviours?*	Entire diet
Is the mean intake of a group or the intake of each individual needed?	Mean intake of the group, although individual intake may be useful in assessing micronutrient adequacy.
Is absolute or relative intake needed?	Absolute
What level of accuracy is required?	As high as possible
What time frame/period is of interest?	Current intake/Cross-sectional design
What are the research constraints in terms of money, time, staff, and respondent characteristics?	Financial, staff and limited time for data collection.
Respondent burden	Needs to be low to ensure adequate participation response.
Focus of analysis	The whole diet: Macro and micronutrients as well as food items and food groups to assess dietary adequacy and dietary quality.
Target group	Low literacy levels

Source: (Lee & Nieman, 2003; Beaton, 1994)

Based upon the answers to the above series of questions it was decided that the 24-hour dietary recall would be the most suitable instrument to use and for the following reasons:

- The method suited the overall aim of the study, which is to assess the mean intake of the *group* and not the individuals' usual intake.
- The 24-hour dietary recall suited the cross-sectional study design that focused on current behaviour (Thompson &, Byers, 1994).
- The method requires no literacy from the respondents and will therefore be appropriate for use in our sample that was expected to include literate and illiterate individuals.
- It was the most cost-effective method in this relatively small number of subjects, given the time and financial constraints within which the study had to be undertaken.
- The 24-hour recall is not time-consuming and would place only a small burden on respondents. This is important considering that respondents will already be at the CHC for a specific reason, frequently involving long periods of waiting.

The primary limitation of the 24-hour recall method as it applies to this study is the occurrence of under or over reporting which may occur since respondents may withhold or alter information about what they ate for various reasons. These include poor memory, embarrassment or to please or impress the interviewer. A tendency to underreport binge eating, alcohol consumption and foods perceived as unhealthful and over reporting of name brand foods, expensive cuts of meats and foods considered as 'healthful' may occur (Feskanich & Willett, 1993). Energy intake is often underestimated if drinks, sauces, and dressings are not reported (Lee & Nieman, 2003). Furthermore, when respondents' actual food consumption is low, they tend to overestimate the amount recalled, and when their actual consumption is high they tend to underestimate the amount recalled (Lee & Nieman, 2003).

A further concern is the fact that data on a single day's diet, no matter how accurate, is a very poor reflection of usual dietary intake because of day-to-day or intra-individual variability in intake (Beaton, 1994; Feskanich & Willett 1993, Block et al, 1986). However, a sufficiently large number of 24-hour recalls may provide a reasonable estimate of the mean nutrient intake of a group (Block et al, 1989; Lee Han et al, 1989, Feskanich & Willett, 1993). The way in which these issues were addressed in this research, is discussed in section 3.7.

3.5.2 Procedure for completion of 24-hour recalls

The 24-hour recalls were administered using the **multiple pass method** developed by the United States Department of Agriculture (Guenther et al, 1994-quoted in Johnson et al, 1996). This method involves 'built-in' prompting in which the interviewer and respondent review the previous day's eating episodes several times to obtain detailed and accurate information about food intake and food portion sizes. It also served as a cross-check for types of food consumed. In this study an adjusted method (Johnson et al, 1996) was used in which a **quick list** of foods eaten in the previous 24 hours is initially compiled (see addendum C). In the second pass, a **detailed description** of foods on the quick list is obtained. The respondent is asked to clarify the description and preparation of foods on the quick list. In the third pass, called the **review**, the interviewer reviews the data collected, probes for additional eating occasions and clarifies food portion sizes using household dishes and measures (Johnson et al, 1996; Lee & Nieman, 2003). It has been reported that respondents exposed to such interviewer probing reported 25% higher dietary intakes than respondents who were not exposed to interviewer probing (Campbell & Dodds, 1967).

For portion size estimation the Dietary Assessment and Education Kit (DAEK) was used to aid valid and reliable dietary assessments (Steyn & Senekal, 2004). The kit was developed by the MRC (Medical Research Council) of South Africa and consultants and consists of food flash cards, a food photo manual as well as master copies of recording sheets that can be adjusted as needed. The food photo manual includes food photographs for the identification of food items and the preparation thereof as well as generic and specific sketches with descriptions for portion size estimation. The reverse side of the food photo cards included specific food codes for the various food items that are identical to the food codes from the FoodFinder^{TM}3 Software program (FoodFinder^{TM}3 Software application, 2002) that was used for analysis of the dietary data.

Each research team involved in administering the 24-hour dietary recalls, had access to a manual and showed subjects the food photo cards and generic sketches at the second and third level of the multipass method to clarify food items and portion sizes. The team used the manual to identify the correct food item, quantify the food intake in grams and used the reverse side of the food photos to identify and assign a code to all food items recorded. Foods that were not in the database were recorded as individual

ingredients with a description of the quantity and preparation method or else the code of a similar product was assigned.

3.5.3 Definition of meal and snack times

Meal times and snack times were categorised for the purposes of dietary analysis based on the time of day (Table 13).

Table 13 : Definition of meal and snack times.

Early morning snack:	5am-6:30am
Breakfast:	6:3am-9am
Am Snack:	9am -12pm
Lunch:	12pm-2pm
Pm Snack:	2pm-5:30pm
Supper:	5:30pm-8pm
Late night snack:	>8pm

3.6 Data Collection Procedures

3.6.1 General logistics of data collection

The three interviews took place over a period of three months in the South African late summer and early autumn, between February and early April 2006.

The **first interview** followed after recruitment and written consent and generally took about 45 minutes. Each subject was assigned a code that was used when entering data for analysis and to ensure anonymity.

Interviews were conducted in either a separate room (Heideveld CHC) or a vacant reception area (Retreat CHC). It involved answering the general diabetes questionnaire (approximately 20-25 minutes) on socio-demographic background, general lifestyle (physical activity, smoking and drinking habits) and dietary and general knowledge on diabetes management. A 24-hour dietary recall (15-20 minutes) was also administered. Interviews took place in the subject's language of choice (either English or Afrikaans).

Height, weight, waist and hip circumference were measured in a separate room (Heideveld CHC) or a secluded corner in the unused reception area (Retreat CHC). Medical folders were used to confirm information on medication, inclusion and

exclusion criteria, co-morbidities and previous values for fasting blood sugar, Hba1c and cholesterol values. The latter three values were often not available and therefore were not used in the final analyses. In cases where medical folders were not available during the interview, the data was later confirmed.

The **second and third interviews** generally took about 20 minutes. The 24-hour dietary recall was administered, as well as any anthropometric procedures that did not take place at the first visit. Any missing data identified in the general questionnaire (administered at the first interview) were also followed up and clarified.

In order to limit dietary differences due to seasonal availability of food, it was aimed to complete data collection within a period of three months. Most subsequent interviews took place on the day the subjects returned for follow-up clinic visits, usually a month apart and on the same day of the week. The fact that not all days of the week was included (e.g. if seen on a Monday the recall would always be of a Sunday) would limit how widely the dietary data can be interpreted unless an adjustment or weighting method was applied. In instances where patients had a longer time lapse before a follow-up appointment, a suitable time was arranged with the primary researcher who conducted such follow-up interviews. Most of these appointments took place at the CHC although 10 follow-up interviews took place at the subjects' home or work place for their convenience.

Each subject received a food parcel at the end of the three interviews. This contained a packet of lentils, split peas, two varieties of sugar beans, barley and popcorn, a tin of pilchards, three low GI dried fruit bars, low salt stock cubes and soup packets as well as pamphlets on diabetes and healthy eating. The aim was to keep the products similar to foods that subjects were usually eating in order not to promote the idea of 'special' or expensive diabetic products. Most of the food items were donated as a result of the researcher's written requests to food companies and some were provided by the Chronic Diseases of Lifestyle unit of the Medical Research Council (MRC). Donators included the Dried Bean Association of South Africa, Saldanha Fisheries and Trufruit dried fruit bar company.

3.6.2 Field workers

Training

The primary researcher (a registered dietitian familiar with the 24-hour dietary recall method and with work experience in the specific communities) was assisted by 12 postgraduate dietetic students as well as a registered dietitian from the Medical Research Council.

The 12 postgraduate students were new to the field of dietetics and had not administered the 24-hour dietary recall before. They received one day of training conducted by a registered dietitian from the Medical Research Council of South Africa and another half day of practical training conducted by the primary researcher. The training manual that forms part of the Dietary Assessment and Education Kit (DAEK) (Steyn & Senekal, 2004) formed the basis for training. This involved an explanation of the 24-hour recall, as well as the different steps and prompts to ensure forgotten foods are remembered. The Food Photo manual was used to explain portion size estimates (using pictures, generic models or brand packaging), cooking methods and different food groups. Anthropometric measurements were also discussed and demonstrated during the training session.

Practical exposure involved administering the recall on one another, followed up the next day by a visit to a nearby CHC where fieldworkers interviewed patients with a similar profile to those in the CHCs targeted for the study. The general diabetes questionnaire was also discussed and piloted at this occasion. Feedback sessions conducted after each practice session were used to clarify any confusion and reinforce the correct procedures. A trip to the local supermarket was undertaken to show fieldworkers food products that they might not all have been familiar with, but that were typically consumed by the target group for the study (e.g. 'fish oil' which is actually sunflower oil, pilchards, beans, lentils, different types of margarines e.g. Marvello).

Fieldwork

As a rule field workers worked in pairs with one doing the recall and one assisting with the food photo manual and coding of data. Thus, there were about four interviewer teams consistently involved in recording data for the 24-hour dietary recall, two teams at each CHC. The other four field workers were generally involved

in administering the general diabetes questionnaire as well as the anthropometric measurements.

On the first day of data collection the researcher was available to help with any queries on the data collection procedures. All recalls were checked and uncertainties were clarified with the fieldworker who administered the recall. A debriefing session was held with the group to highlight problematic aspects that may have arisen, such as incomplete recalls or missing data.

The primary researcher who was responsible for entering the data checked all records (see section 3.7 and 3.8 for more details).

3.7 Validity and reliability of data

3.7.1 Validity

Validity is the degree or *accuracy* to which the method measures what it is intended to measure (Lee & Nieman, 2003; Block & Hartman, 1989). In this study the relevant questions to ask in the context of validity is 1) how accurate the method reflects the usual intake of subjects and 2) whether the questions in the general diabetes questionnaire truly measured their knowledge on diabetes and dietary-related behaviour? Factors that affect validity include respondent characteristics, questionnaire design and quantification, quality control and the adequacy of the reference data (Block & Hartman, 1989).

Validity of dietary intake

Whenever attention is directed toward an individual's diet, the respondent may consciously or unconsciously alter his or her intake either to simplify recording or to impress the interviewer, thus decreasing the information's validity. It is furthermore well known that the validity of dietary recall in especially obese individuals is often questionable, as they tend to underreport their intake (Goris et al, 2000) .

The principal application of a single 24-hour recall is to describe the *average or mean int*ake of a *group* (Lee & Nieman, 2003). Data from *single* 24-hour recalls should not be used to estimate the *proportion* of the population that has adequate or inadequate diets (e.g. the proportion of individuals with less than 30% of energy from fat or that is deficient in vitamin C intake) as usual intake varies between individuals as well as day to day for each individual. If the purpose of a study requires estimating the

distribution of individual intakes within the group, it is necessary to collect more than one recall per individual (Guenther, 1994). Numerous studies investigated the estimated number of recall days that would be required at various levels of precision for various nutrients in different populations (Beaton et al, 1979; Nelson et al, 1989). In general, the *minimum* number of days of intake needed for *gross* characterisation of *usual individual* intake of energy and macronutrients ranges from three to 10 days, and more for micronutrients.

The purpose of this study was primarily to focus on the mean intake of the sample population. The fact that three repeated 24-hour recalls were administered increased the validity of the results. However, the 24-hour recalls were often completed a month apart on the same day of the week and could have affected results by not representing a spread of days and thus typical intake. According to Beaton (1994) randomised sampling of all days of the week would be most appropriate or else an appropriate balance of the types of days that are likely to differ with respect to food intake (e.g. workdays, weekend days) should be covered.

The validity of measurement of dietary intake in free-living individuals is difficult to assess because all methods rely on information given by the subjects themselves, which is not necessarily correct (Bingham, 1994). Since there is no convenient and unobtrusive method of measuring the true intake of free-living people indirect validation of dietary methods is the method most often used.

To assess the validity of dietary data in this study a simple, indirect check of validity of group estimates was applied, namely a comparison between estimated energy intake (average of three 24-hour dietary recalls) and estimated energy expenditure. The latter was determined using the Schofield equation to estimate basal metabolic rate (Schofield et al, 1985) together with the WHO activity factors (WHO, 1985) for sedentary and more active lifestyles (Bingham, 1994). The Schofield formula is generally accepted for use in validity estimations and two separate formulae are used; namely one for those older than 60 years of age and one for those younger than 60 years of age (Table 14). This test is not sufficiently precise for *individual* validations but is appropriate for group estimates (Schofield et al, 1985).

Table 14: The Schofield equation and the WHO activity factor that was used in the present study as an indirect check of validity

The Schofield equation	Physical activity factor used
Women : >60yrs [0.038(weight in kg)+2.755]	Women 1.56 (light activity)
< 60 yrs [0.034(weight in kg)+3.538]	

Source: (Schofield et al 1985; WHO, 1985).

Calculated energy expenditure was subsequently compared to reported energy intakes from the dietary recall to assess validity. Cut-off points suggested by Goldberg et al (1991) were used with ratios between 0.8 and 1.2 accepted and classified as normal reporters. Those below 0.8 were classified as under reporters and those above 1.2 were classified as over reporters.

Validity of general diabetes questionnaire

The content, construct and face validity of the general diabetes questionnaire were ensured by the comprehensive procedure that was followed in the development of the questionnaire (See section 3.4).

3.7.2 Reliability

Reliability is the ability of the method to produce *consistent* results when repeated in similar situations (Lee & Nieman, 2003; Block & Hartman, 1989).

Reliability of the 24-hour dietary recalls

Factors that may affect reliability of dietary data include memory lapses, inaccurate knowledge of portion size, and overestimation of the amounts consumed as well as actual dietary change in the time between two administrations (Block & Hartman, 1989). The degree of variability permitted by the instrument, the error proneness of the response format, quality control of coding and keying (Block& Hartman, 1989) may further affect the reliability of the results. Inexperienced interviewers as well as a large number of interviewer teams may also detract from the reliability of the data recorded (Lee-Han et al, 1989).

The following measures were taken to ensure the best possible reliability of the 24-hour dietary recalls:

- The multiple-pass method was used for data collection. The built-in prompting of this method is designed to improve the accuracy and reliability of the information obtained.
- Training and practice in the multiple pass method was provided to ensure fieldworkers were familiar with the process.
- Quality control was implemented throughout the research process:
- The 24-hour recalls were checked after the first day of data collection and specific queries about missing or unclear data were clarified with field workers.
- Subsequent recalls were periodically checked by the primary researcher while all recalls were checked again during data entering and cleaning.
- As codes were entered onto a spreadsheet, codes or food items were checked against the Foodfinder database as necessary.
- A list of foods consumed was generated from the dataset and checked for unusual foods which were checked against the original recall.
- The final data check involved checking the original recalls against the coded information, focusing specifically on the correctness of indicated preparation methods.

Reliability of the general diabetes questionnaire

To ensure the reliability of the general diabetes questionnaire the field workers were well trained in the administration thereof and each questionnaire was thoroughly checked and corrected if necessary by the primary researcher after completion. It could also have been ensured by repeating the questionnaire in a sub-sample of the main sample e.g. 10% and comparing the resuls found on the two occasions.

3.8 Assessment of adequacy of dietary intake

3.8.1 Dietary adequacy in terms of the Food Based Dietary Guidelines (FBDGs)

For assessment of dietary adequacy in terms of the FBDGs, the per capita portion sizes were compared with recommended portion sizes (i.e. animal foods and fruit and

vegetables) or else by evaluating the most commonly consumed food items eaten daily (Steyn et al, 2006a) in terms of prudent dietary recommendations. For these purposes data on both per capita portion sizes and the most commonly consumed food items eaten daily were obtained from the three 24-hour dietary recalls for each subject. Data from the 24-hour recall was first grouped into 13 broad food categories (Table 15) and the portion per capita for each category was computed. The 13 categories were then collated into the five food groups described by the FBDGs (starches, fat, vegetables and fruit, animal foods and legumes). The portion per capita was then divided manually by what constituted a serving size according to the FBDGs to generate an approximate number of servings consumed by the study sample. E.g. fruit (160.81g) and vegetable (93.49) intake added together was 254.3. When divided by the recommend serving (of approximately 80g) it yielded three servings. The same was done for milk, eggs, meat and meat substitutes.

Table 15: Broad food categories consumed by the study sample as measured by the three 24-hour dietary recalls (n=59)

	Total quantity(gram)	Portion/eaters*	Portion/capita**
CEREALS	13211.8	223.9	223.9
MILK	7889.2	133.7	133.7
SUGAR	6520.0	112.4	110.5
VEGETABLE OILS	874.2	15.1	14.8
FRUIT	9487.5	169.4	160.8
VEGETABLES	5515.8	100.3	93.5
MEAT	5722.5	106.0	97.0
ROOTS	3186.8	65.0	54.0
FISH	1341.8	41.9	22.7
NUTS	411.3	15.2	7.0
PULSES	1415.0	59.0	24.0
EGGS	675.0	29.4	11.4
SOUPS	575.0	143.8	9.8

*The average intake of those who actually consumed the food item

**The average intake for the total sample, n=59

Determination of starch portions was different in that the weights given for the 'cereal' group (Table 15) do not distinguish between 'wet' or 'dry' servings. Typically 30g dry cereal (e.g. All Bran flakes or a slice of bread) or 100g wet (e.g. cooked oats porridge) constitutes a serving of starch. It is thus difficult to determine the correct portion size of starches from the data presented in Table 15. However, data on the actual *carbohydrate* contribution per capita for the food categories typically grouped as carbohydrates (Table 16) could be used to determine a starch serving, which is typically the equivalent of 15-20 grams of carbohydrate. The total carbohydrates for cereals, sugar and root vegetables (Table 16) per capita were added

and divided by 20 (thus a serving of carbohydrate) to calculate the portion of carbohydrate consumed. The data on the macronutrient contribution per capita (Table 16) for the various food categories was also used to verify the serving sizes for fruit, vegetables and meat and fat products in a similar way as for carbohydrates. For instance, a meat serving typically contains 21 gram of protein. Table 16 indicates that meat products contributed almost 21 gram of protein per capita, thus the per capita intake for meat should be about one serving, which is similar to the value that was derived from the weights presented in Table 15.

Table 16: Energy, macronutrient and fibre contribution per capita for various broad food categories (n=59)

	Protein per capita contribution (g)	Fat per capita contribution (g)	Carbohydrates per capita contribution (g)	Fibre per capita contribution (g)	Kilojoules per capita contribution (g)
CEREALS	13.7	9.5	85.0	7.8	2165.7
MILK	6.2	6.3	7.5	0.0	466.0
SUGAR	0.1	0.3	20.4	0.1	365.3
VEGETABLE OILS	0.1	11.1	0.3	0.0	423.2
FRUIT	0.9	0.6	21.7	3.2	482.0
MEAT_	21.0	15.2	3.9	0.4	1064.2
VEGETABLES	1.2	0.6	5.6	1.8	176.0
ROOTS	1.1	4.3	9.7	1.3	434.9
FISH	5.0	2.1	0.8	0.1	308.0
NUTS_	1.6	3.4	1.0	1.1	393.2
PULSES	1.4	0.3	3.3	3.4	291.0
EGGS	1.3	1.3	0.2	0.0	188.2
SOUPS	0.2	0.1	0.5	1.6	262.18

3.8.2 Dietary adequacy in terms of the Dietary Reference Intakes (DRIs)

The Dietary Reference Intakes (DRIs) is a set of four nutrient-based reference values that can be used in assessing and planning diets (Barr et al, 2002), including the Estimated Average Requirement (EAR), the Adequate Intake (AI), the Recommended Daily Allowance (RDA) and the Tolerable Upper Intake Level (UL). Table 17 provides a summary of the different reference values.

Table 17: A comparison of the four nutrient-based reference values that are collectively known as the DRIs.

Estimated Average Requirement (EAR)	Recommended Dietary Allowance (RDA)	Adequate Intake (AI	Tolerable Upper Intake Level (UL)
· The intake that meets the estimated needs of a nutrient of 50% of individuals in a specified gender group, at the given life-stage, or alternatively defines the intake of a nutrient at which the risk of inadequacy is 50%. · It is used as the basis in setting the recommended dietary allowance (RDA).	· Intake meets the nutrient needs of almost all (97-98%) individuals in a specific gender & life-stage. · It defines the nutrient intake at which the risk of inadequacy is negligible (2-3%) · A value to be used in a prescriptive sense, as a goal for dietary intake by individuals.	· Used when data are not sufficient to estimate an EAR (and therefore an RDA). · Set at a level that would meet or exceed the needs of almost all members of a life stage/gender group	· The maximum nutrient intake by an individual, which is unlikely to pose risks of adverse health effects in almost all (97-98%) individuals in a specified group.

Source: Adopted from The Food and Nutrition Board (2005).

The methods for assessing intakes of *groups* are different from those used to assess intakes of *individuals* (Murphy et al, 2006). In the past, adequacy of intakes was often assessed by using the RDAs and the proportion meeting 67% of the RDA for a particular nutrient. However, if the proportion of a group with intakes below the RDA was used to assess the prevalence of inadequacy, it would result in a gross overestimation of inadequacy, since the RDA is an intake level that meets the requirements of 97%-98% of all individuals (Barr et al, 2002; Beaton, 2006). The EAR is the more appropriate reference value to use when estimating adequacy of group intake, although not by comparing the group mean intake to the EAR, but by determining the distribution of intakes and the proportion with intakes below or above the EAR (Barr et al, 2002; Murphy et al, 2006).

When an EAR is not available, the AI is appropriate to evaluate the mean intake of a group since it is set at a level that would meet or exceed the needs of almost all members of a life stage/gender group (Barr et al, 2002). However, the inferences that can be made for nutrients for which only an AI is available are limited since a mean intake below the AI may not necessarily be interpreted as a deficient intake (Barr et al, 2002). It would however be desirable in such instances for intakes to increase (Murphy et al, 2006; Barr et al, 2002). If the mean intake is at or above the AI, a low prevalence of inadequate intakes can be assumed (Barr et al, 2002).

In summary, the EAR was the reference value of choice in this study to estimate dietary adequacy of the group, specifically with reference to micronutrients. Where it was not available, the AI was used, although fewer inferences could be made about dietary adequacy. A comparison with RDAs was included for the sole purpose of making comparisons with results from previous studies.

For the purposes of this research the EAR cut-point method, as described by Murphy et al (2006) was used to assess the prevalence of inadequate intake for specific micronutrient intakes. This entails a simple determination of the number of individuals in the group with usual intakes below the EAR for a specific micronutrient, which reflects the proportion of individuals in the group with inadequate intakes. It does not necessarily identify the individuals whose intakes are below their requirements since some individuals with usual intakes below the EAR may have a lower-than-average requirement. However, if the assumptions of the method are satisfied, it will be counterbalanced by a similar number of individuals with intakes above the EAR, but below their individual (higher than average) requirements (Barr 2002; Murphy et al, 2006).

Furthermore, observed intakes need to be statistically adjusted to partially remove the day-to-day variability in intakes (within-person variation) (Barr et al, 2002) in order to obtain information about the distribution of usual intakes of the nutrient in the group for intakes estimated from a single 24-hour dietary recall. Due to the small study sample and the fact that three 24-hour dietary recalls were obtained, the cut-point method to estimate the prevalence of inadequacy (or the prevalence of adequacy) without statistical adjustments was applied. This was suggested in personal communication with Murphy (2008). The implication of this decision is that without the adjustment, the distribution of intakes will be wider than it should be (because some people ate more than usual on the day(s) intake was reported, while others ate less than usual. The prevalence of inadequacy may therefore be overestimated since the prevalence of intakes below the EAR will be too high (Murphy et al, 2006; Beaton, 2006).

The fact that three dietary recalls were obtained from most subjects will contribute to an attenuation of the day-to-day variability in intakes and will thus provide a better estimate of the usual intake distribution for some nutrients than only one 24-hour recall. However, "*3 days may not be enough for those nutrients with a high day to day*

variation (like vitamins A and B12) and can 'inflate' the observed distribution, thus increasing the proportion of individuals with intakes beyond the selected cut-off' (Carriquiry, 2003:230; Beaton, 2006). The results on the adequacy of micronutrient intake of the study sample will therefore need to be interpreted with caution and may be expected to give an overestimation of inadequacy of intakes. Results from other data such as actual food intake and food groups may also give more perspective when interpreting the data.

3.8.3 Dietary quality in terms of the glycaemic index of carbohydrate-containing foods

The main food items contributing to carbohydrate intake in the study sample were used to assess the GI profile of the diet of subjects. Food items were categorised into three broad categories, namely Low GI≤55; Intermediate GI 56 -69; and High GI≥70. This classification is based on The South African Glycaemic Index Guide (Steenkamp & Delport, 2007), which is in accordance with information on the glycaemic index of other countries. The database of food items that was used (FoodFinder, 2002) group some food items together that differ in their GI values, e.g. 'Wheat-based cereals' include the cereals All Bran as well as Weetbix although the former falls in a lower GI category and Weetbix is classified as a high GI food. Where this was the case the different GI values of the specific food items within that group were indicated.

3.9 Statistical Analysis

Statistical analyses included frequency tables and distributions, means and standard deviations or medians and interquartile ranges depending on the normality of the data. A summary of the data generated for each objective as well as the focus of analysis is presented in Tables 18-22.

OBJECTIVE A:

To develop a profile of coloured persons with type 2 diabetes in the Cape Metropole that covers the following:

i. Weight status and energy balance (Table 18).

Table 18: A summary of data generated and analysed on weight status and energy balance.

Analyses	Data generated/ used	Source of data
Mean ± SD/ Median (IQR) for BMI & Waist circumference. Compared to recommended cut-offs as well as compared to general and coloured population of South Africa. Correlation between BMI – categories and macronutrients Wilcoxon Scores (Rank Sums) for Variables macronutrients, Classified by Variable BMIgroups; Kruskal-Wallis Test	· Body mass index categories · Waist circumference categories · Estimated energy requirements using Schofield equations and WHO activity factors	· Anthropometry: Weight, Height and waist circumference · Estimated energy: General diabetic questionnaire (screening question on physical activity)
Mean ± SD/ Median (IQR) of total energy. Tests for Normality: Shapiro-Wilk Compared to recommended prudent guidelines and energy intake of other populations of South Africa.	· Energy intake	The three 24-hour dietary recalls
Percentage over and under reporters	· Comparison of actual recorded energy intake and estimated energy intake	See above

ii. Quantity and quality of dietary intake (in terms of prudent and SA diabetes guidelines, the SA Food-based Dietary guidelines, Dietary reference intakes and the glycaemic index) (Table 19).

Table 19: A summary of data generated and analysed on the quality and quantity of dietary intake.

Analyses	Data generated/ used	Source of data
Qualitative analysis and comparison to prudent guidelines, the SA FBDGs* and findings in other studies	· Most commonly consumed foods · Main foods contributing to total macronutrients, fibre and sugar · Foods and portions grouped into 5 major food groups	Three 24-hour dietary recalls
Mean ±SD / Median (IQR) of macronutrients. Tests for Normality: Shapiro-Wilk Compared to prudent dietary guidelines for diabetes and other studies	· Macronutrient composition of the diet	
Mean ±SD / Median (IQR) of micronutrients. Tests for Normality: Shapiro-Wilk Compared to EARs or AIs**	· Micronutrient composition of the diet	
Categorisation of CHO-containing foods according to GI categories (low, intermediate and high).	· List of main foods contributing to carbohydrate intake in the diet.	

* See section 3.10.1 ·

**See section 3.10.2

iii. Eating pattern with specific focus on their 24-hour carbohydrate distribution (Table 20).

Table 20: A summary of data generated and analysed on the eating pattern and 24-hour carbohydrate distribution of subjects.

Analyses	Data generated/ used	Source of data
Mean±SD/ median(IQR) Qualitative comparison to other diabetic populations and diabetic dietary guidelines	· Meal frequency: perceived intake vs. actual intake · Energy and carbohydrate distribution throughout the day	Diabetic questionnaire (perceived meal frequency) Three 24-hour dietary recalls(reported meal frequency)

iv. Broad understanding of diabetes and the management thereof (Table 21).

Table 21: A summary of data generated and analysed on the broad understanding of diabetes and its management.

Analyses	Data obtained and used	Source of data
Frequency tables and distributions Qualitative comparison to recommended guidelines for diabetes education and nutrition education aimed at optimal management of diabetes mellitus guidelines. Comparisons to findings for other diabetic populations	· Perception of diabetes and role of diet · Perception of management of diabetes-related complications: hypo and hyperglycaemia	Diabetic questionnaire
Frequency tables and distributions	· View on foods in diabetic diet / 'myths'	
Qualitative comparison to findings for other diabetic populations	· Obstacles to life style management of diabetes	
Frequency tables and distributions Qualitative comparison between knowledge and actual practice and compared to prudent dietary advice and other study findings	· Appropriateness of specific food items in the diabetic diet: Knowledge vs. actual practice	Diabetic questionnaire & three -24 hour dietary recalls

B: To develop recommendations for the implementation of nutrition therapy based on the generated information (Table 22).

Table 22: A summary of data generated and analysed to develop nutrition-related recommendations for the management of type 2 diabetes.

Analyses	Data generated/ used	Source of data
Integration of all information to formulate guidelines.	· Data generated for obj A · Sociodemographic factors General health information	Diabetic questionnaire Three 24-hour dietary recalls

3.10 Ethics

The proposal was submitted and approved by the UCT Research and Ethics Committee. Permission to conduct the study was obtained from the head of the Cape Metropole Department of Health as well as the facility managers from the participating CHCs. The relevant health care workers (doctors, nursing staff and the health promoter at Heideveld CHC) were also contacted and informed. No patient entered the study without signing informed consent, after a full and adequate oral and written explanation of the study had been provided by the investigating team. There

were no foreseeable risks to the patients other than the time and effort to participate and the divulgence of personal information. Patients had the right to withdraw from the survey at any stage without providing a reason. Data generated from the survey was stored in a computer database in a manner that maintained patients' confidentiality. The anonymity of subjects will be maintained in any publication of the data.

(See addendum A: Information Sheet and Consent form. These were available in Enlish and Afrikaans).

CHAPTER 4: RESULTS AND DISCUSSION

4.1. Sociodemographic and general health profile

4.1.1 Results

A total of 59 women were recruited, with 56% of the study sample from Heideveld Community Health Centre (CHC) and 44% from Retreat CHC. The mean age (±SD) of the subjects was 52.8 (±7.8) years. Further sociodemographic information is summarised in Table 23.

Table 23: Sociodemographic profile of the study sample (n=59)

	N (%)		N (%)
Religion		Employment:	
Christian:	41 (69.5)	Unemployed	17 (28.8)
Muslim:	17 (28.8)	Full-time	12 (20.3)
7th Day Adventists:	1 (1.7)	Part-time	5 (8.5)
		Grant/pension	18 (30.5)
Housing		Housewife	2 (3.4)
Informal	1 (1.7)	Other	5 (8.5)
Formal	57 (96.6)		
Other	1 (1.7)	Education	
		<3yrs	1 (1.7)
Electricity access	59 (100)	Std2-5 (grades 4-7)	22 (37.3)
		Std6-8 (grades 8-10)	31 (52.5)
Cooking fuel:		Std9-10 (grades 11-12)	4 (6.8)
Electricity	56 (94.9)	Tertiary	1 (1.7)
Gas	3 (5.1)		
Electrical appliances		Rooms in dwelling	Mean(±SD)
Fridge	57 (96.6)		3.4 (±1.3)
Freezer	25 (42.4)		
Hotplate	18 (30.5)	**Money spend on food/week:**	
Microwave	41 (69.5)	≤R100	5(8.4%)
Stove	51 (86.4)	R101-200	19(32.2%)
Radio	47 (79.7)	R201-R300	8(13.6%)
Television	58 (98.3)	R301-R400	7(11.9%)
Computer	9 (15.3)	R401-R500	5(8.5%)
		>R500	11(18.6%)
		Don't know	1(1.7%)
		Other	3 (5.1%)

The majority of subjects were Christian, lived in formal housing, had access to electricity, a fridge, television, stove and radio and had 10 years or less of education. More than half of all subject (n=32; 54.2%) spent R300 or less per week on food, feeding an average of four people. A third of all subjects spent between R100 and R200 per week on food. Approximately one third of the sample received a grant or pension and one third was unemployed at the time.

The mean (±SD) reported **duration of diabetes** was 75(±77.7) months and the median and interquartile range were 48 (24-96) months.

A third of the sample had never smoked, and one quarter had successfully managed to stop smoking (Table 24). The use of snuff was not taken into account. Of those who still smoked, the majority had unsuccessfully tried to stop, largely due to stress and related problems. A minority of subjects reported drinking alcohol with beer being the most commonly consumed.

Table 24: Self-reported smoking and drinking habits of study sample (n=59)

	N (%)
Smoking	
Never:	21 (35.6)
Stopped:	14 (23.7)
1-9/day:	14 (23.7)
10-19/day:	7 (11.9)
>20/day:	3 (5.1)
Unsuccessfully tried to stop (current smokers) (n=24)	18 (75)
Barriers mentioned by those who attempted to stop smoking (n=18)	
Withdrawal symptoms	5 (27.8)
Stress/problems	7 (41.2)
Other: don't know; habit; socially acceptable; weight gain	6 (35.3)
Alcohol drinking habits	
Yes:	9 (15.3)
No:	50 (84.8)

Hypertension followed by heart-related problems were the most commonly reported personal co-morbidities (Table 25) with diabetes and hypertension the most common co-morbidities among family members of the subjects.

Table 25: Self-reported personal and family co-morbidities* of the study sample (n=59). ** Refers to a parent, sibling, grandparent, aunt or uncle

Personal history of co-morbidities				Family History** of diabetes and co-morbidities			
	Yes N (%)	No N (%)	Don't know N (%)		Yes N (%)	No N (%)	Don't know N (%)
High Blood pressure	47(79.7)	11(18.6)	1 (1.7)	Diabetes	48(81.4)	10(17.0)	1 (1.7)
Heart problems / angina	15(25.4)	41(69.5)	3 (5.1)	High Blood pressure:	46(78.0)	8 (13.6)	5 (8.5)
Stroke	2 (3.4)	57(96.6)	-	Heart problems / angina	18(30.5)	40(67.8)	1 (1.7)
Kidney problems	5 (8.5)	52(88.1)	2 (3.4)	Stroke	18(30.5)	38(64.4)	3 (5.1)
High cholesterol:	10(17.0)	37(62.7)	12(20.3)	Kidney problems	11(18.6)	44(74.6)	4 (6.8)
				High cholesterol:	15(25.4)	33(55.9)	11 (18.6)

The majority of subjects reported that they were only managed on oral hypoglycaemic agents for their diabetes (Table 25). Almost all the subjects were taking metformin (a biguanide), which was often taken with either insulin or the sulphonylureas glibenclamide or glicazide. Only one subject was managed by diet alone and another one by insulin only, due to an allergic reaction to oral agents.

Almost half of the subjects were taking remedies other than prescription medicine for the management of their diabetes (Table 26). The most commonly used remedy was 'als' while the use of a variety of other herbs such as 'wynruik', 'wilde dagga' and herb mixtures were also reported.

Table 26: Reported strategies for diabetes management by the study sample (n=59)

	N (%)		N (%)
Use of prescribed diabetic medication *		Remedies used * (n=27)	
Diet only	1 (1.7)	Als	13(48.2)
Insulin only	1 (1.7)	Wynruik	4 (14.8)
Metformin only	25(42.4)	Wilde dagga	3 (11.1)
Metformin and insulin	14(23.7)	Other herbs/herb mixtures (Boegoe/ salie/ lavender/ bitter herb mixtures)	10(37.0)
Metformin combined with glibenclamide	5 (8.5)		
Metformin combined with glicazide	10(16.9)	Various Other: (Garlic/ lemon juice/ cinnamon/ lukwartblare/ procydin/ Soda water/ guava leaves/ african potato/ vegetable juice)	11(40.7)
Metformin combined with insulin and glibenclamide	3 (5.1)		
Use of remedies besides prescription medicine		Who recommended it? * (n=27)	
YES	27(45.8)	Old folk remedy	5 (18.5)
NO	32(54.2)	Family/friends	5 (18.5)
		Health Professional	2 (7.4)
		Other (Health shop/ chemist/ 'everyone' /marketing/magazine/ own idea)	14(51.9)

* Open question, thus options mentioned by each subject could be none, one or more.

