DIETARY INTAKE, DIET-RELATED KNOWLEDGE AND METABOLIC CONTROL OF CHILDREN WITH TYPE 1 DIABETES MELLITUS, AGED 6-10 YEARS ATTENDING THE PAEDIATRIC DIABETIC CLINICS AT GREY'S HOSPITAL, PIETERMARITZBURG AND INKOSI ALBERT LUTHULI CENTRAL HOSPITAL, DURBAN, KWAZULU-NATAL

BY

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ABSTRACT

The aim of this study was to assess the dietary intake, diet-related knowledge and metabolic control in children with Type 1 Diabetes Mellitus between the ages of 6-10 years attending the Paediatric Diabetic Clinics at Grey's Hospital, Pietermaritzburg and Inkosi Albert Luthuli Central Hospital, Durban, KwaZulu-Natal.

This was a cross sectional observational study that was carried out in a total of 30 subjects out of a possible 35 subjects that qualified for inclusion in the study from both the Grey's Hospital clinic (n=8) and IALCH clinic (n=22).

The dietary intake was assessed in a total of 25 subjects using a three day dietary record (n=20) and a 24 hour recall of the third day of the record (n=16). Diet-related knowledge was assessed using a multiple choice questionnaire. Metabolic control was assessed using the most recent HbA_{1c} and the mean HbA_{1c} results over the previous 12 months from the date of data collection. Height and weight measurements were also carried out. Information on socioeconomic status and education status of the caregivers was obtained from 22 caregivers through follow-up phone calls. All measurements except for dietary intake were obtained from all subjects participating in the study.

The mean percentage contribution of macronutrients to total energy was very similar to the International Society for Pediatric and Adolescent Diabetes (ISPAD) Consensus Guidelines (2002). The mean percentage contribution of macronutrients to total energy from the 3 day dietary records and the 24 hour recalls were as follows: carbohydrate (52% and 49%); sucrose (2% and 2%); protein (16% and 17%); fat (32% and 34%). Micronutrient intake was adequate for all micronutrients except for calcium and vitamin D which showed low intakes.

The mean diet-related knowledge score for the sample was 67% with significantly higher scores in children older than 8 years of age.

The latest HbA_{1c} for the sample was 9.7% and the mean HbA_{1c} over the previous 12 months from the date of data collection was 9.6%. There was a significant positive correlation between age of the participant and the latest HbA_{1c} ($r = 0.473$; $p=0.008$) and a significant negative correlation between the education level of the caregivers and the latest

HbA_{1c} (r = - 0.578; p=0.005) and the mean HbA_{1c} over 12 months (r = - 0.496; p=0.019). Significant differences were found between African and Indian children respectively for HbA_{1c}, with higher values in African children. There was no correlation between BMI for age and latest HbA_{1c} (r = 0.203, p=0.282) or mean HbA_{1c} over 12 months (r = 0.101, p=0.594). Z score for BMI for age was also not correlated with latest HbA_{1c} (r = 0.045, p=0.814) or mean HbA_{1c} over 12 months (r = - 0.012, p=0.951). Children from the Grey's Hospital Clinic were found to have higher HbA_{1c} values (p=0.001) and lower diet-related knowledge scores as compared to the children from the IALCH Clinic (p=0.038). It should be noted that the ethnic and racial composition of the children attending these two clinics differed.

In conclusion the macronutrient intake in this sample was found to be similar to the ISPAD Consensus Guidelines (2002) while calcium and vitamin D intakes were low. Overall this sample displayed good diet-related knowledge while metabolic control was found to be poor.

PREFACE

The work described in this dissertation was carried out in the School of Agricultural Sciences and Agribusiness, University of KwaZulu-Natal, Pietermaritzburg under the supervision of Professor Eleni Maunder and Dr Kimesh Naidoo.

These studies represent original work by the author and have not otherwise been submitted in any form for any degree or diploma to any University. Where applicable, the work of others is acknowledged in text.

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DEDICATION

This dissertation is dedicated to the memory of my late mum, Mrs Kanthie Pillay (née Totaram) 1945-1983.

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ABBREVIATIONS

ADA:	American Diabetes Association
ADSA:	Association for Dietetics in South Africa
AI:	Adequate Intake
BMI:	Body Mass Index
DCCT:	Diabetes Complications and Control Trial
DER:	Daily Energy Requirement
DRIs:	Dietary Reference Intakes
EAR:	Estimated Average Requirement
FAO:	Food and Agriculture Organisation
HbA_{1c}:	Glycosylated haemoglobin
IALCH:	Inkosi Albert Luthuli Central Hospital
ISPAD:	International Society for Pediatric and Adolescent Diabetes
MCQ:	Multiple Choice Questionnaire
NFCS:	National Food Consumption Survey
RDA:	Recommended Dietary Allowances
RNIs:	Recommended Nutrient Intakes
SAVACG:	South African Vitamin A Consultative Group
TE:	Total energy
TEE:	Total Energy Expenditure
UKPDS:	United Kingdom Prospective Diabetes Study
USA:	United States of America
WHO:	World Health Organisation

CHAPTER 1: INTRODUCTION, THE PROBLEM AND ITS SETTING

1.1 Importance of the study

The prevalence of Diabetes Mellitus including Type 1 and Type 2 for all age-groups worldwide, was estimated at 2.8% in 2000 and is projected to increase to 4.4% in 2030 (Wild, Roglic, Green, Sicree & King 2004). Although there is an increase in the prevalence of diabetes in adults, there is also an increase in the number of children being diagnosed with diabetes (Silink 2002a; Wild *et al* 2004). In many parts of the world the incidence of Type 1 diabetes in children is increasing by 3-5% per year, making Type 1 diabetes the most common endocrine disease in childhood (Silink 2002a). A child diagnosed with Type 1 diabetes has a lifetime of diabetes to manage. The life span of the child with Type 1 diabetes may be reduced due to the development of complications associated with diabetes. The development of complications in diabetes is related to how well the diabetes is managed and controlled (Silink 2002a; 2002b).

Although diet has an important role to play in the overall management of Type 1 diabetes, there is very little published scientific literature on the dietary intake of children with Type 1 diabetes and how this compares to the dietary recommendations for children with Type 1 diabetes (Randecker, Smiciklas-Wright, McKenzie, Shannon, Mitchell, Becker & Kieselhorst 1996). According to the South African Health Review 2006-Chronic Conditions in Children the incidence of Type 1 diabetes in South African children is unknown and base-line data on the dietary intake of South African children with Type 1 diabetes is extremely limited. Given the important role of diet in the overall management of diabetes and the increasing number of cases of children with Type 1 diabetes being referred to hospitals in South Africa, the lack of diet-related studies in South African children with Type 1 diabetes is of concern. This study conducted at the Paediatric Diabetic Clinics at Grey's Hospital in Pietermaritzburg and Inkosi Albert Luthuli Central Hospital (IALCH) in Durban will contribute valuable baseline data on dietary intake in South African children with Type 1 diabetes. Dietitians involved in nutrition education of the children with Type 1 diabetes attending the Paediatric Diabetic Clinics at these hospitals will be able to utilise the findings of this study to individualise nutrition education sessions to effectively manage shortcomings in dietary intake.

Diet-related knowledge has been hypothesised to influence dietary adherence and overall metabolic control in diabetics. Very few studies have been conducted in the area of diet-related knowledge in children because of a lack of reliable, quantifiable measures (Delamater, Smith, Kurtz & White 1988). Studies that have been conducted in children with diabetes in the United States of America (USA) and United Kingdom (UK), have found substantial deficits in knowledge on diabetes (Delamater *et al* 1988; McCowen, Hackett, Court & Parkin 1986; Lorenz, Christensen & Pichert 1985; Johnson, Pollak, Silverstein, Rosenbloom, Spillar, McCallum & Harkavy 1982; Collier & Etzwiler 1971; Etzwiler & Sines 1962). Given the lack of research on diet-related knowledge in South African children with Type 1 diabetes, this study will provide important baseline data on the levels of diet-related knowledge in South African children with Type 1 diabetes between the ages of 6-10 years.

Metabolic control of serum blood glucose levels in diabetics is used as a measure of how well the condition is being managed. According to the International Society for Pediatric and Adolescent Diabetes[1] (ISPAD) Consensus Guidelines (2002), metabolic control, which is best assessed using glycosylated haemoglobin (HbA_{1c}), should be measured at least four to six times per year in younger children and three to four times per year in older children. Glycosylated haemoglobin measurements are being carried out regularly at the Grey's Hospital and IALCH Paediatric Diabetic Clinics. This study also aims to collate previous HbA_{1c} results to assess metabolic control retrospectively in the subjects attending these clinics.

Young children with diabetes may gain more weight and be heavier than children of the same age, without diabetes (Kinmonth, Magrath & Reckless 1989). An overweight diabetic may find it more difficult to achieve good glycaemic control and may have an increased risk for developing long-term complications of diabetes, including hypercholesterolaemia and hypertension (McGough 2004). Body Mass Index (BMI) for age is the best single measure of adiposity in childhood and can be used to classify children

[1] International Society for Pediatric and Adolescent Diabetes (ISPAD) is a professional organisation whose aims are to promote science (clinical and basic), education and advocacy in childhood and adolescent diabetes. The new ISPAD Consensus Guidelines (2002) are aimed at providing health care providers with clear guidance in both acute and chronic care of diabetes in children and adolescents.

as being overweight, underweight or at risk for overweight (Power, Lake & Cole 1997). It has been suggested that an increased BMI may be associated with poorer metabolic control in diabetics (McGough 2004), but there is a lack of research in this area. This study therefore aims to determine if there is a relationship between BMI for age and metabolic control in children with Type 1 diabetes between 6-10 years of age attending the Paediatric Diabetic Clinics at Grey's Hospital and IALCH.

There is currently no statistics available for children with Type 1 diabetes in South Africa, due to the lack of a national register (South African Health Review 2006-Chronic Conditions in children). It was decided to use Grey's Hospital in Pietermaritzburg, a referral hospital providing 20% regional and 80% tertiary services and IALCH, a central and tertiary care referral hospital in Cato Manor, Durban as sites for this study as these are the only two Public Health Facility Specialist Paediatric Diabetic Clinics in KwaZulu-Natal (KZN) [Grey's Hospital-KZN Department of Health (DOH)-2007; IALCH-KZN DOH-2003]. These two clinics serve all children with diabetes in KwaZulu-Natal that require treatment in the Public Health Sector and exclude children that are treated in the Private Health Sector. Statistics from the Grey's Hospital and IALCH clinics suggest that there are an increasing number of children with Type 1 diabetes being referred to these two clinics. It is not certain if this is due to an increase in the number of new cases being diagnosed or if this is due to an improvement in the referral system (Ganie 2007). Given the increasing numbers of children with Type 1 diabetes being seen at these clinics and the lack of published South African studies, the findings from this study will provide important baseline data in an area that has not been widely studied.

1.2 Background on the Grey's Hospital and IALCH Paediatric Diabetic Clinics

1.2.1 Grey's Hospital Paediatric Diabetic Clinic

The Paediatric Diabetic Clinic at Grey's Hospital was started in 2000. Prior to this the children were treated at general Paediatric Outpatients at Grey's Hospital and Edendale Hospital in Pietermaritzburg. Children attending the Grey's Hospital Paediatric Diabetic Clinic come from the Western half of KwaZulu-Natal. This area stretches from Kokstad to Vryheid and the Drakensburg to the Tugela and has a population of approximately 1.3 million children. There are currently 43 children between the ages of 6-17 years with diabetes attending the clinic. The clinic operates once a month and children should attend the clinic monthly. Children are able to attend general Paediatric Outpatients if there are

problems between visits. Other Health Professionals involved in the management of these children include a Consultant, Registrar, Dietitian, Psychologist and Nursing Sister for monitoring and assessment (McKerrow 2006).

1.2.2 IALCH Paediatric Diabetic Clinic

The Paediatric Diabetic Clinic at IALCH was started in 2002 by Dr Yasmeen Ganie. This clinic serves an area extending as far north as Pongola and including the Eastern Cape areas of Matatiele and Bizana. This clinic runs every Wednesday morning and children attending this clinic are reviewed at least once a month. This is especially so in the case of younger, problematic diabetics. Newly diagnosed patients with Type 1 diabetes are reviewed weekly initially leading to fortnightly and then eventually on a monthly basis. There are currently 157 children between the ages of 22 months - 17 years with diabetes attending the clinic. Dr Kuben Pillay is the only Registered Paediatrician Endocrinologist in KwaZulu-Natal and does sessions at the Paediatric Diabetic Clinic at IALCH. Registrars rotate through the Diabetic Clinic every 3 months as this forms part of their Paediatric training. Other members of the multidisciplinary team at the IALCH Paediatric Diabetic Clinic include a Paediatric Trained Diabetic Nurse Educator, Clinical Dietitian, Social Worker and Clinical Psychologist (Ganie 2007).

A map of KwaZulu-Natal and the areas served by both the Grey's Hospital Paediatric Diabetic Clinic and the IALCH Paediatric Diabetic Clinic are shown in Figure 1.1.

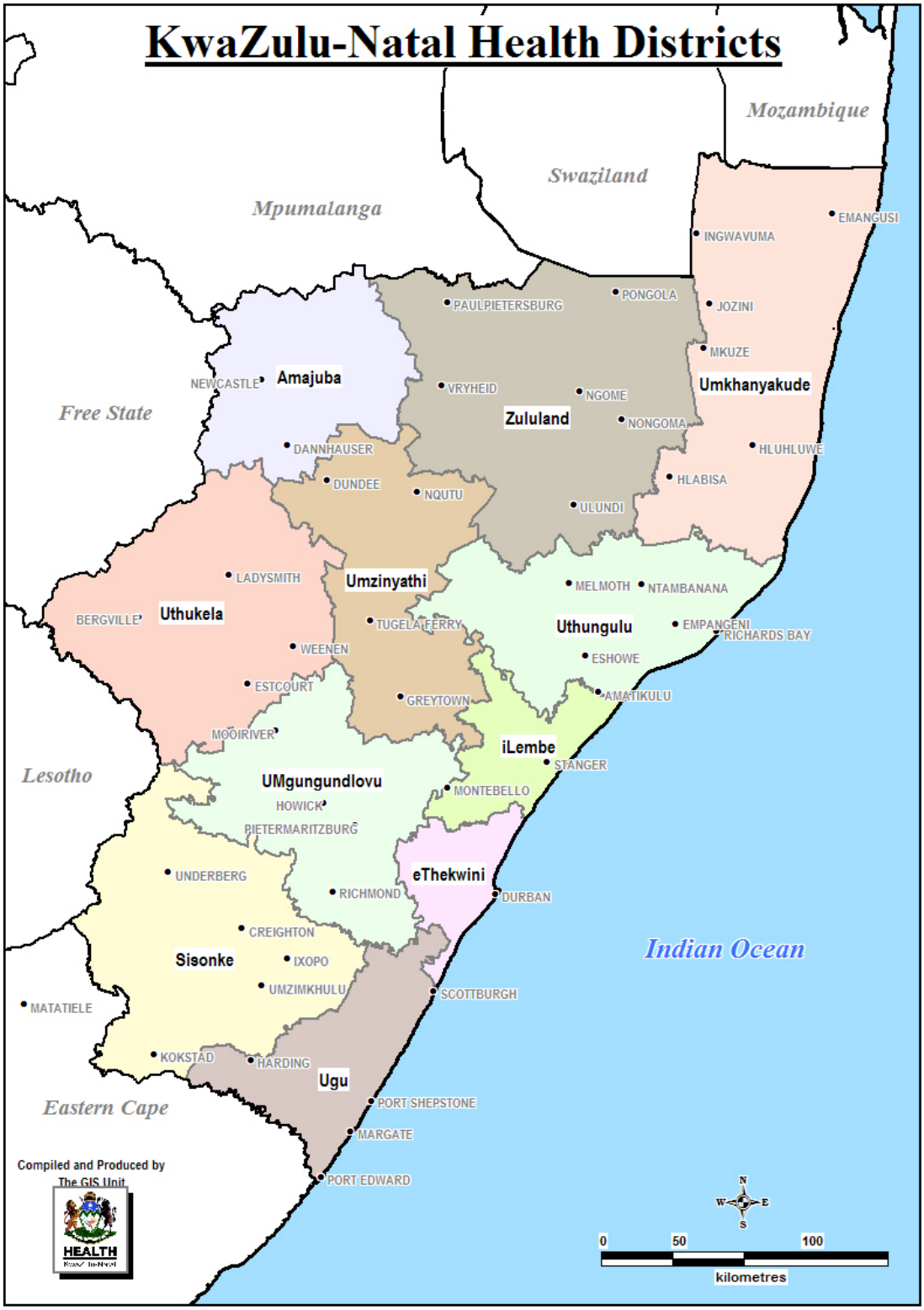

Figure 1.1: Map of KwaZulu-Natal depicting the different Health Districts (KwaZulu-Natal, Department of Health-2001).

1.3 Purpose of the study

The purpose of this study was to assess the dietary intake, diet-related knowledge and metabolic control of children with Type 1 diabetes, aged 6-10 years attending the Paediatric Diabetic Clinics at Grey's Hospital, Pietermaritzburg and Inkosi Albert Luthuli Central Hospital, Durban, KwaZulu-Natal. It is hoped that this study would provide useful baseline data for future studies in this area.

1.4 Type of study

This was a cross sectional, observational study, which included a total of 30 children with Type 1 diabetes between the ages of 6-10 years from both sites.

1.5 Statement of the research problem

To assess the dietary intake, diet-related knowledge and metabolic control of children with Type 1 diabetes, aged 6-10 years attending the Paediatric Diabetic Clinics at Grey's Hospital, Pietermaritzburg and IALCH, Durban, KwaZulu-Natal.

1.6 Statement of the sub problems

1.6.1 Sub problem one

To assess the dietary intake of children with Type 1 diabetes and to compare to dietary recommendations for children with diabetes.

1.6.2 Sub problem two

To assess the diet-related knowledge of children with Type 1 diabetes.

1.6.3 Sub problem three

To assess metabolic control, using glycosylated haemoglobin (HbA_{1c}), in children with Type 1 diabetes.

1.6.4 Sub problem four

To determine if there is a relationship between Body Mass Index (BMI) for age and metabolic control using glycosylated haemoglobin (HbA_{1c}) in children with Type 1 diabetes.

1.6.5 Sub problem five

To determine if there are any other relationships between the variables investigated and metabolic control using glycosylated haemoglobin (HbA_{1c}) in children with Type 1 diabetes.

1.7 Hypothesis

1.7.1 Sub problem one

The dietary intake of children with Type 1 diabetes is not similar to the dietary recommendations for children with diabetes.

1.7.2 Sub problem two

There are deficits in diet-related knowledge in children with Type 1 diabetes.

1.7.3 Sub problem three

Children with Type 1 diabetes have poor metabolic control [HbA_{1c} > 7.6 %-(ISPAD Consensus Guidelines 2002)], as determined by looking at the most recent HbA_{1c} values and the mean HbA_{1c} values over the previous 12 months from the date of data collection.

1.7.4 Sub problem four

An increase in BMI for age is associated with poor metabolic control [HbA_{1c} > 7.6 % - (ISPAD Consensus Guidelines 2002)].

1.8 Definition of terms

Body Mass Index For Age – Defined as weight (kilograms) divided by the square of height (metres²) according to age (World Health Organisation Expert Committee Technical Report Series-Physical Status: The Use and Interpretation of Anthropometry 1995).

Children aged 6-10 years – refers to children who, according to their birth date, were between the ages of 6 to 10 years at the time the study was carried out. This would include children from 6.00 years (72 months) up to and including 10.99 years (131.9 months).

Dietary intake – refers to all food, fluids and dietary supplements consumed over a specific period (24 hours).

Dietary recommendations – refers to intakes of energy, carbohydrate, protein, fat, sucrose, fibre and vitamins and minerals that should be achieved by children with diabetes, in order to achieve good metabolic control and promote normal growth and development, as recommended by International Dietetic Bodies.

Diet-related knowledge – refers to knowledge relating to diet and diabetes, which the child with Type 1 diabetes has acquired since diagnosis and up to the time of the study.

Glycosylated haemoglobin – refers to a biochemical test that is based on the fact that a small percentage of haemoglobin (the pigment in red blood cells) binds to glucose in the blood. This binding remains for the life of the red blood cell which is approximately 3 months. Measuring glycosylated haemoglobin gives the overall blood glucose control for the previous 3 months (Goldstein, Little, Wiedmeyer, England & McKenzie 1986).

Grey's Hospital – A referral hospital providing 20% regional and 80% tertiary services located in Pietermaritzburg which falls in the Umgungundlovu health district (Grey's Hospital-KZN DOH-2007).

Inkosi Albert Luthuli Central Hospital – A central and tertiary care referral hospital situated in Cato Manor, Durban (IALCH-KZN DOH-2003).

Metabolic control – refers to the physiological homeostasis with blood glucose levels that is achieved through a continuous balance of insulin dosage, dietary intake and exercise (Faulkner & Clark 1998). Metabolic control is best measured using glycosylated haemoglobin (HbA_{1c}) [ISPAD Consensus Guidelines 2002].

Paediatric diabetic clinic – a specialised clinic for the treatment of children with diabetes (up to 18 years of age).

Three day dietary record – A food record recorded over three days in which the subject is asked to record all food and beverages consumed using household measures (Gibson 2005, p 44).

Twenty four hour recall – A dietary recall in which the respondent is asked to remember and report all food and beverages consumed in the previous 24 hours or on the previous day. The recall is usually conducted by personal interview with well-trained interviewers as much of the dietary information is collected by asking probing questions (Thompson & Byers 1994).

Type 1 Diabetes Mellitus – A type of diabetes where there is almost an absolute lack of the hormone insulin, as a result of the destruction of pancreatic beta cells and requires daily replacement of insulin (Silink 2002b).

1.9 Study parameters

Only children with Type 1 diabetes between the ages of 6-10 years, attending the Paediatric Diabetic Clinics at Grey's Hospital and Inkosi Albert Luthuli Central Hospital were invited to participate in the study. The age group of 6-10 years was selected as children in this age group should not have reached puberty and metabolic control would not be affected by hormonal changes taking place during puberty. Only children that had been diagnosed with Type 1 diabetes for 3 months or longer, were invited to participate in the study. Only children without any mental impairment could participate in the study. The dietary assessment was carried out on days that formed part of the school term and not during the school vacation.

1.10 Study assumptions

This study makes the following assumptions:

- Subjects would have received some dietary education at the time of diagnosis. Children diagnosed with diabetes are usually not discharged from Hospital unless dietary education has been carried out by the Dietitian with the child and care-givers.
- Subjects understood the diet-related knowledge multiple choice questionnaire.
- Subjects were not prompted or influenced by the interviewer, when the diet-related knowledge multiple choice questionnaires were carried out.
- The interview to assess diet-related knowledge using the multiple choice questionnaire was carried out in a standardised manner.
- Subjects gave an honest account of their dietary intake when carrying out the 3-day food record.
- Care-givers of the subjects did not influence the 3-day food record in any way.
- The translation of the English version of the diet-related knowledge multiple choice questionnaire into Zulu did not change the intended version of the questionnaire in any way.