4.1.2 Discussion of socio-demographic profile, general health status and diabetic medication

Socio-demographic profile

The study sample demonstrated a high rate of unemployment, low educational status, and little money available for food, all reflecting a low socio-economic status. Less than 10% of the study sample had more than 10 years of education, which is lower than the 18% found in a study on a sample of similar ethnicity in a peri-urban community outside of Cape Town reported to have a low socio-economical status (Levitt et al, 1999). Education and income status are important factors when considering appropriate diabetes management guidelines, because it could impact on the ability of subjects to understand and implement treatment guidelines, and as such contribute to non-compliance. Recommendations, dietary in particular, need to be sensitive to the difficulties people of lower income face daily and not alienate them further by impractical and expensive suggestions. Food costs have increased worldwide and foods such as vegetables and fruit that are promoted as part of a healthy diet are more expensive compared to other staple foods in the diet (Drewnowski & Specter, 2004). Low education levels would mean a need for more labour-intensive education on diabetes management, as a handout on diabetes is less likely to be read and understood. It might be more feasible to educate using visual media and/or hands-on demonstrations such as cooking of meals.

General Health

The **smoking** prevalence found in this study (40.7%) is in line with results reported for coloured women in population studies over the past two decades (Steyn et al, 1985; Dept of Health et al, 2002; Dept of Health et al, 2007). As subjects in this study were all diagnosed with diabetes and should have been extensively counselled on the danger of smoking as part of their disease management, the proportion of smokers is larger than expected.

The smoking habits of the study sample combined with their disease puts them at increased risk for cardiovascular disease (CVD) which is evident even at the lowest level of exposure (Erhardt, 2009). Smoking caused between 8.0-9.0% of deaths in 2000 in South Africa and was ranked third in terms of mortality among 17 risk factors (Groenewald et al, 2007). Clinically, smoking decreases high density lipopotein (HDL) cholesterol and increases very low density lipoprotein (VLDL) cholesterol and blood glucose levels (Erhardt, 2009). Smoking cessation reduces the mortality from

coronary heart disease more than other preventive therapies such as cholesterol lowering (Erhardt, 2009) and is a very effective way to improve cardiovascular health in smokers. It is thus very important to focus on cessation of smoking as part of management guidelines.

It could be argued that the drive to stop smoking may indicate awareness of the negative impact of smoking. Furthermore, the inability to stop smoking may reflect a lack of knowledge, skills and support to ensure success. It is likely that more active implementation of smoking cessation programs will enhance long-term quit rates, and can significantly contribute to reduced morbidity and mortality associated with cardiovascular disease (Erhardt, 2009).

Cardiovascular disease is more common, tends to occur at an earlier age, and is more extensive and severe in persons with diabetes. It has also been reported that women with diabetes have an increased risk of mortality from heart disease compared to diabetic men (Gregg et al, 2007). The fact that a quarter of the study sample reported the presence of heart disease is thus in line with what was expected. The low reported presence of high cholesterol levels on the other hand may be considered surprising and is likely to be due to patients not being informed of their cholesterol status or that their cholesterol has not been tested. The latter is not in line with previous South African guidelines for the management of type 2 diabetes mellitus in primary health care (SEMDSA, 2002) in which it is recommended that blood cholesterol levels should be tested at least initially and from then on annually, unless normal. Updated management guidelines now suggest that blood cholesterol be checked at least annually and more frequently if it is high (Levitt et al, 2009).

The high proportion of patients with hypertension in this study is in keeping with the evidence that hypertension generally co-exists in persons with type 2 diabetes (Dobesh, 2006; Nthangeni et al, 2002) and is higher than for coloured women in the general population (Dept of Health et al, 1998; Dept of Health et al, 2007). Hypertension is also one of the five components that form part of the metabolic syndrome. The metabolic syndrome as well as hypertension by itself puts individuals at increased risk for cardiovascular problems (Hanefeld et al, 2009).

The high reported prevalence of diabetes and hypertension among family members of the study sample points to a possible genetic predisposition to diabetes. Quatramoni et al (1994) found that subjects with diabetes were of the opinion that development of

diabetes was unavoidable if it runs in the family. This type of perception may contribute to an attitude of indifference to preventable measures, as there is no expectation of a different outcome. When counseling persons with diabetes it is important to focus on the fact that there are modifiable risk factors, which if addressed, could either prevent the development of diabetes despite potential genetic susceptibility, or delay the progression of the disease and the development of the mentioned co-morbidities. Dietary interventions can play an important role in the management of the condition. A modest amount of weight loss and a low fat diet that includes plenty of fruit and vegetables and low fat dairy with low salt intake will beneficially affect blood pressure and cardiovascular health (Sacks et al, 2001). Studies have also convincingly proven the relationship between improved blood glucose control and a decreased risk of micro-vascular complications (UKPDS, 1998) and evidence is accumulating to suggest a similar benefit in improved glycaemic control and a reduction in macro-vascular complications (Franz, 2008:827).

Insulin resistance itself induces numerous metabolic changes and is characterised by central obesity and associated with dyslipidaemia, hypertension, glucose intolerance and increased prevalence of macro vascular complications (Franz, 2008:827)**.** Any dietary intervention that positively impacts on insulin resistance by means of weight loss will, therefore, also contribute to blood glucose control as well as lowering the risk of the above-mentioned micro-and macro vascular complications.

Reported diabetes medication and remedy use

All subjects in this study, except one, were on some form of medication for diabetes management (oral agents and/or insulin). This may imply that either all subjects were at an advanced stage of the disease at the time of the study (the mean duration of diabetes was six years) or had been diagnosed at a late stage necessitating more intensive therapy to prevent or delay further complications. Alternatively it is also possible that the appropriate treatment protocol using life style intervention as an initial step in treatment (SEMDSA, 1997; SEMDSA, 2002) had not been implemented correctly.

At the time of the present study (2006) lifestyle intervention alone comprised the initial management of type 2 diabetes mellitus (SEMDSA, 1997; SEMDSA, 2002). Possible reasons for the lack of adherence with these guidelines are many: Staff might not have been fully aware of the protocol to be followed or they may have lacked the knowledge to give advice on lifestyle changes. It is also quite likely that staff do not

regularly have access to a dietitian to refer patients timeously (Parker, 2008). Furthermore, it is not known how important other health professionals view the input of a dietitian and the impact of dietary intervention in diabetes management. It can be speculated if dietary intervention is not properly administered and therefore not contributing positively to the management of the person with diabetes, it may add to health professionals' lack of faith in dietary change as a valid intervention.

It may further be speculated that the consequence of overlooking the importance of nutrition therapy as part of a primary strategy to manage diabetes is likely to be an inappropriate reliance on medication. It is not known to what extent this would influence subjects' view and motivation on making life style changes. Patients may be inclined to believe that the drug will allow them much more liberty in their lifestyle approaches to the management of their disease. In a study by Bopape and Peltzer (2002) subjects were found to believe that no one could control diabetes except for health care professionals. If patients are not fully aware of the importance of dietary changes in their management, the use of medication may actually undermine efforts towards self-empowerment, especially in light of a strong family history where they may believe this to be inevitable.

The majority of subjects (94.9%) were on metformin, although more than half of them were also on other glucose–lowering medications such as insulin, gliclazide and glibenclamide. Metformin suppresses hepatic glucose production and lowers insulin resistance but is not associated with hypoglycemia and hence does not require a specific eating pattern or rhythm (Franz, 2008:810). The 'six small meals per day', especially with emphasis on the late night snack has been a popular 'blanket' message to persons with diabetes, but is actually specifically targeted for those on insulin or insulin secretagogues such as the longer-acting sulfonylureas to prevent hypoglycaemia. Only a small number of subjects were on a longer-acting oral agent (glibenclamide), hence the risk of hypoglycemia for the majority of subjects would have been low. It was not determined whether those taking glibenclamide were actually having a late night snack. Patients managed on other types of oral agents would rather need to look at having a maximum limit for carbohydrate at meals to keep their blood glucose from rising too much (Diabetes Care Education, 2003). From a dietary point there would therefore not be a need for rigid carbohydrate counting nor regular snacking as these practices are most relevant for those at risk of hypoglycemia.

Finally, when investigating persons with diabetes management of their disease, the use of non-medical remedies such as herbs and herbal medicines need to be considered. The practice of using bitter substances to lower blood glucose levels has also been found to be common in other diabetic populations (Quatramoni et al, 1994; Nthangeni et al, 2002). Although the present study did not explore the reasons why persons with diabetes use such remedies, Quatramoni et al (1994) reported that persons with diabetes perceived standard medical therapies as having undesirable side effects, whereas traditional remedies were perceived as being acceptable and useful. Persons with diabetes may be reluctant to admit the use of herbal medicine, even if it causes severe adverse effects, because of the fear of being reprimanded (Fugh-Berman, 2000; Quatromoni et al, 1994).

To ensure effective management of persons with diabetes health professionals need to be aware of the fact that many persons with diabetes do make use of remedies in addition to or even as a substitute for medicine. Health professionals need to be aware of the possible reasons for choosing alternative remedies, such as a desire to participate in the therapy process or a fear of side-effects of prescribed medication (Jonas, 1998). The adverse effects, possible interactions with prescribed diabetic medications and even the beneficial effect it might have on blood glucose control need to be taken into consideration (Nilsson et al, 2001). It is interesting to note that preliminary data suggests a potential effect of *Aloe vera* in glycaemic control and it was grouped among the seven most promising supplements in the management of diabetes (Yeh et al, 2003). In time, it might prove to be a remedy that may complement traditional therapy. Future developments in health care in South Africa may ultimately incorporate complementary therapies proven beneficial.

4.1.3 Summary and Conclusions

Data in this section indicate that the following aspects need to be considered in the formulation of recommendations for the management of diabetes in coloured persons attending CHCs in the Cape Peninsula:

- The low formal education level
- The low level of income
- The impact of a diabetic person's family history and family beliefs regarding diabetes

- The need for a supportive environment to enable persons with diabetes to modify their lifestyle (specifically with regards to smoking)

- The recognition of diabetic persons' efforts to take initiative in the management of their disease by taking remedies

- The role of advice from fellow diabetic persons in formulating disease management decisions

- The effective implementation of the existing diabetes management protocol

4.2. Weight status and energy balance

This section includes the results on anthropometry, energy intake and physical activity as well as the discussion thereof. Weight status is reflected by height, weight, body mass index (BMI) and waist circumference. Energy balance is discussed by taking energy intake and energy expenditure estimations into consideration.

4.2.1. Results: Weight Status

A summary of the anthropometric status of subjects is presented in Table 4.5. Classification of body mass index (BMI) and waist circumference according to cut-offs are presented in Tables 27 and 28.

Table 27: Anthropometric measurements of the study sample (n=56*)

	Mean (±SD)	Median (Inquartile range)
Height (cm)	156.6 (6.9)	157.0 (152.9-161.4)
Weight (kg)	80.0 (5.3)	78.8 (67.8-90.2)
BMI (kg/m^2)	32.6 (5.8)	32.9 (28.7-36.5)
Waist circumference (cm)	99.8 (10.8)	101 (93-107.8)
Waist: hip ratio	0.9 (0.1)	0.9 (0.8-0.9)

*Weights were only available for 56 of the 59 subjects.

Table 28: BMI Classification* of the study sample (n=56)**

	N (%)
Optimal: 18.5-24.9	7 (12.5)
25-26.9 Overweight/Acceptable *	4 (7.1)
27-29.9 Overweight at risk	10 (17.9)
30-34.9 Obese	14 (25.0)
35-39.9 Morbidly obese	19 (33.9)
40-50	2 (3.6)

*Optimal BMI <25; Acceptable BMI<27; Additional Action suggested >27 (SEMDSA, 2002)

**Weights were only available for 56 of the 59 subjects.

Almost two thirds of the subjects in this study were obese (BMI ≥ 30) and a third morbidly obese. Only 12.5 % of the subjects fell in the normal BMI category while the majority of subjects had a waist circumference above the 88 cm cut-off point that indicates the need for additional action to be taken (Table 29).

Table 29: Waist circumference classification* of the study sample (n=57)**

Waist circumference in cm	N (%)
<82	3 (5.3)
82-87.9	5(8.8)
88-93.9	8(14.0)
94-101.9	15(26.3)
102-109.9	17(29.8)
110-115	9(15.8)

* Waist Circumference: Women: Optimal <82 cm ; Additional Action suggested >88 cm (SEMDSA, 2002)*

**Waist measurements were only available for 57 of the 59 subjects

4.2.2 Results: Current Energy Intake and Estimation of Validity

Energy intake from 24-hour dietary recalls

The energy intake derived from the 24-hour dietary recalls is summarised in Table 30. Fifty-five subjects completed 3 dietary recalls and 4 subjects completed 2 dietary recalls.

Table 30: Energy Intake of the study sample (n=59)

	Mean (±SD)	Median (Interquartile range)
Energy (kJ)	6053.6 (2298.9)	5849.8 (435.8-7034.1)
Energy (kJ/kg)	18.9 (8.8)	17.5 (14.3-22.0)

Validity of energy intake

The categorisation of the subjects according to Goldberg's cut-off criteria for reporting of energy is presented in Table 31.

Table 31: Classification of the study sample according to the Goldberg cut-off criteria (n=56)

Goldberg categories	N (%)	BMI Category N (%)			
		<27	27-29.9	30-34.9	≥35
Under reporters	46 (82.1)	8(14.2)	7(12.5)	13(23.2)	18(32.1)
Accurate	9 (16.1)	2(3.6)	3(5.4)	1(1.8)	3(5.4)
Over reporters	1 (1.8)	1(1.8)	-	-	-

Most of the study sample were categorised as under reporters and the majority of those who underreported had a BMI of more than 30.

4.2.3 Results: Current physical activity

Most subjects reported that their activity levels during the day were moderate, with leisure time being mostly sedentary. Very few took part in active sport, but most considered daily activities and/or walking as 'being active'. Almost half experienced no barriers to being active (Table 32).

Table 32: Self-reported physical activity levels of the study sample (n=59)

Physical activity during the day	N (%)	Understanding of 'Being active' *	N (%)
Sitting most of the time	15(25.4)	Daily activities	18 (30.5)
Less sitting, more walking and standing	29(49.2)	Walking	26 (44.1)
More hard physical labour	15 (25.4)	Organised sport	10 (17.0)
		Other	5 (8.5)
Leisure time:	N (%)	Barriers mentioned to 'Being active' *	N (%)
Sitting most of the time:	30 (50.9)	None:	28 (47.5)
Less sitting, more walking & standing	25 (42.4)	Tired/Short of breath	12 (20.3)
More walking and/active sport participation	4 (6.8)	Injury or Disease:	7 (11.9)

* Open-ended question

4.2.4 Discussion

Weight Status

Obesity is a well-known risk factor for type 2 diabetes and approximately 80% of persons with type 2 diabetes are obese or have a history of obesity at the time of diagnosis (Expert Committee, 2003). Mokdad et al (2003) reported that the prevalence of type 2 diabetes is three to seven times higher in obese than in normal-weight adults, and those with a BMI >35 kg/m^2 are 20 times more likely to develop diabetes than those with a BMI between 18.5 and 24.9 kg/m^2 (Mokdad et al, 2003; Field et al, 2001).

Our results clearly indicate that obesity was very prevalent in the study sample. Almost two thirds are obese, with a fifth of the group being morbidly obese. When comparing these results to the national profile for overweight and obesity according to the most recent Health and Demographics Survey (SADHS) (Dept of Health et al, 2007) it is evident that the prevalence of overweight in our sample is in line with that found in the SADHS, namely 25%. However, the prevalence of obesity (62.5%) is much higher than that reported in the SADHS (26.6%). It is also higher than the obesity prevalence in black type 2 diabetic women (35 to 47%) with a mean age of 62 years (Nthangeni et al, 2002).

Whether obesity was an etiological factor in the development of diabetes in the study sample was not assessed, but it may have been one of the factors maintaining the condition at the time of the study. Research clearly indicates that moderate weight loss (5% of body weight) can improve insulin action, decrease fasting blood glucose concentrations and reduce the need for diabetes medications in persons with type 2 diabetes (Pi-Sunyer, 1993; Goldstein, 1992; Williams &Kelly, 2000; Torgerson et al, 2004; UKPD, 1990).

Over and above the link with diabetes, obesity is also a risk factor for the development of other co-morbidities and NCDs. In South Africa, a high BMI has been rated fifth in terms of mortality causes out of 17 risk factors (Joubert et al, 2007). Excess body weight is estimated to have caused 7% of all deaths in 2000 in South Africa. The burden in women was approximately double that in males (Joubert et al, 2007). Overall 87% of type 2 diabetes, 68% of hypertensive disease and 45% of ischemic heart disease were attributable to a BMI 21kg/m^2. The high self-reported prevalence of hypertension and CVD in the study sample may thus be largely

explained by the high obesity prevalence in this group, most probably compounded by the presence of diabetes. Therefore, for those who have been diagnosed with diabetes, the presence of overweight/obesity poses an additional treatment challenge (SEMDSA, 2002; Levitt et al, 2009).

Over the past decades it has become clear that obesity with a central distribution rather than gluteal fat accumulation is associated with insulin resistance, a very atherogenic lipid profile and the other features of the metabolic syndrome (Conway et al, 1995; Ha & Lean, 1998; Despres et al, 2001). This association may also apply for individuals with diabetes who have an increased amount of intra-abdominal body fat, although they are not obese according to BMI criteria (Ha & Lean, 1998). The prevalence of intra-abdominal obesity as indicated by waist circumference in this study sample (86%) is much higher than was found for the general female population in South Africa (±50% for the 45-64 age group) as well as for coloured women (36%) (Dept of Health et al, 2007). Whether intra-abdominal obesity had an etiological role in diabetes development was not assessed, but needs to be addressed in the diagnosed diabetic person as it contributes to the challenges relating to the maintenance of the problem.

Weight reduction may improve glucose tolerance, blood lipid levels and blood pressure (Bray, 2007). Chan et al (1994) report that the potential benefits of weight loss will be maximised when risks are greatest, e.g. BMI >30kg/m^2, or with a BMI in the range of 25-30kg/m^2 in the presence of central fat distribution, e.g. waist >88 cm for women, or when hyperlipidaemia or hypertension are present, or where a BMI >25 is compounded by other risks such as smoking, family history or very rapid weight gain (Chan et al, 1994). The study sample did not only display a very high prevalence of central obesity, but most suffered from high blood pressure (about 80%), a quarter reported to suffer from some form of heart condition, 40% smoked and most had strong family histories of the various NCDs. In light of the burden of complications, weight loss and management will be a very important life style strategy and potentially cost-effective intervention to focus on in this population group.

Numerous guidelines stress the importance of weight loss e.g. the Department of Health's 2003 national guideline publication on the prevention and management of weight loss and obesity in South Africa (Dept of Health, 2002; Dept of Health, 2003). The latter publication is comprehensive in that it addresses management objectives for

the obese, causes, target groups for prevention, benefits of weight loss, classification of overweight and obesity. However, the major deficiency is an implementation strategy.

The most current SEMDSA guidelines for the diagnosis and management of type 2 diabetes mellitus do include more specific weight loss recommendations than before (Levitt et al, 2009). However, no clear weight management guidelines for the implementation in practice have been included in these guidelines. It is also not clear whose role it is to facilitate the process. Ideally weight management (reduction) intervention should be multidisciplinary (Bantle et al, 2008) with a dietitian who is qualified to facilitate this process as a member of such an intervention team. However, dietitians in the employ of the Department of Health are generally responsible to serve more than one CHC as well as perform a range of other responsibilities such as infant and child nutrition at clinics, general health promotion and involvement in schools (Goeiman: Personal communication, 2009). Many persons with diabetes will therefore never receive individualised nutritional counselling from a dietitian or may be exposed to one session only. Although once-off visits have been shown to make a difference (Gaetke et al, 2006), it is a well-known fact that the more successful weight loss programs are those that run for extended periods of time and involve regular follow-up and contact (Bantle et al, 2008). In reality other health professionals often end up being providers of dietary advice. It is of concern that healthcare workers in CHCs in the Western Cape (including doctors and nurses) generally seem to feel that they have sufficient knowledge to provide weight management counselling (Parker, 2008), yet they do not. Only 6% of health care workers at CHCs in the Cape Metropole achieved desired scores on aspects regarding lifestyle modification. The section on weight loss in particular was answered poorly by all categories of nursing staff. One of the contributing factors to unsuccessful weight loss may well be the fact that it is given as one of many 'blanket' or general messages received by patients on a constant basis, instead of individualising the messages. Furthermore, if the expectation of health care professionals themselves is that a patient will not succeed, the message may be given but without enthusiasm.

It can be speculated that the lack of focus on obesity prevention/management may in part be because obesity is usually not seen as a disease state as such and usually is not treated with medication. To address this situation, weight management (reduction) should no longer be seen as an adjunct to diabetes therapy, but as a therapy in its own

right. This should influence the way all health professionals are trained as well as nutrition educators and community health workers.

Current Energy intake and validity thereof

Obesity is a condition that usually develops when the total energy intake is above what is needed for daily energy expenditure (positive energy balance) for an extended period of time (Bray, 2007). However, this does not necessarily imply that a positive energy balance was present at the time of the study in all subjects. It is not possible to comment on the status of energy balance of the study sample at the time of the study, as the actual weight of subjects was measured only once and no questions regarding past weight gain/loss were included in the questionnaire.

The mean energy intake of the study sample was 6053 kJ, which is lower than the 6123-6859 kJs reported for coloured women in the 35-64 age groups in the CRISIC study (Steyn et al, 1985) and the 6972 kJ reported for the above 65 year old non-diabetic coloured people *(*Charlton et al, 1997). It is also lower than findings for both urban and rural black persons with diabetes (Nthangeni et al, 2002). This was unexpected as the prevalence of overweight (25%) and obesity (62.5%) in this study was higher than obesity prevalence reported for black persons with type 2 diabetes (35-47%) (Nthangeni et al, 2002) and the older non-diabetic coloured women (47.5%) (Charlton et al, 1997), who apparently had a higher mean energy intake. It is thus important to reflect on the validity of the dietary data obtained in this study.

The dietary validity assessment included in this study involved a simple and indirect check of energy expenditure against energy intake. Estimated energy expenditure (Schofield et al, 1985; WHO, 1985) was compared to energy intakes from the dietary recall, using the cut-off values developed by Goldberg et al (1991) to classify subjects as under-, normal or over reporters. Even though some underreporting could be expected (Goldberg et al, 1991), the finding that 82% of the subjects seemed to have underreported, was not expected. Questions that need to be clarified when considering these results include the appropriateness of the 24-hour dietary recall for the assessment of habitual intake of the target group, the appropriateness of the Schofield equation and Goldberg cut-offs to accurately identify under reporters in this study and the inclination of the obese to underreport. Furthermore, the implications of the high level of underreporting on further interpretation of the dietary data obtained in this study need to be considered.

It is well known that underreporting is one of the limitations of the 24-hour dietary recall. This is especially true for obese populations (Lee &, Nieman, 2003; Feskanich & Willett, 1993; Goldberg et al, 1991). As indicated in Chapter 3, section 3.5.1, the 24-hour dietary recall was chosen as the most viable dietary method option for this particular study despite its limitations, as the aim was to estimate usual intake and in a population with low literacy levels. It is possible that reliability of portion size estimation and coding, and especially reporting of the miscellaneous items such as sauces and gravies was not optimal, and could have contributed to the underreporting. However, quality control measures including the multiple pass method of administering the 24-hour dietary recall, training and standardisation of field workers, as well as supervision by the primary researcher of the interviewing and coding process were implemented to improve reliability and validity of the data.

The appropriateness of applying the Schofield equations (Schofield et al, 1985) for energy expenditure estimation to identify under reporters in this particular study also needs to be considered. The Schofield equations have been widely used as a simple method of predicting basal metabolic rate (BMR) using weight and gender of the individual when it is not feasible to measure actual BMR indirectly or directly. The general acceptability and appropriateness of using these equations is supported by the fact that the World Health Organisation (WHO) adopted them for general use in predicting BMR and the determination of energy requirements (WHO, 1985).

The body of data on which the Schofield equations were based did not include a large percentage of individuals with a very high body weight (>76 kg for women), and thus probably few with a very high body mass index (BMI). This does raise a question regarding the appropriateness of these equations for use in obese groups (Horgan & Stubbs, 2003; Schofield, 1985). As only 12.5 % of subjects in this study were normal weight and 62.5% obese, the question regarding appropriateness of the equations in this study require consideration. BMR actually increases more slowly at heavier weights due to the fact that a greater ratio of fat to lean tissue is being deposited as body fat percentage increases. To ignore this fact would lead to an overestimation of the BMR in the obese. Consequently, the extent of under-reporting as measured by energy expenditure (EE) to BMR in the obese will be over-estimated (Black et al, 1996).

Although using the Schofield equations in obese populations may be associated with a bias toward over estimation of under reporters (Horgan & Stubbs, 2003) it must be

borne in mind that there is substantial objective evidence to suggest that underreporting and selective underreporting in the obese is a true phenomenon *(*Goris et al, 2000*)*. Several researchers report that when respondents' actual food consumption is high they have a tendency to underestimate the amount recalled (Voss et al, 1998). Data on the high under-reporting in the morbidly obese suggest that even adjusting the BMR would not transfer these persons into the category of acceptable reporters (Horgan & Stubbs, 2003). This seems to be particularly significant for women, especially for those with a BMI >35 kg/m^2 (Black et al, 1996). In light of the fact that more than a third (37.5%) of subjects in this study had a BMI >35 kg/m^{2,} it can be argued that a high prevalence of underreporting was to be expected and the use of the Schofield equations to assess accuracy of reported intake had a relatively low potential to bias the results.

If underreporting were a true phenomenon in this study, it would be important to consider the implications thereof for data interpretation. The intake of both macro and micronutrients may seem to be inadequate as a result of underreporting and thus may not be a true reflection of actual intake. Data related to dietary adequacy such as energy intake, macro and micronutrient intake and portion size will therefore need to be interpreted with caution as it may be lower than the 'truth'. The effect of underreporting of total energy intake on the estimates of nutrient intakes when expressed as a per cent of total energy may be less than when expressed in grams or milligrams, although there may still be an effect since it is unlikely that people will underreport everything they eat to exactly the same extent (Poppitt et al, 1998). Based on work of Feskanich & Willett (1993) it may be likely that foods perceived to be unhealthy might be selectively underreported.

Finally, it can be assumed that above discussed underreporting will not impact on meal pattern, distribution of carbohydrates throughout the day and the frequency of intake of the most commonly eaten foods. Therefore, data may give a true reflection of dietary patterns and preferences.

Current physical activity

The effect of eating more energy than needed is worsened when little energy is expended (Laquatra, 2008:495). Some researchers are even of the opinion that energy expenditure (EE) is more important in explaining weight status than energy intake (Prentice & Jebb, 1995).

Physical activity levels of subjects in this study were assessed using three screening level questions (See Chapter 3: Methods; section 3.4). About 50% of subjects considered their daily activity levels as being moderately active (less sitting, more standing), and 50% indicated that leisure time is spent mostly sitting. This is in line with findings in the World Health Survey (2003) according to which 48% of South African women have been classified as being inactive. With the exception of the black population, national South African figures for adults also indicate a high (>90%) prevalence of inactivity at work and during leisure time (Rossouw et al, 1983; Steyn et al, 1985; Steyn et al, 1991; Seedat et al, 1990). If the current lack of physical activity reflects past activity levels, it can be speculated that reduced total energy expenditure contributed to the long-term positive energy balance that resulted in the high levels of overweight and obesity in the present study sample. Low levels of physical activity clearly need to be assessed as part of prevention and management of type 2 diabetes.

Most of the subjects indicated that they understood the concept of "being active" to include activities they do daily, such as housework, gardening and walking. The fact that they see activities of daily living as physical activity is positive, since "Being active" is often seen as unsustainable and consisting of 'sport' or formal exercise only. In one study of obese women, the combination of diet plus advice to increase physical activity by incorporating short periods of activity into daily schedules (e.g. walking instead of driving short distances, taking stairs instead of elevators) was as effective for inducing weight loss as diet plus structured aerobic activity (aerobics classes) (Anderson et al, 1999). Therefore, increasing daily physical activity, such as walking and using stairs can be effective and contribute to increased physical activity (Dunn et al, 1999; Mayer-Davis et al, 1998; Andersen et al, 1999) although some help may be needed to practically increase it to reach a level of at least 150min/ week of moderate-intensity aerobic physical activity (Schoeller et al, 1997). Dividing activity into multiple, short bouts produces similar benefits and can enhance compliance (Pate et al, 1995; Jakicic et al, 1995; Jakicic et al, 1999). However, if the goal is to achieve long-term weight loss higher activity levels of at least one hour per day of moderate (walking) or 30 min per day of vigorous (jogging) activity may be needed (Klein et al, 2004) and individuals may need more support in an organised way to maintain such levels.

When considering interventions in this regard, barriers to increasing physical activity levels need to be considered. In the present study, most subjects mentioned nothing that made it difficult for them to be active, yet few were actually active. This is in line with findings in a United States study in which 82% of overweight adults were aware of the benefits of exercise, but did not exercise (Miller, 1994). Such a finding may in part be because subjects may be unclear about how increased activity can be of specific benefit to them. This was found to be true in a focus group study in low-income Caribbean Latinos where all subjects believed that exercise was important for a person with diabetes, but had little sense that exercise would greatly improve their prognosis (Quatramoni, 1994). If the perceived benefit of physical activity is not clear, motivation to increase physical activity may be low (Day, 1995) even though perceived barriers were few in the present study. It is interesting to note that unlike in other areas in SA (Kruger et al, 2003) safety of environment was not mentioned as a barrier to exercise by subjects in the present study. Although not mentioned, one would have expected access to safe yet inexpensive ways to exercise to be relevant within the South African context to increase physical activities in leisure time. Creative, affordable alternatives and emphasis on increasing activity of daily living should be considered under such circumstances.

4.2.5 Summary and conclusions:

In light of the high prevalence of obesity in the study sample the reported low energy intake is likely to be explained by the high prevalence of underreporting commonly found in obese populations. The high prevalence of obesity and the lack of resources to manage the problem clearly require a more focused approach to address obesity and overweight as a therapy in its own right.

Although energy expenditure was not measured explicitly, the apparent lack of regular physical activity based on screening questions may explain the high levels of overweight, obesity and hypertension in this study sample. Increasing physical activity can contribute to improved blood glucose control, induce and maintain weight loss. A structured exercise program is not required for maintaining weight loss and increasing daily physical activity, such as walking and using stairs, can also be effective.

Based on the data in this section it is concluded that the following aspects need to be considered in the formulation of recommendations for the management of diabetes in coloured people attending CHCs in the Cape Peninsula:

- Weight loss should receive prominence in diabetes treatment in this population group
- Persons with diabetes should be clear on the reason for weight loss and or maintenance.
- Weight gain should be prevented or delayed.
- Weight loss recommendations should be reasonable and achievable.
- Weight loss recommendations should be substantiated by practical implementation strategies.
- The particular contribution of physical activity in the treatment of diabetes and weight management needs to be clearly communicated along with specific ways to increase activity.

4.3. Quantity, quality and adequacy of food intake

The quantity of food intake in this section is expressed in terms of total energy, macro and micronutrient intake while the quality is reflected in the main food items contributing to macronutrients as well as a comparison of quantity outcomes with the Food-based dietary guidelines (FBDGs) of South Africa, prudent guidelines, the glycaemic index and dietary reference intakes (DRIs).

4.3.1 Results: Most commonly consumed foods

A total of 194 different food items were reported by the study sample. The 10 **most commonly consumed food items** were based on foods consumed by the highest percentage of the sample in order to determine typical food items used by most of the sample population. These food items were in descending order: rice, brown bread, potato, white bread, sugar, full cream milk, brick margarine, wheat-based cereals, chicken and baked confectionary (cookies, loaves, pancakes and puddings). Tea and coffee were excluded from these analyses. The most commonly consumed vegetables were pumpkin, gem squash and tomato. Pears, apples and bananas were the most commonly consumed fruit.

The **main food items contributing to total energy intake** included bread, baked confectionary, potato, rice and wheat-based cereals followed by non-carbohydrate sources such as chicken, brick margarine, meat products and medium/low fat spread (Table 33). Only five items from the items that contributed more than 2% to total energy intake were consumed by more than two thirds of subjects. These items were brown and white bread, potato, rice and sugar.

Table 33: Main food items contributing to total energy intake (% of total energy) of the study sample (n=59)

	No. of eaters	%Eaters	Total quantity	Portion/eater *	Portion/ capita**	% of Total energy	Total Kj
BROWN BREAD / ROLLS	46	78.0	3148.3	68.4	53.4	9.6	34471.4
WHITE BREAD /ROLLS	41	69.5	1887.7	46.0	32.0	5.8	20802.1
COOKIES, LOAVES, PANCAKES, TARTS, CAKES PUDDING	32	54.2	1390.8	43.5	23.6	5.7	20305.7
POTATO COOKED	45	76.3	2317.8	51.5	39.3	4.7	16819.1
RICE WHITE/BROWN COOKED	47	79.7	505.5	10.8	8.6	3.5	12478.5
WHEAT BASED CEREALS – ALL BRAN WEETBIX PUFFED WHEAT	34	57.6	765.0	22.5	13.0	3.3	11903.7
CHICKEN MEAT	33	55.9	2641.7	80.1	44.8	3.3	11756.2
BRICK MARGARINE	35	59.3	2137.2	61.1	36.2	3.1	11210.8
MEAT PRODUCTS & DISHES – BOBOTIE COTTAGE PIE PIES BALLS-COOKED FRESH	28	47.5	1450.8	51.8	24.6	2.7	9630.4
MEDIUM /LOW FAT SPREAD	31	52.5	1416.7	45.7	24.0	2.5	9109.1
SUGAR WHITE	40	67.8	192.8	4.8	3.3	2.4	8583.4
FISH - SEA COOKED FRESH	23	39.0	232.7	10.1	3.9	2.3	8131.9
FULL CREAM LIQUID MILKS	35	59.3	847.5	24.2	14.4	2.2	7951.7
CHICKEN STEWS DISHES PIES	18	30.5	3035.0	168.6	51.4	2.1	7670.3
HIGH FAT CHEESE (CHEDDAR GOUDA MOZARELLA)	30	50.8	949.5	31.7	16.1	2.0	7282.2

*The average intake of those who actually consumed the food item

**The average intake for the total sample, n=59

Bread (brown and white), baked confectionary, rice and sugar were the five main foods contributing to total carbohydrate followed by wheat based cereals, potato, cold drinks, pears and apples (Table 34).

Table 34: Main food items contributing to total carbohydrate (CHO) intake: (% of total carbohydrate) of the study sample (n=59)

	No. of eaters	% Eaters	Total CHO	Portion/ eater*	Portion/ capita**	% of total CHO
1. BROWN BREAD / ROLLS	46	78.0	1401.1	68.4	53.4	14.5
2. WHITE BREAD /ROLLS	41	69.5	930.6	46.0	32.0	9.6
3. COOKIES LOAVES PANCAKES TARTS CAKES PUDDING	32	54.2	712.8	43.5	23.6	7.4
4. RICE WHITE/BROWN COOKED	47	79.7	632.3	49.3	39.3	6.5
5. SUGAR WHITE	40	67.8	505.0	12.6	8.6	5.2
6. WHEAT BASED CEREALS - ALL BRAN WEETBIX PUFFED WHEAT	34	57.6	475.3	22.5	13.0	4.9
7. POTATO COOKED	45	76.3	470.7	58.7	44.8	4.9
8. COLD DRINK CARBONATED AVERAGE	21	35.6	220.1	101.8	36.2	2.3
9. PEAR RAW	21	35.6	208.9	69.1	24.6	2.2
10. APPLE AVERAGE RAW	21	35.6	183.9	67.5	24.0	1.9
11. SWEETS HARD BOILED SOFT JELLY	24	40.7	173.5	8.0	3.3	1.8
12. MATZOS CRACKERS PRO VITA	16	27.1	162.5	14.5	3.9	1.7
13. BANANA RAW (PEELED)	24	40.7	159.3	35.3	14.4	1.6
14. FULL CREAM LIQUID MILKS	35	59.3	145.7	86.7	51.4	1.5
15. GRAPE RAW FRESH	19	32.2	140.0	50.0	16.1	1.4

CHO: Carbohydrate
*The average intake of those who actually consumed the food item
**The average intake for the total sample, n=59

Brick margarine was the main source of fat, followed by medium/low fat spread, cooked potato, baked confectionary (cookies/loaves/cake etc) and red meat products (Table 35).

Table 35: Main food items contributing to total fat intake: (% of total fat) of the study sample (n=59)

	No. of eaters	% Eaters	Total fat	Portion/ Eater*	Portion/ capita**	% of Total fat
BRICK MARGARINE	35	59.3	301.5	10.8	6.4	9.2
MEDIUM /LOW FAT SPREAD	31	52.5	245.2	10.7	5.6	7.5
POTATO COOKED ***	45	76.3	193.7	58.7	44.8	5.9
COOKIES LOAVES PANCAKES TARTS CAKES PUDDING	32	54.2	176.8	43.5	23.6	5.4
MEAT PRODUCTS & DISHES -	28	47.5	149.4	33.0	15.7	4.6
HIGH FAT CHEESE (CHEDDAR GOUDA MOZARELLA)	30	50.8	143.2	14.9	7.6	4.4
CHICKEN MEAT	33	55.9	142.1	44.5	24.9	4.3
PEANUT BUTTER; SMOOTH STYLE	23	39.0	111.7	9.7	3.8	3.4
CHICKEN STEWS, DISHES & PIES	18	30.5	107.4	47.4	14.5	3.3
BEEF SAUSAGE - WORS	9	15.3	104.4	32.0	4.9	3.2
FULL CREAM LIQUID MILKS	35	59.3	103.2	86.7	51.4	3.1
FISH - SEA COOKED FRESH	23	39.0	98.9	50.2	19.6	3.0

* Refers only to those who actually consumed the food item
** The average intake for total sample, n=59
***The fact that potato is high up as a food source contributing to total fat intake points to the way it is prepared i.e. with added fat.

Brown bread and wheat-based cereals were by far the main sources of fibre (Table 36). White bread, even though low in fibre contributed a substantial amount due to its frequent and high consumption. No vegetables or fruit featured among the main sources of fibre intake in this population.

Table 36: Main food items contributing to total fibre intake: (% of total fibre) of the study sample (n=59)

	No. of eaters	% Eaters	Total fibre	Portion/eater*	Portion/capita**	% of total fibre
BROWN BREAD / ROLLS	46	78.0	207.2	68.4	53.4	21.9
WHEAT BASED CEREALS - ALL BRAN WEETBIX PUFFED WHEAT	34	57.6	100.9	22.5	13.0	10.6
WHITE BREAD /ROLLS	41	69.5	58.5	46.0	32.0	6.2
POTATO COOKED	45	76.3	46.0	58.7	44.8	4.9
PEAR RAW	21	35.6	43.5	69.1	24.6	4.6
BEANS CANNED IN TOMATO SAUCE	14	23.7	39.1	36.3	8.6	4.1
APPLE AVERAGE RAW	21	35.6	33.7	67.5	24.0	3.6
OATS	17	28.8	22.1	81.3	23.4	2.3
COOKIES LOAVES PANCAKES TARTS CAKES PUDDING	32	54.2	20.1	43.5	23.6	2.1
BEANS SUGAR KIDNEY HARRICOT DRIED	5	8.5	18.9	70.3	6.0	2.0

*Refers only to those who actually consumed the food item
**The average intake for total sample, n=59

Chicken meat and brown bread were the main contributors to protein intake (Table 37). Although fresh fish was an important contributor to protein, only 39% of the study population consumed it. Carbohydrates such as brown and white bread, wheat-based cereals and baked confectionary, consumed by more than half of the study sample, were also among the main 10 contributing food items to protein intake.

Table 37: Main food items contributing to total protein intake (% of total protein) of the study sample (n=59)

	No. of eaters	% Eaters	Total protein	Portion/ eater *	Portion/ capita**	% of total protein
CHICKEN MEAT	33	55.9	382.3	44.5	24.9	12.0
BROWN BREAD / ROLLS	46	78.0	272.7	68.4	53.4	8.5
FISH - SEA COOKED FRESH	23	39.0	218.3	50.2	19.6	6.8
MEAT PRODUCTS & DISHES -	28	47.5	162.6	33.0	15.7	5.1
WHITE BREAD /ROLLS	41	69.5	160.5	46.0	32.0	5.0
CHICKEN STEWS DISHES PIES	18	30.5	137.0	47.4	14.5	4.3
HIGH FAT CHEESE (CHEDDAR GOUDA MOZARELLA)	30	50.8	109.6	14.9	7.6	3.4
FULL CREAM LIQUID MILKS	35	59.3	97.1	86.7	51.4	3.0
MUTTON DISHES - STEWS	8	13.6	94.1	87.2	11.8	2.9
WHEAT BASED CEREALS - ALL BRAN WEETBIX PUFFED WHEAT	34	57.6	91.0	22.5	13.0	2.8
COOKIES LOAVES PANCAKES TARTS CAKES PUDDING	32	54.2	76.5	43.5	23.6	2.4
LOW FAT LIQUID MILK	28	47.5	75.0	81.1	38.5	2.3
PORK	7	11.9	74.1	40.4	4.8	2.3
BEEF STEW	9	15.3	71.7	70.0	10.7	2.2
BEEF (STEAKS FILLET SIRLOIN ETC)	12	20.3	67.6	21.6	4.4	2.1
FISH - SEA CANNED	10	16.9	67.0	30.0	5.1	2.1
CHICKEN EGGS	18	30.5	65.5	29.3	8.9	2.0

*Refers only to those who actually consumed the food item
**The average intake for total sample, n=59

Sugar intake was mainly in the form of white sugar, but baked confectionary, carbonated drinks and sweets were also prominent sources (Table 38).

Table 38: Main food items contributing to total sugar intake: (% of total sugar) of the study sample (n=59)

	No. of eaters	%Eaters	Total sugar	Portion/ Eater*	Portion/ capita**	% of total sugar
SUGAR WHITE	40	67.8	505.0	12.6	8.6	30.2
COOKIES LOAVES PANCAKES TARTS CAKES PUDDING	32	54.2	305.3	43.5	23.6	18.3
COLD DRINK CARBONAT ED AVERAGE	21	35.6	220.1	101.8	36.2	13.2
SWEETS HARD BOILED SOFT JELLY	24	40.7	172.3	8.0	3.3	10.3
JAM /MARMELADE	14	23.7	66.3	7.7	1.8	4.0
CHOCOLATE SWEETS	10	16.9	56.3	10.4	1.8	3.4
WHEAT BASED CEREALS - ALL BRAN WEETBIX PUFFED WHEAT	34	57.6	51.3	22.5	13.0	3.1
COLD DRINK SQUASH TYPE	25	42.4	46.0	131.1	55.6	2.8
CAKE ICING	4	6.8	31.0	12.5	0.8	1.9
BEANS CANNED IN TOMATO SAUCE	14	23.7	22.9	36.3	8.6	1.4
PUMPKIN/BUTTERNUT HUBBARD SQUASH COOKED	20	33.9	19.4	50.5	17.1	1.2
SUGAR BROWN	6	10.2	19.0	3.3	0.3	1.1
FULL CREAM ICE CREAM	3	5.1	16.5	43.3	2.2	1.0

*Refers only to those who actually consumed the food item
**The average intake for total sample, n=59

4.3.2. Results: Comparison of intake to food groups of FBDGs

A comparison of the mean number of servings per food group as consumed by the study sample and compared to the FBDGs recommended number of servings per food group per day is presented in Table 39. (See discussion in Chapter 3: Methods; section 3.10.1 for more details). These analyses indicate that intake was low especially for milk, as well as for vegetables, fruit and legumes.

Table 39: **Average daily number of servings per food group consumed by the study sample and comparison to the South African Food-Based Dietary guidelines**

Food groups: serving size	Recommended number of daily servings (FBDGs* for adults 25-60 years	Daily intake of the study group	
Starch (Bread, cereal, rice and pasta) and sugar 1 serving=1 slice of bread (30g); ½ c cooked pasta/rice/porridge; 1 small potato	6-8 servings (30g dry cereal/ 100g wet)	±6 servings(including root vegetables: potato, sweet potato, carrots)	
Vegetables and Fruit 1 serving=1 medium fruit/ ½ cup cooked veg/1 cup raw vegetables	5 servings (400g) of vegetables and fruit	± 3 servings (254.3g) excluding root vegetables	
Meat, poultry, fish and eggs (1 serving 75-100g cooked chicken, fish, meat without bone/ 2 eggs/ *And/or*	2-3 servings	± 1 serving meat/chicken; 0.25 serving fish (±1.8 serving/week); 0.3 serving egg (±2.5/wk); 0.07 serving nuts.	Total: 1.57 servings/day
Dry beans, split peas, lentils and soy regularly (1 serving: 1 cup cooked/ 200g cooked)	At least 3 times a week	0.12 servings (±0.8 servings/wk)	
Milk, 1 c milk/yogurt/40-50g cheese	250ml	½ serving	
Fats (including nuts and oils) ±1 teaspoon oil	'Sparingly'	3 servings	

*Serving size based on the recommended serving size in the FBDGs; Source: Dept of Health, 2004.

4.3.3 Results: The glycaemic index profile of carbohydrate-containing foods

The glycaemic index (GI) of the carbohydrate sources most commonly consumed by the study sample is presented in Table 40 as either Low ≤55; or Intermediate GI 56-69; or High GI≥70 (Steenkamp & Delport, 2007). The results point to the fact that most of the 15 main sources of carbohydrate consumed by the study sample could be classified as high or intermediate GI, depending on the specific item selected for analysis (see Chapter 3: Methods; section 3.10.3 for more detail). Fruit and dairy were sources of low GI carbohydrates.

Table 40: The Glycaemic Index of the main carbohydrate-containing food items consumed by the study sample (n=59)

	Glycaemic Index (Description used for analysis)	% Of total CHO
BROWN BREAD / ROLLS	HIGH(Standard South African brown bread)	14.5
WHITE BREAD /ROLLS	HIGH(Standard South African white bread)	9.6
COOKIES LOAVES PANCAKES TARTS CAKES PUDDING	HIGH (Average Biscuits, Marie Biscuits)	7.3
RICE WHITE/BROWN COOKED	HIGH (Average rice)	6.6
SUGAR WHITE	INTERMEDIATE	5.2
WHEAT BASED CEREALS - ALL BRAN WEETBIX PUFFED WHEAT	HIGH (Weetbix) INTERMEDIATE (Kellogg's All Bran)	4.9
POTATO COOKED	HIGH	4.9
COLD DRINK CARBONAT ED AVERAGE	INTERMEDIATE (Carbonated drinks e.g. Coke/Fanta)	2.3
PEAR RAW	LOW	2.2
APPLE AVERAGE RAW	LOW	1.9
SWEETS HARD BOILED SOFT JELLY	HIGH	1.8
MATZOS CRACKERS PRO VITA	LOW (Provita) HIGH (Cream crackers)	1.7
BANANA RAW (PEELED)	INTERMEDIATE	1.7
FULL CREAM LIQUID MILKS	LOW (although high in fat)	1.5
GRAPE RAW FRESH	LOW (Portion size NB)	1.5
OATS	INTERMEDIATE-HIGH (House brands)	1.4
ORANGE JUICE (LIQUI FRT/CERES CANNED/BOTTLED)	INTERMEDIATE	1.2
PASTA & NOODLE DISHES	LOW (durum wheat pasta)	1.2
MANGO RAW (PEELED)	INTERMEDIATE	1.2
LOW FAT LIQUID MILK	LOW	1.2
PUMPKIN/BUTTERNUT HUBBARD SQUASH COOKED	HIGH	1.1
PLUM/PRUNE RAW	LOW	1.1
BIRYANI (RICE LENTILS ETC)	LOW	1.0
FRUIT SYRUPS	INTERMEDIATE	1.0
BEANS CANNED IN TOMATO SAUCE	LOW	0.9
MAIZE BASED SNACKS -NIKNAKS CHIPNIKS	HIGH	0.9
POTATO CRISPS	LOW (although high in fat)	0.8
JAM /MARMELADE	INTERMEDIATE	0.8
CHOCOLATE SWEETS	INTERMEDIATE/HIGH	0.7
PEACH RAW	LOW	0.7
SKIM LIQUID MILK	LOW	0.6
MAIZE PORRIDGE & DISHES	HIGH (if hot, not reheated)	0.6
LOW FAT YOGHURT	LOW	0.6
COLD DRINK SQUASH TYPE	INTERMEDIATE	0.6
BEANS SUGAR KIDNEY HARRICOT DRIED	LOW	0.5
BREAKFAST CEREAL MAIZE BASED CORN FLAKES PUFFED CORN ETC.	HIGH	0.5

*In the SA food composition table multiple items are reflected by one code e.g. the code for breakfast cereals include weetbix (High in GI), Kellogg's All Bran (Intermediate GI) and puffed wheat (high in GI). For the purposes of the analysis the GI of one or two appropriate food items per food code was selected. See chapter 3: Methods;section 3.10.3 for more detail

4.3.4 Results: Macronutrient composition of the diet

The mean (±SD) and median (IQR) macronutrient intakes in the diet of type 2 diabetic women are presented in Table 41**.** The distribution for all but fibre was abnormal and therefore median values will be used in the discussion of the results.

Table 41: Mean (±SD) and Median (IQR) values for energy and macronutrient intakes of the study sample (n=59)

	Mean (±SD)	Median (Interquartile range)	EAR *
CHO (g)	163.7 (52.8)	160.0 (126.6-188.7)	100g
Total sugars (g)	39.8 (19.0)	37.6 (26.7-50.5)	
Added sugar *(g)	28.3 (22.8)	23.7 (13.1-38.9)	
Sucrose (g)	17.1 (10.7)	15.1 (8.6 -25.2)	
Fibre (g)	16.1 (5.8)	15.2 (12.2- 19.6)	21-25 **
Soluble fibre (g)	3.0 (1.5)	2.7 (1.9-3.9)	
Fat (g)	55.6 (31.3)	46.4 (32.1-73.7)	***
Saturated fat (g)	16.6 (9.3)	15.0 (9.0-21.7)	
Poly-unsaturated fat (g)	15.2 (10.2)	12.9 (7.7-21.7)	
Mono-unsaturated fat (g)	18.6 (10.9)	16.9 (9.8 -23.9)	
Cholesterol (g) †	176.3 (94.2)	164.7 (101.0 -230.1)	
Total transfats (g) ††	1.1 (1.2)	0.4 (0.4 - 1.8)	
Protein (g)	54.2 (18.2)	52.1 (43.8-63.2)	
gProt/ kg	0.7g/kg (0.3)	0.7 (0.6-0.8)	0.66g/kg/day
Plant Protein (g)	19.8 (7.3)	19.2 (15.2-24.8)	
Animal Protein g)	32.5 (13.1)	32.2 (24.6-40.7)	
Animal: plant protein	1.8 (0.8)	1.6 (1.2-2.0)	
Alcohol (g)	0.7 (5.0)	0 (0)	

*EAR: Estimated Average Requirements

**Adequate intake (AI) for fibre

***Neither an AI nor a RDA has been set for fat because there is insufficient data to determine a defined level of intake at which the risk of inadequacy or prevention of chronic disease occurs (Food and Nutrition Board, 2005).

† There is no evidence for a biological requirement for cholesterol and, therefore, neither an RDA nor an AI was set (Food and Nutrition Board, 2005).

†† Data on trans fats were also incomplete and cannot be used for interpretation**.**

The macronutrient composition of the diet is summarised in Table 42. The percentage carbohydrate (47.4% median) to total energy was below the generally recommended

50-65% while the percentage fat intake (33.1% median) to total energy intake was higher than the recommended 30%. The percentage polyunsaturated and monounsaturated fats as well as percentage sugar were in line with prudent guidelines. The percentage saturated fat intake (9.6% median) was in line with prudent guidelines for the general population but higher than recommendations for diabetes management.

Table 42: The contribution of macronutrients to total energy (TE) intake of the study sample (n=59)

	Prudent guidelines*	Mean (±SD)	Median (Interquartile range)
Total protein as %TE	10-20%	15.4 (2.9)	15.1 (13.2-17.5)
Total carbohydrates as % of TE	50-65% **	46.4 (6.6)	47.4 (41.9-51.0)
% Added sugar as % of TE	<10%+**	7.6% (4.4)	6.9% (3.6-10.7)
Total Fat as % of TE †	<30%	32.8† (8.2)	33.1 (26.8-39.8)
Saturated fat as % of TE	<7%	9.9% (2.9)	9.6% (8.1-11.8)
Polyunsaturated fat as % of TE	<10%	8.9% (3.3)	8.6% (6.2-10.9)
Monounsaturated fat as % of TE	10%+	11.0% (3.1)	11.1% (8.5-13.3)

* Source: Bantle et al, 2008 unless otherwise specified
**Franz et al, 2004; SEMDSA, 1997
† The sum of the different types of fats does not add up to 100% of the total fat content. The reason for this is that the total fat content of a food item also consists of non-fatty acid components such as glycerol, sterols and phospholipids (Wolmarans & Danster 2008).

4.3.5 Results: Micronutrient Intake

The mean (±SD) and median (IQR) intakes of minerals and vitamins are summarised in table 43. More than half of the sample did meet the estimated average requirement (EAR) for riboflavin, niacin, vitamin B12, zinc, chromium and phosphorus. More than half of the sample did not meet the EAR for vitamins A, C, E, B6 thiamin, folic acid, and magnesium. Folic acid and magnesium were the micronutrients that the highest number of the study sample failed to meet the EAR. Where EAR values were not available mean and median intakes were compared to Adequate Intake (AI) levels. None of subjects met the AI for calcium.

Table 43: Micronutrient intake of the study sample compared to Estimated Average Requirements (EARs) and Recommended Daily Allowances (RDAs) (n=59) †

Micronutrient (unit)	Mean (±SD)	Median (interquartile range)	RDA*	EAR**	% <EAR
Vitamin A (ug)	606.3 (750.9)	433.1 (231.1-695.3)	700	500	59.3
Vitamin C (mg)	59.4 (42.2)	49.4 (30.5-71.8)	75	60	64.4
Vitamin E (mg)	10.9 (6.4)	8.9 (5.9-15.2)	15	12	62.7
Thiamin (mg)	0.8 (0.3)	0.8 (0.6-1.0)	1.1	0.9	66.1
Riboflavin (mg)	1.1 (0.5)	0.9 (0.7-1.2)	1.1	0.9	45.8
Niacin (mg)	13.8 (5.6)	13.5 (9.8-16.6)	14	11	40.6
Folic Acid (ug)	172.8 (71.7)	159.8 (127.7-211.8)	400	320	94.9
Vit B6 (mg)	1.0 (0.5)	0.9 (0.7-1.2)	1.3 (31-50yrs) 1.5 (>51yrs)	1.1 (31-50yrs) 1.3 (>51yrs)	58.3%<1.1 88.6%<1.3
Vit B12 (ug)	3.7 (3.4)	2.8 (1.8-4.1)	2.4	2.0	32.2
Zinc (mg)	7.3 (2.8)	6.9 (5.4-8.3)	8	6.8	45.8
Magnesium (mg)	210.2 (76.3)	196.7 (149.5-256.4)	320	265	83
Potassium (mg)	1861.0 (696.3)	1752.3 (1430.3-2151.3)	-	-	-
Calcium (mg)	411.7 (204.3	349.2 (265.7-524.0)		1000**(31-50yrs) 1200(>51yrs)	100%<1000*** 100%<1200
Chromium (ug)	43.0 (22.8).	36.1 (28.9-56.6)		25 **(31-50yrs) 20 **(>51yrs)	8.3%<25*** 17%<20
Phosphorus (mg)	807.4 (297.3)	727.4 (602.6-951.8)	700	580	18.6
Sodium (mg) †	1271.7 (558.9)	1125.7 (899.4-1650.3)	-(<2400?? prudent)	-	
Iron (mg)	7.7 (2.7)	7.1 (5.8-9.4)	18 (31-50) 8(>50)	8.1 (31-50) 5.0(>50)	33.3%<8.1 20%<5

Certain micronutrients were excluded from the analyses since the percentage missing values in some of the databases that the Foodfinder program is based on (Langenhoven et al, 1991) is too high or the nutrient is not yet included e.g. pantothenate, selenium, biotin, copper, iodine, boron, manganese, vitamin K.
*RDA: Recommended Daily Allowance
**EAR: Estimated Average Requirement.
***AI: Adequate Intake (where an EAR is not available)
†Salt intake was not determined.

4.3.6 Discussion

Education of the South African public regarding healthy eating is based on the Food Based Dietary Guidelines (FBDGs) which were officially adopted as national dietary guidelines in May 2003. When educating persons with diabetes, the principles entrenched in the FBDGs can and should also form part of diabetes focused dietary messages. For this reason the discussion on the quantity and quality of the dietary intake of the study sample is based on the FBDGs. The first FBDG, 'Enjoy a variety of foods' is discussed following the other guidelines, as it in essence refers to all the other guidelines.

FBDG 'Make starchy foods the basis of most meals'

When assessing the carbohydrate intake of persons with diabetes, the total amount (quantity) as well as the quality of carbohydrate is important (Bantle et al, 2008). When considering the total amount of carbohydrate, the FBDG of making starch the basis of meals (6-11 servings of starchy foods) is in line with the 50-55% carbohydrate of total energy previously recommended as prudent for persons with diabetes (Franz et al, 2004). The most updated ADA management guidelines do not specify an energy contribution from carbohydrate, but recommend adjustments to be made based on the individual's diet (Bantle et al, 2007b; Bantle et al, 2008).

The total amount of carbohydrates consumed by the study sample was a mean of 163.7g (median of 160g). This intake is in line with the 167g reported for 45-64 year old coloured women in the CRISIC study (Steyn et al, 1985). In the latter study sucrose consumption constituted about one third of total carbohydrate consumption (Steyn et al, 1985; Langenhoven et al, 1988a) although it was much lower in our study (10%) (See discussion of FBDG on sugar intake for detail).

The carbohydrate contribution to total energy of 46.3% is lower than the 50-65% recommended for persons with diabetes in the past by the ADA (Franz et al, 2004, SEMDSA, 1997), but acceptable when the British recommendation of 45-60% is considered (Connor et al, 2003). As can be expected, the carbohydrate intake was much lower than that of a group of black persons with type 2 diabetes, since the black population traditionally consumes a high carbohydrate diet (Nthangeni et al, 2002). When comparing the intake of the study sample to the 6-11 servings recommended as part of the FBDGs (Dept of Health, 2004) the six servings of starch with the inclusion of root vegetables is acceptable, although on the low side.

All evidence thus points to a carbohydrate intake at the lower end of all the cited recommendations. The potential effects of this level of total carbohydrate intake need to be considered. According to McMillan-Price and Brand–Miller (2004) one of the original motivations for the focus on a higher carbohydrate intake was that it is not energy dense, and thus usually replaces fat in the diet which is much more energy dense. Furthermore, evidence points to the fact that fat tissue formation (de novo lipogenesis) does not occur to any great extent in humans with excessive energy intake in the form of carbohydrates. On the other hand, there are studies that have shown that a habitual high-carbohydrate diet may induce the enzymes involved in the de novo lipogenesis pathway (Aarsland et al, 1997). The major factor to consider with a low carbohydrate intake is therefore whether it results in an increased fat intake.

Although control of total carbohydrate intake in diabetes is important, the type (quality) of carbohydrate also needs to be considered. The FAO/WHO Report (1998) recommends that the bulk of carbohydrate-containing foods consumed should be those rich in fibre and with a low glycaemic index (GI). Appropriately processed cereals, vegetables, legumes and fruits are particularly good food choices (FAO/WHO, 1998). Diabetes organisations in many countries have generally endorsed this approach in their advice for treatment of both types of diabetes as well as for reducing the risks of type 2 diabetes (Connor et al, 2003; Bantle et al, 2008), although the United States has not wholeheartedly endorsed the concept of the GI (Bantle et al, 2008).

In view of the above recommendations concerning the quality of carbohydrate intake, it is clear from the results of our study that both fibre intake and GI of the diet may not be appropriate. Typical Western foods such as potatoes, breads and low-fat cereal products are digested and absorbed rapidly, resulting in a high glycaemic load and thus increased demand for insulin (Foster-Powell et al, 2002; Holt et al, 1997). These types of foods were among the main contributors to total carbohydrate intake in this study population, namely brown bread/rolls, white bread/rolls followed by baked confectionary (cookies, loaves, pancakes, tarts, cakes and pudding), rice, sugar, wheat-based cereals and potato. Although a high GI does not necessarily equate with a low fibre intake, many of these items are refined products low in fibre, and have a high or intermediate GI.

When considering fibre intake by the study population (16g), it is evident that the diet also reflects poorer carbohydrate choices in that it fails to meet prudent guidelines for

total fibre intake. These findings are in line with what was found in other studies in non-diabetic coloured study populations such as the CRISIC study (10-12g fibre) (Steyn et al, 1982) and Charlton's (1997) study in people older than 65 years (16g of fibre). It is much lower compared to a study in black persons with diabetes from both rural and urban communities (19-21g) (Nthangeni et al 2002). This can probably be explained by the fact that the most commonly consumed carbohydrates in both rural and urban black subjects were less processed, including maize porridge, sorghum and brown bread. The low intake of several micronutrients by the study sample, especially thiamine, supports the high intake of refined carbohydrates since thiamin is found mostly in the outer layers of the grain and in the germ (which are removed during the refining process) (Combs, 2008:85). In light of the reported preference for white bread and other refined cereals in this study, it would seem that routine prudent dietary messages regarding increased fibre intake are either not delivered, or not effectively delivered or not implemented by the person with diabetes.

In summary, it is clear that the study population had a carbohydrate intake in the lower range of recommendations and had a preference for more refined carbohydrates, thus low in fibre with high GI values. The recommendation to make starchy foods the basis of most meals should thus be accompanied by advice to choose unrefined or minimally processed cereals and grains high in fibre and to concentrate on low GI choices. However, to prevent confusion around low and high GI foods, general high fibre and low GI food items should be emphasised instead of the actual GI of the foods (Colombani, 2004).

FBDG 'Eat sugar sparingly and not between meals'

In the past sugar was viewed as a potent stimulator of increased blood glucose. However, GI related research indicates sugar has a moderate GI (Steenkamp & Delport, 2007; Foster-Powell & Brand Miller, 1995). It will therefore not increase blood glucose more rapidly than the same energy value of typical starches such as brown bread and cooked potato (American Dietetic Association, 2004, Bantle et al, 2007b & 2008), although the latter will be more nutrient-dense. Therefore, most current recommendations permit 30 - 50 g sugar per day for persons with diabetes, provided that this is consumed within the context of the total energy allowance, that it does not replace nutrient-dense and high-fibre foods, and that it is incorporated into mixed meals (FAO/WHO, 1998).

The reported mean sugar intake in this study sample of 28.3 g was substantially lower when compared to both the CRISIC study (58-71g) (Steyn et al, 1985) and older coloured women (69g)(Charlton, 1997) and similar to the lowest values (27.8) found for adult South Africans with the 24-hour dietary recall method (Nel & Steyn, 2002). In terms of the contribution to total energy, the reported 7.6% fell within the generally accepted guidelines of less or equal to 10% of total energy (Connor et al, 2003; Franz et al, 2004). This is markedly lower than the findings of the CRISIC study (Steyn et al, 1985) where sugar intake contributed 15.5-17.9% of total energy. However, black persons with type 2 diabetes (Nthangeni et al, 2002) of both rural and urban background had a lower intake (2.6-3.8%) compared to this study sample.

The low reported intake of sugar in this study population may reflect the impact of the 'sugar' message; hence the marked difference compared to the general population, especially whites, Indians and urban blacks who are all likely to follow a more westernised way of eating. However, it can be speculated that sugar intake could have been underreported in this population of persons with diabetes because it has traditionally been linked to high blood glucose and would thus have been considered as an 'unhealthy food'. Furthermore, it seems highly unlikely that this study sample would have a sugar intake in line with rural black groups in South Africa who typically still follow a strict prudent diet that is low in fat and high in unrefined carbohydrates (Steyn et al, 2006b). If sugar intake was underreported, it could have contributed to a low estimation of total carbohydrate intake and total energy intake.

The most important sources of sugar in this study included white sugar (in tea and coffee), baked confectionary, carbonated drinks and sweets (hard-boiled/jelly). These items are generally low in fibre and micronutrients and are thus carbohydrate dense. Unless portion size is controlled, these foods have the potential to contribute to glycaemic load and ultimately weight gain. Although it can be quite acceptable to include small amounts of these foods in or after a meal, the bulk of the meal should contain lower GI foods such as vegetables, fruit and low GI starches and dairy (Steenkamp & Delport, 2007), which was not the case in this study. Furthermore, food items contributing to sugar were not typically eaten as part of a meal, but as snacks (sweets, confectionary, carbonated drinks). Since these food items reflect what we see in the general coloured population, there is a clear need to educate those with diabetes on appropriate inclusion of sugar and sugar-containing foods in their diets.

FBDG 'Eat fats sparingly'

When considering recommendations for fat intake by persons with diabetes, two core issues need to be considered, namely the **total amount of fat** as well as the **quality of the fat** consumed.

The total fat intake of 55.6g by this study sample was lower than the 61-68g reported for 35-64 year old women in the CRISIC study (Steyn et al, 1985) and the 62g reported for >65 year old women by Charlton (1997). It is in line with the FBDG that recommends fat to be consumed 'sparingly' and could reflect an actual change in behaviour due to the effect of nutritional messages targeted at the diabetic population. However, in the light of the high prevalence of obesity, it is more likely a reflection of underreporting, as foods considered as 'unhealthful' are likely to be underreported (Feskanich & Willett, 1993).

When the contribution of fat intake to total energy intake is considered, the total fat contribution of almost 33% of total energy intake exceeds the prudent guideline of an intake of 30% or less and is in line with the studies mentioned earlier, namely 35.9-36.8% in the CRISIC study (Steyn et al, 1985) and 33% in the study by Charlton (1997). The meat and fats/oil group contributed the most to total fat intake. Red meat products were consumed less frequently compared to chicken meat, but contributed more to total fat. The substantial contribution of cooked potato to total fat intake reflects the cooking method of adding oil or margarine. Baked confectionary is another group of food items that contributed substantially to total fat intake.

As far as quality of fat intake is concerned, dietary goals for individuals with diabetes focus on limiting saturated fatty acids (SFAs), trans fats, and cholesterol intakes (Bantle et al, 2008). The 9.9% contributed by SFAs to total energy (TE) is in line with general prudent dietary guidelines (<10% of TE), but higher than current diabetic guidelines of less than 7% of TE (Bantle et al, 2008). It is lower than values reported in the CRISIC study (11.4-11.5%) (Steyn et al, 1985), similar to that found in the older coloured population (10.3%) (Charlton et al, 1997) and lower than what have generally been found in the white, coloured and Indian South Africans (Vorster et al, 1997).

Foods that have contributed to the SFA intake of the study sample include meat (red meat, chicken and sausage) and milk (high fat cheese and full cream milk) products. These were the same products that were also found to be among the 10 main

contributors of fat in the general coloured population (Steyn et al, 1985). Many in the study sample have consumed chicken and, although it can potentially be a lower fat choice, it has been a prominent contributor to fat, most likely because it was eaten with the skin on or because of the addition of fat in cooking. Dietary advice should thus focus on a reduction of intake of these prominent sources of SFAs.

Monounsaturated fats (MUFAs) contributed almost 11% of the total energy intake of the study sample, which is similar to results in older coloured women (11.3%) (Charlton et al, 1997). However, consumption of food items known to be particularly good sources of MUFA were not prominent, with the exception of peanut butter. The low consumption of other good sources of MUFA such as canola oil, nuts and avocado may have been due to the high cost of these products as well as not being in season (referring to avocadoes) at the time of data collection. However, even though specific products high in MUFAs were not commonly consumed, the intake of MUFAs was adequate. Chicken contains significant amounts of MUFA and was among the top ten foods contributing to total fat intake. Emphasis on increasing MUFA may therefore not be a first priority, although it should always be included in basic nutrition education. As with all 'good' fats, emphasis on food items high in MUFAs need to be in context of keeping the overall fat content of the diet moderate.

The overall **polyunsaturated fatty acid** (PUFA) intake of 8.9% fall well within recommended guidelines of <10% of total energy and is also in line with results from the CRISIC study (8.8% of total energy) (Langenhoven et al, 1988a). The n-3 fatty acid intake was not quantified in this study but was most probably low since fish consumption (especially oily fish) was low and the contribution of fish intake to total fat is likely to come from the oil it has been fried in. Although trans fats were not accurately quantified in this study due to missing data in the database, it is very likely that the intake in the study sample was on the high side. This notion is based on the fact that, as is the case for the majority of South Africans(Steyn et al, 2006a; Langenhoven et al, 1995) hard brick margarine was a prominent source of fat for the study sample. Hard brick margarine generally has a high trans fat content. Baked confectionaries are also generally high in trans fats since the fat used in the preparation thereof is often hard brick margarine or other hydrogenated plant fats (American Dietetic Association, 2005).

The reported **cholesterol** intake of this study sample is well below the newest ADA 2007 & 2008 guidelines of less than 200mg cholesterol per day (Bantle et al, 2007b;

Bantle et al, 2008). The low reported intake of cholesterol is supported by the fact that the food sources that contributed the most to total fat intake are mainly those from plant origin, namely brick margarine, medium/low fat spread, cooked potato (where oil and margarine are used in preparation) and baked confectionary. These findings are in line with other findings in South African population groups, where intake using the 24-hour dietary recall method, showed that with the exception of white and coloured adult men, all groups had cholesterol intakes that fell within the prudent dietary guidelines (Vorster et al, 1997; Steyn et al, 1985).

In summary, the percentage of total energy derived from fat was too high and the quality of fat consumed was not optimal. Efforts in this study population should firstly be directed towards lowering saturated and trans fats since MUFA, PUFA and cholesterol intake was in line with prudent dietary guidelines. Emphasis on a reduction of the use of hard margarine and high fat meat products on one hand, and sources of n-3 fatty acids on the other hand, needs to be included in dietary education of persons with diabetes.

FBDG 'Eat plenty of vegetables and fruits every day'

The recommendations for fruit and vegetable consumption for the person with diabetes is similar to what is recommended for the general population, namely an intake of five vegetables and fruit a day or the equivalent of 400g in total (Dept of Health, 2004). Consideration of the GI and GL of especially fruit is also necessary since fruits contain substantial amounts of carbohydrates.

The low number of servings consumed from the **vegetable and fruits group** by the study sample is in line with results from a survey involving all population groups of South Africa, which reported low intakes of fruit and vegetables, particularly in Asians, coloureds and Africans (Langenhoven et al, 1995). The findings of this study indicate that only one fruit and one vegetable (excluding root vegetables) is consumed per day, adding up to only 60% of the recommended 400g (WHO, 2003; Dept of Health, 2004). This would also explain the fact that a high proportion (>50%) of the study sample did not meet the EARs for important antioxidants such as vitamins A, E and C, which are found in vegetables and fruits. These findings are also in line with reported intake of the general South African population with more than 40% of South Africans not eating vegetables and almost 70% not eating fruit (Nel & Steyn, 2002). The lack of variety of vegetable and fruit intake found in this study could further

contribute to the high prevalence of the sample not meeting EARs for many micronutrients, such as vitamins A, C and E as well as vitamin B6, folic acid and magnesium. The most commonly consumed fruits in this study, namely apples, pears and bananas are similar in their nutrient content and not particularly high in vitamin C (4-5mg vit C/100g). In terms of vegetable intake, only tomato, pumpkin and gem squash were consumed by more than 30% of the population. Besides tomato, these vegetables are generally low in most minerals and vitamins.