- All caregivers of subjects would have access to a landline telephone or cellular phone in order for the researcher to obtain the 24 hour recall via phone.

1.11 Summary

The incidence of Type 1 diabetes in children is increasing in many parts of the world and a diagnosis of diabetes in childhood presents a great challenge to both the child and the care-givers as diabetes requires a lifetime of careful management and monitoring to achieve and maintain good control of the condition. Due to the lack of research in the area of dietary intake, diet-related knowledge and metabolic control in children with Type 1 diabetes in South Africa, the aim of this study was to assess dietary intake, diet-related knowledge and metabolic control in children with Type 1 diabetes between the ages of 6-10 years attending the Paediatric Diabetic Clinics at Grey's Hospital and IALCH in KwaZulu-Natal.

CHAPTER 2: LITERATURE REVIEW

2.1 Introduction

In South Africa the leading causes of mortality in children under the age of 5 years are Human Immunodeficiency Virus (HIV)-associated conditions, perinatal conditions, pneumonia, diarrhoea and malnutrition. In South Africa about 20% of children have a chronic condition which requires long-term management and care. Congenital heart disease, neurological disorders, HIV and asthma are the most prevalent of these chronic conditions among South African children (Bradshaw, Bourne & Nannan 2003).

Type 1 diabetes is also a chronic disease in childhood for which the incidence in South African children is unknown due to the lack of a national register (South African Health Review 2006-Chronic Conditions in Children). It is known that Type 1 diabetes is currently the most common chronic disease in childhood after asthma and is increasing by 3-5% per annum in many parts of the world (Silink 2002b). Approximately 80-85% of all cases of diabetes in childhood are Type 1 (Franzese, Valerio & Spagnuolo 2004). With Type 1 diabetes there is autoimmune-mediated destruction of pancreatic beta cells that results in an absolute deficiency of insulin (Haller, Atkinson & Schatz 2005).

A diagnosis of diabetes in childhood presents a great challenge to both the child and the parents, as the management of diabetes is a complex and demanding process that requires life-long specialised medical care, dietary management and education (Drozda, Dawson, Long, Freson & Sperling 1990). Although diet has an important role to play in the overall management of Type 1 diabetes, there is very little published scientific literature about the dietary intake of children with Type 1 diabetes and how this compares to the dietary recommendations (Randecker *et al* 1996). Diet-related knowledge has been hypothesised to influence dietary adherence and overall metabolic control in patients with diabetes (Johnson *et al* 1982). Very few studies have been conducted in the area of diet-related knowledge in children with diabetes due to a lack of reliable, quantitative measures (Delamater *et al* 1988).

The aim of this Literature Review is to provide a brief background on Type 1 diabetes in children. Metabolic control and the consequences of poor metabolic control in patients with diabetes will also be discussed as well as the dietary recommendations and the role of

diet in the overall management of diabetes. Research conducted in the area of dietary intake and diet-related knowledge in children with Type 1 diabetes will also be reviewed as well as the methods used to assess dietary intake in children.

2.2 Background to Type 1 Diabetes Mellitus in children

According to Haller *et al* (2005) new cases of Type 1 diabetes tends to peak in the 5-7 year age group and at puberty. Type 1 diabetes is clinically characterised by a rapid onset of polyuria, polydypsia, polyphagia and weight loss (Connell & Thomas-Dobersen 1991). In 30-35% of cases, children have a dramatic onset of Type 1 diabetes and present with diabetic ketoacidosis (DKA) while others have a gradual onset over several months (Price & Pokorny 2002; Franzese *et al* 2004). DKA is the most severe acute diabetic complication (Franzese *et al* 2004) and is defined by the International Society for Pediatric and Adolescent Diabetes [ISPAD-2002] as diabetics having hyperglycaemia (blood glucose > 11mmol/L), pH < 7.3, bicarbonate <15 mmol/L and who are 5% or more dehydrated (ISPAD-2002). DKA is a major cause of morbidity and mortality in children with Type 1 diabetes and treatment of DKA must be prompt and accurate in all cases (Kaufman 1998). This next section will expand on the incidence, causes and management of Type 1 diabetes in children.

2.2.1 Worldwide incidence of Type 1 Diabetes Mellitus

A standard method of collection and analysis of epidemiological data on Type 1 diabetes in children started in the 1980s. The Diabetes Epidemiology Research International Group (DERI) collected standardised incidence data on Type 1 diabetes up to the mid 1980s from Finland, Israel, Japan and the United States of America (USA) [Karvonen, Tuomilehto, Libman & LaPorte 1993].

The EURODIAB Aetiology of Childhood Diabetes on an Epidemiological Basis (ACE) Study was a collaborative European Study that was set up to determine the incidence of childhood insulin-dependent diabetes mellitus[2] (IDDM) in Europe, between 1989 and 1990. The study found that Finland had the highest incidence of Type 1 diabetes in

[2] Although the term insulin-dependent diabetes mellitus (IDDM) was widely used to refer to diabetes mellitus where there is an absolute lack of insulin secretion or insulin action, or both, with international agreement (World Health Organisation-1998) the name was changed to Type 1 Diabetes [International Society for Pediatric and Adolescent Diabetes (ISPAD) - Consensus Guidelines 2002].

children, followed by Sardinia. Eastern European countries had the lowest incidence rate. A large geographic variation in the incidence of Type 1 diabetes was found throughout Europe (Green, Gale & Patterson 1992).

Prior to 1990, most of the information regarding the incidence of Type 1 diabetes came from Europe and North America (Karvonen, Viik-Kajander, Moltchanova, Libman, LaPorte & Tuomilehto 2000). In 1990 the World Health Organisation (WHO) began the Multinational Project for Childhood Diabetes (DiaMond). The main goal of the DiaMond project was to investigate and monitor patterns in incidence of Type 1 diabetes in children up to the year 2000 (LaPorte, Tuomilehto & King 1990). The DiaMond project involved a total of 100 centres and 50 (developed and developing) countries from Europe, Asia, North and South America and Africa and contributed valuable information on incidence of diabetes in children (Karvonen *et al* 2000). The study also confirmed that the incidence of Type 1 diabetes was highest among Caucasian populations as compared to Mongoloid and Negroid populations throughout the world. There were also geographic differences in Type 1 diabetes incidence within ethnic or racial groups (Karvonen *et al* 2000).

According to the DiaMond project a seasonal variation was observed in the month of diagnosis in most countries. A lower incidence was reported during the summer months as compared to the winter months. There was also a clear difference in incidence between the Northern and Southern hemispheres of the world. An incidence of greater than 20.0 per 100 000 was found in countries above the equator, but not in countries below the equator. This suggests that geographical location and climate may have a role to play in the onset of diabetes. The only African countries included in the DiaMond project were Algeria, Tunisia, Sudan and Mauritius. Intermediate incidence rates were reported from the African countries while Mauritius, an island on the east coast of Africa had a low incidence (Karvonen *et al* 2000).

The North African countries included in the DiaMond project are not representative of the African continent as a whole. Other African countries were not included because of a lack of national registers for children with Type 1 diabetes. It is recommended that other African countries, including South Africa should look towards developing national registers for children with Type 1 diabetes, to be eligible for inclusion in worldwide surveillance programmes (Ganie 2007).

2.2.2 Causes of Type 1 Diabetes Mellitus

Various factors seem to interact together to bring about the beta-cell destruction and absolute insulin deficiency seen in Type 1 diabetes. These factors include a genetic predisposition, the environment including diet and infection as well as immunity (Connell & Thomas-Dobersen 1991). Viral infections, hormones and stress are some of the possible factors that have been suggested to trigger Type 1 diabetes (Franzese *et al* 2004). It has also been suggested that reduced exposure to viruses due to improved hygiene may also be a cause as it reduces the range of immune defences available (Silink 2002b). Recent developments suggest that milk protein, gluten and vaccinations may also have a role to play in the more frequent onset of Type 1 diabetes at a younger age (Akerblom, Vaarala, Hyoty, Ilonen & Knip 2002). A high intake of animal protein has been suggested to be involved in the pathogenesis of Type 1 diabetes, while a vegetarian diet has been associated with decreased incidence of Type 1 diabetes (Muntoni, Cocco, Aru, Cucca & Muntoni 2000). A vitamin D insufficiency has also been suggested to play a role in the development of diabetes (Calvo & Whiting 2005).

2.2.3 Management of Type 1 Diabetes Mellitus

The management of Type 1 diabetes involves the daily replacement of the deficient hormone, insulin (Berdanier 1994). Franzese *et al* (2004) suggest a mean total daily requirement of insulin in pre-pubertal patients of 0.7-0.8 Units/Kg. The insulin plan for children with Type 1 diabetes is based on individual requirements and lifestyle. The insulin plan usually involves short-acting insulin before breakfast and lunch, together with a combination of short-acting and intermediate long-acting insulin at dinner (Franzese *et al* 2004). The most important therapeutic goals for children with Type 1 diabetes include metabolic control of blood glucose levels and prevention of secondary complications (Faulkner & Clark 1998).

Now that some background has been provided on Type 1 diabetes in children, the next section of this Literature Review will focus on metabolic control in children with Type 1 diabetes.

2.3 Metabolic control in children with Type 1 Diabetes Mellitus

Given the fact that diabetes is a chronic condition and currently without a cure, the most important goal of management is achieving metabolic control of blood glucose levels and

the prevention of long-term complications of diabetes (Faulkner & Clark 1998). Achieving glycaemic control requires achieving a balance between food intake, insulin levels and energy expenditure (ISPAD Consensus Guidelines 2002). The next section of this Literature Review will look at what metabolic control is, how it is measured, the relationship between metabolic control and the risk for development of long-term complications of diabetes and the factors that affect metabolic control.

2.3.1 What is metabolic control?

Metabolic control of serum blood glucose levels in diabetics is used as a measure of how well the condition is being managed. Good metabolic control suggests that physiological homeostasis of blood glucose levels has been achieved with frequent blood glucose monitoring, regular physical activity, correct insulin administration and appropriate nutritional management [Position Statement of the American Diabetes Association (ADA): Care of Children with Diabetes in the School and Day Care Setting 2000].

2.3.2 How is metabolic control measured?

Optimal metabolic control can only be assessed and maintained by frequent and accurate monitoring of blood glucose control (ISPAD Consensus Guidelines 2002). Some of the methods that can be used to measure glycaemic control include self-monitoring of blood glucose, monitoring of urine glucose, monitoring of urinary ketones, glycated haemoglobin and fructosamine. Although self-monitoring of blood glucose, urine glucose and urinary ketones provide useful information about glycaemic control over a few days, these methods do not reflect glycaemic control over the long term (ISPAD Consensus Guidelines 2002).

Glycated haemoglobin is the generic term for haemoglobin containing glucose and is produced by the non-enzymatic glycosylation of haemoglobin at a rate proportional to the prevailing blood glucose concentration. The level of glycated haemoglobin is also dependent on the red blood cell lifespan. Providing that the red blood cell lifespan is normal, the glycated haemoglobin measures mean blood glucose concentration in the preceeding 3 months which is the approximate half life of the red blood cell. There are various minor haemoglobin components, including HbA_{1a}, HbA_{1b} and HbA_{1c} (Goldstein *et al* 1986). According to the ISPAD Consensus Guidelines (2002), glycated haemoglobin monitoring, specifically HbA_{1c}, has been shown to be the most useful measure in

evaluating metabolic control and is the only measure for which good data are available regarding the relationship with later microvascular complications, in patients with diabetes (ISPAD Consensus Guidelines 2002).

According to the ISPAD Consensus Guidelines (2002), HbA_{1c} should be measured at least four to six times per year in younger children and three to four times per year in older children and there should be a minimum of one measurement per year in all children with diabetes. The frequency of measurement of HbA_{1c} depends very much on the availability of facilities. The ISPAD recommendation is that facilities for the measurement of HbA_{1c} should be available to all centres caring for young people with diabetes (ISPAD Consensus Guidelines 2002).

2.3.3 Relationship between metabolic control and risk for the development of long-term complications of Diabetes Mellitus

During the early 20th century there was thought to be an association between elevated blood glucose concentrations and complications of diabetes. It was only during the last three decades of the 20th century that significant human observation studies and clinical trials became available to show a direct link between high blood glucose levels and the development of diabetic complications. The United Kingdom Prospective Diabetes Study (UKPDS) was a long-term clinical trial conducted in the UK between 1977 and 1991 and showed that the risks of complications associated with diabetes could be significantly lowered when HbA_{1c} values were less than 8.0% [Position Statement of the ADA: Implications of the United Kingdom Prospective Diabetes Study (UKPDS) (2000)].

The Diabetes Control and Complications Trial (DCCT) was a clinical study conducted from 1983 to 1993 by the National Institute of Diabetes and Digestive and Kidney Diseases (NIDDK) in the United States of America and Canada. This multicenter, randomised clinical trial was the largest most comprehensive diabetes study ever conducted and showed that lowering blood glucose concentrations slowed or prevented the development of diabetic complications [Position Statement of the ADA: Implications of the DCCT (2000)]. An HbA_{1c} of less than 7% was found to be associated with a reduction in diabetic complications while a rise in HbA_{1c} above 7.5% was found to be associated with an increased risk of later micro vascular complications [Position Statement of the ADA: Implications of the DCCT (2000)]. It is also important to note that the DCCT

involved mostly adults with Type 1 diabetes and when the cohort of adolescents included in the DCCT was analysed separately, the mean HbA_{1c} level achieved in the group of adolescents that were intensively treated was more than 1% higher than the corresponding values in adult subjects in the DCCT. Fewer than 50% of the adolescents receiving intensive treatment achieved a mean HbA_{1c} of less than 8% (Diabetes Control and Complications Trial Research Group 1994).

According to the ISPAD Consensus Guidelines (2002), for each individual child the target HbA_{1c} should be the lowest achievable HbA_{1c} without the occurrence of frequent severe hypoglycaemia. Optimal HbA_{1c} should be less than 7.6 % for children with diabetes (ISPAD Consensus Guidelines 2002); while the American Diabetes Association (ADA) recommends that the goal for HbA_{1c} should be less than 8% in the 6-12 age groups (Silverstein, Klingensmith, Copeland, Plotnick, Kaufman, Laffel, Deeb, Grey, Anderson, Holzmeister & Clark 2005). The normal range for HbA_{1c} as given by the IALCH Pathology Laboratory is 4.8-6.0%. A large cross-sectional study by Mortensen & Hougaard (1997) conducted in 18 countries in Europe, Japan and North America, involving 2873 children with Type 1 diabetes reported a mean baseline HbA_{1c} value of 8.6%, with only 34% of patients achieving an HbA_{1c} value of less than 8%. Dorchy, Roggemans & Willems (1997) reported a mean HbA_{1c} of 6.6% in a group of 144 Belgian subjects with Type 1 diabetes under the age of 18 years. A similar study involving 2579 French children with Type 1 diabetes reported an overall mean HbA_{1c} value of 8.97% with 33% of patients achieving an HbA_{1c} of less than 8% (Rosilio, Cotton, Wieliczko, Gendrault, Carel, Couvaras, Ser, Gillet, Soskin, Garandeau, Stuckens, Le Luyer, Jos, Bony-Trifunovic, Bertrand, Leturcq, Lafuma, The French Pediatric Diabetes Group & Bougneres 1998). Patton, Dolan & Powers (2007) found a mean HbA_{1c} of 8.3% in a group of 33 children aged 2-8 years, with Type 1 diabetes in the United States of America (Patton *et al* 2007).

Aiming for an HbA_{1c} of less than 7% in children is debatable in light of the increased risk of hypoglycaemia with low HbA_{1c} levels in children (Mortensen & Hougaard 1997). Hypoglycaemic seizures in young children have been found to lead to brain injury and neurocognitive decline (Silverstein & Malone 2000). Aiming for a normal HbA_{1c} while trying to reduce the risk of hypoglycaemia, requires modification of the goal of therapy in most children with diabetes (Silverstein & Malone 2000). It may be more practical and

safe to aim for less tight blood glucose control in children with Type 1 diabetes, but this must still be weighed against the risk for microvascular complications (Mortensen & Hougaard 1997).

2.3.4 Factors that affect metabolic control

Many factors have been found to be predictors of HbA_{1c} concentration in children with Type 1 diabetes. These factors include age, gender, duration of disease, number and frequency of insulin injections and frequency of blood glucose monitoring (Levine, Anderson, Butler, Antisdel, Brackett & Laffel (2001). A study by Haller, Stalvey & Silverstein (2004) found a correlation between increased frequency of self-monitoring of glucose and lower HbA_{1c} levels in a group of 229 children with Type 1 diabetes between the ages of 9-15 years, attending a camp for diabetics in the USA. This suggested that increased frequency of self-monitoring of blood glucose may result in lower HbA_{1c} values (Haller *et al* 2004). A study by Levine *et al* (2001) in the USA found that the frequency of blood glucose monitoring was the only modifiable predictor of HbA_{1c} in 300 subjects aged 7 to 16 years with Type 1 diabetes (Levine *et al* 2001).

Levine *et al* (2001) reported an increase in HbA_{1c} values with increasing age in the children aged between 7-16 years while Haller *et al* (2004) also found a positive correlation between increasing age and increasing HbA_{1c} in the children aged between 9-15 years. Mortensen & Hougaard (1997) reported that there was a significant increase in HbA_{1c} with age. This was found specifically in girls up to 12 years and with boys up to 14-15 years (Mortensen & Hougaard 1997). A study conducted by Daneman, Wolfson, Becker & Drash (1981) in Pittsburgh, USA on 477 boys and girls (up to 16 years of age) with Type 1 diabetes also found a significant correlation between increasing HbA_{1c} and increasing age, but only in females up to 16 years of age and not in males. Possible explanations for this finding could be the hormonal changes taking place during puberty in females. The stabilisation or slight decrease in HbA_{1c} values after 16 years of age may be due to the stabilisation of sex hormones at the end of puberty. A decrease in compliance with treatment as children get older could partly explain the trend towards poorer metabolic control, with increasing age (Daneman *et al* 1981).

Although diet has an important role to play in helping to achieve metabolic control, there is no overwhelming evidence to suggest that deviations from the dietary recommendations

for children with Type 1 diabetes, can affect metabolic control. Schmidt, Klover, Arfken, Delamater & Hobson (1992) aimed to assess the relationship between metabolic control and compliance with prescribed food exchanges, energy intake and fat intake in a group of 69 patients between 4-18 years with Type 1 diabetes in the USA. The researchers found no relationship between metabolic control and higher fat intake, however a significant correlation was found between HbA_{1c} and carbohydrate and fat exchange deviations in the outpatient group (Schmidt *et al* 1992).

Although physical activity is encouraged in well-controlled patients with diabetes, it is still debatable whether physical activity improves metabolic control in patients with Type 1 diabetes (Franzese *et al* 2004). It has been suggested that BMI for age may be related to metabolic control in children with diabetes (Schmidt *et al* 1992). According to Kinmonth *et al* (1989), young children with diabetes may gain more weight and be heavier than children of the same age, without diabetes (Kinmonth *et al* 1989). An overweight diabetic may also find it more difficult to achieve good glycaemic control (McCough 2004). BMI in children which is calculated by dividing weight in kilograms by the square of height in metres is gender and age specific because children's body fatness changes with time as they grow, and because boys and girls differ in their body fatness as they mature (Bini, Celi, Berioli, Bacosi, Stella, Giglio, Tosti & Falorni 2000). After standardisation for age using Z-scores, BMI is the best weight/height index for assessing over-nutrition in childhood (Ulijaszek 1997, p 302). A review article by Power *et al* (1997) also confirms that BMI is the best single measure of adiposity in childhood and adolescence (Power *et al* 1997).

According to Schmidt *et al* (1992) BMI for age is regarded as a variable that measures dietary compliance and the authors aimed to assess the relationship between metabolic control and BMI for age in a group of 69 patients between 4-18 years with Type 1 diabetes. Schmidt *et al* (1992) found no relationship between BMI for age and metabolic control (Schmidt *et al* 1992). Due to a lack of research investigating the relationship between BMI for age and metabolic control an objective of this study is to determine if there is a relationship between BMI for age and HbA_{1c} in children with Type 1 diabetes. Given the association between HbA_{1c} and risk for complications as reported by the DCCT [Position Statement of the ADA: Implications of the DCCT (2000)], it is important to measure HbA_{1c} on a regular basis to assess risk for the development of complications. This is

especially important in children with diabetes as the development of complications can affect their quality of life in the long-term. In keeping with this, this study aims to assess HbA_{1c} in order to assess overall metabolic control and to determine if there are any significant relationships between metabolic control and age, gender, frequency of self-monitoring of blood glucose, duration of diagnosis, diet-related knowledge score, hospital clinic attended, race group of subjects, monthly income per household, education level of the caregivers and completion/non completion of dietary records by subjects.

2.4 The role of diet in the management of Type 1 Diabetes Mellitus in children

2.4.1 Background

Dietary intake and nutrition education are especially important in the management of diabetes as compared to other conditions. Diet has proved to be an integral part of the management of diabetes and is essential for achieving good metabolic control, which greatly reduces the risk of developing long-term complications of diabetes (Connell & Thomas-Dobersen 1991). The Registered Dietitian has an essential role to play in the dietary management of diabetes. A challenge for the Dietitian is to achieve the best compromise by using a dietary prescription which suits the family's lifestyle together with an insulin regime that allows for optimal glycaemic control (Magrath & Hartland 1993). The goals of dietary management in children with Type 1 diabetes are to prevent severe hypoglycaemia and postprandial hyperglycaemia, ensure normal growth, development and sexual maturation and to prevent acute and chronic complications associated with the condition (Randecker *et al* 1996; Connell & Thomas-Dobersen 1991). Dietary management of Type 1 diabetes in children involves the development of an individualised meal plan based on usual eating habits and lifestyle factors (Randecker *et al* 1996).

Despite the important role of diet in the overall management of Type 1 diabetes, it is often regarded as the most difficult part of treatment (Gilbertson, Brand-Miller, Thorburn, Evans, Chondros & Werther 2001). Adherence to meal plans and dietary guidelines are especially problematic for children with diabetes (Delamater *et al* 1988). Only 29% of children aged 7 to 16 years attending a camp for diabetics in the USA revealed that they followed their diet "absolutely all of the time" (Franz 1981). Christensen, Terry, Wyatt, Pichert & Lorenz (1983) concluded that only 10% of the children (with an average age of 16 years) complied with prescribed food exchanges, 90% of the time in a study conducted in the USA. A study by Lorenz *et al* (1985) also found poor dietary adherence among 90

children between the ages of 9 to 15 years, attending a camp for diabetic children in the USA. Inadequate patient knowledge of dietary management and inadequate motivation are two reasons that have been suggested for the poor dietary adherence seen in children with Type 1 diabetes (Lorenz *et al* 1985).