It can be argued that the low recorded fruit and vegetable intake by the study sample may reflect underreporting thereof. Fruit is often perceived to be forbidden or to be restricted in persons with diabetes, which may have impacted on the frequency of consumption or accuracy of reporting. On the other hand, vegetables are widely recommended as part of prudent dietary guidelines, and may thus be less likely to be underreported (Feskanich & Willett, 1993). However, in light of the similarity of intake of vitamins A and C in this sample with that of the CRISIC study in the Cape Peninsula in 1982 (Steyn et al, 1985) as well as the general low fruit and vegetable intake by South Africans, it may indicate that the results are a true reflection of actual fruit and vegetable intake.

As far as the total fibre contribution is concerned, it is not unexpected that the fibre intake in the sample population was so low, since fruit and vegetables are very good sources of fibre, both soluble and insoluble. As mentioned earlier the fact that these findings are in line with findings in other coloured populations indicate that little dietary modification has taken place in regards to increasing fibre intake, despite it being a relatively simple message to incorporate. By increasing the intake of fruit and vegetables fibre intake can be increased along with achieving multiple other secondary dietary benefits such as reducing fat and increasing antioxidant intake. The addition of one medium apple (150g; 3.45g fibre) a day and half a cup of cooked broccoli (75g; 1.95g fibre) and a medium carrot (60g; 1.62 g fibre) will increase the fibre intake with 7g, almost 50% of the current mean intake of fibre (FoodFinder^{TM}3, 2002).

As for the **GI** of fruit, two out of the three fruits most commonly consumed by the study sample, namely apples and pears, are deciduous fruit and have a low GI, while bananas have an intermediate GI. The low overall fruit consumption and small reported portion sizes would not have impacted negatively on the overall GI of the diet. Focus on detailed information on the GI of fruits in dietary education may inhibit

a varied intake, especially in this population with a low education status and limited choice as to which fruits to buy. Emphasis on a variety of fruits with emphasis on portion control is likely to be a better approach to ensure a varied intake yet achieving a low GI diet.

In summary, it is evident that vegetable and fruit consumption is low both in terms of quantity and variety and is contributing to the low fibre intake as well as low micronutrient intake. In dietary counselling emphasis should be placed on increasing the intake of vegetables and fruits high in fibre and with a low GI/GL that are already being consumed by the study sample. Economical alternatives, such as cabbage and carrots, can also be emphasised to increase variety whilst encouraging raw as well as cooked variations to prevent monotony.

Within this context it is important to bear in mind that simply improving knowledge of the recommended vegetable and fruit intake will not have a marked effect on its intake (Domel et al, 1993). In areas in South Africa where significant improvements in vegetable and fruit intake occurred, the increased vegetable and fruit intake correlated with the increased percentage of respondents who grew their own vegetables (Walsh et al, 2003). Thus, the nutrition education programme implemented in the area improved consumption through both improved knowledge on benefits of vegetables and fruit as well as addressing household food insecurity through community vegetable garden projects (Walsh et al, 2003). The feasibility of this type of approach is worth investigating.

FBDG 'Eat dry beans, peas, lentils and soy regularly'

Legumes are unique foods because of their rich nutrient content, including starch, vegetable protein, soluble and insoluble fibre, phytochemicals, minerals and vitamins (Anderson et al, 1991). The high fibre, very low GI (except for broad beans) and low fat content of legumes (with the exception of soy and chickpeas) makes it particularly suited to be included in the diet of persons with diabetes. The insoluble fibre component with its bulking properties promotes gastrointestinal function, hydration capacity, binding properties and fermentability. However, it is the substantial amounts of soluble components in legumes that are of particular relevance in diabetes since it may significantly lower blood glucose and cholesterol concentrations (Vorster et al, 1987; Vorster & Venter, 1994; Geil & Anderson, 1994).

Our study findings indicate that the consumption of legumes by the study sample was low. Daily intake per capita was negligible and not near the FBDG recommendation of one serving (one cup cooked) three times a week (600g/week) (Dept of Health, 2004). Products that were consumed occasionally included lentils, split peas and baked beans, while soybean products were not consumed by any of the study sample.

It is not clear why intakes of these products are so low, as they are generally inexpensive and culturally acceptable, especially in a traditional dish such as biryani that contains lentils. It can be speculated that dishes containing dried beans and lentils are more frequently prepared in cold winter months and the study only reflected intake in summer months. However, worldwide there has been a reduction in legume consumption because of urbanisation and the globalisation of the food trade (Lintas & Cappelloni, 1992). Walsh et al (2003) reported that even where dried legumes such as legumes and beans were included in food aid parcels in low-income coloured communities in the Free State and Northern Cape, no significant improvement in median frequency of legume intake was observed. Although inexpensive to buy, long soaking and cooking times may be a barrier in terms of time and cost of cooking fuel in the preparation of dried beans. In consumer testing in the development of the FBDGs, legume consumption of specifically dry beans was limited where cooking fuel was an expensive resource (Love et al, 2008). In this regard, lentils are different, as it does not require soaking or long cooking times (Van Eyssen, 2002).

The lack of soy in the diet may be due to a lack of knowledge on how to prepare it in a way that is tasty, as soy is known to be quite strong in taste. Although soy foods are relatively high in fat they will still be lower in total fat, saturated fat and cholesterol than the foods they frequently replace, such as meats and cheese. Furthermore, sterols in soybeans inhibit cholesterol absorption in the small intestine, thereby decreasing serum cholesterol concentrations (Weststrate & Meijer, 1998). The moderate amount of oil in soy is predominantly unsaturated, and includes α-linolenic acid, an n-3 fatty acid not commonly found in plant foods (Messina, 1999).

It is interesting to note that despite the low intake of legumes by the study sample, it was the second most important contributor to fibre intake, even higher than the contribution of fruit or vegetables. These results illustrate the value of legume consumption in terms of fibre intake and consequently all the health benefits associated with a high fibre intake. Half a cup of cooked lentils can add up to 6g of fibre to the diet (FoodFinder^{TM}3, 2002). A further advantage of legumes is that these

foods are also micronutrient dense. Legumes can provide many of the micronutrients that the study sample lacked in their diet, such as calcium, magnesium, folate, thiamine and vitamin B6 as well as others such as zinc, iron, phosphorus, potassium and riboflavin (Geil & Anderson, 1994). Thus, by increasing the intake of legumes the fibre as well as micronutrient intake can be increased substantially.

In summary, with escalating food prices, the inclusion of legumes would be invaluable in the diet of the coloured person with diabetes due to it being a good quality carbohydrate, good source of plant protein, fibre and micronutrients as well as its low GI and high satiety value. It can also be substituted for higher fat (particularly saturated fat) animal protein sources and so displace fat from the diet (Geil & Anderson, 1994). Consideration needs to be given to create ways of overcoming obstacles that prevent the consumption of legumes in this low-income community.

FBDG 'Chicken, fish, milk, meat or eggs can be eaten daily'.

The recommended protein intake for persons with diabetes is similar to that recommended for the general population, namely 10-20% of total energy, based on the amount needed for maintenance of lean body mass (Gannon et al, 2003). This recommendation has remained stable over the past decades with amounts and types of carbohydrates and fats receiving more prominence in the management of diabetes. However, in recent years dietary protein has received more attention for its potential role in the management of hyperglycaemia as well as weight loss (Gannon et al, 2003). As far as the best protein sources are concerned, it is recommended that those with diabetes, like the general population, consume fat-free and low fat animal products (Scholtz et al, 2001) and emphasise the increased incorporation of plant protein intake such as beans, peas, lentils and soy foods (Dept of Health, 2004).

When considering the protein intake of the study population, the median protein intake of 52g per day amounts to an intake of ±0.7g protein per kg/day. The 15.4% (median) contribution of protein for the study sample is in agreement with prudent guidelines for persons with diabetes. It is also in line with that found for the general coloured population (14.8-15.8%) (Steyn et al, 1982), older coloured people (14.7%) (Charlton et al, 1997), and black persons with type 2 diabetes (14.3-14.7%) (Nthangeni et al, 2002). This may indicate that the reported protein intake is a true reflection of protein intake of these individuals and may not have been underreported.

In the present study, typical of a westernised dietary pattern, animal protein was the main contributor (almost 60%) to protein intake, in contrast to the more traditional diet of black persons with type 2 diabetes where plant protein formed the basis of protein intake (Nthangeni et al, 2002). This is also reflected in the fact that the most important sources of protein included animal products such as chicken products, fish, red meat products and high fat cheese and milk. Therefore, although the intake of protein was adequate and not excessive, the commonly consumed protein sources were high in fat and saturated fat, thus contributing to the high percentage energy consumed in the form of fat.

Actual intake of red meat, chicken and fish was in line with the FBDG recommendation of one serving a day. Fish intake was much lower than meat intake, but did translate to almost two servings of fish per week, which compares favourably with the recommendation for persons with diabetes to aim for at least two portions of fish a week (Bantle et al, 2007b; Bantle et al, 2008; Connor et al, 2003). The fact that fish was among the main contributors to total fat intake is most probably explained by the practice of frying fish in a batter, rather than consumption of oily varieties of fish (high in n-3 fatty acids). As in the general South African population, accessibility and price, especially of fresh fish in inland areas, may be major constraints for more regular consumption (Langenhoven et al, 1988b). Confusion around the benefit of tinned fish may also contribute to its low consumption. Tinned fish products are generally high in salt and those with high blood pressure are advised to limit the intake of tinned products for this reason.

The **milk intake** of 133ml is less than the recommended 250ml per day that the FBDG recommends (Dept of Health, 2004) and consistent with the low reported milk intake for the general coloured population in South Africa (Scholtz et al, 2001). As for the general South African population, full cream milk is the choice of preference (Wolmarans & Oosthuizen, 2001). A tendency to exclude milk from the diet in response to advice to make lower fat dairy choices (Scholtz et al, 2001) may in part explain the low intake of milk in this study population. The low milk intake is also reflected in the fact that the mean dietary intake of calcium for all study subjects was below the adequate intake (AI). An analysis of intake patterns by other researchers showed that low calcium diets are also low in many other essential micronutrients needed for health (Barger-Lux et al, 1992). This is in line with results in this study population, namely that less than optimal intake levels have been found for vitamins

A, C, E, thiamin, folic acid, vitamin B6, and magnesium. Additional advantages of adequate milk intake include a blood pressure lowering effect and possibly weight loss (McCarron & P Heaney, 2004). The latter is based on the fact that in population studies the level of calcium intake has been found to be inversely related with weight status (Pereira et al, 2002), although some investigators remain unconvinced about this association (Dwyer et al, 2005).

Egg intake by the study sample was lower (2.5 eggs per week) than the three to four eggs that is recommended by the FBDG (Scholtz et al, 2001). The low intake may be due to the perception that egg intake raises serum cholesterol concentrations and consequently the risk of CVD. This perception is based on the high cholesterol content of egg yolk (±200mg cholesterol/medium-size egg) (FoodFinder^{TM}3, 2002). However, even though it is now well accepted that dietary cholesterol is not the principal dietary determinant of plasma LDL cholesterol (rather saturated and trans fats), dietary fat guidelines for persons with diabetes are similar to those formulated for individuals with CVD, including a cholesterol intake below 200mg (Bantle et al, 2008). Therefore, the current egg intake is probably in line with these guidelines for cholesterol intake.

In summary, total protein intake of the study sample is adequate and in accordance with general guidelines for persons with diabetes as well as the FBDGs. However, more emphasis is needed on low fat animal protein choices such as lean meat and fish prepared without oil as well as the more regular inclusion of low fat dairy and plant protein products such as beans, lentils and soy.

FBDG 'If you drink alcohol, drink sensibly'

Guidelines across the world generally recommend that if adults with diabetes choose to use alcohol, daily intake should be limited to a moderate amount (one drink per day or less for women and two drinks per day or less for men) (Bantle et al, 2008). The FBDGs are slightly more liberal and recommend up to three standard drinks per day for men and two standard drinks a day for women (Dept of Health, 2004). It must however be borne in mind that the FBDGs are targeted at the general population.

The women in this study sample reported a very low mean alcohol intake of 0.65(±5) g/day. This is similar to the 0.9g of alcohol consumed by both urban and rural black female persons with diabetes (Nthangeni et al, 2002) and the 0.3g/day reported in

older coloured women (Charlton et al, 1997), although it was suggested in the latter study that the habitual alcohol intake was probably higher. The low intake in this study could in part be because almost a third of the study sample was Muslims who do not generally consume alcohol.

FBDG 'Eat Salt sparingly'

Salt intake was not assessed in this study but in the light of the high prevalence of hypertension there would be reason to emphasise low salt intake. There is strong evidence pointing to the value of restricting salt intake to lower blood pressure (Cutler et al, 1991). Although salt-sensitive individuals would benefit more from salt restrictions than salt-resistant individuals would, the identification of these groups remains a challenge (Charlton & Jooste, 2001). For persons with diabetes and symptomatic heart failure, dietary sodium intake of less than 2 000 mg/day may reduce symptoms. In normotensive and hypertensive individuals, a reduced sodium intake of 2300 mg/day with a diet high in fruits, vegetables, and low-fat dairy products lowers blood pressure (Bantle et al, 2007b). The FBDGs do not specify an amount to be used but stress using '*very little at a time'* and to limit the use of salty foods and snacks while encouraging alternative flavourants such as herbs and spices (Dept of Health, 2004).

FBDG 'Enjoy a variety of foods'

The goal of recommending dietary variety is to encourage dietary adequacy by including the essential nutrients in sufficient amounts to meet the dietary reference intakes (DRIs) (Earl & Borra, 2008:342). Choosing a variety of foods to meet DRIs should also provide adequate amounts of nutrients for which recommended levels have not been well defined as well as sufficient intake of non-nutrient biologically active compounds in the diet that may influence health and susceptibility to disease (Earl & Borra, 2008:342).

Nutritional scientists and consumers conceptualise dietary variety as including different foods and different food groups as part of the diet, as well as altering the method of food preparation (Maunder et al, 2001). For the purpose of this study the approach suggested by Kreb-Smith et al (1987) to assess dietary variety was applied namely the assessment of the inclusion of foods from each of the five food groups (starches, fats, dairy, fruit and vegetables and meat and meat substitutes). Even though

eighty percent of the study sample consumed items from every major food group, a closer look at food choices within each food group points to a diet low in variety. The following discussion of choices within the five food groups supports this statement:

Starches

The five items that contributed most to carbohydrate intake were brown and white bread, potato, rice (white) and sugar. White bread, white rice and sugar are refined and processed sources of carbohydrate low in fibre and micronutrients (except for the micronutrients that white bread may be fortified with by law). The fact that white bread was third in terms of its contribution to total fibre only emphasises the lack of high fibre carbohydrates in the diet. Furthermore, all of these staples either have a high or intermediate GI. The diet noticeably lacks variety in terms of whole grains and low GI starchy foods.

Fats

Only a small number of food items considered as sources of fat were consumed by more than half of the study population. These were brick margarine, full cream milk, baked confectionary, medium/low fat spread and high fat cheese. Red meat products, meat dishes and chicken meat and dishes were other products that contributed to total fat intake. Besides margarine (brick and med/low fat spread), peanut butter was the most commonly used fat spread (39%) with sunflower oil the main oil used for cooking. The reported use of other plant fats or oils, such as olive and canola oil, nuts and avocado was low. This is not surprising as these fats and/ oils are costly. Based purely on the food items contributing to fat intake, it seems that there is a limited intake of food sources high in the more beneficial mono-unsaturated fats and the n-3 fatty acids found in fish. However, based on the macronutrient results MUFA intake is adequate.

Vegetables & Fruit

More than 90% of the study sample reported the daily consumption of some form of fruit or fruit juice and vegetable. The fruits most commonly consumed were bananas, pears, apples and grapes. These fruits were however only consumed by about a third (32-40.7%) of the subjects. The most commonly consumed vegetables, namely pumpkin, tomato and gem squash were consumed by a third or less of subjects (30.5-33.9%). Except for tomato, none of these vegetables or fruit count among those being

most protective against disease, such as cruciferous vegetables, carrots, and raw and fresh fruit, especially citrus fruit (Tavani & Vecchia, 1995; Steinmetz & Potter, 1996). The low overall intake as well as limited variety could have contributed to inadequate intakes of micronutrients typically found in vegetables and fruit such as vitamin C, vitamin A, magnesium, antioxidants and fibre (See paragraph on the FBDG, '*Eat plenty of vegetables and fruit everyday*' for further detail in this regard).

Meat and Meat substitutes

The most commonly consumed meat products reported by the study sample included chicken and red meats. Less than 60% of the study sample consumed fish and only 40% reported consumption of legumes and eggs. In addition to high protein content, fish is also an excellent source of several micronutrients as well as n-3 fatty acids. Eggs are not only excellent sources of vitamin B12, iron, riboflavin and folate, but also an economical option when it comes to animal protein (Scholtz et al, 2001). The infrequent consumption of legumes could be due to various barriers such as taste, flatulence, long cooking periods, and lack of knowledge on how to incorporate it in the diet (Diabetes New Zealand, 2005). Overall dairy consumption was low and mainly in the form of milk.

It is clear that the study sample may benefit from the promotion of a greater variety of protein choices, especially since food items such as lentils and eggs are also economical choices. Including more of these items in their diet should greatly increase the quality and nutrient profile of their diets.

In summary, although the study sample consumed foods from all the major food groups, on closer examination the diet is clearly lacking adequate variety and quantity within all of the five food groups. The limited intake of especially vegetables, fruit, milk, unrefined carbohydrates and legumes is confirmed and reflected in the very low fibre intake of the study sample as well as the small number of subjects that met the estimated average requirements(EARs) for vitamins A, C, E, B6, thiamin, folic acid, magnesium and the adequate intake(AI) for calcium.

Love et al (2008) found that affordability is the major constraint in South African populations to achieve variety in the diet, particularly with regard to fruits, vegetables and foods of animal origin (Love et al, 2008). When affordability limited intake of foods from animals (in particular meat), the use of fats increased in an attempt to enhance the taste of the meals. Where cooking fuel was an expensive resource,

legume consumption (specifically dry beans) was limited. In the light of escalating food prices, the impact of affordability is likely to remain an obstacle to improve dietary variety.

Another factor that may contribute to lack of variety in the diet is the perception that the diabetic diet is a special diet, not only in terms of expense but also limited in terms of taste and variety. Messages on 'bad' and good' foods in the past may have contributed to this view, such as the exclusion of certain fruits, thus creating confusion to what is acceptable to incorporate in the diet. If this is indeed the case, more emphasis should be placed in future on the message that a diabetic diet is not a special diet, but only a healthy diet that can be followed by the whole family. A healthy diet does not mean a bland diet and variety can contribute to health. The FBDGs aim to do this.

4.3.7 Summary and Conclusion

Data in this section indicate that the following aspects need to be considered if the FBDGs are going to be used as a vehicle to formulate recommendations for the management of type 2 diabetes in coloured people attending CHCs in the Cape Peninsula:

- Most of the food-based dietary guidelines discussed in this section most were not met by the current food choices.
- The diet of the study sample was specifically low in fibre and lacking in vegetable, fruit and legumes with a clear preference for refined carbohydrate and saturated fat items.
- The dietary intake of the study sample does not differ much from the available data on the general coloured population.
- Specific dietary factors that need attention are the following:
    - Reduction of total fat intake, especially trans fats and saturated fats;
    - The increased consumption of vegetables and fruits;
    - Substituting high fibre starchy foods for refined and processed starchy foods;

- The appropriate inclusion of sugar and sugar-containing foods;
- An increased frequency of legume consumption;

- Economical and tasty ways to incorporate the above changes in the diet need to be formulated.

4.4. Eating pattern and compliance with guidelines in this regard

This section reports and discusses results on subjects' self-reported meal patterns, frequency of meals and snacks and compares this information to meal frequency derived from the three 24-hour dietary recalls. Results on the macronutrient distribution of meals and snacks and a discussion thereof are also included.

4.4.1 Results

Results presented in Table 44 show that more than three quarters of the study sample consumed breakfast, lunch and supper (derived from the 24-hour dietary recall data).. Most of the subjects snacked between meals, combined with either three meals or one to two meals/day. Afternoon snacking was the most common.

Table 44: The meal frequency of the study sample as recorded in each of the three 24-hour dietary recalls[†]

Meal and snack times	Recall 1 n=59	Recall 2 n=59	Recall 3 n=55
	n (%)	n (%)	n (%)
Early morning= 5-6:30am	5 (8.5)	8 (13.6)	7 (12.7)
Breakfast=6:30am-9am	45 (76.3)	45 (76.4)	44 (80.0)
Am snack=9am -12pm	37 (62.7)	39 (66.1)	31 (56.4)
Lunch=12pm-2pm	48 (81.4)	51 (86.4)	48 (87.3)
Pm snack=2-5:30pm	48 (81.4)	46 (78.0)	42 (76.4)
Supper=5:30-8pm	49 (83.1)	50 (84.8)	50 (90.9)
Late night snack=>8pm	27 (45.8)	25 (42.4)	26 (47.3)

Table 45 presents the frequency of snacking by those individuals who did snack between meals. About one third of subjects snacked two times while a third snacked three or more times.

[†] Meal and snack times were categorised afterwards, based on the time of day.

Table 45: Frequency of snacking derived from the three 24-hour dietary recalls

	Recall 1 n=59	Recall 2 n=59	Recall 3 n=55
	n (%)	n (%)	n (%)
≤ 1 snack time	19(32.2)	18(30.5)	21(38.2)
2 snack times	23(39.0)	21(35.6)	17(30.9)
≥ 3 snacks	17(28.8)	20(33.9)	17(30.9)

Table 46 presents the self-reported meal pattern of the study sample compared to the meal pattern derived from results of the three dietary recalls. A fifth self-reported that they ate only three meals a day without snacking, while results obtained from the 24-hour dietary recall demonstrated that very few actually ate only three meals a day. A very small percentage indicated that they ate one to two meals a day with snacks, although almost a third actually consumed one to two meals with snacking daily.

Table 46: Self-reported meal pattern of the study sample vs. actual meal pattern derived from each of the three 24-hour dietary recalls (n=59)

Meal pattern	Self-reported n=59	Recall1 n=59	Recall 2 n=59	Recall 3 n=55
	n (%)	n (%)	n (%)	n (%)
3 meals per day (no eating between meals)	13 (22.0)	1 (1.7)	3 (5.1)	3 (5.5)
3 meals per day (with eating between meals)	29 (49.2)	28 (47.5)	29 (49.1)	33 (55.9)
1 - 2 meals per day (no eating between meals)	6 (0.2)	1 (1.7)	2 (3.4)	0 (0)
1 - 2 meals per day (with eating between meals)	5 (8.5)	28 (47.5)	25 (42.4)	19 (34.6)
Nibble the whole day, no specific meals	4 (6.8)	1 (1.7)	-	-
Other	2 (3.0)			

The distribution of energy, carbohydrates, fat, protein, fibre and sugar in snacks and meals is presented in Table 47. Energy and consumption of all the macronutrients were the highest at lunch and supper times. Carbohydrate was spread throughout the day, with less than 15g difference between meals and snacks. Sugar intake was the highest at the afternoon snack.

Table 47: Distribution of energy, carbohydrates, fat, protein, and sugar in snacks and meal times for the study sample (n=59)

Eating time	Energy distribution (Kilojoules)		Carbohydrate distribution (g)		Fat distribution(g)		Protein distribution(g)		Sugar distribution(g)	
	Mean(±SD)	Median(IQR)	Mean(±SD)	Median(IQR)	Mean(±SD)	Median(IQR)	Mean(±SD)	Median(IQR)	Mean(±SD)	Median(IQR)
Early morning	158(167)	94(30-284)	5.4(6)	3.3(1-10)	1.0(2)	0.7 (0-1)	1.1(1)	0.7(0-2)	2.0(3)	0.7 (0-3)
Breakfast	823(488)	777(507-1187)	26.5(16)	25.6(17-34)	5.8(5)	4.2(2-9)	6.4(4)	6.0(4-10)	4.7(5)	3.3(1-7)
Am snack	920(718)	764(389-1432)	25.2(18)	25.1 (11-35)	9.0(9)	6.0(2-17)	6.8(6)	4.4(2-10)	3.8(4)	2.7(1-6)
Lunch	1523(723)	1422(1037-1886)	38.7(18)	35.6 (27-47)	14.6(9)	11.9(9-21)	14.6 (8)	13.8(9-20)	3.6(5)	1.7(0-5)
Pm snack	936(762)	757(313-1254)	29.2(21)	26.5 (13-40)	8.1(10)	3.9(2-11)	5.8(7)	3.1(1-9)	7.6(9)	5.1(2-11)
Supper	1651(914)	1491(1143-1994)	39.0(26)	34.3(26-47)	15.9(12)	13.8(8-20)	19.4 (9)	18.8(12-26)	6.6(15)	2.6(0-7)
Late night snack	656(680)	478(134-921)	17.7(17)	14.2(7-25)	6.4(7)	5.0(1-10)	4.7(5)	3.2(1-7)	4.3(7)	1.6(0-6)

4.4.2 Discussion:

The quantity of carbohydrate-rich foods consumed is important both from an energy intake viewpoint and in light of the glycaemic load of a meal. Distribution of particularly carbohydrates throughout the day has always been one of the core messages for persons with diabetes because of the effect of carbohydrate on blood glucose. This is especially important for the type 1 person with diabetes on a fixed insulin regimen (Franz, 2008:822). In the case of persons with type 2 diabetes at least three equal-sized meals everyday with optional snacks is generally recommended (SEMDSA, 1997). However, late night snacks are routinely recommended for those on insulin at night to prevent hypoglycaemia (Franz, 2008:822).

The results of this research show that the study sample followed a meal pattern of two to three meals and at least two snacks daily. More than 40% of the study sample ate a late night snack, although it was not assessed whether the ones who did so were actually on insulin therapy. The fact that more than 75% of the study sample ate breakfast is encouraging and contrary to previous findings on meals and nutritional intakes of adult coloured people in the Western Cape (Langenhoven et al, 1988a) where breakfast consumption was found to be uncommon. Black persons with type 2 diabetes attending primary health-care services were more regular in their consumption of breakfast, lunch and supper (>90% for each meal) compared to this study. The black subjects were less inclined to snack between meals (Nthangeni et al, 2002). The distribution of carbohydrates and energy throughout the day in our study seems appropriate, as there are no large differences in intake that could potentially lead to a high glycaemic load at a particular point.

When comparing the self-reported meal pattern to the meal pattern derived from the three 24-hour dietary recalls, it is evident that there is a discrepancy. Half of the study sample described their meal pattern as three meals per day with snacks, with a third of the study sample reporting that they do not snack between meals. The data derived from the 24-hour recalls point to the fact that almost half actually consumed three meals a day, but that the majority also snacked in between meals. The apparent underestimation of snacks that characterised the self-reporting of snacks could be explained by the way people differentiate between the concepts of a ‘snack’ vs. a ‘meal’. A limitation of this part of the data collection was that these concepts were not

defined when the subjects were requested to report on their meal pattern. For the purposes of deriving a meal pattern from the 24-hour dietary recalls, the definition of a snack vs. a meal was based on time slots as was described in the methods section (Chapter 3; section 3.6.2: Table 13). This could explain the discrepancy between how the study sample perceived their meal pattern versus their actual consumption to some extent. However, it does not exclude the possibility that subjects considered what should be viewed as a meal as a snack or that they in actual fact did not recall snacking between meals or viewed it as an insignificant contribution to their dietary intake. It would not only be very important in future research to clarify this type of terminology, but also when formulating recommendations and giving nutrition education.

In terms of the composition of meals and snacks the energy, carbohydrate, fat and protein content was the highest at lunch and supper times. This was expected since these are traditionally the main meals of the day. Meals and snacks were high in carbohydrate and consistent with the FBDG of *"making starch the basis of each meal"*. It was not assessed which foods were typically eaten as snacks. However, since the most commonly consumed carbohydrates predominantly had a high GI (such as baked confectionary and bread) and were low in fibre, it can speculated that snacks quite probably comprised of such poor choices. Furthermore, since the overall intake of vegetables and fruit was low, it can also be assumed that fruits and vegetables were not commonly consumed as snack items. This is in line with the findings of Langenhoven et al (1988a) for the general coloured population, namely a pattern of heavy snacking between meals, which frequently tended to supply large quantities of sugar and fat. Since snacking seems to be a part of the eating pattern of this ethnic group, both in the general and diabetic populations, it may be appropriate to focus nutrition messages on improving the quality of snacks rather than discouraging the habit in total. Thus, emphasis on lower GI carbohydrates and snacks may promote a more moderate blood glucose response and can contribute to increased satiety of the meal/snack. Examples of appropriate snacks, number of snacks and number of snack times may be helpful in improving the habit of snacking. Energy-dense snacks can be replaced with lower energy-dense foods higher in fibre. In this way a familiar pattern can be upheld while energy intake is limited.

In summary, the majority of subjects consumed either one to two meals or three meals with snacks. Carbohydrates appropriately formed the basis of these meals and snacks and were distributed fairly evenly throughout the day. The quality of snacks (and meals) can be improved by an emphasis on low GI and/or high fibre carbohydrate items as well as fruit and low fat dairy. In light of the high prevalence of obesity it should be emphasised that snacks should be incorporated as part of total energy intake for the day and not over and above their recommended intake. This is where the help of a dietitian can be very valuable to ensure that snacks consists of good food choices including carbohydrates, fat and protein. A clear definition of 'snack' vs. 'meal' is recommended and will be essential for future research on this topic.

4.4.3 Summary and Conclusion

Data on the meal and snack pattern of the study sample indicate that the following aspects need to be considered in the formulation of recommendations for the management of coloured persons with type 2 diabetes attending CHCs in the Cape Peninsula:

- Snacking forms part of the eating pattern of the study population.
- Snacks are consistent with the FBDG of '*making starch the basis of each meal'*, although the **quality** was likely to be poor, reflecting the general intake profile of the study sample, namely low in fibre, fruit and vegetables and high in refined carbohydrates and fat.
- The definition of a snack vs. a meal need to be clarified
- Guidance on the number of snacks at a snack time and appropriate portions and examples is necessary.

4.5 Broad understanding and perception of diabetes and dietary aspects of the management of diabetes

The following section focuses on general understanding of diabetes, the management thereof and general dietary aspects related to diabetes management.

4.5.1 Results: General diabetes management

Almost a third of subjects indicated that they are not clear on how to describe diabetes (Table 48). Less than a fifth made mention of high blood sugar and/or the involvement of insulin or the pancreas. When asked about the role of diet in the management of diabetes, they were vague about benefits other than the immediate effect that diet had on blood glucose control (57.6%, n=34). Improved health was mentioned by 25.4 %(n=15), weight management by 18.6% (n=11) and prevention of complications by 5% (n=3).

Table 48: Definition of diabetes as explained by the study sample* (**n=59)**

Definition of diabetes	N (%)
Don't know/vague/non-specific	16 (27.1)
High sugar in blood	13 (22.0)
To do with Pancreas/insulin	11 (18.6)
Symptoms mentioned	21 (35.7)
Role of Diet: Causative	10 (16.9)
Role of Diet: Management	17 (28.8)
Complications mentioned	13 (22)
Other management strategies	5 (8.5)
Other	3 (5.1)

* Multiple answers

Table 49 presents the perception of the study sample regarding causes, symptoms and management of diabetes. Most reported that they had never experienced low blood sugar and a third did not know the signs or symptoms of low blood sugar. More than half of the study sample correctly mentioned the taking of insulin or diabetic tablets as one of the causes of low blood sugar and a third also mentioned that eating too little can lead to low blood sugar. More than one third indicated feelings of faintness as one of the symptoms of low blood sugar. The majority of the subjects correctly mentioned that eating something could treat low blood glucose.

Table 49: Perception of causes and symptoms of hypoglycaemia by the study sample* (n=59)

Cause of low blood sugar	N (%)	Symptoms low blood sugar:	N (%)	What to do when low blood sugar?	N (%)
Not eating/too little:	19 (32.2)	Sweat	3 (5.1)	Medicine:	3 (5.1)
Eating incorrectly:	4 (6.8)	Faint	24(40.7)	Eat:	37(62.7)
Water:	1 (1.7)	As for high BG:	3 (5.1)	Hospital/clinic:	7 (11.9)
Tablets/Insulin:	35 (59.3)	Hunger	1 (1.7)	Sugar water:	5 (8.5)
Other:		Irritability	1 (1.7)	Lie down	4 (6.8)
E.g. low iron; sour food; alcohol, menstruation	8 (15.3)	Palpitations	1 (1.7)	Don't know:	10(17.0)
		Headaches	2 (3.4)	Other:	
		Confusion	2 (3.4)	E.g. Take insulin, test sugar, drink water	4 (6.8)
		Don't know	19(32.2)		
		Other:			
		varied answers	5 (8.5)		

*multiple answers

At least half of the study sample attributed hyperglycaemia to dietary factors with 42% directly relating it to the intake of sugar or sweet foods and 39% relating it to fat intake (Table 50). Tiredness or weakness (64%, n=38) was by far the most frequently mentioned symptom of hyperglycaemia followed by thirst (22%, n=13). The study sample was unclear on the management of hyperglycaemia and the drinking of fluid (water or tea) was mentioned most frequently (46%, n=27) followed by taking medication (37%, n=22) and sleeping (24%, n=14). Only about a third mentioned taking medication and very few mentioned going to a clinic or hospital as a way to respond to hyperglycaemia.

Table 50: Perception on causes and symptoms of hyperglycaemia by the study sample* **(n=59)**

Cause of high blood sugar	N (%)	What to do when high blood sugars	N (%)
Diet: general	32 (54.2)	Take medication	22 (37.3)
Diet: sugar/sweet foods	25 (42.4)	Eat	5 (8.5)
Diet: Fats/fatty foods	23 (39.0)	Hosp/clinic	7 (11.9)
Stress/worry	13 (22.3)	Other: Water/tea:	27 (45.8)
Other:		Sleep:	14 (23.7)
E.g. spicy food, little insulin, too little rest	10 (16.9)	Remedy:	7 (11.9)
Don't know	3 (5.1)	Don't know:	2 (3.4)
		Other:	4 (6.8)

Symptoms of high blood sugar	N (%)		N (%)
Thirsty	13 (22.0)	Headache	6 (10.2)
Urinate often	3 (5.1)	Dizzy/shaky/drunk	15 (25.4)
Vision poor	6 (10.1)	Affecting mood: down/sad/moody	7 (11.9)
Feel tired/weak	38 (64.4)	Don't know	3 (5.1)
Dry skin 1	4 (6.8)	Other :	
Infection (skin/vagina/bladder)	1 (1.7)	E.g. hot flushes; leg pain; weight loss	9 (15.2)
Hunger	2 (3.9)		

* Multiple answers

When considering other ways in which diabetes affects their health, eye problems were mentioned by 49.2% (n=29), amputations by 37.3% (n=22), heart problems by 25.4% (n=15), kidney problems by 23.7% (n=14), stroke by 15.3% (n=9), poor wound healing by 10.2% (n=6) and other by 11.9 % (n=7).

4.5.2 Results: Dietary aspects of diabetes management.

Less than a third (32.2%) of the study sample indicated that they generally follow a 'diabetic' diet. Most of the study sample stated that they either do not follow a 'diabetic' diet or only some of the time.

Table 51 presents data on how the study sample thought a 'diabetic' diet differs from a 'normal' diet. A lowered fat intake was by far the most frequently mentioned point, followed by a decreased intake of sugary foods and eating more vegetables. Smaller portions and the importance of whole grains were mentioned by very few of the study sample.

Table 51: Perceptions on the difference between a 'diabetic' diet and a 'normal' diet in coloured women with type 2 diabetes (n=59)

Question: How do *you* think a diabetic diet should be different from a 'normal' * diet? **	
	N (%)
Decrease fat intake: oil, fried, skin off, cooking method	45 (76.3)
Decrease sugar, sweets, pudding, cake/sugar-free	24 (40.7)
Increase Vegetables/ salads	15 (25.4)
Have smaller portions/less	10 (17.0)
Low salt	9 (15.3)
Whole grains	6 (10.2)
Increase Water intake	5 (8.5)
No difference	3 (5.1)

**'Normal' = the way persons without diabetes eat*

***Multiple answers*

Table 52 presents a comparison between what subjects would advise other persons with diabetes in terms of eating specific food items compared to their own practices (derived from the three 24-hour dietary recalls). They proposed recommendations focused on a very low and infrequent intake of food items such as cold drinks, white sugar and white bread even though their own diet showed a high frequency of intake of these items. Food items that were highly recommended for other persons with diabetes by the study sample, but actually consumed infrequently by themselves, included milk, Provitas, cream crackers, oats, mealie porridge, baked beans, pilchards and lentils. The study sample were clearly not sure about whether fruit juice, brown sugar, Marie biscuits, white toast, sweet potato, eggs, nuts, avocado and pudding should be included in the diet of a person with diabetes or not.

Table 52: Comparison of recommendations made by the study sample to persons with type 2 diabetes vs. their own practices (n=59)

Food Item	Recommendation for other diabetic persons*	Correctness of recommendation**	Actual intake by sample***	Actual compliance to own recommendation
Alcohol	Avoid/Little	Correct	Very low	Good Compliance
Fruit Juice	Uncertain	Uncertain (should be avoid/little)	Low	Good Compliance (to correct recommendation)
Cold drinks	Avoid/Little	Correct	Medium Low	Moderate compliance
Milk	Good/ Often, but limit Amounts	Correct (emphasis on low fat)	Medium	Poor compliance (low milk intake and mostly full cream)
White Sugar	Avoid/Little	Correct	High	Poor compliance
Brown Sugar	Uncertain	Uncertain(should be similar as for white sugar);	Very low	Good compliance (to correct recommendation)
Honey	Avoid/Little	Correct	Very low	Good Compliance
Jam	Avoid/Little	Correct	Low	Good Compliance
Marie Biscuits	Uncertain	Uncertain (should be avoid/little)	Low	Good compliance (to correct recommendation)
Provitas	Good/ Often, but limit Amounts	Correct	Very low	Poor compliance
Cream Crackers	Good/ Often, but limit Amounts	Incorrect	Very low	Good compliance(to correct recommendation)
Bread	Good/ Often, but limit Amounts	Correct(emphasis on whole-wheat/low GI)	High	Moderate Compliance (high intake of white bread)
White Toast	Uncertain	Uncertain(should be avoid/little)	High	Poor compliance(to correct recommendation)
Potatoes	Good/ Often, but limit Amounts	Correct(but high GI)	High	Good Compliance
Rice	Very good/ Often, but limit Amounts	Correct(may be high GI)	High	Good compliance
Sweet Potato	Uncertain	Uncertain (should be good/Often, but limit amounts)	Very low	Poor compliance(to correct recommendation)
Oats	Good/ Often, but limit Amounts	Correct	Low	Poor compliance
Weetbix	Good/ Often, but limit Amounts	Correct(but High GI)	Medium	Good Compliance
Mealie porridge	Good/ Often, but limit Amounts	Correct (but high GI)	Very low	Poor compliance
Baked Beans	Good/ Often, but limit Amounts	Correct	Low	Poor compliance
Legumes	Good/ Often, but limit Amounts	Correct	Very low	Poor compliance
Pilchards	Good/ Often, but limit Amounts	Correct	Low	Poor compliance
Red Meat	Avoid/Little	Correct (lean meat, small portions)	Medium	Moderate compliance (often high fat meats)
Sausage	Avoid/Little	Correct:	Low	Good compliance
Polony	Avoid/Little	Correct:	Low	Good compliance
Eggs	Uncertain	Uncertain (good/ often, but limit amounts)	Medium	Good compliance (to correct recommendation)
Nuts	Uncertain	Uncertain (good/ often, but limit amounts)	Low	Poor compliance (to correct recommendation)
Avocado	Uncertain	Uncertain (good/often, but limit amounts)	Very low	Poor compliance (to correct recommendation)
Fried chips & crisps	Avoid/Little	Correct:	Medium	Moderate compliance
Pudding	Uncertain	Uncertain	Medium	Moderate compliance
Pies & samoosas	Avoid/Little	Correct:	Very low	Good compliance
Sweets	Avoid/Little	Correct:	Medium	Moderate compliance
Chocolate	Avoid/Little	Correct:	Low	Good compliance
Fresh fruit	Good/ Often, but limit Amounts	Correct:	Low	Poor compliance(poor intake)
Canned fruit	Avoid/Little	Correct:	Low	Good compliance

Footnotes follow on the next page.

*In the original questionnaire the study sample could give one of five responses, namely 'avoid'; 'allowed but little'; 'often, but limit amounts'; 'very good' or 'do not know'. The five responses were collated for further interpretation by combining 'avoid' and 'little' into one category and 'very good' and 'often but limited' into another category. The 'don't know' response fell away since it was negligible. A response % of 60 for a category was taken as a definitive correct or incorrect answer.

**Where response % was fairly similar and not reaching 60 for one of the two categories results were described as 'uncertain'. The correct recommendation is then given in brackets.

***Intake was derived from the 24-hour dietary recall data and categorised according to percentage reported intake. The following cut-offs were formulated based on the % consumption: Very high (>80%); High (60-80%); Medium (40-60%); Low (20-40%) and Very low (<20%).

Fruit was generally regarded as a highly recommended item to include in the diet, although actual reported intake of fruit was low. A specific open-ended question on fruit was asked to further distinguish between views on specific fruits. Grapes were identified by 37.3% (n=22) of the study sample as a fruit that should be avoided, followed by bananas (23.7%; n=14) and spanspek (23.7%; n=14). Although overall fruit intake was low, bananas (40.7%; n=24) were in fact the most frequently consumed fruit by the study sample, followed by apples and pears (35.6%; n=21) and grapes (32.2%; n=19).

When considering the sources of dietary information, doctors were mentioned by 52.5 % (n=31), nurses by 13.6% (n=8), dietitians by 23.7% (n=6) and others by 10.2 % (n=6). Two thirds indicated that they had never been to see a dietitian.

Of the 18.6% who indicated that they eat differently from the rest of their family due to their diabetes, the majority indicated that the differences entailed having smaller portions, less added sugar and the use of a different cooking method (i.e. boiling instead of frying). The main complaints about the 'diabetic' diet were that of expense (59.3%; n=35), while craving 'forbidden' foods were mentioned by 42.2% (n=25), lack of taste by 35.6% (n=21) and 15.3% (n=9) had no problems with the diet. The fact that the diet was different to what their family preferred was mentioned by 15.3% (n=9) while regular meals (11.9%; n=7), eating out (10.2%, n=6) and hunger (10.2%; n=6) were also reported as factors that made it difficult to follow a diabetic diet.

4.5.3 Discussion

An explanation and recognition of diabetes symptoms together with the appropriate action to take, as well as an awareness of complications and basic dietary principles to manage diabetes are all aspects that should form part of basic diabetes education at primary level (Levitt et al, 2009; SEMDSA, 1997). It is of concern that the study sample was not able to give a simple explanation of a disease that affects their lives in so many ways. This is however consistent with findings in black persons with type 2

diabetes where only 40% were able to give an explanation of their disease (Nthangeni et al, 2002). In another study amongst persons with type 2 diabetes in the Northern Province, most persons (60%) reported that they did not know why they had diabetes and what caused it (Bopape & Peltzer, 2002). One explanation for a finding such as this is that the low levels of education of subjects in these studies make comprehension of the disease difficult. However, if this is the case, the appropriateness of the education that is taking place for persons with diabetes needs to be questioned and adjusted to a level where they can develop a basic, but good understanding of their disease is essential. Although knowledge in itself does not guarantee better self-management (Day 1995; Nurymberg, 1996), an understanding of diabetes can contribute to improved control in persons with poorly controlled type 2 diabetes (Hartz et al, 2006 ; Lerman, 2005). The fact that the study sample had been diagnosed with diabetes for a mean of six years indicates that it cannot be taken for granted that those with long-standing diabetes have achieved a certain level of diabetes education and are ready for more in-depth education.

The fact that symptoms of being dizzy, shaky or drunk were mentioned by a substantial number of respondents as symptoms of *both* hyperglycaemia and hypoglycaemia is also expected. Diabetes is one of the several chronic diseases with symptoms that are not readily identifiable (Tripp-Reimer et al, 2001). One contributing factor might be that most of persons with type 2 diabetes in the public health care system do not have glucometers to measure and monitor their own blood sugar levels and thus never have the opportunity to be able to check their blood glucose when they experience certain symptoms. One of the reasons why seeking health care was low on the list of management options when subjects do experience high or low blood sugar, may be due to the fact that they do not actually know when their blood sugar is very high or low and how severe it is.

The vagueness of the responses of the study sample on what to do when blood sugar is high is, however, particularly alarming, since it is a situation that most of the study sample will encounter. The perception of many that drinking fluids will lower blood sugar or that sleep might make it better, is reason for concern and underlines the confusion surrounding the management of hyperglycaemia. In a study in Pakistani Moslems with type 2 diabetes mellitus only 24% knew how to manage persistent hyperglycaemia (Hawthorne & Tomlinson, 1999). Women, especially those who could not read, were less likely to understand why glucose levels should be

monitored, and had poorer glycaemic control overall (Hawthorne & Tomlinson, 1999). These issues need to be considered when recommending guidelines for persons with diabetes in this sample population.

The fact that eye problems and amputations were frequently reported as complications of diabetes is in line with findings that there is a high prevalence of micro vascular complications in South Africans with long-duration diabetes mellitus (Motala et al, 2001). However, of concern is the fact that in our study most subjects did not mention heart disease as a complication of diabetes while the WHO report that fifty percent of persons with diabetes will die of cardiovascular disease (primarily heart disease and stroke) (WHO, 2006). Heart disease might be a less 'visible' threat but if the diabetic individual does not recognise the threat to his/her own health, the advantage of behaviour change (such as consuming a diet low in saturated fat) is also unlikely to be seen as important (Day, 1995). More emphasis is needed on the very real risk and debilitating effects of heart disease and especially the important role that dietary and other lifestyle changes can play in its management.

The discrepancy between dietary knowledge and actual dietary intake is not surprising and in line with the general experience that providing information about diabetes to the person with diabetes is not sufficient to ensure compliance (Nurymberg et al, 1996). The majority of the study sample correctly identified a need to limit fat as an important aspect of a diabetic diet, although their actual fat intake was still above 30% of total energy intake. Limiting sugar intake and increasing vegetable intake were two other aspects identified by many as important. However, sweet baked confectionary was one of the main food items contributing to total energy and carbohydrate intake whilst vegetable intake was poor.

Food items that were highly recommended by the study sample for consumption by other persons with diabetes were generally healthy choices, low in fat and low in refined carbohydrates, such as oats, pilchards, legumes and fresh fruit. Their actual practices, however, were often in contrast to this advice, e.g. intake of legumes, pilchards and fruit was poor. Similarly, food items such as cold drinks, white sugar and fried chips and crisps that were correctly recommended 'to be avoided' or 'have little of' were consumed by 40-60% of the study sample.

It is interesting that sweet, tropical fruits are often seen as fruit that should be avoided, although it is similar, or sometimes lower in GI compared to a typical serving of

starchy food such as a slice of ordinary brown (or white) bread. Ideally this is the type of information that needs to be delivered in the context of the individual dietary pattern. However, it is quite likely that the perceived inappropriateness of some fruit is not the primary reason for its low consumption, but rather the cost of it (Drewnowski & Darmon, 2005).

The identification of 'grey areas' such as the appropriateness of brown sugar, Marie biscuits, white toast, fruit juice, sweet fruits such as bananas and grapes, as well as baked beans, eggs and sweet potato can be very valuable to those involved in dietary education for diabetes. The latter three food items are all economic choices and good sources of macro and micronutrients. When prepared with little fat and consumed in appropriate portions the addition of these items can serve to improve the variety of the diet and lessen the typical feeling of restriction (or craving 'forbidden' foods) that so many persons with diabetes experience regarding their diet.

The fact that only a small number of the study sample mentioned smaller portions as an important aspect of the diet also needs consideration for future recommendations. Firstly, decreasing portion sizes is a basic way to decrease energy intake for the purposes of weight loss (Ello-Martin et al, 2005). As discussed before, weight loss is a very important aspect of diabetes management, especially in this population with its very high prevalence of obesity. Emphasis on small portions of especially high fat and high energy dense items and more liberal portions of high bulk food items such as vegetables can 'dilute' energy density and still ensure enough bulk in the diet as well as satisfy a desire for variety and taste. Secondly, portion size control of especially carbohydrates at meals and snacks is important for the regulation of blood sugar levels. Although our data do suggest that carbohydrate and sugar intake was low, the chosen type of carbohydrates was typically of higher GI. In the light of the possible presence of underreporting, these types of carbohydrates can more easily contribute to a high glycaemic load when consumed in large quantities.

The fact that most of the study sample was unclear about the specific benefits of diet, besides the benefit of improved blood glucose control, has also been found in other diabetic populations (Quatromoni et al, 1994). This highlights the need for improved knowledge as an important aspect of behavioural change (Maldonato et al, 1995) in the study population since improved communication on the benefit of diet have been shown to promote healthful dietary change (Patterson et al, 1996).

The complaint that a 'diabetic' diet is expensive is another barrier, although not unique to our study population. It was also the number one complaint of South African black persons with type 2 diabetes to following a diabetic diet (Nthangeni et al, 2002). Puerto Rican persons with diabetes also reported low income and expense of foods as one of the key reasons for not following a prescribed diet (Tripp-Reimer et al, 2001). Although nutrition educators would like to convince persons with diabetes that a diabetic diet is neither a special diet nor an expensive diet, studies conducted in Australia, Canada, and the European Union have confirmed the fact that healthier diets are more costly (Stender et al, 1993; Andrieu et al, 2003; Cade et al, 1999). These observations pose a serious challenge for the current strategies for health promotion since dietary guidelines calling for more nutritious diets all promote an increased consumption of vegetables, fruit, and whole grains and lean meat. However, these high quality diets are in fact costly and provide less dietary energy compared to refined grains, fats and sweet that provide energy at a lower cost (Drewnowski & Darmon, 2005). Therefore, simply encouraging low-income households to consume more costly foods cannot be an effective strategy to promote dietary changes. In light of rising food prices and overall increased cost of living (Johns, 2008) it is more relevant than ever before to include messages aimed at addressing the issue of expense.

In the light of this, two aspects may be important to consider for the person with diabetes. Firstly, the person with diabetes needs to be convinced of the beneficial role that diet could play in order for them to make dietary changes that might in the short term look more costly. If the perceived advantage of the change does not seem greater than the perceived disadvantages, it is unlikely to lead to behaviour change (Maldonato et al, 1995), especially in light of the barrier of cost. Secondly, the person with diabetes needs to be empowered to make the best choices possible given his/her economic situation. It may be speculated that because certain dietary messages receive more prominence, persons with diabetes may look at certain, more expensive changes (e.g. buying soft low fat margarine) as a first priority, while not making other important but less costly changes (such as using less margarine or cooking with lentils). It is important that persons with diabetes realise that they can make changes in almost any circumstance. Those involved in dietary education and nutrition therapy need to assist diabetic individuals to recognise and encourage the changes they can make that will contribute to better outcomes.

Dietary restriction and lack of taste have also been mentioned as barriers to following the dietary recommendations by black persons with type 2 diabetes (Nthangeni et al, 2002). Lack of clarity or mixed messages received from various sources might contribute to the idea of dietary restriction and lack of variety. As mentioned earlier baked beans, eggs, avocado and sweet potato were identified as food items about which the study sample were uncertain regarding the appropriateness in the diabetic diet. Incorporation of only a few items such as these can serve to improve variety and taste as well as improve the overall dietary quality of the diet. The recommendation to limit fat and sugar intake may also contribute to the idea of a tasteless diet along with an oversimplified message that all food must be boiled, not fried. It is not known how empowered persons with diabetes actually are to cook tasty, yet low fat, low salt and low sugar meals. It may be more valuable in this low social economic group to practically demonstrate cooking techniques instead of merely mentioning it.

The belief that a diabetic diet is a tasteless and restrictive way of eating will also influence the measure to which the diabetic's family will be willing to follow this eating pattern. A lot of emphasis has been placed in recent years on the fact that a diabetic diet is a healthy diet for the whole family to follow. However, if family members have the perception that taste and variety is sacrificed, it will prevent them from following such a diet along with the person with diabetes. Although only a few in our study explicitly mentioned the way family eats as a barrier, it had also been reported as one of the difficulties to adhere to a diabetic diet in other diabetic groups. In persons with type 2 diabetes in the Northern Province it was found that dietary needs of a person with diabetes were frequently put aside for the sake of the family (Bopape & Peltzer, 2002). Women especially may view the need to change their diet as being selfish and costly, and therefore a burden to her family (Bautista-Martinez et al, 1999; Day, 1995). The social environment, especially the family, may therefore prove to be much more powerful than the professional advice given (Day, 1995). For this reason, the family must be considered an integral part of treatment, especially concerning diet, instead of merely focusing on individual management (Lerman et al, 2005).

The finding that most of the study sample had never been counselled by a dietitian is in line with findings elsewhere in South Africa (Nthangeni et al, 2002). Most persons with diabetes in the latter study received their dietary information on diabetes from a

doctor, as in our study, or from nursing staff (Nthangeni et al, 2002). Even though the number of dietitians employed by the Cape Metropole Area has never been higher, namely 17 community dietitians, they need to deliver a dietetic service to all 45 CHCs as well as to clinics and non-governmental organisations (Goeiman: Personal communication, 2009). As a result they may visit a CHC only once to three times a month (Marshall: Personal communication, 2008). It is clearly not realistic to expect all persons with diabetes to be seen by a dietitian.

However, the fact that doctors and nurses are left to do the majority of dietary counselling is not a good alternative either, as they are people with the least time to perform dietary counselling and often lack the training and skills to do it (Parker, 2008). Health care education may furthermore be left to health promoting officers in day hospitals who are former family planning educators. They are responsible for all health care education in the CHC, ranging from HIV awareness, mental health and family planning. The Cape Metropole does have nutrition advisors who are trained in providing general advice on healthy eating for diabetes and are supervised by community dietitians. However, only 14 nutrition advisors are employed in the Cape Metropole district and they serve both CHC and baby clinics (Marshall: Personal communication, 2008).

In light of the obvious limitations in terms of time, work force and training two aspects can be addressed within this existing framework. Firstly, all health care providers should be trained to view every professional contact as an opportunity to affirm or convey appropriate dietary messages. Secondly, consistent dietary messages need to be delivered and training and tools for this should be provided. Inconsistent messages given by different health providers regarding the type and quantity of foods to eat have caused confusion in black persons with type 2 diabetes (Nthangeni et al, 2002) and may lead to rejection of all dietary messages (Day, 1995). The dietitian can render a valuable service to ensure that consistent dietary education takes place at every opportunity. Training should address gaps in both knowledge and behaviour as identified by our study as well as other available studies.

In addition to strengthening the existing framework, the use of community workers may also be helpful. Community workers who may be have diabetes themselves, but are successfully implementing lifestyle changes, may be very effective in conveying dietary messages. In an earlier section (section 4.1.1 and 4.1.2), it was reported that

subjects used diabetes remedies and that most received this advice from family or friends. In the same way, information from a diabetic peer may be received with more enthusiasm since it is someone who knows what they are going through and faces similar challenges.

4.5.4 Summary and conclusion

Based on the data in this section the following aspects need to be considered in the formulation of recommendations for the management of coloured persons with type 2 diabetes attending CHCs in the Cape Peninsula:

- It cannot be assumed that those with longstanding diabetes are more knowledgeable or that they have received more input regarding basic diabetes management aspects.
- Specific aspects related to nutrition therapy that should be covered (based on the identified limitations in the knowledge of the study sample):
    - The symptoms and management of hyper and hypoglycaemia and self management steps to take.
    - The benefits and the role of diet in the management of diabetes.
    - The complications of diabetes, in particular the risk of cardiovascular disease.
    - The promotion of specific foods that are currently consumed infrequently by the study population, such as lentils, beans, pilchards and sweet potato.
    - The aspect of cost and taste in the diabetic diet
    - The inclusion of the whole family in nutrition therapy of the person with diabetes.
- Consistency of dietary messages provided by health care providers
- The use of peer-educators from the community to assist in dietary education.

4.6 Summary of limitations

Efforts made to ensure or improve aspects concerning reliability and validity of the study have been discussed in Section 3.7. However, despite these efforts there are still limitations that may impact on the application and generalisability of the study. The most important limitations of this study are as follows:

· The small sample size and the fact that no men were included in the study limit the application and generalisability of the study results to the general coloured diabetic population.

· The fact that biochemistry values (such as fasting blood glucose, HbA1c and total cholesterol) were not available for all participants made it impossible to draw more objective conclusions regarding the measure of participants blood glucose control and other complications.

· The underreporting that is a well-known limitation of the 24-hour dietary recall and is especially true for obese populations, may have been present in this study and limits the interpretation of dietary intake data.

· The fact that 24-hour recalls were often completed a month apart on the same day of the week could have affected results by not representing a spread of days and thus typical intake. Furthermore, three days may not have been enough to assess micronutrient intakes due to the high day to day variation.

· Physical activity levels were only measured at a screening level. A more specific measurement of physical activity could have improved the reliability of calculation of energy expenditure.

CHAPTER 5: SUMMARY, RECOMMENDATIONS AND FINAL CONCLUSIONS

5.1 Summary of study

The aim of this study was to develop recommendations for the implementation of nutrition therapy for coloured women with type 2 diabetes attending CHCs in the Cape Metropole. This was accomplished by assessing subjects' weight status; eating pattern; quantity and quality of dietary intake, using dietary guidelines for women with diabetes, the South African FBDGs, DRIs and the GI as reference standards. Subjects' broad understanding of diabetes and the management thereof were also assessed. A questionnaire was developed to assess socio-demographic background, lifestyle-related factors (physical activity, smoking and drinking habits) and nutrition and diabetes management-related knowledge. For dietary assessment purposes three 24-hour dietary recalls were obtained from each subject using the multiple pass method. A convenience sample of 59 coloured women with type 2 diabetes participated in the study. The data was collected over a period of three months at two community health care centres serving predominantly coloured people.

The results indicate that the study sample had a low socio-economic status, low level of formal education and a strong family history of type 2 diabetes. Most of the subjects were overweight (25%) or obese (62.5%) and had low levels of physical activity. Although low in total energy (±5850kJ) possibly due to underreporting, the subjects' diet was high in energy derived from total fat (±33%) and saturated fat (9.9%), with food products high in trans fats being consumed frequently. The diet was low in fibre (16g), lacking in adequate amounts of vegetables, fruit, legumes and possibly n-3 fatty acids, with a clear preference for refined carbohydrate food items. The majority of the sample did consume breakfast (±77.6%), lunch (±85%) and supper (±86.3%) and had a pattern of snacking between meals.

As far as diabetes knowledge is concerned, the study sample displayed inadequate knowledge in areas relating to the management of hypo and hyperglycaemia as well as the complications of diabetes, specifically the risk of cardiovascular disease. Most of the study sample (67%) had never been counselled by a dietitian and were not clear

on the role of diet in diabetes management other than some short-term benefits. Although subjects were able to identify healthy food choices, this was not reflected in actual food choices, specifically in relation to fat, sugar, vegetables and fruit, legume and refined carbohydrate choices. Expense, followed by taste and the restrictions associated with a 'diabetic' diet were identified as important barriers to following a diet for persons with diabetes.

Recommendations to advise the development of interventions for diabetes education, dietary behaviour change and weight loss at the level of the female coloured person with diabetes were subsequently developed based on the above-mentioned findings (See 5.2 A). However, interventions at individual level can only be effective within the context of a supportive framework at other levels, i.e. optimal capacity of health care professionals to implement appropriate interventions and the necessary policies at the different levels of government to support and drive initiatives. Recommendations advising decisions regarding training of the health care professional as well as policy development at government level on diabetes management were therefore also formulated (see 5.2B and 5.2C). A summary of recommendations are provided in Table 53.

Table 53: A summary of the recommendations to ensure optimal nutrition therapy of coloured women with type 2 diabetes attending CHC's based on the findings of this research.

Level of intervention	Broad recommendation	Specific actions
A: Recommendations aimed at the coloured woman with diabetes to ensure optimal nutrition therapy.	A1 The coloured women with diabetes should receive appropriate nutrition-related diabetes education.	A1.1 A systematic plan or cycle of educational talks and health promotion activities should be established. A1.2 The use of herbal or other remedies by women with diabetes should be acknowledged and included in diabetes education. A1.3 The impact of a family history of type 2 diabetes on self-efficacy of the person with diabetes should be placed in perspective. A1.4 The low level of formal education of the target group needs to be borne in mind in the development of educational content and materials.
	A2 Coloured women with diabetes should receive evidence-based, appropriate interventions for dietary behaviour change	A2.1 "Eat fat sparingly": Reduce saturated and transfat intake. A2.2 "Have plenty of vegetables and fruit": Increase vegetable and fruit intake. A2.3 "Make starchy foods the basis of all meals": Improve CHO choices -high in fibre and/or low GI. A2.4 "Eat sugar sparingly": Promote food choices low in sugar and refined CHOs. A2.5 "Eat dry beans, peas, lentils and soy regularly": Increase frequency of intake. A2.6 "Chicken, fish, milk, meat or eggs can be eaten daily": Substitute high fat animal products for low fat animal products or meat-alternatives. A2.7 Clarify the role of meals and snacks in the diet of a person with type 2 diabetes.
	A3 Coloured women with diabetes should receive evidence-based, appropriate weight management interventions	A3.1 Weight screening should include routine measurements of weight, height, BMI and waist circumference. A3.2 Weight monitoring should be implemented through regular follow-up and ongoing long-term support e.g. in a support group setting. A3.3 Weight management goals should be clarified. A3.4 Weight management guidelines should focus on the most prominent behaviour changes that will optimise the chance of coloured women with diabetes to maintain a 5% weight loss.
	A4 Coloured women with diabetes should be educated on the importance and required level of physical activity.	A4.1 Clarify the role of physical activity in diabetes management. A4.2 Clarify the role of physical activity in energy balance and weight management. A4.3 Identify and promote appropriate activities to increase physical activity levels.

Level of intervention	Broad recommendation	Specific actions
B: Recommendations aimed at health care professionals to ensure optimal nutrition therapy for persons with type 2 diabetes:	B1 Health professionals should have an understanding of basic nutrition principles.	B1.1 Exposure to the FBDGs and associated core nutrition principles for health should form part of the curriculum of all health care professionals. B1.2 Information on the FBDGs could also be included as options in continuous education programmes for health care professionals.
	B2 Health care professionals should have an understanding of the principles of nutrition therapy for the person with diabetes and the importance thereof in the management of the disease.	B2.1 Core nutrition principles for the management of diabetes need to be emphasised in the training of health care professionals. B2.2 Specific aspects concerning the role of nutrition therapy in diabetes management need to be emphasised in the training of health care professionals.
	B3 Health care professionals should have an understanding of the principles of successful weight management for type 2 diabetes.	B3.1 Core weight management principles need to be emphasised in the training of health care professionals.
	B4 Health care professionals should ave an understanding of the importance of adapting nutrition therapy to accommodate specific needs of individuals.	B4.1 Factors that may result in specific needs related to nutrition therapy in individuals with diabetes attending CHCs, namely socio-economic status and literacy level,, need to receive attention in the training of health care professionals.
	B5 Health care professionals should have access to suitable education materials and tools to empower them to provide consistent, evidence-based, nutrition therapy messages.	B5.1 Materials and education tools that are suitable in a low socio-economic, low literacy context need to be provided by the Department of Health. B5.2 Health care professionals need to be trained in the use of such materials and tools, bearing in mind their patients' socio-economic and literacy levels. B5.3 Health care professionals need to be trained to develop and create appropriate material and tools for use in their specific context.

Level of intervention	Broad recommendation	Specific actions
C: Recommendations to advise government regarding relevant policies and protocols to facilitate optimal nutrition therapy for the person with type 2 diabetes.	C1 Government should ensure the availability of a protocol at CHC level for the management of persons with type 2 diabetes.	C1.1 Such a protocol should include details on: • An evidence-based diabetes management protocol • Detailed guidelines on the nutrition therapy of diabetes • Duties • Role players • Guidelines on training needs of health care professionals • Nutrition education material and equipment
	C2 Government should ensure the availability of a protocol at CHC level for effective weight management interventions.	C2.1 Similar to C1.1
	C3 Government should formulate and implement relevant nutrition-related policies aimed at training institutions in collaboration with the Health Profession's Council of South Africa (HPCSA).	C3.1 The Health Profession's Council of South Africa (HPCSA) should be involved in ensuring that the curricula at training institutions cover aspects on diabetes and weigh management in sufficient detail, including both theoretical and practical aspects. C3.2 The HPSCA should also promote the inclusion of the above-mentioned aspects in sufficient detail in continuous education programs for health care professionals working in CHCs.

5.2 Recommendations for nutrition therapy of coloured women with type 2 diabetes attending CHC's based on the findings of this research.

The recommendations that follow are aimed to inform the development of the appropriate nutrition therapy for the management of diabetes at individual level (A). Recommendations to advise decisions regarding training of health care professionals (B) and policies that need to be in place (C) to provide the necessary context follow.

A: Recommendations aimed at the individual coloured women with type 2 diabetes to ensure optimal nutrition therapy [‡]

The recommendations in this section focus on appropriate nutrition-related diabetes education (A1), dietary behaviour change (A2) and weight management (A3).

A1 Recommendations to inform appropriate nutrition-related <u>diabetes education</u> of the coloured women with type 2 diabetes.

A1.1 A systematic plan or cycle of educational talks and health promotion activities should be established to ensure that all aspects of diabetes (disease and management) are covered within the course of the exposure of a person with type 2 diabetes to educational and health promotion activities at CHCs.

Specific aspects related to nutrition therapy that need to be emphasised in this cycle include the following:

- The symptoms and management of hyper and hypoglycaemia;
- Diabetic complications and risk indicators;
- The benefits and the role of diet in the management of diabetes;
- Healthy food choices for persons with type 2 diabetes;

[‡] *The term, coloured women, is used when referring to specific recommendations relating to this group. The term, individual(s) with diabetes, is used where recommendations clearly apply to all persons with diabetes.*

- Preparation of economic and tasty meals.

A1.2 The use of herbal or other remedies by women with diabetes should be acknowledged and included in diabetes education.

The following aspects in this regard should receive attention:

- Creating awareness regarding 'home remedies' or herbs that could potentially cause harm or interact with medication.
- Acknowledging the potential of home-remedies that may have beneficial affects.

A1.3 The impact of a family history of type 2 diabetes on self-efficacy of the person with diabetes to manage the disease should be placed in perspective.

The following aspects in this regard should receive attention:

- Creating awareness that a family history of diabetes does not mean the course of diabetes is inevitable.
- Emphasising the fact that effective intervention (diet, physical activity and medication) can play a role in delaying the initiation of type 2 diabetes, as well as the progress and severity of the disease, and thus ultimately the quality and quantity of life.

A1.4 The low level of formal education of the target group needs to be borne in mind in the development of educational content and materials.

Emphasis should be placed on educational materials that are predominantly based on visual educational principles to convey relevant messages. e.g. cooking demonstrations and food displays; picture-based posters and pamphlets and use of role play: live / video.

A2 Recommendations to advise evidence-based, appropriate interventions for <u>dietary behaviour change</u> in coloured women with type 2 diabetes.

The existing FBDGs should be used as a primary nutrition education guide for coloured women with type 2 diabetes. Based on the outcomes of this study it is recommended that specific points should be emphasised as part of individual FBDGs

to ensure optimal outcomes of nutrition therapy in coloured women with type 2 diabetes. These specific points are as follows:

A2.1 "Eat fat sparingly": Reduce saturated and transfat intake.

Emphasise reduction in intake of total fat, saturated fat and trans fat, as well as an increase in intake of n-3 fats. Promote suitable alternatives to high fat products (Table 54).

Table 54: Food choices to promote a diet low in total fat, saturated and transfats.

Have less...	Rather have	Reason/Comment
Brick margarine	To bake: Oil or Brick margarine specifically low in trans fats (read label); As a spread: Soft margarine; peanut butter; Avocado, low trans fat brick margarine or no margarine (best). Use a little fat only.	Brick margarine is typically high in trans fats. Brick margarines that are low in trans fats are available. However, the low education level may be a barrier in identifying these products as labels need to be read and interpreted.
Baked confectionary	Home-baked confectionary made with oil or low trans fat brick margarine. Use as little fat as possible in baking.	Hydrogenated vegetable fats (high in trans fats) are often an ingredient in commercially-prepared baked confectionary. Baked confectionary is also often high in refined carbohydrates and total fat.
Crisps, chips, fried foods and food preparation methods using a lot of oil	Popcorn made with little oil as a savoury snack Use little or no oil in cooking meat, fish and vegetables (e.g. potatoes). Use alternative ways to flavour food other than fat, such as herbs, onions and vegetables and fruit.	Fat is energy dense and lowering fat used in food preparation will help to lower total fat in the diet.
Full cream milk, cheese & cream	Low fat or fat-free dairy products	Full cream dairy products are high in total and saturated fat. Low fat or fat-free milk products provide similar calcium and other micronutrient levels as found in full cream milk.
High fat red meat e.g. mince dishes & chicken with skin	Have small portions; cut off all visible fat, extend meat with legumes, use little or no fat in preparation. Use lean mince meat or fish (tinned or fresh) prepared with little or no fat.	High fat meat products are high in total and saturated fats. Fish, especially oily varieties such as pilchards and mackerel, provide a good source of n-3 fats.

A2.2 “Have plenty vegetables and fruit”: Increase vegetable and fruit intake.

Emphasise an increased intake of vegetables and fruit in total as well as an increase in variety, focusing on the following:

- Promote vegetables and fruit that are nutrient dense and/or high in fibre and/or low in GI that are already commonly consumed by the study population e.g. tomato, pumpkin, apples, pears and citrus fruit.

- Promote best value for money choices e.g. instead of buying gem squash with low nutritive value, rather buy butternut, carrots or spinach; use all edible parts of vegetables and fruits (well-washed carrot and beetroot leaves and peels can be included in soups and stews; add overripe fruit to porridge or home-made baked confectionary).

- Promote varied use of available vegetables and fruit (to limit boredom and taste fatigue) e.g. cabbage can be used as a salad with apple or carrots; it can be finely shredded to use in stir-fries; leftovers can be used in soups and stews; leaves can be filled with mince/ lentils/ meatballs. Carrots can be eaten raw as a snack, grated as a salad, lightly cooked as a supper vegetable, added to meatballs or mince to extend the dish.

- Encourage a fruit as the ideal snack or dessert instead of baked confectionary. Fruit can also be added to baked confectionary such as cakes and muffins.

A2.3 “Make starchy foods the basis of all meals”: Improve CHO choices that are high in fibre and/or low GI.

Emphasise the substitution of refined and processed carbohydrates for high fibre and/or lower GI carbohydrate choices, focusing on the following:

- Encouraging the selection of food items high in fibre and /or low in GI that are already commonly consumed by the study sample e.g. brown bread, provitas , pasta and baked beans.

- Encouraging intake of fibre and low GI carbohydrate sources that are not commonly consumed by the study sample e.g. whole wheat bread, low GI bread, potato with skin (prepared without fat), barley and legumes.

- Suggesting suitable alternatives to refined baked confectionary e.g. fruit-based confectionary/desserts, fruit salad, fruit loaves, fruit muffins, whole-wheat bran muffins made with little fat and using oil or low trans fat brick margarine.

A2.4 "Eat sugar sparingly": Promote food choices low in sugar and refined CHOs.

Emphasise moderate consumption of sugar and sugar-containing food items in the context of a healthy diet, focusing on the following:

- Promoting an understanding of why sugar intake needs to be limited; namely that it adds empty energy (thus very low nutrient density) to the diet and may contribute to raised blood sugar and/or weight gain when consumed in large quantities or in combination with other refined/high GI carbohydrates.

- Suggesting appropriate ways to include sugar in the diet; namely as part of a high fibre meal or food item.

- Identification of popular and frequently consumed food items in the diet that are high in sugar and suggest alternatives (Table 55):

Table 55 : Food choices to decrease sugar intake

Have less...	Rather have...	Reason/Comment
Baked confectionary & boiled sweets	Home-baked confectionary lower in sugar, with added bran, oats, fruit or grated vegetables. Fruit-based desserts Fresh fruit Home-made popcorn Consider non-nutritive sweeteners*	The alternatives provide less energy-dense, nutrient-dense options that are higher in fibre and lower in GI. These items should be consumed in moderate portions within the context of appropriate total energy intake.
Cold drinks (carbonated and squash-type)	Water ; flavoured with fruit pieces / mint leaves / cucumber slices/ diluted fruit juice	

*Non-nutritive sweeteners may be recommended where appropriate although expensive

A2.5 "Eat dry beans, peas, lentils and soy regularly": Increase frequency of intake.