2.4.2 Dietary recommendations for children with Type 1 Diabetes Mellitus

The dietary recommendations for patients with diabetes have changed dramatically since the discovery of insulin in 1921 [Position Statement of the ADA: Nutrition Recommendations and Principles for People with Diabetes Mellitus (2000); Waldron, Swift, Raymond & Botha 1997]. Prior to the discovery of insulin, patients were fed very low carbohydrate diets of 10 g carbohydrate per day and minimum amounts of protein and fat to prevent blood glucose levels from rising too high (Position Statement of the ADA: Nutrition Recommendations and Principles for People with Diabetes Mellitus 2000). More recently, there has been a shift from the concept of a "diabetic diet" to that of a meal plan based on current dietary recommendations and individual nutrition assessment and treatment goals and outcomes (Position Statement of the ADA: Nutrition Recommendations and Principles for People with Diabetes Mellitus 2000).

According to a Statement of the American Diabetes Association on the Care of Children and Adolescents with Type 1 Diabetes (Silverstein *et al* 2005) there are no specific requirements for children with diabetes because of a lack of research in the area. The nutrient recommendations are therefore based on requirements for all healthy children. The UK also has a similar recommendation. According to the Nutrition Subcommittee of the Diabetes Care Advisory Committee of Diabetes UK (2003), the dietary recommendations for children with diabetes represent a combination of the general principles of dietetic management in diabetes care and the requirements for healthy children. It has also been suggested that the use of the word "diet" should be avoided with children, as it conveys a message of restriction and prohibition (Franzese *et al* 2004). Extrapolating guidelines and advice for adults to children can also be problematic as it could compromise the intake of energy and micronutrients or be altogether unacceptable to the child (Kinmonth *et al* 1989).

The next section will review the general dietary recommendations for children with Type 1 diabetes as well as dietary recommendations for diabetes, from SA, the USA, the UK and the ISPAD Consensus Guidelines (2002).

The following are the general dietary recommendations for children with Type 1 diabetes:

- Children with diabetes have the same nutritional requirements as non-diabetic children (Kinmonth *et al* 1989).
- Drastic changes in diet involving unfamiliar foods or eating patterns for the child with diabetes alone should be avoided. Dietary recommendations for the child with diabetes should consist of good eating habits that can be extended to the whole family (Magrath & Hartland 1993).
- Meals and snacks should be regularly distributed throughout the day to prevent extreme episodes of hypoglycaemia and hyperglycaemia (Kinmonth *et al* 1989). Meals and snacks should be consumed at roughly the same time each day as insulin injections need to be given at the same time each day. The amounts of food eaten at each meal and snack should be the same each day (Connell & Thomas-Dobersen 1991).
- Special "diabetic foods" are not necessary (Magrath & Hartland 1993). Although alternative sweeteners can be useful at times, the issue of safety is more relevant in children than adults (Connell & Thomas-Dobersen 1991). Children are more likely than adults to overdose on alternative sweetners because of their lower body weight (Connell & Thomas-Dobersen 1991). According to Franzese *et al* (2004), the use of artificial sweeteners in children with Type 1 diabetes is not recommended however the authors do not elaborate as to why such a recommendation is made (Franzese *et al* 2004).
- In the case of vigorous exercise, adjustments must be made in meal planning (Franzese *et al* 2004).
- Kinmonth *et al* (1989) recommend that all children with diabetes have access to a skilled Registered Dietitian who can translate the main aspects of dietary management into a nutritionally adequate, acceptable diet (Kinmonth *et al* 1989).
- The dietary prescription (calculation of nutritional requirements for each individual child) should be reviewed every 3 months to ensure that it meets the needs of the growing child (Connell & Thomas-Dobersen 1991).

- Comprehensive dietary education must be repeated every 3-5 years (Franzese *et al* 2004).

Although dietary recommendations for children with diabetes are not available from all dietetic organisations the Association for Dietetics in South Africa (ADSA) and the ISPAD Consensus Guidelines (2002) have put forward specific recommendations for children. According to the ISPAD Consensus Guidelines (2002) the nutritional recommendations are based on adult recommendations and children over the age of 5 years of age should be encouraged to adopt adult nutritional guidelines. Table 2.1 presents a summary of the dietary recommendations for diabetes. The ISPAD Consensus Guidelines (2002) and ADSA have put forward specific dietary recommendations for children while the recommendations from the American Diabetes Association (ADA) and Diabetes UK are for adults.

Table 2.1: A summary of the dietary recommendations for the nutritional management of diabetes in adults from the ADA and Diabetes UK and in children from the ISPAD Consensus Guidelines and ADSA [Position Statement of the ADA-Nutrition Recommendations and Principles for People With Diabetes Mellitus – 2000; Nutrition Sub Committee of the Diabetes Care Advisory Committee of Diabetes UK-2003; ISPAD Consensus Guidelines 2002; Position Statement of ADSA-Dietary Management of People With Diabetes Mellitus-1996].

	ADA[3]	UK[4]	ISPAD[5]	ADSA[6]
Energy	Achieve and maintain normal growth.	Based on usual intake and allow for normal growth and development.	Sufficient for growth but to avoid obesity.	Adequate for normal growth and development.
Protein	10-20% of Total Energy (TE) 0.8 g/kg/day in overt nephropathy	10-20% of TE Not > 1g/kg/day	10-15 % of TE Should decrease with age.	Same as for Recommended Dietary Allowance (RDA)[7] 4-6 yrs : 24 g/day 7-10 yrs : 28 g/day Males: 11-14yrs: 45g/day Females: 11-14yrs: 46 g/day
Total fat	< 30% of TE (> 2 years)	< 35% of TE	30-35% of TE	< 30% of TE (> 2 years) 40% of TE (< 2 years)
Saturated fat	< 10 % of TE	< 10 % of TE	< 10% of TE	< 10 % of TE
Cholesterol	< 300 mg/day < 200 mg/day if dyslipidaemia	No recommendation given.	No recommendation given.	No recommendation given.
Carbohydrate	55-60% of TE	40-60% of TE	>50% of TE	50-65% of TE
Sucrose	No restriction. To be substituted for other carbohydrate sources.	10% of TE (maximum), eaten in the context of a healthy diet.	Not more than 10% of TE.	Limited amounts as part of a balanced diet.
Fibre	20-35 g/day	No quantitative recommendation. Emphasise soluble fibre.	Child's age + 5g/day (for children > 2 years of age)	3g / 1000kJ
Vitamin and mineral supplementation	Not needed with adequate intake.	Not needed with adequate intake.	Not usually recommended unless deficiency is confirmed.	For "at risk" groups only.

[3] Position statement of the American Diabetes Association-Nutrition Recommendations for people with Diabetes Mellitus-2000
[4] Nutrition Sub Committee of the Diabetes Care Advisory Committee of Diabetes UK-2003
[5] International Society for Pediatric and Adolescent Diabetes (ISPAD) Consensus Guidelines for Children with Diabetes Mellitus-2002
[6] Association for Dietetics in South Africa (ADSA) Nutritional Recommendations for Children with Diabetes Mellitus - 1996
[7] Recommended Dietary Allowances (RDA) established by the Food and Nutrition Board (FNB) of the Institute of Medicine/National Academy of Sciences (IOM/NAS)-1989

2.4.3 Macronutrient and micronutrient recommendations

In the following section, in addition to commenting on the dietary guidelines and recommendations shown in Table 2.1, some additional relevant information from the literature will also be discussed.

Energy

From Table 2.1 it can be seen that there is consensus among ADSA, the ADA, Diabetes UK and ISPAD (2002) regarding energy requirements. According to ADSA (1996), the energy requirements are the same as for non-diabetic children and energy must be adequate for normal growth and development (Position Statement of ADSA-1996). The energy content of the diet should be based on what the child usually eats rather than theoretical formulae, provided that the child is not overweight (Kinmonth *et al* 1989). Energy needs may vary according to activity level and growth spurts (Connell & Thomas-Dobersen 1991). The dietary prescription should be reviewed regularly to allow for growth and physical exercise without obesity (Magrath & Hartland 1993).

Protein

From Table 2.1 it can be seen that the recommendations for protein from Diabetes UK and the ADA are similar [10-20% of Total Energy (TE)], while ADSA recommends a protein intake similar to the Recommended Dietary Allowance (RDA) and the ISPAD guideline is 10-15% of TE [Nutrition Sub Committee of the Diabetes Care Advisory Committee of Diabetes UK-(2003); Position Statement of the ADA: Nutrition Recommendations and Principles for People with Diabetes Mellitus (2000); Position Statement of ADSA (1996); ISPAD (2002)].

Protein intake in children with Type 1 diabetes must be enough to ensure adequate growth and development (Randecker *et al* 1996). It is widely recommended that an intake equivalent to the RDA for protein be achieved and maintained [Position Statement of ADSA (1996); Randecker *et al* 1996]. According to the ISPAD Consensus Guidelines (2002), protein intake should be at the lower range with persistent microalbuminuria, raised blood pressure or established nephropathy (ISPAD Consensus Guideline 2002). The first sign of diabetic nephropathy is microalbuminuria, an increased albumin excretion rate (Silverstein *et al* 2005). Patients with microalbuminuria may benefit from a protein intake

of 0.8-1.0g/kg/day, but because usual intakes are often higher than this range, compliance may be poor (Connell & Thomas-Dobersen 1991). A high protein intake is often obtained from protein of animal origin. This may result in an expensive diet that is also high in saturated fat and cholesterol (Wolever 1999). An advantage of using protein from plant sources is that it is high in dietary fibre and complex carbohydrates. In children with diabetes, it is recommended that dietary protein should be obtained from a combination of both plant and animal sources as protein foods of animal origin tend to be high in fat, especially saturated fat, while protein of plant origin provides more fibre and complex carbohydrates (Kinmonth *et al* 1989).

Fat

From Table 2.1, the fat recommendations from ADSA and the ADA are similar (< 30% of TE) while Diabetes UK recommends < 35% of TE and the ISPAD (2002) guideline is 30-35% of TE. There is agreement amongst ADSA, the ADA, Diabetes UK and ISPAD with the recommendation for saturated fat intake (<10% of TE) [Position Statement of ADSA (1996); Position Statement of the ADA: Nutrition Recommendations and Principles for People with Diabetes Mellitus (2000); Nutrition Sub Committee of the Diabetes Care Advisory Committee of Diabetes UK- (2003); ISPAD (2002)]. Guidelines for fat intake in school-children with Type 1 diabetes are similar to that for adults (Kinmonth *et al* 1989).

Atherosclerosis can contribute to an increased incidence and earlier presentation of cardiovascular disease (CVD), cerebrovascular disease and peripheral vascular disease, and is a major cause of morbidity and mortality in patients with Type 1 diabetes [Glowinska, Urban, Koput & Galar 2003; DCCT Research Group 1994]. Although data are limited, studies have shown a significant increase in atherosclerosis in adolescents with diabetes, relative to non-diabetics (Krantz, Mack, Hodis, Liu, Liu & Kaufman 2004). It has also been shown that risk factors for atherosclerosis and atherosclerotic changes in blood vessel walls are present during childhood and adolescence (Glowinska *et al* 2003). In children and adolescents with Type 1 diabetes both dietary changes and improvement in glycaemic control have been found to return elevated blood lipid levels to normal (Connell & Thomas-Dobersen 1991).

Cholesterol

Table 2.1 shows that only the ADA gives a guideline on cholesterol intake while there are no guidelines from ADSA, Diabetes UK and ISPAD. Cholesterol intake should be less than 300 mg/day and may need to be reduced further if Low Density Lipoprotein (LDL) cholesterol is raised (Recommendations for the nutritional management of patients with diabetes mellitus: The Diabetes and Nutrition Study Group of the European Association for the Study of Diabetes – 2000). The ADA suggests that cholesterol intake should be reduced to 200 mg/day if there is evidence of dyslipidaemia (Position Statement of the ADA: Nutrition Recommendations and Principles for People with Diabetes Mellitus 2000).