Promote the regular inclusion of beans, peas, lentil or soy in the diet, with emphasis on the following:

- Being specific about the frequency of consumption that will be of benefit, namely at least three times a week;

- Encouraging the consumption of culturally specific dishes/products that contain legumes e.g. lentil biryani, baked beans and soup;

- Encouraging new approaches to incorporate legumes in the existing diet e.g.

  The use of lentils instead of mince or adding lentils or beans to mince dishes such as shepherd's pie, bobotie, spaghetti mince and mince curries,

  The addition of beans or lentils to rice or pastas;

  Making sprouts from dried beans, lentils and peanuts to add to sandwiches, stir-fries or salads;

  Making flavourful spreads from cooked lentils or beans.

- Promoting the consumption of legumes that do not require long cooking or soaking times e.g. split lentils, whole lentils or unflavoured soy mince; the use of the hay box for legumes that require long cooking times.

- Increasing awareness of the benefits of regular consumption of legumes, namely: cholesterol-lowering, low GI, low in fat, high in fibre, high in micronutrients, economical and good value for money.

A2.6 "Chicken, fish, milk, meat or eggs can be eaten daily": Substitute high fat animal products for low fat animal products or meat-alternatives.

Emphasise low fat alternatives as indicated in Table 56:

Table 56: Food choices to lower the intake of high fat animal products

Have less...	Rather have...	Reason/Comment
Meat and meat products high in fat e.g. high fat mince, polony, sausage, chicken with skin	Small portions of meat Meat trimmed of all visible fat, Chicken without the skin. Meat products prepared with little or no oil. Fish e.g. pilchards, tinned mackerel, fresh fish (prepared in little or no oil). Meat-alternatives on its own or added to meat dishes e.g. lentils, dried beans and soy.	High fat meat and dairy products are high in total and saturated fat. Animal products are also more costly compared to meat-alternatives such as lentils, dried beans and soy. The latter products are generally low in fat, economical and high in fibre, especially soluble fibre. Soluble fibre assists in lowering blood cholesterol and blood sugar levels.
Full cream dairy products (Milk, cheese and cream)	Low fat or skimmed milk Low fat cheese or small portions of regular cheese(more economical)	

A2.7 Clarify the role of meals and snacks in the diet for the woman with type 2 diabetes.

Ensure that meals and snacks are in line with guidelines for the management of women with type 2 diabetes and the FBDGs. For these purpose the following should be emphasised:

- Defining the role of regular meals in the diet for the woman with type 2 diabetes, namely that it may assist in moderating blood glucose extremes and thus reduce insulin secretion.

- Reminding overweight women with type 2 diabetes who choose to have snacks that it contribute to the overall energy intake of the diet.

- Providing examples of appropriate snacks and portion sizes e.g.

  Dairy: Glass of milk / small yoghurt

  Fruit: Commonly consumed fruits such as apples, pears, and citrus / ½ cup fruit salad or stewed fruit / 2 pieces of dried fruit

  Unrefined carbohydrates: slice of whole-wheat bread or seed loaf with peanut butter (no margarine)/ leftover meat/avocado; 2 cups home-made popcorn (1 tsp oil) / 3 provita biscuits with 1 tsp marg/peanutbutter.

  Occasional treats (*better options to refined 'baked confectionary'*): small piece of milk tart made with low fat or fat-free milk without crust / small high fibre muffin (although not necessarily low in fat) / fruit loaf e.g. banana or carrot bread (thin slice), ½ cup cold custard made with fat-free or low fat milk and a fruit/ tablespoon peanuts with a fruit.

A3 Recommendations to advise evidence-based, appropriate <u>weight management</u> interventions in coloured women with type 2 diabetes.

Weight management should receive prominence in nutrition therapy in this population group, with a focus on weight screening and monitoring, realistic weight management/ loss goals, guidelines for energy intake and control as well as increased levels of physical activity.

A3.1 Weight screening should include routine measurements of weight, height, BMI and waist circumference.

A3.2 Weight monitoring should be implemented through regular follow-up and ongoing long-term support e.g. in a support group setting.

A3.3 Weight management goals should be clarified. Attention should be given to the following:

- Weight stabilisation i.e. no weight gain/loss for a set period e.g. three months, whether the person with diabetes is normal, overweight or obese;
- Formulation of a small (5-10%) weight loss aim if necessary once weight has been stabilised;
- Explanation of the benefit of small weight losses e.g.5%, namely improved glucose tolerance, blood lipid levels and blood pressure.

A3.4 Weight management guidelines should focus on the most prominent behaviour changes that will optimise the chances of coloured women with diabetes to maintain a 5% weight loss.

These behaviour changes should focus on the following:

Control and/ or decrease of total energy intake

- Replace energy-dense carbohydrate-containing foods (or fat and carbohydrate combination) with foods high in fibre and decreased energy-density (Table 57);

Table 57: Food choices to control total energy intake

Have less	Rather have
White bread	Whole wheat or low GI bread Smaller portions
Sugar, sweets and baked confectionary (cake, icing, biscuits, muffins, scones)	See Table 53 Smaller portions
Cold sweetened drinks (gas and squash-type)	See Table 53
Snacks high in sugar and/or fat	Smaller portions See Table 53

- Practice portion control;

- Snack in moderation: Have small portions and place emphasis on choices high in fibre and low in fat.

Decrease total fat intake:

- Use less or no fat in food preparation (Table 58);
- Replace high fat foods with low fat foods (Table 58);
- Have small portions of high fat foods.

Table 58: Food choices to decrease total fat intake

Have less	Rather have
Foods fried in oil or margarine e.g. onions, potatoes, fish, eggs and meat	'Dry-fry' or use small amounts of water or stock.
High fat meat and meat products e.g. regular mince, fatty meat cuts, sausage, polony	See Tables 52 and 54
Full cream milk products: Full cream milk, cream (added to baked confectionary), cheese	See Tables 52 and 54
Snacks high in fat e.g. crips	See Table 52

Substitute low GI and high fibre foods for foods high in GI and/or low in fibre (to promote fat oxidation and increase levels of satiety and fullness) (Table 59).

Table 59 : Food choices to include lower GI and /or higher fibre foods

Have less	Rather have
White and brown bread	Smaller portion with protein topping e.g. baked beans/lentils Whole wheat/low GI bread
White rice	Barley, brown rice or add lentils or dried beans to rice, pasta
Potato (without skin).	Smaller portion potato with skin, sweet potato, corn
Baked confectionary	See Tables 53 and 54

Increase physical activity levels : See A4 for detail.

A4 Recommendations to educate coloured women with type 2 diabetes on the importance and required level of physical activity, with specific emphasis on the following aspects:

A4.1 Clarify the role of physical activity in diabetes management, focusing on the following:

- Improvement of short-term complications by improving blood glucose control through increased insulin sensitivity.
- Improvement of long-term complications by decreasing insulin resistance, enhancing insulin sensitivity as well as reducing blood cholesterol and blood pressure levels.
- Required levels of physical activity to achieve the above-mentioned benefits:

  At least 150 min/week of moderate-intensity aerobic activity, distributed over at least three days. Activity can also be divided into multiple, short bouts, to reach a level of at least 150min/ week e.g three sessions of 10 minutes' activity during the day.

A4.2 Clarify the role of physical activity in energy balance and weight management, focusing on the following:

- Increase of energy expenditure
- Succesfull long-term weight loss and maintenance
- Required levels of physical activity to achieve the above-mentioned benefits for weight management:

  Longer periods of moderate exercise e.g. one hour per day of walking; Shorter vigorous activity e.g. 30 min per day of jogging (most days of the week).

A4.3 Identify and promote appropriate activities to increase physical activity levels. The following activities could be emphasised (Table 60):

Table 60 : Suggestions to increase physical activity levels.

Types of activities	Examples
Activities of daily living	Walking instead of driving short distances; taking stairs instead of elevators, gardening, house work.
Structured activities that can be done at home (keeping physical condition in mind)	Demonstrated by a physiotherapist e.g. stretching, lifting of small weights
Organised activities outside of the home (safe and affordable)	Community initiatives in a safe and affordable environment; e.g. dancing or walking clubs, organised sport activities at sports clubs.

B: Recommendations aimed at health care professionals to ensure optimal nutrition therapy for persons with type 2 diabetes

In order for dietary interventions aimed at the coloured women with type 2 diabetes to be successful, the facilitators of change, namely the health care professionals servicing the CHCs, should be equipped to do so through appropriate training as well as ensuring the availability of the necessary resources at CHC level.

B1 Health care professionals should have an understanding of basic nutrition principles:

B1.1 Exposure to the FBDGs and associated core nutrition principles for health should form part of the curriculum of all health care professionals.

B1.2 Information on the FBDGs should also be included as options in continuous education programmes for health care professionals.

B2 Health care professionals should have an understanding of the principles of nutrition therapy for the person with diabetes and the importance thereof in the management of the disease:

B2.1 Core nutrition principles for diabetes need to be emphasised in the training of health care professionals. These principles refer to the following:

- Distribution of energy derived from carbohydrate;
- The glycaemic index;
- Decreasing total, saturated and trans fat;
- Promoting the intake of more beneficial fats; and
- Emphasising the individualising of dietary recommendations.

B2.2 Specific aspects concerning the role of nutrition therapy in diabetes management that need to be emphasised in the training of health care professionals include the following:

- Nutrition therapy alone can be a way of treating diabetes for some persons with diabetes, even though most will have to take medication as well.
- Nutrition therapy remains a cornerstone of treatment even when/if oral agents or insulin is prescribed
- Nutrition therapy is important in the management of diabetes as it contributes to the short and longer term control of blood glucose levels, thus preventing hypo and hyperglycaemic incidents as well as the longer term micro and macro vascular complications of type 2 diabetes.

B3 Health care professionals should have an understanding of the principles of successful weight management for type 2 diabetes.

B3.1 Core weight management principles need to be emphasised in training.

These principles include the following:

- Energy intake control through low fat intake; portion control; substitution of energy-dense food with food lower in energy and /or GI and/or high in fibre.
- The benefit of initial weight stabilisation followed by small weight losses (e.g. 5-10%).
- The importance of physical activity
- The importance of regular follow-up and support

B4 Health care professionals should have an understanding of the importance of adapting nutrition therapy to accommodate specific needs of individuals.

B4.1 Factors that may result in specific needs related to nutrition therapy for diabetes in patients attending CHCs, namely socio-economic status and literacy level, need to receive attention in the training of health care professionals.

B5 Health care professionals should have access to suitable education materials and tools to empower them to provide consistent, evidence-based, nutrition therapy messages.

B5.1 Materials and education tools that are suitable in a low socio-economic, low literacy context need to be developed by the Department of Health. Emphasis should be placed on the following:

- Educational material should be developed for specific use by health care providers e.g. a small desk-top flip-chart on the FBDGs.
- Standardised demonstrations and displays should be developed to reinforce messages, especially in the absence of a dietitian, e.g. food products displays, a food plate model and models of food items to demonstrate appropriate portion sizes.
- Appropriate equipment should be provided to measure and provide feedback to the person with diabetes e.g. a scale, a height measure, a BMI chart, and a measuring tape for measuring waist circumference.

B5.2 Health care professionals need to be trained in the use of such materials and tools, bearing in mind their patients' socio-economic and literacy levels.

B5.3 Health care professionals need to be trained to develop and create appropriate material and tools for use in their specific context, such as food displays relevant to their patients' socio-economic and literacy level if necessary.

C: Recommendations to advise government regarding relevant policies and protocols to facilitate optimal nutrition therapy for the person with type 2 diabetes.

In order for interventions at individual level to be successful and effectively implemented by health care professionals, the necessary policies and protocols need to be in place at national, provincial and district levels of government to ensure the implementation of evidence-based, appropriate interventions.

C1 Government should ensure the availability of a protocol at CHC level for the management of persons with type 2 diabetes.

C1.1 Such a protocol should include details on the following:

- An evidence-based diabetes management protocol, thus based on the latest SEMDSA 2009 guidelines;
- Detailed guidelines on the nutrition therapy of diabetes in context of the management protocol (see A)
- Duties: Screening and medical management; nutrition therapy; general diabetes education and support; motivating for behaviour change.
- Role players: The dietitian; medical doctor; nursing staff; health promoting officer and/or nutrition advisor ; support groups, peer educators and possibly physiotherapist.
- Guidelines on training needs of health care professionals to ensure optimal service delivery of nutrition therapy (see B).
- Nutrition education material developed by government and equipment e.g. scale, height measure, measuring tape, BMI chart (see B5).

C2 Government should ensure the availability of a protocol at CHC level for effective weight management interventions.

C2.1 Such a protocol should include details on the following:

- An evidence-based weight management protocol based on the weight management guidelines published by the Dept of Health, 2003.
- Weight management goals (see A3.2)
- Detailed guidelines on the most important nutrition and physical activity behaviour changes to achieve and maintain weight loss (See A3, A4, B3).
- Duties: Weight screening, regular follow-up and feedback; support, general nutrition education and nutrition therapy (in groups or individually), practical education and support in increasing physical activity levels; motivation for behaviour change.
- Role players: The dietitian; medical doctor; nursing staff; health promoting officer and/or nutrition advisor; support groups, peer educators and possibly a physiotherapist.

- Guidelines on training needs of health professionals to ensure optimal service delivery of nutrition therapy for diabetes (see B).

- Nutrition education material developed by government and equipment e.g. scale, height measure, measuring tape, BMI chart (see B5).

C3 Government should formulate and implement relevant nutrition-related policies aimed at training institutions in collaboration with the Health Profession's Council of South Africa (HPCSA).

C3.1 The Health Profession's Council of South Africa (HPCSA) should be involved in ensuring that the curricula at training institutions cover aspects on diabetes and weigh management in sufficient detail, including both theoretical and practical aspects.

C3.2 The HPSCA should also promote the inclusion of the above-mentioned aspects in sufficient detail in continuous education programs for health care professionals working in CHCs.

5.3 Final conclusions

The results of this research point to the fact that specific dietary aspects need to be addressed to ensure optimal nutrition therapy in the coloured female with type 2 diabetes. These include the high intake of total fat, saturated fat and preference for food choices high in trans fats as well as refined (low in fibre) and /or high GI carbohydrates. The very low vegetable, fruit and legume consumption as reflected by the low fibre intake are further aspects that need to be addressed to improve the outcomes of nutrition therapy in this population. Furthermore, the need for effective weight management interventions in this group is critical in light of the very high levels of obesity that were found.

The existing FBDGs can be used as a means to incorporate specific dietary recommendations aimed at the coloured person with type 2 diabetes. These messages need to be consolidated through practical demonstration and support. The identified discrepancies between knowledge of healthy food choices and the lack of actual implementation thereof in the diet of the study sample, highlight the need to identify and overcome barriers that prevent the successful implementation of nutrition therapy.

Underlying the formulated recommendations should be the recognition of the context of the target group. It is important to bear in mind that no nutrition-related recommendation can be made without considering the low socio-economic background of the coloured population from which the study sample was drawn, the importance of family and peers in terms of advice and implementation as well as the pertinent barrier of the cost of following a 'diet' for a person with diabetes.

Health care professionals involved in diabetes management of this population need to be empowered through appropriate training and continuous education opportunities. This needs to be supported by the necessary educational materials and tools to ensure the dissimination of consistent and appropriate messages on diabetes, the role of diet and weight management. Besides the role of government in ensuring the availability of the relevant protocols at CHC level pertaining to diabetes management and weight management, supportive initiatives (not investigated as part of this this study) at national level such as the home-grown food garden initiative, the anti-smoking campaign and promoting physical activity levels are essential to help create an environment in which recommended behaviour change can be implemented.

The recommendations formulated in this chapter are based on the findings of a sample of coloured women with type 2 diabetes and are thus specifically aimed at the coloured female with diabetes attending CHCs. However, it may well be of value for coloured men and other South Africans with type 2 diabetes attending public health care facilities. As with all recommendations, the true value will be in the actual implementation thereof.

6. REFERENCES

Aarsland A, Chinkes D & Wolfe RR (1997) Hepatic and whole body fat synthesis in humans during carbohydrate overfeeding. *Am J Clin Nutr* **65**, 1774-1782.

Adam O, Wolfram G & Zollner N (1986) Effect of alpha-linolenic acid in the human diet on linoleic acid metabolism and prostaglandin biosynthesis. *J Lipid Res* **27**, 421–426.

American Diabetes Association (2001a) Clinical Practice Recommendations: Position statement: nutrition recommendations and principles for people with diabetes mellitus. *Diab Care* **24,** Suppl, 44S-47S.

American Diabetes Association (1999) Position Statement: Nutrition Recommendations and principles for people with diabetes mellitus. *Diab Care* **22**, Suppl. 1, S45.

American Diabetes Association (2001b) Patient information: a step-by-step approach to complementary therapies. *Diabetes Spectrum* **14**, 225.

American Diabetes Association (2001c) Patient information: guidelines for using vitamin, mineral, and herbal supplements. *Diabetes Spectrum* **14**, 160.

American Diabetes Association (2004) Nephropathy in diabetes. *Diab Care* **27**, Suppl1, S79-S83.

American Diabetes Association (2008a) Diagnosis and classification of diabetes-Position Statement. *Diab Care* **31** Suppl. 1, S55-S60.

American Diabetes Association (2008b) Standards of Medical Care in Diabetes-Position Statement. *Diab Care* **31**, Suppl1, S12-S54.

American Dietetic Association (2004) Position of the American Dietetic Association: Use of Nutritive and Non-nutritive Sweeteners. *J Am Diet Assoc **104**, 255-275.*

American Dietetic Association (2005) Nutrition Fact sheet: Keeping *Trans* Fats in Focus. http:// www.eatright.org (accessed 23/07/2009) *miami-dade.ifas.ufl.edu/.../Soybean%20Trans%20Fats%20in%20Focus.pdf*

Amos AF, McCarty DJ & Zimmet PZ (1997) The rising global burden of diabetes and its complications: Estimates and projections to the year 2010. *Diabet Med* **14**, Suppl. 5, S7–S84.

Andersen RE, Wadden TA, Bartlett SJ, Zemel B, Verde TJ & Franckowiak SC (1999) Effects of lifestyle activity vs structured aerobic exercise in obese women: a randomized trial. *J Am Med Assoc* **281**, 335–340.

Anderson AS (2003) The challenge of implementing dietary advice. *J Hum Nutr Dietet* **16**, 391–392.

Anderson DA & Wadden TA (1999) Treating the obese patient: suggestions for primary care practice. *Arch Fam Med **8***, 156–167.

Anderson JW, Smith BM & Washnock CS (1991) Cardiovascular and renal benefits of dry bean and soybean intake. *Am J Clin Nutr* **70,** Suppl, 464S-474S.

Anderson-Loftin W, Barnett S, Bunn P, Sullivan P, Hussey J & Tavakoli A (2005) Soul Food: Culturally Competent Diabetes Education. *Diabetes Educ* **31**(4), 555-563.

Andrieu E, Darmon N & Briend A (2003) Cost of diets and nutrient intakes. *Poverty, food & health in welfare*, International Conference, July 2003,Lisbon (abstr).

Arner P (2002) Insulin resistance in type 2 diabetes: role of fatty acids. *Diabetes Metab Res Rev* **18,** Suppl. 2, S5-S9.

Banister NA, Jastrow ST, Hodges V, Loop R & Gillham MB (2004) Diabetes self-management training program in a community clinic improves patient outcomes at modest cost (Research and Professional Briefs). *J Am Diet Assoc* **104**(5), 807-810.

Bantle JP, Wylie-Rosett J, Albright AL et al (2007a) Position of the American Dietetic Association and Dietitians of Canada: Dietary Fatty Acids. *Diab care* **107**, 1599-1611.

Bantle JP, Wylie-Rosett J, Albright AL et al (2007b) American Diabetes Association Position Statement: Nutrition Recommendations and Interventions for Diabetes. *Diab Care* **30**, Suppl 1, S48-S65.

Bantle JP, Wylie-Rosett J, Albright AL et al (2008) Nutrition recommendations and interventions for diabetes: a position statement of the American Diabetes Association. *Diab Care*. 31, Suppl 1, S61-S78**.**

Barger-Lux MJ, Heaney RP, Packard PT, Lappe JM & Recker RR (1992) Nutritional correlates of low calcium intake. *Clin Appl Nutr* **2**, 39-44.

Barr S, Murphy SP & Poos M (2002) Commentary: Interpreting and using the Dietary Reference Intakes in dietary assessment of individuals and groups. *J Am Diet Assoc* **102**(6), 780-8.

Bautista-Martinez S, Aguilar-Salinas CA, Lerman I et al (1999) Diabetes knowledge and its determinants in a Mexican population. *Diabetes Educ* **25**(3), 374-81.

Baylin A, Kabagambe EK, Ascherio A Spiegelman D & Campos H (2003) High 18:2 transfatty acids in adipose tissue are associated with increased risk of nonfatal acute myocardial infarction in Costa Rican adults. *J Nutr* **133,** 1186-1191.

Bazzano LA, Serdula M & Liu S (2005) Prevention of type 2 diabetes by diet and lifestyle modification. *J Am Coll Nutr* **24**, 310–319.

Beaton GH (1994) Approaches to Analysis of Dietary Data: Relationship between planned analysis and choice of methodology. *Am J of Clin Nutr* **59,** Suppl, 253S-261S.

Beaton GH (2006) Review Article: When is an individual an individual versus a member of a group? An Issue in the Application of the Dietary Reference Intakes. *Nutr Rev* **64**(*5), 21-25.*

Beaton GH, Milner BA, Corey P, McGuire V, Cousins M, Stewart E, Ramos M, Hewitt D, Grambsch PV, Kassim, N & Litlle IA (1979) Sources of variance in 24-hour dietary recall data: implications for nutrition study design and interpretation. *Am J Clin Nutr* **32,** 2546-2559.

Benatar SR (1997) Health Care Reform in the New South Africa. *N Engl J Med* **336**(12), 891-895.

Bertelsen J, Christiansen C, Thomsen C, Poulsen PL, Vestergaard S, Steinov A, Rasmussen LH, Rasmussen O & Hermansen K (1993) Effect of meal frequency on blood glucose, insulin, and free fatty acids in NIDDM subjects. *Diab Care* **16**, 4-7.

Bhattacharyya OK, Estey EA & Cheng AYY(2008) Update on the Canadian Diabetes Association 2008 clinical practice guidelines. *Canadian Family Physician • Le Médecin de famille canadie* **55,** *39-43.*

Bingham SA (1994) The use of 24-h urine samples and energy expenditure to validate dietary assessments. *Am J Clin Nutr* **59,** Suppl, 227S-231S.

Blaauw, R (2007) Personal communication. Dietitian and senior lecturer University of Stellenbosch, Tygerberg.

Black AE, Coward WA, Cole TJ & Prentice AM (1996) Human energy expenditure in affluent societies: analysis of 574 doubly-labelled water measurements. *Eur J Clin Nutr* **50**(2**)**, 72 - 92.

Blades M, Morgan JB, Dickerson JW (1997) Dietary advice in the management of diabetes mellitus-history and current practice. *J R Soc Health* **117**, 143-150.

Block & Hartman (1989) Issues in reproducibility and validity of dietary studies. *Am J Clin Nutr* **50**, 1133-1138.

Block G (1989) Human Dietary Assessment: Methods and Issues. *Prev Med* **18**, 653-660.

Block G, Hartman AM, Dresser CM, Carroll MD, Gannon J & Gardner L (1986) A data-based approach to diet questionnaire design and testing. *Am J Epidemiol* **124,** 453-469.

Bopape MW & Peltzer K (2002) Health beliefs and stress among non-insulin dependent diabetes outpatients in a rural teaching hospital in South Africa. *Health SA Gesondheid* **7**(4), 38-46.

Bornet FRJ, Costagliola D, Salwa WR, Blayo A, Fontveille A, Haardt MJ, Letanoux M, Tchobroutsky G & Slama G (1987) Insulinemic and glycemic indexes of six starch-rich foods taken alone and in a mixed meal by type 2 diabtecs. *Am J Clin Nutr* **45**, 588-595.

Boule NG, Haddad E, Kenny GP, Wells GA. & Sigal RJ (2001) Effects of exercise on glycaemic control and body mass in Type 2 diabetes mellitus: a meta-analysis of controlled clinical trials. *J Am Med Assoc* **286**, 1218–1227.

Bradshaw D & Steyn K, editors (2001) *Poverty and chronic Disease in South Africa, Technical Report 2001***.** Burden of Disease Research Unit Chronic Diseases of Lifestyle Unit, WHO Collaborating Centre.

Brand-Miller J, Hayne S, Petocs P & Colagiuri S (2003) Low-glycemic index diets in the management of diabetes: a meta-analysis of randomized controlled trials. *Diab Care* **26**(8), 2261-2267.

Brand-Miller JC (2003) Glycemic Load and Chronic disease. *Nutr Rev*, **6**(5),Suppl, S49-S55.

Brand-Miller JC, Thomas M, Swan V, Ahmad ZI, Petocz P & Colagiuri S (2003b) Physiological validation of the concept of glycemic load in lean young adults. *J Nutr* **133**, 2728–2732.

Bray G (2007) The Metabolic Syndrome and Obesity, Totowa, New Jersey, Humana Press.

Brown JB, Nichols GA & Perry A (2004) The burden of treatment failure in type 2 diabetes. *Diab Care* **27,** 1535-1540.

Brown SA (1990) Studies of educational interventions and outcomes in diabetic adults: a meta-analysis revisited. *Patient Educ Counsel* **16**, 189–215.

Brown SA, Upchurch S, Anding R, Winter M & Ramirez G (1996) Promoting weight loss in type II diabetes. *Diab Care* **19,** 613–624.

Brown TT, Cole SR, Li X, et al (2005). Antiretroviral therapy and the prevalence and incidence of diabetes mellitus in the multicenter AIDS cohort study. *Arch Intern Med* **165,**1179–1184.

Buchanan TA (2001) Pancreatic B-cell defects in gestational diabetes: implications for the pathogenesis and prevention of type 2 diabetes. *J Clin Endocrinol Metab* **86**, 989-93.

Cade J, Upmeier H, Calvert C & Greenwood D (1999) Costs of a healthy diet: analysis from the UK Women's Cohort Study. *Public Health Nutr* **2**, 505–512.

Calder PC (2005) Polyunsaturated fatty acids and inflammation. *Biochem Soc Trans* **33**(2), 423-427.

Camelon KM, Hadell K, Jämsén PT, Ketonen KJ, Kohtamäki HM, Mäkimatilla S, Törmälä ML & Valve RH (1998) The Plate Model: a visual method of teaching meal planning. DAIS project group. Diabetes Atherosclerosis Intervention Study. *J Am Diet Assoc* **10**, 1155-8.

Campbell IW & Lebovitz H (2001) What is diabetes? Fast Facts, 2nd ed., pp18-65, Oxford, Health Press Limited.

Campbell VA & Dodds ML (1967) Collecting dietary information from groups of older people. *J Am Diet Assoc* **51**, 29-33.

Canadian Diabetes Association (2000) Position Statement :Guidelines for the nutritional management of diabetes mellitus in the new millennium. A position statement by the Canadian Diabetes Association. *Can J Diabetes* **23,** 56-69.

Canadian Diabetes Association (2003) Nutrition therapy: Canadian Diabetes Association Clinical Guidelines Expert Committee. *Can J Diabetes* **27**, Suppl, S27-S31.

Care Interventions Team (2001) Needs of the Recently Diagnosed. *Report and Recommendations of the Listening Project*. London: Diabetes UK.

Carriquiry A (2003) In Johnson RK, Hankin PH. Dietary Assessment and Validation 2nd ed., pp 227-241 In *Research. Successful Approaches* [Monson ER editor]. American Dietetic Association.

Castelli WP, Abbott RD & McNamara PM (1983) Summary estimates of cholesterol used to predict coronary heart disease. *Circulation* **67**, 730-734.

Chan JM, Rimm EB & Colditz GA (1994) Obesity, fat distribution and weight gain as risk factors for clinical diabetes in men. *Diab Care* **17**, 961-969.

Chandalia MC, Garg A, Lutjohann D, Von Bergmann K, Grundy SM & Brinkley LJ (2000) Beneficial effects of high dietary fibre intake in patients with type 2 diabetes mellitus. *N Engl J Med* **342**, 1392-1398.

Charlton KE & Jooste PL (2001) Eat salt sparingly-sprinkle don't shake! *S Afr J Clin Nutr* **14**(3), Suppl, S55-S64.

Charlton KE, Womarans P, Marais AD & Lombard CJ (1997) Macronutrient intake and cardiovascular risk factors in older coloured South Africans. *East Afr Med J* **74**(8), 478-486.

Chew I , Brand JC, Thorburn AW & Truswell AS (1988) Application of glycemic index to mixed meals. *Am J Clin Nutr* **47**, 53–56.

Choudhary P (2004) Review of dietary recommendations for diabetes mellitus. *Diabetes Res Clin Pract* **65,** Suppl. 1, S9–S15.

Clarke R, Frost C, Collins R, Appleby P & Peto R (1997) Dietary lipids and blood cholesterol: quantitative meta-analysis of metabolic ward studies. *BMJ* **314**, 112–117.

Clement S (1995) Diabetes self management education. *Diab Care* **18**, 1204–1214.

Colditz GA, Willett WC, Stampfer MJ, Manson JE, Hennekens CH, Arky RA & Speizer FE (1990) Weight as a risk factor for clinical diabetes in women. *Am J Epidemiol* **132**,501-513.

Collier G & O'Dea K (1983) The effect of co ingestion of fat on the glucose, insulin, and gastric inhibitory polypeptide responses to carbohydrate and protein. *Am J Clin Nutr* **37**, 941–944.

Collier GR, Wolever TM, Wong GS & Josse RG (1986) Prediction of glycemic response to mixed meals in noninsulin-dependent diabetic subjects. *Am J Clin Nutr* **44**, 49–52.

Colombani PC (2004) Glycemic index and load-dynamic dietary guidelines in the context of disease. *Physiol & Behav* **83**, 603-610.

Combs GF (2008) In *Krause's Food and Nutrition & Diet Therapy*, 12th edition. Chapter 4: Vitamins, p85 [Mahan LK & Escott-Stump S, editors] London:Saunders.

Connor H, Annan F, Bunn E, Frost G, McGough N, Sarwar T & Thomas B (2003) The implementation of nutritional advice for people with diabetes. *J Hum Nutr Diet* **16**, 421–452.

Conway JM, Yanovski SZ, Avila NA & Hubbard VS (1995) Visceral adipose tissue differences in black and white women. *Am J Clin Nutr* **61,** 765-771.

Coulston AM & Reaven GM (1997) Much ado about (almost) nothing. *Diab Care* **20**, 452-456.

Coulston AM, Hollenbeck CB, Liu GC, Williams RA, Starich GH, Mazzaferri EL & Reaven GM (1984) Effect of source of dietary carbohydrate on plasma glucose, insulin, and gastric inhibitory polypeptide responses to test meals in subjects with noninsulin-dependent diabetes mellitus. *Am J Clin Nutr* **40**, 965–970.

Coulston AM, Hollenbeck CB, Swislocki AL & Reaven GM (1987) Effect of source of dietary carbohydrate on plasma glucose and insulin responses to mixed meals in subjects with NIDDM. *Diab Care* **10**, 395–400.

Cutler JA, Follmann D, Elliott P & Suh I (1991) An overview of randomised trials of sodium reduction and blood pressure. *Hypertension* **17**, Suppl I, S27-S33.

Day JL (1995) Why should patients do what we ask them to do? *Patient Educ Counselling* **26,** 113-118.

DeFronzo RA (1988) The triumvirate: β-cell, muscle, liver. A collusion responsible for NIDDM. *Diabetes* **37**, 667-87.

Delahanty LM & Halford BH (1993) The role of diet behaviors in achieving improved glycemic control in intensively treated patients in the Diabetes Control and Complications Trial. *Diab Care* **16,** 1453–1458.

Department of Health (2000) *The Primary Health Care Package for South Africa – a set of norms and standards*. Part 1 Norms and standards for health clinics. Department of Health, Pretoria. www.doh.gov.za/docs/policy/norms/full-norms.html (accessed 30/6/2009)

Department of Health (2002) Obesity**.** Treatment guidelines. *www.doh.gov.za/docs/factsheets/pharma/.../edladult140-175.pdf* (accessed 22/07/2009)

Department of Health (2003) *Prevention and management of overweight and obesity in South Africa*. National Guideline. Directorate: Chronic Diseases, disabilities and geriatrics.

Department of Health (2004) *South African guidelines for healthy eating for adults and children over the age of seven years*. Department of Health, Directorate:Nutrition, Pretoria.

Department of Health, South African Medical Research Council & Measure DHS+ (2002) *South Africa Demographic and Health Survey 1998*. Chapter 11 Utilisation of Health Services and chronic medication. *www.doh.gov.za/facts/1998/sadhs98 (*accessed 14/7/2009)

Department of Health, South African Medical Research Council & Measure DHS+ (2007) *South Africa Demographic and Health Survey 2003*. *http://www.doh.gov.za/docs/misc/sadhs-f.html* (accessed 20/05/2009).

Despres JP, Lemieur I & Prud'homme D (2001) Treatment of obesity: need to focus on high risk abdominally obese patients. *Br Med J* **322**, 716–720.

Diabetes and Nutrition Study Group (DNSG) of the European Association for the Study of Diabetes (2004) Evidence-based nutritional approaches to the treatment and prevention of diabetes mellitus. *Nutr Metab Cardiovasc Dis* **14**, 373-394.

Diabetes Care and Education Dietetic Practice Group (DCE DPG) members (2003) Educational handout *Ready, Set, Start Counting* 2003.

Diabetes New Zealand (2005) A guide to beans, lentils, legumes and pulses *The Magazine of Diabetes New Zealand* Winter 2005 *www.diabetes.org.nz/food_and_nutrition/healthy_food_choices__and__tips/food/legumes* (accessed 22/05/2009)

Dobesh PP(2006) Managing hypertension in patients with type 2 diabetes mellitus Therapy Update. *Am J Health Syst Pharm* **63**(12), 1140-1149.

Doherty Y, Hall D, James PT, Roberts SH & Simpson J (2000) Change counselling in diabetes. The development of a training programme for the diabetes team. *Patient Educ Counselling* **40**, 63–278.

Domel SB, Baranowski T, Davis H, Leonard SB, Riley P & Baranowski J (1993) Development and evaluation of a school intervention to increase fruit and vegetable consumption among 4th and 5th grade students. *J Nutr Education* **25**, 345-349.

Drewnowski A & Darmon A (2005) The economics of obesity: dietary energy density and energy cost. *Am J Clin Nutr* **82,** Suppl, 265S–273S.

Drewnowski A & Specter SE (2004) Poverty and obesity: the role of energy density and energy costs. *Am J Clin Nutr* 79(1), 6-16.

Dunn AL, Marcus BH, Kampert JB, Garcia ME, Kohl HW & Blair SN (1999) Comparison of lifestyle and structured interventions to increase physical activity and cardiorespiratory fitness: a randomized trial. *J Am Med Assoc* **281,** 327–334.

Dwyer JT, Allison DB & Coates PM (2005) Dietary supplements in weight reduction. *J Am Diet Assoc* **105 (**5), Suppl 1, S80-S86.

Earl R & Borra ST (2008) In *Krause's Food and Nutrition & Diet Therapy*, 12th edition. Chapter 15: Guidelines for Dietary planning, p342 [Mahan LK & Escott-Stump S, editors] London:Saunders.

Eckel RH (2003) Editorial : A new look at dietary protein in diabetes. *Am J Clin Nutr* **78**, 671-672.

Ello-Martin JA, Ledikwe JH & Rolls BJ (2005) The influence of food portion size and energy density on energy intake: implications for weight management. *Am J Clin Nutr* **82,** Suppl, 236S-241S.

Erhardt L (2009) *Abstract*: Cigarette smoking: An undertreated risk factor for cardiovascular disease. *Atherosclerosis* **205**(1), 23-32.

Eriksson KF & Lindgarde F (1991) Prevention of type 2 (non-insulin-dependent) diabetes mellitus by diet and physical exercise: the 6-year Malmo feasibility study. *Diabetologia* **34**, 891– 898.

Expert Committee on the Diagnosis and Classification of Diabetes Mellitus (2000) Report of the Expert Committee on the Diagnosis and Classification of Diabetes Mellitus. *Diab Care* **23**, Suppl 1, S4-19.