Carbohydrate

From Table 2.1, it can be seen that there are slight differences in carbohydrate recommendations for diabetes between ADSA, the ADA, Diabetes UK and ISPAD. Specifically for children, the emphasis should be on unrefined, fibre-rich sources and the intake of carbohydrate should never be lower than the usual family intake (Kinmonth *et al* 1989).

Sucrose

There appears to be a wide variation in the recommendations for sucrose among the different authorities. Although Diabetes UK and the ISPAD recommendation is not more than 10% of TE for sucrose, both ADSA and the ADA state that sucrose should be used as part of a balanced diet. The use of sucrose in the diabetic diet has traditionally been associated with increased blood sugar levels and its exclusion from the diabetic diet was the most important dietary modification in the dietary management of diabetes (Coulston 1994). It has been shown that sucrose does not worsen glycaemic control in well-controlled patients with Type 1 diabetes (Forlani, Galuppi, Santacroce, Braione, Giangiullio, Ciavarella & Vannini 1989; Bantle, Laine & Thomas 1986). It may be necessary to limit sucrose intake only in terms of balanced eating and dental health (McGough 2004). The use of sucrose (up to 10% of TE) in mixed meals, rich in soluble fibre and spaced throughout the day may improve palatability and acceptability of the diet in children with Type 1 diabetes (Kinmonth *et al* 1989).

Fibre

From Table 2.1, ADSA, the ADA and ISPAD give a quantitative recommendation for fibre while Diabetes UK emphasises the intake of soluble fibre. Different types of dietary fibre have different effects in different parts of the gastrointestinal tract, depending on the composition, physical properties and the form in which it is consumed (Kinmonth *et al* 1989). Intake of soluble fibre has been found to decrease the postprandial glycaemic response in children with Type 1 diabetes (Kinmonth, Angus, Jenkins, Smith & Baum 1982). Although 10-20g/day of fibre is regularly recommended, higher intakes of fibre are not advised (Franzese *et al* 2004). According to Randecker *et al* (1996) high fibre diets may result in inadequate energy intake and the impairment of mineral absorption (Randecker *et al* 1996). Fibre intake should be monitored in children with diabetes to ensure that the recommended amounts are consumed and to guard against excessive intake (Kinmonth *et al* 1989).

Vitamins and minerals

There is consensus among ADSA, the ADA, Diabetes UK and ISPAD that the use of vitamin and mineral supplements is not necessary unless dietary intake is compromised [Position Statement of ADSA-(1996); Position Statement of the ADA: Nutrition Recommendations and Principles for People with Diabetes Mellitus (2000); Nutrition Sub Committee of the Diabetes Care Advisory Committee of Diabetes UK- (2003); ISPAD (2002)]. According to ADSA, micronutrient supplements may be needed when a deficiency can be demonstrated, when there is consumption of a very low energy diet, in uncontrolled diabetes or potential groups who are at nutritional risk. Both ADSA and the ADA recommend that although there are theoretical reasons to supplement with antioxidants, there is insufficient evidence to support daily supplementation with antioxidants in diabetes [Position Statement of ADSA (1996); Position Statement of the ADA: Nutrition Recommendations and Principles for People with Diabetes Mellitus (2000)]. Kinmonth *et al* (1989) suggest that the micronutrient intake and status should be monitored in children with diabetes because a high-fibre intake could reduce the bioavailability of minerals like calcium, zinc and iron. Drastically reducing fat intake (less than 10% of total energy) can also reduce the intake and absorption of fat-soluble vitamins such as vitamin A and D (Kinmonth *et al* 1989).

2.4.4 Food Based Dietary Guidelines

The Food Based Dietary Guidelines were officially adopted by the South African National Department of Health on the 4th of May 2003. Food Based Dietary Guidelines provide dietary guidelines in terms of foods, rather than quantitative measures. These guidelines are made up of descriptive statements that provide simple, practical advice for making food choices. These guidelines may be particularly useful for children because of the lack of numerical quantities (Love 2003). It is recommended that the Food Based Dietary Guidelines be incorporated into the dietary management of children with diabetes (Love 2003).

2.5 Assessment of dietary intake in children with Type 1 Diabetes Mellitus

2.5.1 Problems with carrying out dietary assessment in children

Dietary assessment is difficult among adults and especially problematic and challenging among children (Domel, Thompson, Baranowski & Smith 1994). Although direct observation of dietary intake is regarded as the most accurate method of dietary assessment, direct observations are too expensive and time consuming for large-scale studies. Thus children's self-reports of dietary intake are necessary (Domel 1997). Several problems exist in the accurate assessment of dietary intake in children (Eck, Klesges & Hanson 1989). Children's memories are often thought to be less accurate than that of adults (Krall, Dwyer & Coleman 1988). Children also have low literacy, a general lack of interest and a short attention span (Crawford, Obarzanek, Morrison & Sabry 1994). A limited knowledge of foods, food preparation and food measurement may also impact on the accuracy of dietary assessment in children (Rockett & Colditz 1997; Crawford *et al* 1994). Before the age of 12 years, children have a limited ability to estimate and indicate portion size and may not pay attention to aspects of food and drink that are unimportant to them (Sobo, Rock, Neuhouser, Maciel & Neumark-Sztainer 2000). Children may also change their response when they are recording dietary intake, when they anticipate being questioned about dietary intake and when they are aware of being observed (Eck *et al* 1989).

2.5.2 Methods used to assess dietary intake in children

Dietary assessment methods include both quantitative and qualitative approaches and shortcomings can be found in both approaches (Stuff, Garza, O' Brian Smith, Nichols & Montandon 1983). Some of the techniques that can be used to assess dietary intake include

food records, 24 hour recall, diet history, food frequency questionnaire and direct observation of dietary intake (Domel 1997; Medlin & Skinner 1988). The most appropriate method for a particular investigation depends on the objectives of the specific study and the population being assessed (Domel 1997). Attempting to achieve a balance between the need for accuracy and validity on one end, and practicability on the other is a major challenge (Jenner, Neylon, Croft, Beilin & Vandongen 1989). It is widely accepted that errors exist in every method of dietary assessment and that no method provides the truth about the nutritional intake of an individual (Nelson 1997, p 241).

The method of dietary assessment chosen in studies involving children is dependent on the age of the child, the objectives of the study and the setting of the study. The fact that the subjects in this study were only going to be seen once played a significant role in determining which methods would be used to assess dietary intake. The next section of this Literature Review will critically evaluate the different dietary assessment methods available for use in children and to justify the methods chosen for use in this study. The dietary assessment methods that will be critically evaluated include: food records, 24 hour recall, diet history, food frequency questionnaire and direct observation.

Food records

Food records are written accounts of the actual intake of food and beverages consumed during a specified time period (McPherson, Hoelscher, Alexander, Scanlon & Serdula 2000). The specified time period may be 1, 3, 5 or 7 days (McPherson *et al* 2000; Stuff *et al* 1983). A food record can either be a weighed food record or an estimated food record. A weighed food record requires the subject or caregiver to weigh all foods and beverages consumed by the subject during a specified period of time (Gibson 2005, p 45). With the estimated food record the subject is required to record all foods and beverages eaten at the point of consumption in household measures for a specific period of time (Gibson 2005, p 44). With food records, the respondents are required to record detailed information about their dietary intake and include brand names, ingredients of mixed dishes, food preparation methods and measured estimates of amounts consumed (McPherson *et al* 2000). The amounts consumed may be measured with a scale or household measures such as cups, teaspoons and tablespoons (Thompson & Byers 1994). With food records, error due to memory loss is reduced because the information is collected at the time of consumption (McPherson *et al* 2000).

The number of days used in a dietary record can influence the accuracy of the information collected. A one-day food record cannot be used to characterise individual patterns or to identify people at nutritional risk. Food records recorded over multiple days must be obtained to characterise and quantify dietary intake (Farris, Frank, Webber & Berenson 1985). When analysing a multiple-day record, the mean of several days intake is assumed to be representative of a person's usual intake (Craig, Kristal, Cheney & Shattuck 2000). As the number of days used in the record increases there is a significant increase in incomplete records. The validity of the information collected decreases in the later days of a 5-day or 7-day recording period (Thompson & Byers 1994). The number of days used is usually restricted to 3 to 4 days because of the high burden on participants and the high costs for researchers (Craig *et al* 2000). The food record should include both weekends and weekdays as it provides a closer estimation of actual dietary intake (Stuff *et al* 1983).

According to Mascarenhas, Zemel & Stallings (1998), the best method for assessing dietary intake in children, is to perform a 3 day weighed record of food intake as it is more representative of their dietary intake, than a single 24-hour recall (Mascarenhas *et al* 1998). According to Stuff *et al* (1983), the 3-day record reasonably approximates measurements obtained in a 7-day record (Stuff *et al* 1983). The completion of the food record can be a demanding task for the subject, who must be literate (Rockett & Colditz 1997). According to Domel (1997), food records should only be used in children older than 9 years, as records from younger children have been found to be more unreliable (Domel 1997). In the case of children who are younger and illiterate, dietary records can be recorded by the parent or care-giver, who must be made aware of the need for a true, honest and accurate account of the child's intake (Thompson & Byers 1994). It is also useful to provide the child with an example of a completed food record so that they can follow the correct format in recording their dietary intake (Gilbertson *et al* 2001).

24 hour recall

In the 24-hour dietary recall, the respondent is asked to remember and report all food and beverages consumed in the previous 24 hours or on the previous day. The recall is usually conducted by personal interview with well-trained interviewers as much of the dietary information is collected by asking probing questions (Thompson & Byers 1994). The 24-hour recall incorporates a detailed description of the food, including brand names, ingredients of mixed dishes, food preparation methods and portion sizes consumed

(McPherson *et al* 2000). According to Eck *et al* (1989), the 24-hour recall is the measure most commonly used, when the purpose is to assess the current intake of children (Eck *et al* 1989). The 24-hour recall appeals to most researchers because it appears to meet the constraints for young children (Emmons & Hayes 1973). A once-off 24-hour recall may however not be representative of the child's usual dietary pattern (Stunkard & Waxman 1981).

Dietary recalls are often conducted using a parental report of the child's intake or by having a parent assist the child in the recall (Lytle, Nichaman, Obarzanek, Glovsky, Montgomery, Nicklas, Zive & Feldman (1993). Eck *et al* (1989) found that the consensus recall, in which the mother, father and child reported together, produced the most accurate estimate of the child's observed dietary intake. The consensus recall also appeared to reduce the tendency to over-report low intakes and under-report high intakes (Eck *et al* 1989). A study by Lytle *et al* (1993) concluded that children had a difficult time quantifying portion sizes of almost all foods, when using the 24-hour recall. Overestimation occurred more frequently than underestimation (Lytle *et al* 1993). According to Krall *et al* (1988), food models or samples as well as household measuring utensils should be used to estimate portion sizes in recalls involving children (Krall *et al* 1988). Due to its dependency on memory and accurate estimation of portion sizes, the use of the 24-hour recall as the only method of dietary assessment in children, remains debatable.