Expert Committee on the Diagnosis and Classification of Diabetes Mellitus (2003) Follow-up report on the diagnosis of diabetes mellitus. *Diab Care* **26**, 3160–3167.

Febbraio M & Stewart K (1996) CHO feeding before prolonged exercise: effect of glycemic index on muscle glycogenolysis and exercise performance. *J Appl Physiol* **81**, 1115-1120.

Febbraio M, Keenan J, Angus D, Campbell S, Garnham A (2000) Preexercise carbohydrate ingestion, glucose kinetics, and muscle glycohgen use: effect of the glycemic index. *J Appl Physiol* **89,** 1845-1851.

Feskanich D & Willett WC (1993) The use and validity of food frequency questionnaires in epidemiological research and clinical practice. *Medicine, Exercise, Nutrition , and Health* **2,**143-154.

Field AE, Coakley EH, Must A, Spadano JL, Laird N, Dietz WH, Rimm E & Colditz GA (2001) Impact of overweight on the risk of developing common chronic diseases during a 10-year period. *Arch Intern Med* **161**, 1581–1586.

Food and Agricultural Organisation/World Health Organisation (1998) Carbohydrates in human nutrition. Report of a Joint FAO/WHO Expert Consultation. *FAO Food Nutr Pap* **66**, 1-140.

Food and Nutrition Board (2005) Dietary Reference Intakes for Energy, Carbohydrate, Fiber, Fat, Fatty Acids, Cholesterol, Protein, and Amino Acids (Macronutrients). Institute of Medicine of the National Academies. Washington, DC, National Academy Press. www.nap.edu (accessed 20/06/2009)

FoodFinder™3. Dietary Analysis software. Parow Valley, Cape Town: Medical Research Council ;2002. Available from http://foodfinder.mrc.ac.za. (accessed 23/07/2009)

Foster-Powell K & Brand Miller J (1995) International tables of glycemic index. *Am J Clin Nutr* **62,** 8751-8935.

Foster-Powell K, Holt SH & Brand-Miller JC (2002) International table of glycemic index and glycemic load values. *Am J Clin Nutr* **76**, 5–56.

Franz MJ (2008) In *Krause's Food and Nutrition & Diet Therapy,* 12th edition. Chapter 34: Medical Nutrition Therapy for Diabetes Mellitus and Hypoglycemia of Nondiabetic Origin p792-835 [Mahan LK & Escott-Stump S, editors] London:Saunders.

Franz MJ (2003a) Respond to Brand-Miller et al and Mann. Meta-analysis of Low-Glycemic Index Diets in the Management of Diabetes. *Diab Care* **26**(12), 3364.

Franz MJ (2003b) The glycemic index: not the most effective nutrition therapy (Editorial). *Diab Care,* **26**(8), 2466-2468.

Franz MJ, Bantle JP, Beebe CA et al (2004) American Diabetes Association: Nutrition Principles and recommendations in diabetes *Diab Care* **27**, Suppl, S36-S46.

Franz MJ, Bantle JP, Beebe CA et al (2002) Evidence-based nutrition principles and recommendations for the treatment and prevention of diabetes and related complications. *Diab Care* **25**,148 –198.

Franz MJ, Monk A, Barry B, McClain K, Weaver T, Cooper N, Upham P, Bergenstal R & Mazze RS (1995a) Effectiveness of medical nutrition therapy provided by dietitians in the management of non-insulin-dependent diabetes mellitus: a randomized, controlled clinical trial. *J Am Diet Assoc* **95**, 1009–1017.

Franz MJ, Splett PL, Monk A, Barry B, McClain K, Weaver T , Upham P, Bergenstal R, & Mazze RS *(*1995b) Cost-effectiveness of medical nutrition therapy provided by dietitians for persons with non-insulin dependent diabetes mellitus. *J Am Diet Assoc* **95**, 1018–1024.

Frost G & Dornhorst A (2000) The relevance of the glycaemic index to our understanding of dietary carbohydrates. *Diabet Med* **17**, 336–345.

Frost G, Leeds A , Trew G, Margara R & Dornhorst A (1998) Insulin sensitivity in women at risk of coronary heart disease and the effect of a low glycemic diet. *Metabolism* **47**, 1245-1251.

Fugh-Berman A (2000) Review Herb-drug interactions. *Lancet* **355**, 134–138.

Gaetke LM, Stuart MA & Truszczynska HAT (2006) A single nutrition counseling session with a registered dietitian improves short-term clinical outcomes for rural Kentucky patients with chronic diseases. *J Am Diet Assoc* **106**,109-112.

Gannon MC, Nuttall FQ, Sayeed A, Jordan K & Hoover H (2003) An increase in dietary protein improves the blood glucose response in persons with type 2 diabetes. *Am J Clin Nutr* **78**, 734-741

Garber AJ (1998) Vascular disease and lipids in diabetes. *Med Clin North Am* **82**, 931-48.

Garg A (1998) High-monosaturated fat diets for patients with diabetes mellitus: a meta-analysis. *Am J Clin Nut* **67**, Suppl, 577S–582S.

Garrow IS & Owen AM (1990) *Dietary fibre, food intake and obesity*. In: Fibre-is it good for you? pp 37-48 [Bloom SR, editor]Southampton, UK: Duphar Medical Relations.

Gastaldelli A, Ferrannini E, Miyazaki Y, Matsuda M & DeFronzo RA (2004) Beta-cell dysfunction and glucose intolerance: results from the San Antonio metabolism (SAM) study. *Diabetologia*. **47**, 31-39.

Gatto LM, Sullivan DR & Samman S (2003) Postprandial effects of dietary trans fatty acids on apolipoprotein(a) and cholesteryl ester transfer. *Am J Clin Nutr* **77,** 1119-1124.

Geil PB & Anderson JW (1994) Nutrition and health implications of dry beans: a review. *J Am Coll Nutr* **13,** 549-558.

Gibney M & Vorster H (2001) South African Food-based Dietary Guidelines Editorial. *S Afr J Clin Nutr* **14**(3), Suppl, S2.

Glazier RH, Bajcar J, Kennie NR & Willson K (2006) Review Article: A Systematic Review of Interventions to Improve Diabetes Care in Socially Disadvantaged Populations. *Diab Care* **29**, 1675–1688.

Goeiman, Hilary(2009) Personal communication.Deputy Director Integrated Nutrition Programme, Directorate Comprehensive Health Programmes Department of Health.

Gohdes D (1988) Diet therapy for minority patients with diabetes. *Diab Care* **11(**2), 189-191.

Goldberg GR, Black AE, Jebb SA, Cole TJ, Murgatroyd PR, Coward WA & Prentice AM (1991) Critical evaluation of energy intake data using fundamental principles of energy physiology: 1. Derivation of cut-off limits to identify under-recording. *Eur J Clin Nutr* **45**, 569-581.

Goldstein DJ (1992) Beneficial health effects of modest weight loss. *Int J Obes Relat Metab Disord* **16**, 397–415.

Goris AHC, Westerterp-Plantenga MS & Westerterp KR (2000) Undereating and underrecording of habitual food intake in obese men: selective underreporting of fat intake. *Am J Clin Nutr* **71,**130–134.

Gregg EW, Gu Q, Cheng YJ, Narayan KMV & Cowie CC (2007) Mortality Trends in Men and Women with Diabetes, 1971 to 2000. *Ann intern med* **147**(3), 149-155**.**

Groenewald P, Vos T, Norman R, Laubscher R, Van Walbeek C, SaloojeeY, Sitas F, Bradshaw D & the South African Comparative Risk Assessment Collaborating Group (2007) Estimating the burden of disease attributable to smoking in South Africa in 2000. *S Afr Med J* **97**(8), 674-681.

Groop L (2000) Pathogenesis of type 2 diabetes: the relative contribution of insulin resistance and impaired insulin secretion. *Int J Clin Pract Suppl* **113**, 3-13.

Guenther PM (1994) Research needs for dietary assessment and monitoring in the United States. *Am J of Clin Nutr* **59**, Suppl, 168S-170S.

Guerrero-Romero F & Rodríguez-Morán M (2005) Complementary therapies for diabetes: the case for chromium, magnesium, and antioxidants. *Arch Med Res* **36**(3), 250-257.

Gulliford MC, Bicknell EJ & Scarpclio JH (1989) Differential effect of protein and fat ingestion on blood glucose responses to high and low glycemic index carbohydrates in noninsulin dependent diabetic subjects. *Am J Clin Nutr* **50**,773-777.

Guy N (2003) Glycemic Carbohydrate: An International Perspective. *Nutr Rev* 61(5), Suppl, S34-S39.

Ha TKK & Lean MM (1998) Recommendations for the nutritional management of patients with diabetes mellitus. *Eur J Clin Nutr* **52,**467-481.

Hammond KA (2008) In *Krause's Food and Nutrition & Diet Therapy*, 12th edition. Chapter 16: Dietary and Clinical Assessment, p372 [Mahan LK & Escott-Stump S, editors] London:Saunders.

Hanefeld M, Karasik A, Koehler C, Westermeier T & Chiason JL (2009) Metabolic syndrome and its single traits as risk factors for diabetes in people with impaired glucose tolerance: the STOPNIDDM trial. *Diabetes Vasc Dis Res* **6,** 32–37.

Hartz A, Kent S, James P , Xu Y, Kelly M & Daly J (2006) Factors that influence improvement for patients with poorly controlled type 2 diabetes. *Diabetes Res Clin Pract* **74**(3), 227-232.

Hawthorne K & Tomlinson S (1999) Pakistani moslems with Type 2 diabetes mellitus: effect of sex, literacy skills, known diabetic complications and place of care on diabetic knowledge, reported self-monitoring management and glycaemic control. *Diabet Med* **16**(7), 591-597.

Hawthorne K, Robles Y, Cannings-John R & Edwards AG (2008) Culturally appropriate health education for type 2 diabetes mellitus in ethnic minority groups. *The Cochrane Database of Syst Rev* 2008; issue 3, CD006424.

Health facility Definitions (2006) www.doh.gov.za/docs/misc/nhrpl/hfd.pdf (accessed 30/04/2009).

Heilbronn LK, Noakes M & Clifton PM (1999) Effect of energy restriction, weight loss, and diet composition on plasma lipids and glucose in patients with type 2 diabetes. *Diab Care* **22**, 889–895.

Heiner CB, Hengstler P, Schindler C & Meier G (2002) N-3 Polyunsaturated Fatty Acids in coronary Heart Disease: A Meta-analysis of randomised controlled trials. *Am J Med* **112,** 298-304.

Helmrich SP, Ragland DR, Leung RW & Paffenbarger RS Jr (1991) Physical activity and reduced occurrence of non-insulin-dependent diabetes mellitus. *N Engl J Med* **325**, 147–152.

Hendricks, C: Personal communication: Information Management, Metro District Health Services.

Hill J (2006) Management of diabetes in South Asian communities in the UK. *Nurs Stand* **20** (25), 57-64.

Hollenbeck CB, Coulston AM, Reaven GM (1986) Glycemic effects of carbohydrates: a different perspective. *Diab Care* **9**, 641–647.

Holman RR, Sanjoy KP, Angelyn Bethel M. Matthews DR & Neil HAW (2008) 10-Year Follow-up of Intensive Glucose Control in Type 2 Diabetes. *N Eng J Med* **359**, 1577-1589.

Holt S**,** Brand J, Sovony C & Hansky J (1992) Relationship of satiety to postprandial glycemic, insulin and cholecystokinin responses. *Appetite* **18**, 129-141.

Holt SHA, Brand-Miller JC & Petocx P (1997) An insulin index of common foods: the insulin demand generated by 1000-kJ portions of common foods. *Am J Clin Nutr* **66**, 1264-1276.

Horgan GW & Stubbs J (2003) Predicting basal metabolic rate in the obese is difficult. Original communication. *Eur J Clin Nutr* **57**, 335–340.

Howell WH, McNamara DJ, Tosca MA, Smith BT & Gaines JA (1997) Plasma lipid and lipoprotein responses to dietary fat and cholesterol:a meta-analysis. *Am J Clin Nutr* **65**, 1747–1764.

Hu FB, Manson JE, Stamper MJ, Colditz G , Liu S, Solomon CG & Willett WC (2001a) Diet, lifestyle, and the risk of type 2 diabetes mellitus in women. *N Engl J Med* **345**, 790–797.

Hu FB, Stampfer MJ, Manson JE, Rimm E, Colditz GA, Rosner BA, Hennekens CH & Willett WC (1997). Dietary fat intake and the risk of coronary heart disease in women. *N Engl J Med* **337**, 1491-1499.

Hu FB, van Dam & Liu S (2001b) Diet and risk of type 2 diabetes: the roles of types of fat and carbohydrate. *Diabetologia* **44**, 805–817.

Hughes GD, Puoane T & Bradley H (2006) Ability to manage diabetes – community health workers' knowledge, attitudes and beliefs. *JEMDSA* **11**(1), 10-14.

International Diabetes Institute (2000) *The Asia-Pacific Perspective: Redefining Obesity and its Treatment*. Health Communications Australia Pty Limited. http://www.obesityasiapacific.com/default.htm.

Jakicic JM, Wing RR, Butler BA & Robertson RJ (1995) Prescribing exercise in multiple short bouts versus one continuous bout: effects on adherence, cardiorespiratory fitness, and weight loss in over-weight women. *Int J Obes* **19**, 893–901.

Jakicic JM, Winters C, Lang W & Wing RR (1999) Effects of intermittent exercise and use of home exercise equipment on adherence, weight loss, and fitness in overweight women: a randomized trial. *J Am Med Assoc* **282**, 1554–1560.

James PT, Leach R, Kalamar E & Shayeghi M (2001) The Worldwide Obesity Epidemic. *Obesity Research* **9**, Suppl. 4, 228S-233S.

James SL, Muir JG., Curtis SL & Gibson PR (2003) Clinical Perspectives: Dietary fibre: a roughage guide. *Internal Med J* **33**, 291–296.

Järvi AE, Karlström BE, Granfeldt YE, Björck IE, Asp NL & Vessby BOH (1999) Improved Glycemic Control and Lipid profile and Normalised Fibrinolytic Activity on a Low-Glycemic Index Diet in Type 2 Diabetic Patients. *Diab Care* **22**(1), 10-18.

Jenkins DJ (1997) Carbohydrate tolerance and food frequency. *Br J Nutr* **77,** Suppl 1, S71-S81.

Jenkins DJ, Wolever TM, Jenkins AL, Thorne MJ, Lee R, Kalmusky J, Reichert R & Wong GS (1983) The glycaemic index of foods tested in diabetic patients: a new basis for carbohydrate exchange favouring the use of legumes. *Diabetologia* **24**, 257–264.

Jenkins DJ, Wolever TM, Vuksan V, Brighenti F, Cunnane SC, Rao AV, Jenkins AL, Buckley G, Patten R, Singer W**, et al (**1989) Nibbling versus gorging: metabolic advantages of increased meal frequency. *N Eng J Med* **321**(14), 929-934.

Jenkins DJA, Axelsen M, Kendall CWC, Augustin LS, Vuksan V & Smith U (2000) Dietary fibre, lente carbohydrates and the insulin-resistant diseases. *Br J Nutr* **83**, Suppl. 1, S157-S163.

Johns L (2008) Cape Argus newspaper, April 12 p6.

Johnson RK, Driscoll P & Goran MI (1996) Comparison of multiple-pass 24-hour recall estimate of energy intake with total energy expenditure determined by the doubly labelled water method in young children. *J Am Diet Assoc* **96**, 1140-1144.

Jonas WB (1998) Alternative medicine - learning from the past, examining the present, advancing to the future. *JAMA* **280**,1616-1619.

Jones K, Bone A, Gill G, Martin S, Padmore E, Dolan M et al.(1989) Factors affecting weight loss in obese Type 2 diabetes—the vital role of the dietitian. *Pract Diabetes* 6, 18–19.

Joubert J, Norman R, Bradshaw D, Goedecke JH, Steyn NP, Puoane T & the South African Comparative Risk Assessment Collaborating Group (2007) Estimating the burden of disease attributable to excess body weight in South Africa in 2000. *S Afr Med J* **97**, 683-690.

Karlstrom B, Vessby B & Eliasson M (1989) Diet – a balanced approach. In *Diabetes* 1988, pp. 923–925, [R. Larkins, P.Zimmet & D. Chisholm,editors]. Amsterdam: Elsevier, 1989.

Kengne AP, Amoah AGB, Mbanya JC (2005) Cardiovascular Complications of Diabetes Mellitus in Sub-Saharan Africa. *Circulation* **112,** 3592-3601.

King H, Aubert RE & Herman WH (1998) Global burden of diabetes, 1995-2025: prevalence, numerical estimates, and projections. Division of Noncommunicable Diseases, World Health Organization, Geneva. *Diab Care* **21**(9), 1414-31.

Kinosian, B, Glick H & Garland G (1994) Cholesterol and coronary heart disease: predicting risks by levels and ratios. *Ann Int Med* **121,** 641-7.

Klein S, Sheard NF, Pi-Sunyer X, Daly A ,Wylie-Rosett J, Kulkarni K & Clark NG (2004) Weight Management Through Lifestyle Modification for the Prevention and Management of Type 2 Diabetes:Rationale and Strategies. A statement of the ADA, the North American Association for the Study of Obesity, and the American Society for Clinical Nutrition. *Diab Care* **27**(8), 2068-2073.

Kohrt WM, Kirwan JP, Staten MA, Bourey RE, King DS & Holloszy JO (1993) Insulin resistance in aging is related to abdominal obesity. *Diabetes* **42**(2), 273-81.

Kratz M, Cullen P, Kannenberg F, Kassner A, Fobker M, Abuja PM, Assmann G & Wahrburg U (2002) Effects of dietary fatty acids on the composition and oxidizability of low density lipoprotein. *Eur J Clin Nutr* **56**, 72–81.

Kreb-Smith SM, Smiciklas-Wright H, Guthrie HA & Krebs-Smith J (1987) The effects of variety of food choices on dietary quality. *J Am Diet Assoc* **87,** 897-903.

Krentz A (2006) Editorial: Effective management of type 2 diabetes and metabolic syndrome: beyond glucose control. *S Afr J Diabetes Vasc Dis* **3**(1), 6-7.

Kris-Etherton PM, Harris WS & Appel LJ (2002) Fish consumption, fish oil, omega-3 fatty acids, and cardiovascular disease. *Circulation* **106**, 2747–2757.

Kruger HS, Venter CS & Vorster HH (2003) Physical inactivity as a risk factor for cardiovascular disease in communities undergoing the rural to urban transition: the THUSA study. *Cardiovasc J S Afr* **14**(1), 16–23.

Labadarios D (editor), Steyn NP, Maunder E, MacIntyre U, Swart R, Gericke G, Huskisson J, Dannhauser A, Vorster HH & Nesmvuni AE. *The National Food Consumption Survey (NFCS)*: children aged 1–9 years, South Africa, 1999. Pretoria: Department of Health; 2000. Available: http://www.sun.ac.za/nutrition/nfcs.html

Labadarios D, Walker ARP, Blaauw R & Walker BF (1996) Traditional diets and meal patterns in South Africa. *World Rev Nutr Diet* **79**, 70-108.

Laine DC, Thomas W, Levitt MD, Bantle JP (1987) Comparison of predictive capabilities of diabetic exchange lists and glycemic index of foods. *Diab Care* **10**, 387–394.

Langenhoven ML, Steyn K & van Eck M (1988a) The food and meal pattern in the Cape Peninsula coloured population. *Ecology Food Nutr* **22,** 107-116.

Langenhoven M, Kruger M, Gouws E & Faber M (1991) *MRC Food Composition Tables*.Third Edition. Parow: Medical Research Council.

Langenhoven ML, Wolmarans P, Groenewald G, Richter MJC & van Eck M (1988b) Nutrient intakes and food and meal patterns in three South African population groups. *Front Gastrointest Res* **14**, 41-48.

Langenhoven ML, Wolmarans P, Jooste PL, Dhansay MA & Benadé AJS (1995) Food consumption profile of the South African adult population. *S Afr J Science* **91,** 523-528.

Laquatra I (2008) In *Krause's Food and Nutrition & Diet Therapy,* 12th edition. Chapter 16: Nutrition for weight management, p495 [Mahan LK & Escott-Stump S, editors] London:Saunders

Lee RD & Nieman DC (2003) Nutritional Assessment, third edition, McGraw-Hill Higher Education, NY.

Lee YM, Haastert B, Scherbaum W & Hauner H (2003) A phytosterol-enriched spread improves the lipid profile of subjects with type 2 diabetes mellitus: a randomized controlled trial under freeliving conditions. *Eur J Nutr* **42**, 111–117.

Leeds AR (1979) The dietary management of diabetes in adults. *Proc Nutr Soc* **38**, 365-371.

Lee-Han H, McGuire V & Boyd F (1989) A Review of the methods used by studies of dietary measurement. *J Clin Epidemiol* **42**(3), 269-279.

Lemaitre RN, King IB, Raghunathan TE, Pearce RM, Weinmann S, Knopp RH, Copass MK, Cobb LA & Siscovick DS (2002) Cell membrane trans-fatty acids and the risk of primary cardiac arrest. *Circulation* **105**, 697-701.

Lerman I (2005) Review article: Adherence to Treatment: The Key for Avoiding Long-Term Complications of Diabetes. *Arch Med Res* **36,** 300–306.

Lerman I, Lozano L, Villa AR et al (2004) Psychosocial factors associated with poor diabetes self-care management in a specialized Center in Mexico City. *Biomed Pharmacother* **58**, 566–570.

Levitt N, Amod A, Ascott-Evans B et al (2009) SEMDSA Guidelines for Diagnosis and Management of Type 2 Diabetes Mellitus for Primary Health Care – 2009. *JEMDSA* **14**(1), 55 – 58.

Levitt NS & Bradshaw D (2006) The impact of HIV/AIDS on Type 2 diabetes prevalence and diabetes healthcare needs in South Africa: projections for 2010, Diabetes UK. *Diab Med* **23**, 103–106.

Levitt NS, Steyn K, Katzenellenbogen JM, Bradshaw D, Hoffman MN & Bonnici F(1993) The prevalence and identification of risk factors for NIDDM in Urban Africans in Cape Town, South Africa. *Diab Care* **16**, 601-607.

Levitt NS, Steyn K, Lambert EV, Reagon G, Lombard CJ, Fourie JM, Rossouw K & Hoffman M (1999) Modifiable risk factors for type 2 diabetes mellitus in a peri-urban community in South Africa. *Diabet Med* **16**, 946-950.

Lewin S, Dick J, Pond P, Zwarenstein M, Aja GN, van Wyk BE, Bosch-Capblanch X & Patrick M (2005) Lay health workers in primary and community health care. *Cochrane Database of Syst Rev* 2005, Issue 1. Art. No.: CD004015. DOI: 10.1002/14651858.CD004015.pub2

Link N (1999) Diabetes Management of type 2 diabetes mellitus. *West J Med* 172, 25-26.

Lintas C & Cappelloni M (1992) Effect of processing on legume resistant starch. *Eur J Clin Nutr* **46**,Suppl. 2, S103-S104.

Livesey G, Taylor R, Hulshof T & Howlett J (2008) Glycemic response and health—a systematic review and meta-analysis: relations between dietary glycemic properties and health outcomes. *Am J Clin Nutr* **87,** Suppl, 258S– 2568S.

Love P (2003) Food-based dietary guidelines for the patient with diabetes. *CME* **21**(10), 564-571.

Love P, Maunder EMW & Green JM (2008) Are South African Women willing and able to apply the new food-based dietary guidelines? Lessons for nutrition educators. *S Afr J Clin Nutr* **21**(2), 17-24.

Lovejoy JC (1999) Dietary fatty acids and insulin resistance. *Curr Atheroscler Rep* **1**,215–220.

Loveman E, Frampton GK & Clegg AJ (2008) The clinical effectiveness of diabetes education models for Type 2 diabetes: a systematic review. *Health Technol Assess* **12**(9), 1-116.

Ludwig DS (2000) Dietary glycemic index and obesity. *Am J Clin Nutr* **130**, Suppl 2, 280S-283S.

Lundsford TR & Lundsford BR (1996) Research forum. How to critically read a journal research article. *J Prosthet Orthot* **8**(1), 24-31.

Maldonato A, Bloke D, Cecil M, Fraticelli E & Fallucca F (1995) Diabetes mellitus: lessons from patient education. *Patient Educ Counselling* **26**, 57-66.

Malerbi D, Paiva E, Duarte A & Wajchenberg B (1996) Metabolic effects of dietary sucrose and fructose in type II diabetic subjects. *Diab Care* **19**, 1249-1256.

Mann J (2001) Dietary fibre and diabetes revisited. *Eur J Clin Nutr* **55**, 919–921.

Marshall, Gillian (2008) Personal communication. Senior community dietitian, Cape Metropole, Department of Health.

Mash R, Levitt NS, Van Vuuren U & Martell R (2008) Improving the annual review of diabetic patients in primary care: an appreciative inquiry in the Cape Town District Health Services. *SA Fam Pract* **50**(5):50a-50d.

Mash, B (2009) Personal communication. Family Medicine and Primary Care , Stellenbosch University.

Matthews B & Hayes TM (1987) The effect of dietary advice on diabetic control. *Pract Diabetes* **4**, 85–86.

Mauger JF, Lichtenstein AH, Ausman LM,Jalbert SM, Jauhiainen M, Ehnholm C & Lamarche B (2003) Effect of different forms of dietary hydrogenated fats on LDL particle size. *Am J Clin Nutr* **78**, 370-375.

Maunder EMW, Matji J & Hlatshwayo-Molea T (2001) Enjoy a variety of foods-difficult but necessary in developing countries. *S Afr J Clin Nutr* **14(** 3), Suppl, S7-S11.

Mayer-Davis EJ, D'Agostino R Jr, Karter AJ, Haffner SM, Rewers MJ, Saad M & Bergman RN (1998) Intensity and amount of physical activity in relation to insulin sensitivity: the Insulin Resistance Atherosclerosis Study. *J Am Med Assoc* **279,** 669–674.

McCarron DA & Heaney RP (2004) Estimated healthcare savings associated with adequate dairy food intake**.** *Am J Hypertens 17*, 88-97**.**

McCumisky M (2009) Personal communication. Western Cape branch manager of Diabetes South Africa. capewc@diabetessa.co.za

McMillan-Price J & Brand-Miller J (2004) Dietary Approaches to Overweight and Obesity. *Clin Dermatol* **22**, 310-314.

Mensink RP, Zock PL, Kester AD, Katan MB (2003) Effects of dietary fatty acids and carbohydrates on the ratio of serum total to HDL cholesterol and on serum lipids and apolipoproteins: a meta-analysis of 60 controlled trials *Am J Clin Nutr* **77**(5), 1146-1155.

Messina M (1999) Legumes and soybeans: overview of their nutritional profiles and health effects. *Am J Clin Nutr* **70,** Suppl, 439S-450S.

Meyer KA, Kushi LH, Jacobs DR Jr, Slavin J, Sellers TA, & Folsom AR (2000) Carbohydrates, dietary fiber, and incident type 2 diabetes in older women. *Am J Clin Nutr* **71**, 921–930.

Miller W (1994) Exercise: Americans don't think it's worth it! *Obesity and health* **8**(2), 29-31,38.

Mokdad AH, Ford ES, Bowman BA, Dietz WH, Vinicor F, Bales VS & Marks JS (2003) Prevalence of obesity, diabetes, and obesity-related health risk factors. *J Am Med Assoc* **289**, 76–79.

Monk A, Barry B, McClain K, Weaver T, Cooper N & Franz MJ (1995) Practice guidelines

for medical nutrition therapy provided by dietitians for persons with non-insulin-dependent diabetes mellitus. *J Am Diet Assoc* **95**, 999-1006.

Motala AA (2002) Abstract: Diabetes trends in Africa. *Diabetes Metab Res Rev* **18,** Suppl. 3, S14-S20.

Motala AA, Pirie FJ, Gouws E, Amod A & Omar MA (2001) Microvascular complications in South African patients with long-duration diabetes mellitus. *S Afr Med J* **91**(11), 987-992.

Motala AA, Pirie FJ, Gouws E,Amod A & Omar MAK (2003) High incidence of Type 2 diabetes mellitus in South African Indians: a 10-year follow-up study. Diabetes UK.*Diabetic Medicine* **20**, 23–30

Mozaffarian D, Rimm EB, King IB, Lawler RL, McDonald GB & Levy WC (2004) Trans fatty acids and systemic inflammation in heart failure. *Am J Clin Nutr* **80**,521-1525.

Murphy MC, Chapman C, Lovegrove JA, Isherwood SG, Morgan LM, Wright JW & Williams CM(1996) Meal frequency; does it determine postprandial lipaemia? *Eur J Clin Nutr* **50**(8), 491-497.

Murphy SP (2008) Personal communication: Researcher at Cancer Research Centre of Hawaii, University of Hawaii.

Murphy SP, Guenther PM & Kretsch MJ (2006) Commentary**:** Using the Dietary Reference Intakes to Assess Intakes of Groups: Pitfalls to Avoid. *J Am Diet Assoc* 106 (10),1550-1553.

Nathan DM, Buse JB, Davidson MB, Ferrannini E, Holman RR, Sherwin R & Zinman B (2008) Management of Hyperglycemia in Type 2 Diabetes: A Consensus Algorithm for the Initiation and Adjustment of Therapy. Update regarding thiazolidinediones: a consensus statement from the American Diabetes Association and the European Association for the Study of Diabetes. *Diab Care* **31**(1), 173-175.

Nathan DM, Buse JB, Davidson MB, Heine RJ, Holman RR, Sherwin R & Zinman B (2006) Management of hyperglycemia in type 2 diabetes: a consensus algorithm for the initiation and adjustment of therapy. A consensus statement from the American Diabetes Association and the European Association for the Study of Diabetes. *Diab Care* **29**, 1963-1972.

National Cholesterol Education Program Expert Panel (2001) on Detection, Evaluation, and Treatment of High Blood Cholesterol in Adults. *J Am Med Assoc* **285**, 2486-2497.

Nel JH & Steyn NP(2002) Report on South Africa Food Consumption Studies Undertaken amongst different population groups(1983-2000):Average intakes of foods most commonly consumed[online]. Available: http://www.sahealthinfo.org/nutrition/scientific.htm.

Nelson M, Black AE, Morris JA, Cole TJ (1989) Between- and within-subject variation in nutrient intake from infancy to old age: estimating the number of days required to rank dietary intakes with desired precision. *Am J Clin Nutr* **50**, 155-167

Nelson M, Lean MEJ, Connor H , Thomas BJ, Lord K, Hartland B, Waldron S, McGough N, Walker L, Ryan A & Start K (2000) Survey of dietetic provision for patients with diabetes. *Am J Clin Nutr* **17**(8),565 – 571.

Nilsson M, Trehn G &.Asplund K (2001) Use of complementary and alternative medicine remedies in Sweden. A population-based longitudinal study within the northern Sweden MONICA Project. *J Int Med* **250**, 225-233.

Norris SL, Zhang X, Avenell A, Gregg E, Brown TJ, Schmid CH & Lau J (2005) Long-term non-pharmacological weight loss interventions for adults with type 2 diabetes mellitus. *Cochrane Database of Syst Rev* 2005, Issue 2. Art. No.: CD004095. DOI: 10.1002/14651858.CD004095.pub2.

Nthangeni G, Steyn NP, Alberts M, Steyn K, Levitt NS, Laubscher R, Bourne L, Dick J & Temple N (2002) Dietary Intake and barriers to dietary compliance in black type 2 diabetic patients attending primary health-care services. *Public Health Nutr* 5**(2**), 329-338.

Nurymberg K, Kreitler S & Weissler K (1996) The cognitive orientation of compliance in short- and long-term type 2 diabetic patients. *Patient Edu Couns* **29**, 25-39.

Nuttall FQ & Gannon MC(1991) Plasma glucose and insulin response to macronutrients in nondiabetic and NIDDM subjects. *Diab Care* **14**, 824–838.

Nuttall FQ, Mooradian AD, Gannon MC, Billington C & Krezowski P (1984) Effect of protein ingestion on the glucose and insulin response to a standardised oral glucose load. *Diab Care* **7,** 465-470.

Opperman M (2005) Dietary challenges for optimal control of type 2 diabetes. Editorial. *S Afr J Diabetes Vasc Dis* **2** (1), 6-8.

Parker B, Noakes M, Luscombe N & Clifton P (2002) Effect of a high-protein, high–monounsaturated fat weight loss diet on glycemic control and lipid levels in type 2 diabetes. *Diab Care* **25**, 425– 430.

Parker W (2008) Lifestyle Modification Education in chronic diseases of lifestyle provided by health professionals at primary health care facilities in the Western Cape, South Africa. PhD Thesis, University of Cape Town.

Pastors JG, Warshaw H, Daly A, Franz M & Kulkarni K (2002) The Evidence for the Effectiveness of Medical Nutrition Therapy in Diabetes Management. *Diab Care* **25**(3), 608–613.

Pate RR, Pratt M, Blair SN, Haskell WL, Macera CA, Bouchard C, Buchner D, Ettinger W, Heath GW & King AC(1995) Physical activity and public health: a recommendation from the Centers for Disease Control and Prevention and the American College of Sports Medicine. *J Am Med Assoc* **273**, 402–407.

Patterson RE, Kristal AR & White E (1996) Do beliefs, knowledge, and perceived norms about diet and cancer predict dietary change? *Am J Public Health* **86**(10), 1394-1400.

Pawlak DB, Ebbeling CB & Ludwig DS (2002) Should obese patients be counselled to follow a low-glycaemic index? Yes. *Obes Rev* **3**, 235-243.

Pereira MA, Jacobs DR Jr, Van Horn L, Slattery ML, Kartashov AI & Ludwig DS (2002) Dairy consumption, obesity, and the insulin resistance syndrome in young adults:the CARDIA Study. *J Am Med Assoc* **287**(16), 2081-2089.

Perlstein R & Willcox J (1997) Review paper: Glycemic index in diabetes management. Dietitians Association of Australia. *Aust Jf Nutr Diet* **5**, 57-63.

Pietinen P, Ascherio A, Korhonen P, Hartman AM, Willett WC, Albanes D & Virtamo J (1997) Intake of fatty acids and risk of coronary heart disease in a cohort of Finnish men. The Alpha-Tocopherol, Beta-Carotene Cancer Prevention Study. *Am J Epidemiol* **145,** 876-887.

Pi-Sunyer FX (1993) Short-term medical benefits and adverse effects of weight loss. *Ann Intern Med* **119**, 722–726.

Pi-Sunyer FX (2002) Glycemic index and disease. *Am J Clin Nutr* **76**, Suppl, 290S-298S.

Poppitt SD, Swann D, Black AE & Prentice AM (1998) Assessment of selective underreporting of food intake by both obese and non-obese women in a metabolic facility. *Int J of Obesity and Related Met Disord* **22**, 303-311.

Pories WJ, MacDonald KG Jr, Morgan EJ, Sinha MK, Dohm GL, Swanson MS, Barakat HA, Khazanie PG, Leggett-Frazier N & Long SD (1992) Surgical treatment of obesity and its effect on diabetes: 10-y follow- up. *Am J Clin Nutr*, **55**, Suppl, 582S-585S.

Prentice AM & Jebb SA (1995) Obesity in Britain: gluttony or sloth? *BMJ* **311**(7002), 437-439.

Quatromoni PA, Mibauer M, Posner BM, Carballeira NP, Bruni M & Chipkin SR (1994) Use of focus groups to explore nutrition practices and health beliefs of urban Caribbean Latinos with diabetes. *Diabetes Educ* **17**(8), 69-873.

Raben A, Holst JJ, Christensen NJ & Astrup A (1996) Determinants of postprandial appetite sensation: macronutrient intake and glucose metabolism *Int J Obes* **20**,161-169.

Reaven GM, Hollenbeck CB & Chen Y-DI (1989) Relationship between glucose tolerance, insulin secretion, and insulin action in non-obese individuals with varying degrees of glucose tolerance. *Diabetologia* **32**,52-55.

Reaven PD, Grasse BJ, & Tribble DL (1994) Effects of linoleate-enriched and oleate-enriched diets in combination with alphatocopherol on the susceptibility of LDL and LDL subfractions to oxi-dative modification in humans. *Arterioscler Thromb* **14**, 557-566.