Diet history

The diet history method of dietary assessment involves questioning the respondent about the past diet in the form of usual meal patterns, in a one to two hour interview. The major strength of the diet history is its assessment of usual meal patterns and details of long-term food intake, rather than intakes for a short period of time (Thompson & Byers 1994). A study by Livingstone, Prentice, Coward, Strain, Black, Davies, Stewart, McKenna & Whitehead (1992) assessed energy intakes in children between 3 to 18 years, by means of a diet history. The authors found that the reporting of food intake during the diet history was found to be heavily influenced by surrounding distractions, the intelligence and motivation of the child, the complexity and regularity of food patterns and the age at which children could reliably report their own food intake, in settings not controlled by adults (Livingstone *et al* 1992). A weakness of the diet history method is that it requires children

to recall dietary intake from the past, understand spatial relationships and be able to apply mathematical skills. Children also need to have the stamina to complete the one to two hour interview. Due to the great respondent burden, the diet history method is not often used in children (McPherson *et al* 2000).

Food frequency questionnaire

With the food frequency questionnaire (FFQ), the respondent is presented with a list of foods and is required to say how often each food item is eaten. The frequency of food consumption may be given as a certain number of times per day, per week or per month (Nelson & Margetts 1997, p 58). The use of food frequency questionnaires in children is dependent on the child's ability to recall past events. If food frequency questionnaires are used in children, without parental assistance, the questions regarding the frequency of food consumption have to cover a more recent reporting period (McPherson *et al* 2000). The frequency of consumption may also influence the child's recall accuracy, with frequently consumed items less likely to be forgotten than items that are consumed less often (Krall & Dwyer 1987). Although food frequency questionnaires are much better suited for ranking subjects according to food or nutrient intake, they do not provide a good estimate of levels of intake (Thompson & Byers 1994). According to Sobo *et al* (2000), children have difficulty in understanding and estimating portion sizes of foods. This coupled with a poor ability to recall past events may make the FFQ an unsuitable method for assessing dietary intake in children (Sobo *et al* 2000).

Direct observation

Seeing that dietary assessment is difficult in children, observation methods provide a means of obtaining more accurate dietary assessments of children by avoiding errors of recall (Baranowski & Domel 1994). The use of direct observation in assessing dietary intake of children is useful in children who are preliterate (third grade or younger). Observation methods can be carried out in a lunchroom setting with school meals or in a controlled school or group activity (McPherson *et al* 2000). With observation methods, intensively trained observers unobtrusively watch children to determine foods eaten, brand names and portion sizes consumed. Multiple observations can provide a measure of usual intake. Observations are often used as a validation standard for dietary intake studies among school-aged children. The observation method can be expensive and time-consuming and inappropriate for large-scale studies. Observation over a 24 hour period

may also be practically unfeasible. It appears that some form of self-report still seems appropriate for most dietary assessment needs among children (McPherson *et al* 2000).

2.5.3 Dietary assessment methods used in dietary intake studies in children with Type 1 Diabetes Mellitus

In order to determine the most appropriate method of dietary assessment for a particular study, it is also useful to look at the dietary assessment methods that have been used by other researchers, in similar studies. Table 2.2 shows a summary of the studies that have assessed dietary intake among children with Type 1 diabetes, and the methods that were used.

Table 2.2: A summary of the dietary intake studies conducted in children with Type 1 Diabetes Mellitus

STUDY	COUNTRY	No. OF SUBJECTS	AGE RANGE OF SUBJECTS	DIETARY ASSESSMENT METHOD USED	PERIOD OF DATA COLLECTION
Hackett, Court, McCowen & Parkin (1988)	UK	168	<10.5 - >12.5 years	Estimated 3 day food diary	3 consecutive days, once off
Schmidt *et al* (1992)	USA	69	4-18 years	Estimated 3 day food record	3 consecutive days, once off
Price, Lang, Eiser & Tripp (1993)	USA	62	> 8 years	3 random, 24-hour recalls *2 weekdays and 1 weekend day*	3 month period
Randecker *et al* (1996)	USA	66	4-9 years	3 random, 24-hour recalls *2 weekdays and 1 weekend day*	2 week period
Virtanen, Ylonen, Rasanen, Ala-Venna, Maenpaa & Akerblom (2000)	Finland	39	< 6 years	Estimated, repeated 3 day food record *2 weekdays and 1 weekend day*	3, 6, 12, 18, 24 month intervals
Gilbertson, Thorburn, Brand-Miller, Chondros & Werther (2003)	Australia	104	8-13 years	Estimated, repeated 3 day food diary *2 weekdays and 1 weekend day*	1,3,6,12 month intervals
Mayer-Davis, Nichols, Liese, Bell, Dabelea, Johansen, Pihoker, Rodriguez, Thomas & Williams (2006)	USA	1511	10-22 years	Single Food Frequency Questionnaire	Once off

In the studies reviewed, a variety of dietary assessment methods were used in children with Type 1 diabetes. The methods used included multiple 24-hour recalls, a 3-day food record and a 3-day food diary with the food record and food diary being the most common methods chosen. The 3-day food record and the 3-day food diary involve the same

procedure for recording dietary intake but are referred to by different names. Although the most appropriate method for the particular study was chosen, most researchers also identified limitations of the dietary assessment method used. This confirms that there is no single method of dietary assessment which gives a true measure of dietary intake and all methods suffer from the lack of an external standard of truth (Price *et al* 1993; Christensen *et al* 1983). The key is to choose the method that is most appropriate for the particular study and subjects and to acknowledge the limitations of the method, which may affect the validity of the study.

2.5.4 Dietary assessment methods chosen for use in this study

The methods chosen for use in this study were determined by considering the age of the participants as well as the setting and circumstances surrounding data collection. For the purpose of assessing dietary intake in this study, involving children aged 6-10 years with Type 1 diabetes, a 3-day dietary record was chosen. Although the weighed food record is considered to be the gold standard for dietary assessment (Rockett & Colditz 1997), it was not used in this study due to practical limitations. An estimated 3-day dietary record was chosen for this study instead of a weighed food record because the subjects were seen once only and it would not be practical to see the subjects again on a follow up just to collect the food scales. Also there was the risk of not having all the food scales returned to the researcher after the data collection period was over. Furthermore a weighed food record can also be difficult to complete even in literate subjects. In the National Food Consumption Survey conducted in South African children aged 1-9 years in 1999, a weighed food record was used to validate the 24 hour recall in literate subjects. Unfortunately there was not enough weighed food records that were completed well enough for use in the study (Maunder 2007).

A study by O'Connor, Ball, Steinbeck, Davies, Wishart, Gaskin & Baur (2001) aimed to compare measurements of energy intake from diet records and total energy expenditure from the doubly labelled water method to investigate misreporting of energy intake in 47 children between the ages of 6-9 years in Australia. With assistance from the child, the caregivers were asked to record the child's food and drink intake for 3 consecutive days, including 1 weekend day and 2 weekdays. Metric measuring spoons and cups were given to the subjects to measure intake. The researchers concluded that 3 day food records were

suitable for use in studies on energy intake in children between 6-9 years of age, at the group level (O'Connor *et al* 2001).

For this study it was decided that the 3-day food record would consist of 2 weekdays and 1 weekend day to provide a closer estimation of actual dietary intake, as has been done in other studies (Gilbertson *et al* 2003; O'Connor *et al* 2001; Virtanen *et al* 2000; Randecker *et al* 1996; Price *et al* 1993). Due to the fact that the subjects were seen once and were not going to be seen at the clinic again it was decided that mailing the completed dietary records would be the best method to ensure that the researcher received the completed dietary records. The subjects were provided with a stamped addressed envelope in order to facilitate the return of the completed diet records. According to Babbie & Mouton (2001, p 259) including a stamped, addressed envelope for return of questionnaires is useful in small surveys and increases the response rate because of the reduced respondent burden (Babbie & Mouton 2001, p 259).

As neither the 24 hour recall nor the measured food record is regarded as a gold standard and due to practical limitations with this study it was decided that a 24 hour recall of the third day of the 3 day dietary record would be used to validate the 3 day dietary record. The 24 hour recall would have to be obtained using the telephone because the subjects and caregivers were only seen once at the clinic. According to Casey, Goolsby, Lensing, Perloff & Bogle (1999) the use of the telephone proved to be a practical, feasible and valid method for collecting dietary information in surveys while Tran, Johnson, Soultanakis & Matthews (2000) concluded that the use of the telephone was an objective and effective method for obtaining dietary recalls and that results were similar to results obtained with in-person interviews. One disadvantage of using the telephone to collect data is the unavailability of telephones in some households. Although telephones are more readily available today as compared to a few years ago, this is still a problem in some populations (Dillman 1978, p 42). From the 2001 South African Census the percentage of households with a landline telephone and/or cellular phone in the dwelling according to racial groups was as follows: African (31.1%), Coloured (54.4%), Indian/Asian (87.1%) and White (95.2%). In KwaZulu-Natal, 39% of the total population had access to a landline telephone and/or cellular phone in the household [Census 2001-South Africa]. This suggests that it was likely that most subjects would have access to either a landline telephone and/or cellular phone.

2.5.5 Studies that have assessed dietary intake in children with Type 1 Diabetes Mellitus

Although dietary management has been recognised as an important part of the overall management for children with Type 1 diabetes, there is a lack of published scientific literature regarding the actual dietary intake of these children (Randecker *et al* 1996). Diet is also commonly identified as the main problem encountered when caring for a child with diabetes (Hackett *et al* 1986). Studies that have assessed dietary intake in children with Type 1 diabetes have predominantly been carried out in the USA, UK and Finland. The important role of diet in the overall management of diabetes and the lack of published literature on the dietary intake of children with Type 1 diabetes in South Africa further emphasises the need for research in this area. It is also important to take note that the dietary habits of children in South Africa differ according to the race and culture and this must also be taken into account when assessing dietary intake. The next section of this Literature Review will examine studies that have assessed dietary intake in children with Type 1 diabetes. Studies by Hackett *et al* (1988), Price *et al* (1993) and Gilbertson *et al* (2003) will not be reported on in the next section as these studies only reported on dietary intake of selected nutrients. The studies reviewed will include those by Schmidt *et al* (1992), Randecker *et al* (1996), Virtanen *et al* (2000), Mayer-Davis *et al* (2006) and Patton *et al* (2007). Findings related to mean intake of energy, carbohydrate, protein, fat, saturated fat, cholesterol and fibre are presented in Table 2.3. Micronutrient and sucrose intake will also be discussed in the next section.

Table 2.3: Summary of findings from studies that have reported dietary intake in children with Type 1 diabetes, from the USA and Finland

Study[8]	Country	Aim of study	No. of subjects	Age range of subjects	Mean energy intake	Mean carbohydrate intake [% of Total Energy (TE)]	Mean protein intake (% of TE)	Mean fat intake (% of TE)	Mean saturated fat intake (% of TE)	Mean fibre intake (g/day)
Schmidt *et al* (1992)	USA	To investigate the relationship between compliance with a prescribed diet and metabolic control.	69	4-18 years	Significantly greater than prescribed energy	46 %	15 %	39 %	Not assessed	Not assessed
Randecker *et al* (1996)	USA	To assess dietary intake of children with Type 1 DM and to compare with current nutritional recommendations.	66	4-9 years	Intakes close to the RDA	53 %	17 %	32 %	11.4	16.6
Virtanen *et al* (2000)	Finland	To assess dietary intake of children with Type 1 DM at diagnosis and to follow up over a 2 year period.	39	Under 6 years	Energy intake lower than in non-diabetic children of the same age	52 %	18 %	30 %	11 %	23
Mayer-Davis *et al* (2006)	USA	To describe dietary intake among a large cohort of youth with Type 1 DM and to compare intake with current nutritional recommendations.	740	10-14 years	Under - reporting increased with increases in BMI	49 %	16 %	37 %	13.5 %	13.1
Patton *et al* (2007)	USA	To examine dietary intake, dietary adherence and glycemic control in young children with Type 1 DM.	33	2-8 years	Below the USA-Dietary Reference Intake (DRI) for energy	53 %	15 %	34 %	Not reported	Not reported

[8] Not all of the studies mentioned in Table 2.2 are discussed in Table 2.3. Studies by Hackett *et al* (1988), Price *et al* (1993) and Gilbertson *et al* (2003) have been omitted in Table 2.3 because these studies did not report on energy, carbohydrate, protein and fat intake. Hackett *et al* (1988) reported on day to day variation in carbohydrate and energy intake, Price *et al* (1993) looked at prescribed versus unrestricted carbohydrate diets and Gilbertson *et al* (2003) studied the effect of low-glycaemic index dietary advice on dietary quality and food choice.