Risérus U, Willett WC & Hu FB (2009) Dietary fats and prevention of type 2 diabetes. *Prog Lipid Res* **48**(1), 44-51.

Rossouw JE,, Du Plessis JP, Benadé AJS, Jordaan PC, Kotze JP, Jooste PL & Ferreira JJ (1983) Cornary risk factor screening in three rural communities. *S Afr Med J* **64**, 430-436.

Sacks FM, Svetkey LP, Vollmer WH, Appel LJ, Bray GA & Harsha D *(2001)* Effects on blood pressure of reduced dietary sodium and the dietary approaches to stop hypertension (DASH) diet. *New Engl J Med* **334,** 3-10.

Salmeron J, Ascherio A, Rimm EB, Colditz GA, Spiegelman D, Jenkins DJ, Stampfer MJ, Wing AL & Willett WC (1997) Dietary fiber, glycemic load, and risk of NIDDM in men. *Diab Care* **20**, 545–550.

Saxena R, Voight BF, Lyssenko V, et al (2007) Genome-wide association analysis identifies loci for type 2 diabetes and triglyceride levels. *Science* **316**, 1331-1336.

Schillinger D, Grumbach K , Piette J , Wang F, Osmond D, Daher C, Palacios J, Sullivan GD & Bindman AB (2002) Associations of health literacy with diabetes outcomes. *J Am Med Assoc* **288**, 475–482.

Schoeller DA, Shay K & Kushner RF (1997) How much physical activity is needed to minimize weight gain in previously obese women? *Am J Clin Nutr* **66**, 551–556.

Schofield C (1985) An annotated bibliography of source material for basal metabolic rate data. *Clin Nutr* 39C, Suppl 1, 42 – 91.

Schofield WN, Schofield C & James WPT (1985) Basal metabolic rate. *Human Nutr Clin Nutr* **39C,** Suppl1, 1-96.

Scholtz SC, Vorster HH (jun), Matshego L & Vorster H H (2001) Foods from animals can be eaten every day-not a conundrum. *S Afr J Clin Nutr* **14**(3), Suppl, S39-47.

Schulze MB, Liu S, Rimm EB, Manson JE, Willett WC & Hu FB (2004) Glycemic index, glycemic load, and dietary fiber intake and incidence of type 2 diabetes in younger and middle-aged women. *Am J Clin Nutr* **80**, 348 –356.

Seedat YK (1999) Coronary heart disease in South African Indians. *S Afr Med J* 89, Suppl 2, S76–S80.

Seedat YK, Mayet FG, Khan S, Somers SR & Joubert G (1990) Risk factors for coronary heart disease in the Indians of Durban. *S Afr Med J* **78**, 447–454.

SEMDSA (2002) Revised SEMDSA Guidelines for diagnosis and management of type 2 diabetes mellitus for primary health care in 2002: semdsa.org.za/dessa/files/dm2-guidelines.pdf. (accessed 20/10/2008).

SEMDSA Consensus Document (1997) Guidelines for the management of type II(non-insulin-dependent) diabetes mellitus at primary health care level in South Africa. *S Afr Med J* **87**(4): 497-512.

Senekal M, Steyn NP & Nel J (2009) A questionnaire for screening the micronutrient intake of economically active South African adults. *Public Health Nutr* **27**, 1-9.

Shaw KM (2006) Overcoming the hurdles to achieving glycemic control. *Metabolism* **55**, Suppl 1, S6– S9.

Sheard NF, Clark NG, Brand-Miller JC, Franz MJ, Pi-Sunyer FX, Mayer-Davis E, Kulkarni K & Geil P (2004) Dietary Carbohydrate (Amount and Type) in the Prevention and Management of Diabetes. A Statement by the American Diabetes Association. *Diab Care* **27**(9), 2266-2271.

Sheils JF, Rubin R & Stapleton DC (1999) The estimated costs and savings of medical nutrition therapy: the Medicare population. *J Am Diet Assoc* 99, 428–435.

Sigal RJ, Kenny GP, Wasserman DH & Castaneda-Sceppa C (2004) Physical activity/exercise and type 2 diabetes. *Diab Care* **27**, 2518–2539.

Simpson RW, Mann JI, Eaton J, Moore RA, Carter R & Hockaday TDR (1979). Diet and diabetes. *Diabetologia* **18**, 89-95.

Sjöström CD, Peltonen M, Wedel H & Sjöström L (1999) Bariatric Surgery use in Type 2 Diabetes: Bariatric Surgical Procedures. *Obesity Res* **7**, 477-485.

Slabber M (2005) PhD. Complexities of consumer understanding of the glycaemic index concept and practical guidelines for incorporation in diets. *S Afr J Clin Nutr* **18**(3), 252-257.

Speechly DP & Buffenstein R (1999) Greater appetite control associated with an increased frequency of eating in lean males. *Appetite* **33(**3**),** 285-97.

Spiller RC (1999) Impact of dietary fibre on absorption in the small intestine. *Curr Opin Gastroenterol* **15**, 100–2.

Steenkamp G & Delport L (2007) The South African Glycemic Index and Load Guide. A GIFSA Publication.

Steinmetz K & Potter J (1996) Vegetables, fruit, and cancer prevention: a review. *J Am Diet Assoc* **96,** 1027- 1039.

Stender S, Skovby F, Haraldsdóttir J, Andresen GR, Michaelsen KF, Nielsen BS & Ygil KH (1993). Cholesterol-lowering diets may increase the food costs for Danish children. A cross-sectional study of food costs for Danish children with and without familial hypercholesterolaemia. *Eur J Clin Nutr* **47**, 776–86.

Steyn K, Jooste PL, Bourne L et al (1991) Risk factors for coronary heart disease in the black population of the Cape Pensinsula. *S Afr Med J* **79**, 480-485.

Steyn K, Jooste PL, Langenhoven ML, Benade AJS, Roussouw JE, Steyn M, & Jordaan PCJ (1985). Coronary risk factors in the coloured population of the Cape Peninsula (CRISIC). *S Afr Med J* **67**, 619-625.

Steyn NP & Levitt NS (2004) Dietary Management of Diabetes Mellitus in Sub-Saharan Africa. In *International Textbook of Diabetes Mellitus,* pp 757-769 [Defronzo RA, Ferrannini E, Keen H, Zimmet P, editors]. New York. John Wiley & Sons, Ltd.

Steyn NP & Senekal M (2004) Dietary Assessment and Education Kit (DAEK): Chronic Diseases of Lifestyle Unit, Medical Research Council, PO Box 19070, Tygerberg, 7505.

Steyn NP , Lambert EV & Tabana H (2009) Nutrition interventions for the prevention of type 2 diabetes. *Proc Nutr Soc* **68**, 55–70

Steyn NP**,** Albertse EC**,** van Wyk Kotze TJ**,** van Heerden L**,** Kotze JP (1986) Analysis of the diets of 12-year-old children in Cape Town. *S Afr Med J* **69**, 739-742.

Steyn NP, Bradshaw D, Norman R, Joubert J, Schneider M & Steyn K (2006b) Dietary Changes and the Health Transition in South Africa: implication for health policy. Chronic Disease of Lifestyle Unit and Burden of Disease Research Unit of the Medical Research Council.

Steyn NP, Burger S, Monyeki KD, Alberts M, Nthangeni G (2001) Variation in dietary intake of the adult population of Dikgale. *S Afr J Clin Nutr* 14(4), 140-145.

Steyn NP, Mann J, Bennett PH, Temple N, Zimmet P, Tuomilehto J, Lindström J & Louheranta A (2004) Diet, nutrition and the prevention of type 2 diabetes. *Public Health Nutr* **7**(1A), 147–165.

Steyn NP, Mbhenyane XG (2008) Workforce development in South Africa with a focus on public health nutrition. *Public Health Nutr* **11**(8), 792-800.

Steyn NP; Maunder EMW, Labadarios D & Nel JH(2006a) Foods and beverages that make significant contributions to macro-and micronutrient intakes of children in South Africa-do they meet the food-based dietary guidelines? *S Afr J Clin Nutr* **19**(2), 66-76.

Stolar MW, Hoogwerf BJ, Gorshow SM, Boyle PJ & Wales DO (2008) Managing Type 2 Diabetes: Going Beyond Glycemic Control. *J Manag Care Pharm.* **14**(5), Suppl Sb,S2-S19.

Sun Q, Ma J, Campos H, Hankinson SE, Manson JE, Stampfer MJ, Rexrode KM, Willett WC & Hu FB (2007) A prospective study of trans fatty acids in erythrocytes and risk of coronary heart disease. *Circulation* **115**, 1858-1865.

Tavani A & Vecchia C (1995) Fruit and vegetable consumption and cancer risk in a Mediterranean population. *Am J Clin Nutr* **61,** Suppl, 1372S-1377S.

Thompson FE & Byers T (1994) Dietary Assessment Resource Manual. *J Nutr* **124**, 245S-2317S.

Torgerson JS, Hauptman J, Boldrin MN & Sjostrom L (2004) XENical in the Prevention of Diabetes in Obese Subjects (XENDOS) study: a randomized study of orlistat as an adjunct to lifestyle changes for the prevention of type 2 diabetes. *Diab Care* **27**(1), 155-161

Tripp-Reimer T, Choi E, Skemp Kelley L & Enslein JC (2001) Cultural Barriers to Care: Inverting the problem. *Diabetes Spectrum* **14**(1), 13-22.

Truswell AS, Thomas BJ & Brown AM (1975). Survey of dietary policy and management in British diabetic clinics. *BMJ* **4** (5987), 7-11.

Tuomilehto J, Lindstrom J, Eriksson JG et al (2001) Prevention of type 2 diabetes mellitus by changes in lifestyle among subjects with impaired glucose tolerance. *N Engl J Med* **344,** 1343–1350.

Two Feathers J, Kieffer EC , Palmisano G et al (2005) Racial and Ethnic Approaches to Community Health (REACH) Detroit Partnership: Improving Diabetes-Related Outcomes Among African American and Latino Adults. *Am J Public Health* **95**, 1552–1560.

United Kingdom Prospective Diabetes Study (UKPDS) Group (1998) Intensive blood-glucose control with sulphonylureas or insulin compared with conventional treatment and risk of complications in patients with type 2 diabetes (UKPDS 33). *Lancet* **352**, 837-53.

United Kingdom Prospective Diabetes Study 7 (UKPDS) (1990) Response of fasting plasma glucose to diet therapy in newly presenting type II diabetic patients. *Metabolism* **39**, 905–912.

Unwin N, Setel P, Rashid S, Mugusi F, Mbanya JC, Kitange H, Hayes L, Edwards R, Aspray T & Alberti KGSO (2001) Noncommunicable diseases in sub-Saharan Africa: where do they feature in the health research agenda? *Bull World Health Organ* **79**(10), 947-53.

Van de Sande M, Dippenaar H & Rutten GE (2007) The relationship between patient education and glycaemic control in a South African township. *Prim Care Diabetes* **1**(2), 87-91.

Van Eyssen E (2002) *Bean Renaissance* Dried Bean Producers Organisation, Arcadia South Africa.

Venn BJ & Mann JI (2004) Cereal grains, legumes and diabetes. *Eur J Clin Nutr* **58**, 1443–1461.

Venter CS, Slabber M & Vorster HH (2003) Labelling of foods for glycaemic index: Advantages and problems. *S Afr J Clin Nutr* **16**, 118-126.

Vessby B (1994) Dietary carbohydrates in diabetes. Review. *Am J Clin Nutr* 59, Suppl, 742S-746S.

Vorster HH & Nell TA (2001) Make Starchy Foods the Basis of Most Meals. *S Afr J Clin Nutr* 14(3), Suppl, S17-S24.

Vorster HH & Venter CS (1994) Health benefits of dry beans (Phaseolus vulgaris): a review. *S Afr J Food Sci Nutr* **6,** 72-76.

Vorster HH (2005) Corresponding author. The glycaemic index in practice –consensus statement of a small group of South African dietitians. *S Afr J Clin Nutr* **18**, (3), 260-264.

Vorster HH, Oosthuizen W, Jerling JC, Veldman FJ & Burger HM (1997) A review of the nutritional status of South Africans from 1975 to 1996 *The Nutritional Status of South Africans. A Review of the Literature*. *Narrative and Tables*. Durban: Health Systems Trust, 1-**48**, 1-122.

Vorster HH, van Tonder E, Kotzé JP, Walker ARP (1987) Effects of graded sucrose additions on taste preference, acceptibility, glycemic index and insulin response to butter beans. *Am J Clin Nutr* **45**, 575-579.

Voss S, Kroke A, Klipstein-Grobusch K & Boeing H (1998) Is macronutrient composition of dietary intake data affected by underreporting? Results from the EPIC-Potsdam study. *Eur J Clin Nutr* **52**, 119-126.

Wajchenberg BL (2007) Beta-cell failure in diabetes and preservation by clinical treatment. *Endocr Rev* **28**(2), 187-218.

Walsh CM, Dannhauser A & Joubert G (2003). Impact of a nutrition education programme on nutrition knowledge and dietary practices of lower socioeconomic communities in the Free State and Northern Cape. *S Afr J Clin Nutr* **16**(3), 89-95.

Warshaw, HS (1997) Carbohydrate counting, *Countdown* **18** (2), 28-31.

Welch IML, Bruce C, Hill SE & Read NW (1987) Duedenal and ileal lipid suppresses postpradial blood glucose and insulin responses in man: possible implications for the dietary management of diabetes mellitus. *Clin Sci* **72**, 209-216.

Weststrate JA & Meijer GW (1998) Plant sterol-enriched margarines and reduction of plasma total and LDL-cholesterol concentrations in normocholesterolaemic and mildly hypercholesterolaemic subjects. *Eur J Clin Nutr* **52,** 334-343.

Wikipedia (2009) *Coloured: Southern Africa*. http://en.wikipedia.org/wiki/Colored (accessed 23/07/2009)

Williams KV & Kelley DE (2000) Metabolic consequences of weight loss on glucose metabolism and insulin action in type 2 diabetes. *Diabetes Obes Metab* **2***(3)***,** 121–129.

Williams MV, Baker DW, Parker RM & Nurss JR(1998) Relationship of functional health literacy to patients knowledge of their chronic disease: a study of patients with hypertension and diabetes. *Arch. Intern Med* **158**, 166–172.

Wing RR & Hill JO (2001). Successful weight loss maintenance. *Annu. Rev. Nutr* **21**, 323-341.

Wiseman MJ, Dodds R, Bending II & Viberti GC (1987) Dietary protein and the diabetic kidney. *Diabetic Med* **4**, 144-146.

Wolever TM (1990) Metabolic effects of continuous feeding. *Metabolism* **39**, 947-951.

Wolever TM, Jenkins DJ (1986) The use of the glycemic index in predicting the blood glucose response to mixed meals. *Am J Clin Nutr* **43**,167–172.

Wolever TM, Jenkins DJ, Josse RG, Wong GS, Lee R (1987) The glycemic index: similarity of values derived in insulin-dependent and non-insulin-dependent diabetic patients. *J Am Coll Nutr* **6**, 295–305.

Wolever TM, Jenkins DJ, Vuksan V, Josse RG, Wong GS, Jenkins AL (1990) Glycemic index of foods in individual subjects. *Diab Care* **13**, 126–132.

Wolever TM, Nguyen PM, Chiasson JL, Hunt JA, Josse RG, Palmason C, Rodger NW, Ross SA, Ryan EA & Tan MH (1994) Determinants of diet glycemic index calculated retrospectively from diet records of 342 individuals with non-insulin-dependent diabetes mellitus. *Am J Clin Nutr* **59**, 1265–1269.

Wolever TM, Nuttall FQ, Lee R, Wong GS, Josse RG, Csima A & Jenkins DJ (1985) Prediction of the relative blood glucose response of mixed meals using the white bread glycemic index. *Diab Care* **8**(5), 418-428.

Wolever TM, Vorster HH, Bjorck I et al (2003) Determination of the glycaemic index of foods: interlaboratory study. *Eur J Clin Nutr* **57**,475–482.

Wolever TMS, Jenkins DJA, Jenkins AL, Josse RG (1991) The glycemic index: Methodology and clinical implications. *Am J Clin Nutr* **54**, 846-854.

WoleverTMS (1997) The glycemic index: flogging a dead horse? *Diab Care* **20**, 452–456.

Wolmarans P & Danster NA (2008). Characteristics of the South African Food Composition Data Base, an essential tool for the nutrition fraternity in the country: Part 1. *S Afr J Clin Nutr* 21(**4**), 308-313.

Wolmarans P & Oosthuizen W (2001) Eat fats sparingly-implications for health and disease. *S Afr J Clin Nutr* **14** (3), Suppl, S48-S55.

World Health Organisation (1985) Energy and protein requirements.*Technical Report Ser* No. 724. Geneva: WHO.

World Health Organisation (1991) Community involvement in health development: Challenging health services. *Technical Report Ser* No 809. Geneva: WHO.

World Health Organisation (1998) Obesity. Preventing and managing the global epidemic. Report of a WHO consultation on obesity. WHO/NUT/NCD/981. Geneva: WHO.

World Health Organisation (2003) *Diet, Nutrition and the Prevention of Chronic Diseases. Joint WHO/FAO Expert Consultation. WHO Technical Report Series* no. 916. Geneva: WHO.

World Health Organisation (WHO) (2006) Fact sheet N°312 September 2006 http://www.who.int/mediacentre/factsheets/fs312/en/index.html

World Health Organization (2003) World Health Survey South Africa, unpublished work www.who.int/infobase/mddetails.aspx?surveycode=101733c2&print=1 (accessed 21/07/2009)

Xavier F & Pi-Sunyer FX (2002) Glycemic index and disease. *Am J Clin Nutr* **76**, 290S–298S.

Yach D, Hawkes C, Gould CL & Hofman KJ (2004) The global burden of chronic diseases: overcoming impediments to prevention and control. *J Am Med Assoc* **291,** 2616-2622**.**

Yeh GY ; Eisenberg DM ; Kaptchuk TJ ; Phillips RS (2003) Systematic Review of Herbs and Dietary Supplements for Glycemic Control in Diabetes. *Diab Care* **26**, 1277–1294.

Yki-Järvinen H (1992) Glucose toxicity. *Endocr Rev* **13**(3), 415–431.

ADDENDUM A:

ADDENDUM B:

ADDENDUM C:

Addendum A: UNIVERSITY OF CAPE TOWN

School of Health & Rehabilitation Sciences

Divisions of Communication Sciences & Disorders · Nursing & Midwifery·
Nutrition & Dietetics · Occupational Therapy · Physiotherapy
Old Main Building · Groote Schuur Hospital · Observatory ·7925
Telephone: +27 21 406 6401
Fax: +27 21 406 6323

Information Sheet

A Cross-sectional descriptive study of the habitual dietary intake of diabetic patients attending community health care centres in Cape Town.

C.M. Meyer (THRCAT006), MSc in Nutrition and Dietetics, School of Health and Rehabilitation Sciences, Faculty of Health Sciences, UCT, **Collaborators: Principal Supervisor:** Prof NS Levitt, Endocrinology , Department of Medicine, Faculty of Health Sciences, UCT, **Co-Supervisors:** Dr N.P. Steyn, Medical Research Council, Chronic Diseases of Lifestyle, Belville,, I Schloss – Division of Nutrition and Dietetics, School of Health and Rehabilitation Sciences, Faculty of Health Sciences, UCT

What is this study about?

This study is being undertaken for a higher degree in Nutrition and Dietetics at the University of Cape Town. The aim of this research is to find out more about the dietary habits of type 2 diabetics in this community. Different diabetics attending primary health care centres in the Cape Metropole Area will participate.

What will you need to do?

- If you are willing to participate you will give the researchers written permission to have access to your medical folder at the health facility. They will use your folder to record your medication, blood sugar levels and results of tests done for cholesterol and blood sugar control.
- You will be asked questions about your diet, lifestyle and general background at your first interview. Your height, weight, waist and hip circumference will also be taken at this time. This will take about 45 minutes of your time.
- We will then make two more appointments with you in the next 2 months to come to back to the health facility. These 2 visits will only take about 20 minutes of your time. You will again be asked questions about your diet.

There will be no risks to you other than the time and effort to participate and the sharing of personal information on your life style. All information will be handled as confidential and anonymous. You will have the right to withdraw from the survey at any stage without stating a reason. Your participation or refusal will in no way influence the treatment you receive at the community health centre.

You participation in this study may help us to better understand the role of diet in the treatment of diabetes and may impact how we treat diabetics in future.

You are welcome to contact us should you have any other questions.
Contact details: C. Meyer, 084 4401975 / 021-5323465

Statement of Informed consent I:

Participation in diabetic research project

If you decide to participate after the study have been explained to you and you have read through the information sheet you will need to sign a consent form. Thereby you give your permission to allow us access to your medical folders under strict conditions of confidentiality. You agree to be interviewed at 3 different occasions over the next three months as well as to being weighed and measured at the first interview. These interviews will take place in your language of choice, either Afrikaans or English.

Participation in this study is voluntary. You are free to refuse or withdraw your consent regarding your participation in the study at any time. Declining will by no means influence your present and future health care. All information will be treated as confidential and anonymous.

Statement by the Researcher:
I have fully explained the procedures, identifying those, which are investigational, and have explained their purpose. I have answered any questions that have arisen regarding these procedures to the best of my ability.

Signed by Researcher/Investigator: …….Witness…….

Date:……

Statement by the Participant:
I have been fully informed as to the procedures to be followed, including 3 interviews and other measurements.

In signing this consent form, I agree to this investigation and understand that I am free to refuse or withdraw this consent regarding my participation in the study at any time. I understand that any questions I may have at any time will also be answered.

Signed:…… Code: ☐

Date:……

Witness:……

Diabetes Study Questionnaire: Cape Metropole/2006

INTERVIEWER NAME AND CODE: ……

NAME OF THE PARTICIPANT …… CODE

1.Gender F M **2.Birth Date:** D D M M 1 9 Y Y **3.Interview Date:** D D M M 2 0 0 5

Inclusion criteria:

- ☐ Diabetic who have been diagnosed at least 6 months ago
- ☐ South African citizen & of mixed race descent
- ☐ Between 35 and 65 years old
- ☐ Managed on tablets and/ diet or a combination of insulin & tablets
- ☐ Attending a community health care centre in the Cape Metropole

Exclusion criteria:

- ☐ On insulin therapy alone
- ☐ Renal failure
- ☐ An inability to communicate

A: General and Demographic Information

4. Name of Community Health Centre:

5. Folder Number

6. Religion

_ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _

7. Contact number: _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _

8. [Dwelling] What type of house do you live in?: (*Mark one only*)

Informal (Shack)	Formal (House,flat...)	Other: specify
1	2	3……

9. How many rooms does this house have? (excluding bathroom, if separate): -------

10. Do you have electricity inside your home?

Yes	No
1	2

11. What fuel do you mainly use for cooking? (*One answer only*)

Electric	Gas	Other (specify)
1	2	3……

12. Which of the following do you have in your home :.

	Yes=1	No=2	
a)Fridge	1	2	a)
b)Freezer(separate)	1	2	b)
c) Hot plate	1	2	c)
d)Microwave	1	2	d)
e)Stove	1	2	e)
f)Radio	1	2	f)
g)TV	1	2	g)
h)Computer	1	2	h)

13. What is your highest schooling level?

Less than 3 yrs (0-std1)	Std 2-5)	Gr 8-10 (Std6-8)	Gr11-12 (Std9-10)	Tertiary
1	2	3	4	5

14.	What work do you do? Unemployed: 1 | Full-time employed or own work/ business: 2 | Part-time/ Contract work: 3 | Other(specify) Eg grant/pension: 4.....	
15.	How much money do you think is spent on food weekly in your home? ≤R100: 1 | R101-200: 2 | R201-R300: 3 | R301-R400: 4 | R401-R500: 5 | >R500: 6 | Other:specify: 8.....	
16.	How many people need to be fed on that food?	

B: LIFE STYLE FACTORS

17	**Physical Activity** (adjusted from The Nutrition Monitor)	
17a	**On average**, how active are you at work **OR** during the day?(if not employed)**(*mark only one*):**	
	1.Sitting most of the time, little walking or standing — 1	
	2.Less sitting, more walking and standing, but no hard physical labour — 2	
	3.Very little sitting, mostly walking and/or hard physical labour e.g. scrubbing, washing windows, digging , gardening — 3	
17b	**On average**, how active are you in your free time -when you are **NOT** at work **OR** NOT doing housework – i.e.relaxing? **(*mark only one*):**	
	1.Sitting most of the time, little walking, no sport — 1	
	2.Less sitting, more walking and/or participation in light exercise or sport — 2	
	3.Very little sitting, mostly walking and/or active participation in exercising/sport — 3	
17c.	What does it mean to you when you are told to 'be active'? (*Or to do exercise*)	
17d	Is there anything that makes it difficult for you to be active?	

18	**Tobacco Use**:	
18a	On average, how much do you smoke (*mark one only*) Never smoked: 1 | Stopped: 2 | 1-9/day: 3 | 10-19/day: 4 | >20/day: 5 (If no 1-go to question 19)	
18b	Have you ever tried to stop smoking? (If NO, go to question 19) — Yes: 1 | No: 2	
18c	If yes, what prevented you from stopping completely? Withdrawal symptoms: 1 | Social life: 2 | Not applicable(N.A) / Other:specify: 3……	

19	**Alcohol**	
19a	Do you drink any alcohol? *(If NO, go to question 20)* — Yes: 1 | No: 2	
19b	If YES, what do you drink? (*Can mark more than one)* Beer: 1 | Wine: 2 | Other:*specify*: 3……	

Key: **One drink** = 1tot (25ml) hard liquor (rum,gin,whiskey etc)
=60ml sweet wine/sherry =125ml table wine =340ml beer(1 can)

19c How much alcohol do you drink on average during the week?(*5 days-include Friday night*)

Nothing	1-3 drinks	4-9 drinks	>10 drinks	Other:specify
1	2	3	4	5……

19d How much alcohol do you drink on average during the weekend?(*Sat & Sunday*)

Nothing	1-2 drinks	3-4drinks	>4drinks	Other:specify
1	2	3	4	5……

C Medical History

20 **Diagnosis**

When were you first told that you have diabetes or sugar in the blood?

Date:	
Number of years	

21 **Co-morbidity**

Do you have any of the following health problems? (*Go through each one*)

	Yes=1	No=2	Don't know=3
a)High Blood Pressure	1	2	3
b)Heart attack/angina	1	2	3
c)Stroke	1	2	3
d)Kidney Disease	1	2	3
e)High blood cholesterol	1	2	3

22 **Medication**

22a Are you using other remedies or medicine for diabetes other than what you get at the day hospital?

Yes	No
1	2

(If NO, go to Question 23)

22b IF YES: What?

22c Who recommended it to you?

23 **Family History**

Do you have any close relatives(brother,sister,parents,uncles,aunts) who suffer from the following? *(Ask and Answer each one*)

	Yes=1	No=2	Don't know=3
a)Diabetes ('*high sugar*')	1	2	3
b)High Blood Pressure	1	2	3
c)Heart attack/angina	1	2	3
d)Stroke	1	2	3
e)Kidney Disease	1	2	3
f)High blood cholesterol(fats)	1	2	3

D Diabetes Knowledge: *I am now going to ask you some questions on diabetes. There are no right or wrong answers. Just tell me what you think.*

24 If you have to tell a new diabetic what diabetes is-what will you tell him/her?
(*Probe...what is happening in your body when you have diabetes?*)
_____
_____

25 What could make your blood sugar go too high? (Probe...what do *you* think..)

26. How would you feel if your blood sugar is **too high**? (*Probe…What would the symptoms be?)*
(**DO NOT READ OPTIONS –** *May have more than one answer)*

	Mentioned=1	Not mentioned=2
a)Get thirsty	1	2
b)Urinate frequently	1	2
c)Have blurred vision	1	2
d)Feel tired or weak	1	2
e)Other(please specify) 3		

a)	
b)	
c)	
d)	
e)	

27 What would you ***do*** if your blood sugar is **too high**? (Probe...what do you think ...)
(**DO NOT READ OPTIONS –** *May have more than one answer)*

	Mentioned=1	Not mentioned=2
a)Take medication	1	2
b)Eat	1	2
c)Go to the hospital/clinic	1	2
d)Other(please specify).....3		

a)	
b)	
c)	
d)	

28 What could cause your blood sugar to become **too low?** *(Even if it has never happened to you)*

29. How would you feel if your blood sugar **is too low**? Or how do you think you will feel...(*Probe…What would the symptoms be?)*
(**DO NOT READ OPTIONS –** *May have more than one answer***)**

	Mentioned=1	Not mentioned=2
a)Sweat/hot	1	2
b)Faint/dizzy	1	2
c)Other(please specify)..... (3)		

a)	
b)	
c)	

30 What would you ***do*** when your blood sugar is too low? (even if it has never happened to you)
(**DO NOT READ OPTIONS–** *May have more than one answer***)**

	Mentioned=1	Not mentioned=2
a)Take medication	1	2
b)Eat	1	2
c)Go to the hospital/clinic	1	2
d)Other(please specify)..... 3		

a)	
b)	
c)	
d)	

31. How else can diabetes affect your health? (*Probe…What other problems can a diabetic experience?)* **DO NOT READ OPTIONS--** *May have more than one answer)*

	Mentioned=1	Not mentioned=2
a)Heart problems	1	2
b)Amputations	1	2
c)Eye problems	1	2
d)Other(please specify)..... 3		

a)	
b)	
c)	
d)	

E Diet Information: *I am now going to ask you questions on diet.*

32. Who told you about a diet for diabetes or which foods to eat?
(*Can have more than one answer)*

	Mentioned=1	Not Mentioned=2
a)Doctor	1	2
b)Dietitian	1	2
c)Nurse	1	2
d)Other(specify).....3		

a)	
b)	
c)	
d)	

33. Have you ever been to a dietitian for advice?

Yes	No
1	2

34. How do you think diet can make a difference in diabetes?
(**DO NOT READ OPTIONS--** *May have more than one answer)*

	Mentioned=1	Not Mentioned=2
a)Blood sugar control	1	2
b)Preventing complications	1	2
c)weight loss	1	2
d)Other(specify).....		

a) b) c) d)

35. What do you find hardest about the diet for diabetes?
Give opportunity to answer, then probe: 'Why is it sometimes difficult to follow the diet?' (*May have more than one answer, but do not read the options.)*

	Mentioned	Not Mentioned
a)Expensive	1	2
b)Not tasty	1	2
c) Food not easily available	1	2
d)Other(specify)..... 3		

a) b) c) d)

F Dietary Practices and Perceptions:

I am now going to ask you questions about your eating habits. There are no right answers so please feel free to speak freely and answer as truthfully as possible.

36 Which pattern best describes your **USUAL** eating pattern? Do you eat....

3 meals per day (no eating between meals)	1
3 meals per day (with eating between meals)	2
1 - 2 meals per day (no eating between meals)	3
1 - 2 meals per day (with eating between meals)	4
Nibble the whole day, no specific meals	5
Other(specify).....	6

37a. Is your main meal the same as the rest of the family? (***If YES***, *go to question 38)*

Yes=1	No=2	Other=3.....

37b. IF NO, how does your food differ from theirs?

38. Would you say you are following a diabetic diet?

Yes=1	No=2	Other=3.....

39. How do *you* think a diabetic diet should be different from a 'normal' diet?
('*normal' = the way other people eat, non-diabetics)*

40-76.	If you have to give ***other*** diabetics advice, what would you advise them about the following foods: Should they avoid it? Is it something that is particularly good for them, or that they can eat often but in small quantities or something they should eat very little of? (*Read item , mark and go on to the next.* ***Keep it short!*** *Write down comments if patient specifies or give reasoN. Remind them that they are giving <u>other</u> diabetics advice.*						
	Item	**Avoid**	**Allowed**			**Comments**	**Code**
			Very good	Often, but limit amounts	Little		
40	Alcohol	1	2	3	4	……	
41	Fruit Juice	1	2	3	4	……	
42	Cold drinks	1	2	3	4	……	
43	Milk	1	2	3	4	……	
44	White Sugar	1	2	3	4	……	
45	Brown Sugar	1	2	3	4	……	
46	Honey	1	2	3	4	……	
47	Jam	1	2	3	4		
48	Marie Biscuits	1	2	3	4	……	
49	Provitas	1	2	3	4	……	
50	Cream Crackers	1	2	3	4	……	
51	Bread	1	2	3	4	……	
52	White Toast	1	2	3	4	……	
53	Potatoes	1	2	3	4	……	
54	Rice	1	2	3	4	……	
55	Sweet Potato	1	2	3	4	……	
56	Oats	1	2	3	4	……	
57	Weetbix	1	2	3	4	……	
58	Mealie porridge	1	2	3	4	……	
59	Baked Beans	1	2	3	4	……	
60	Lentils,split peas & dried beans	1	2	3	4	……	
61	Pilchards	1	2	3	4	……	
62	Chicken	1	2	3	4	……	
63	Red Meat	1	2	3	4	……	
64	Sausage	1	2	3	4	……	
65	Polony	1	2	3	4	……	
66	Eggs	1	2	3	4	……	
67	Nuts	1	2	3	4	……	
68	Avocado	1	2	3	4	……	
69	Fried chips&crisps	1	2	3	4	……	
70	Pudding	1	2	3	4	……	
71	Pies & samoosas	1	2	3	4	……	
72	Sweets				4	……	
73	Chocolate	1	2	3	4	……	
74	Fresh fruit	1	2	3	4	……	
75	Canned fruit	1	2	3	4	……	
76.	Are their any (other) fruit that you would advise other diabetics not to eat at all?…… ……						

Thank you *for answering all these questions! It will help us to understand the difficulties and challenges of a diabetic. I will now make a follow-up appointment with you in one month's time when you come for your visit to the day hospital. Our interview will then only take 15-20 minutes of your time. We will also give you a call to remind you of your appointment.*

G Information obtained from folder

77 Last 3 blood glucose measurements (Obtained from folder):

Date	Blood Glucose value

78 Other Biochemistry: (if available)

	Date reported	Measurement
Cholesterol		
Hba1c		

79 **Medication for diabetes(Obtained from folder)**

Insulin (Actraphane/Protophane)
Metformin
Glibenclamide

80 **Diagnosis:**

Date	Time in years

81 **Co-morbidity**

	Yes=1	No=2
High Blood Pressure		
Heart attack/angina		
Stroke		
Kidney Disease		
High blood cholesterol(fats)		

Checklist for field workers: (Please tick)

- ☐ Is your name and the participant's name recorded?
- ☐ Are all answers filled in?
- ☐ All data from the folder collected?
- ☐ Fill in right hand column codes
- ☐ Follow-up appointment made AND recorded
- ☐ Mention any problems experienced with the interview:.....
- ☐ Make a note of any questions you missed...to follow-up.

24 HOUR RECALL QUESTIONNAIRE

NAME OF THE PARTICIPANT …… CODE ☐☐☐☐

Tick the day of the week, which you are recalling? **Monday** ☐ **Tuesday** ☐

Wednesday ☐ **Thursday** ☐ **Friday** ☐ **Saturday** ☐ **Sunday** ☐

FORM 1: 24 HOUR RECALL SUMMARY SHEET

STEP 1 Foods/drinks eaten/drunk during the day	**STEP 2** Forgotten foods/drinks

Step 2: To check whether the subject forgot anything, the interviewer asks the following:

- *"Did you have any cold drinks or other drinks yesterday?"*
- *"Did you have any sweets and or chocolate yesterday?"*
- *"Did you have any cake yesterday?"*
- *"Did you have any cookies yesterday?"*
- *"Did you have any savoury snacks like chips/pop corn/salty biscuits yesterday?"*
- *"Did you have any (other) fruit yesterday?"*
- *"Did you have any (other) vegetables yesterday?"*
- **"***Did you have any (other) bread or rolls yesterday?"*

Was what you ate and drank yesterday? …. (mark the appropriate block with a X)

The same as usual?	More than usual?	Less than usual?

What **type of milk** is usually used in your home?
Answer:……..

What **type of butter or margarine** is usually used in your home?
Answer:…….

FORM 2: DATA SHEET FOR INFORMATION COLLECTED IN STEP 3 OF THE 24-HOUR RECALL INTERVIEW

Time of day	Any comments on the time	Food item (carried forward from Form 1)	Detailed description of the item as well as preparation	Detailed description of the portion size	Code	Weight (g)