Energy

It is important for children with diabetes to have adequate energy intake, in order to ensure normal growth and development (Position Statement of ADSA -1996). A study by Schmidt *et al* (1992) which investigated compliance with dietary prescriptions in diabetics aged 4 to 18 years, found that energy intakes were significantly greater than the prescribed energy intake. Subjects were found to have added an average of 1562 kJ of energy to the prescribed energy intake. There was no correlation between greater energy intake and metabolic control (Schmidt *et al* 1992), so it remains to be seen whether increased energy intake affects metabolic control. Low dietary energy intake was reported by Virtanen *et al* (2000). The authors found that in diabetic children under 6 years of age, energy intake was lower than the energy intake in non-diabetic children of the same age. This could be due to the greater control imposed on dietary intake in diabetic children by caregivers (Virtanen *et al* 2000). Patton *et al* (2007) also found low energy intakes with mean energy intakes being lower than the USA-Dietary Reference Intake (DRI) for energy.

From these published studies it can be seen that energy intakes vary in children with Type 1 diabetes. The low energy intakes reported by Virtanen *et al* (2000) could have been due to the fact that parents had more control over the energy intakes of the children because of their younger age (under 6 years of age). Inadequate growth can result from a reduced energy intake in young children with diabetes. The study did not mention whether the children with lower energy intakes were growing at an acceptable rate or not (Virtanen *et al* 2000). An increased energy intake as compared to the energy prescription as reported by Schmidt *et al* (1992) is of concern as increased energy intake increases the risk of becoming overweight or obese, which may consequently lead to poor metabolic control (Schmidt *et al* 1992).

Carbohydrate

Carbohydrate intake is important in children with Type 1 diabetes because it can influence blood glucose levels and overall metabolic control (Coulston 1994). There seems to be a variation in carbohydrate intake amongst children with Type 1 diabetes in the studies reviewed. Randecker *et al* (1996), Virtanen *et al* (2000) and Patton *et al* (2007) reported carbohydrate intakes of 53%, 52% and 53% respectively, which fell within the recommended range [Randecker *et al* (1996); Virtanen *et al* (2000); Patton *et al* (2007)]. Schmidt *et al* (1992) reported that mean actual carbohydrate intake in children with Type 1

diabetes was 36g greater than the prescribed intake. The variation in carbohydrate intake may have accounted for a portion of the significant relationship between HbA_{1c} and exchange variations in this group (Schmidt *et al* 1992). Both Schmidt *et al* (1992) and Mayer-Davis *et al* (2006) reported relatively low intake of CHO (46% and 49% respectively). A low carbohydrate diet is not recommended in patients with diabetes as it may lead to hypoglycaemia. In children this is of concern because of the decreased cognitive function and possible brain damage associated with frequent hypoglycaemic episodes in young children with diabetes (Silverstein & Malone 2000).

Protein

From Table 2.3, protein intake in all of the studies reviewed [Schmidt *et al* (1992); Randecker *et al* (1996); Virtanen *et al* (2000); Mayer-Davis *et al* (2006); Patton *et al* (2007)] was found to be within the recommended range of 10-20% of TE [Position Statement of the ADA-Nutrition Recommendations and Principles for People With Diabetes Mellitus (2000); Nutrition Sub Committee of the Diabetes Care Advisory Committee of Diabetes UK (2003)]. Consistent high protein intake among diabetics can have a negative impact on renal function, if there is renal impairment. Protein intake must be monitored in children with Type 1 diabetes because of the risk of developing nephropathy (Connell & Thomas-Dobersen 1991).

Fat

Schmidt *et al* (1992), Randecker *et al* (1996), Mayer-Davis *et al* (2006) and Patton *et al* (2007) all reported higher fat intakes among diabetic children as compared to the ADA recommendations [Position Statement of the ADA: Nutrition Recommendations and Principles for People with Diabetes Mellitus (2000)]. Randecker *et al* (1996) found that mean intake of fat and saturated fat was slightly higher than recommended levels (Randecker *et al* 1996). Schmidt *et al* (1992) found that diabetic children added up to 20 g of additional fat to the recommended intakes. Approximately 80% of the added fat was obtained from saturated sources. Snack items, breakfast breads and meat products were the main sources of added fat. The higher fat intake was not correlated with metabolic control (Schmidt *et al* 1992). Virtanen *et al* (2000) reported an increase in fat intake from 26% to 30% over a 2 year follow-up period. Intake of saturated fatty acids was found to be near the upper recommended value of 10% of total energy (Virtanen *et al* 2000). It is important to take note of the increased fat and specifically saturated fat intake among

children with diabetes, as it increases the risk for cardiovascular problems and may aggravate already increased lipid and lipoprotein levels (Schmidt *et al* 1992). With a consistent protein intake, fat intake may be increased to account for the reduced energy resulting from a simple carbohydrate restriction (Kinmonth *et al* 1989). Cholesterol intake was assessed in the study by Randecker *et al* (1996) and was found to be within the recommended range for people with diabetes. It would have been interesting to measure the cholesterol levels in the subjects involved in the study by Schmidt *et al* (1992), as 80% of the added fat came from saturated fat sources (Schmidt *et al* 1992).

Fibre

Virtanen *et al* (2000) reported that intake of dietary fibre among children with diabetes was close to the recommended range of fibre for school aged children (Virtanen *et al* 2000). Although the reported fibre intakes in children with Type 1 diabetes were lower than the recommendation in the study by Randecker *et al* (1996), the children with Type 1 diabetes still consumed more fibre than age-matched non-diabetic children. This may suggest that diabetic children are aware of the increased requirements for fibre in diabetes (Randecker *et al* 1996).

Sucrose

Not many studies have assessed sucrose intake in children with diabetes. From the studies reviewed, sucrose intake was assessed in only 2 studies. Virtanen *et al* (2000) reported a sucrose intake of 3% of total energy. This intake was below the recommendation of not more than 10% of total energy from Diabetes UK and ISPAD, which are the only two organisations that give a recommendation for sucrose intake in diabetes [Nutrition Sub Committee of the Diabetes Care Advisory Committee of Diabetes UK- (2003); ISPAD (2002)]. Mayer-Davis *et al* (2006) reported a mean sucrose intake of 38g/day which was not reported as a percentage of total energy.

Vitamins and minerals

Patton *et al* (2007) found that less than 50% of the children met 100% of the daily USA-DRI for calcium and only one child met at least 100% of the daily USA-DRI for vitamin B_{12} (Patton *et al* 2007). Virtanen *et al* (2000) reported low intake of vitamin D from food while vitamin A intake was 1.6 times higher in children with diabetes as compared to control children (Virtanen *et al* 2000). Randecker *et al* (1996) reported inadequate intake

of vitamin D, vitamin E and zinc in diabetic children. Vitamin E and zinc intake was also found to be of concern in a nationwide sample of non-diabetic children of the same age. Micronutrient intake was assessed from food alone and did not include intake of micronutrient supplements (Randecker *et al* 1996). These findings suggest that dietary modifications in children with diabetes may compromise micronutrient intake, and micronutrient supplementation may be warranted.

In summary from the studies reviewed there seems to be variation in dietary intake among children with Type 1 diabetes. The observations of high total fat, saturated fat and energy intake are of concern because of the increased risk for the development of obesity and cardiovascular complications. These two areas of dietary intake require attention by the Registered Dietitian responsible for dietary management of the child with Type 1 diabetes, in order to minimise the risk for development of complications associated with poor metabolic control. It is important to note that there are no published studies on the dietary intake of South African children with diabetes and that the conclusions that have been drawn have been obtained from studies conducted in other countries.

2.6 Dietary intake and anthropometric status of South African children

Although no dietary intake studies have been conducted in South African children with diabetes, results from the South African Vitamin A Consultative Group Study (SAVACG - 1996) conducted in children aged 6 to 71 months and the National Food Consumption Survey (NFCS-1999) conducted in children aged 1-9 years in South Africa provide some insight into the nutrient intake and anthropometric status of South African children. According to the NFCS (1999), the mean energy intake of children in all provinces in South Africa was below the recommended energy for age. The mean protein intakes in all groups and in all provinces were greater than the RDA. Fat contributed less than 30% of TE while protein contributed less than 15% of TE. Carbohydrate intake was greater than 65% of TE in all provinces except for the Western Cape. The dietary intake of the following nutrients was found to be less than 67% of the RDA: calcium, iron, zinc, selenium, vitamin A, vitamin D, vitamin E, riboflavin, niacin and vitamin B_6. In summary the great majority of children consumed a diet deficient in energy with poor micronutrient density (NFCS -1999).

According to the SAVACG study (1994) one in three children had a marginal vitamin A status (serum vitamin A concentration below 20 ug/dL) while one in five children were found to have iron deficiency anaemia. This data suggests that the micronutrient status of South African children may be less than optimal and that the problems with micronutrient intake in South African children with diabetes may be different to the findings reported by other countries, especially developed countries. In terms of anthropometry, the SAVACG study (1996) revealed that 22.9% of children were stunted and 9.3% of children were underweight, while the NFCS (1999) showed that at least 21, 6% of children between the ages of 1 and 9 years old were stunted (NFCS-1999; SAVACG-1996).

Although there is a lack of studies on energy intake in South African children with diabetes, there is evidence of both chronic inadequate and excessive energy intake among non-diabetic children. According to the Armstrong, Lambert, Sharwood & Lambert (2006) the prevalence of overweight in South African children aged 6-13 years is 14.0% for boys and 17.9% for girls while the prevalence of obesity is 3.2% for boys and 4.9% for girls. This suggests that the problems of moderate stunting and overweight and obesity co-exist among South African children and that patterns of under and over nutrition are changing (Jinabhai, Taylor & Sullivan 2005).

The level of dietary knowledge among patients with Type 1 diabetes has been suggested to influence dietary intake and adherence. The next section of this Literature Review will examine expected knowledge levels in school children and will review studies that have assessed diabetes and diet-related knowledge levels in children with Type 1 diabetes.

2.7. Knowledge levels in children with Type 1 Diabetes Mellitus

Adherence to dietary guidelines is generally recognised as one of the practices that must be maintained in order to achieve optimal management of Type 1 diabetes. Inadequate patient knowledge of dietary management has been cited as one of the reasons for poor dietary adherence (Lorenz *et al* 1985). Although patient's knowledge regarding diabetes has been shown to be poor, knowledge and skill in managing diet has rarely been studied because of a lack of objective, quantifiable measures (Johnson *et al* 1982). Given the growing need for independence and the fact that school-aged children, aged 6-11 years spends most waking hours away from home in school, recreational activities, sports or with friends, adequate

knowledge on dietary management and dietary skills is imperative (Charron-Prochownik, Becker, Brown, Liang & Bennett 1993; Lorenz *et al* 1985). It has also been suggested that knowledge and skills regarding diet should be evaluated regularly by the diabetes educator in children with Type 1 diabetes (Silverstein *et al* 2005).

2.7.1 Expected knowledge levels in school-aged children

Although parents assume responsibility for the majority of diabetes management of infants and young children, school-age children are expected to become more independent and involved in self-care activities (Saucier & Clark 1993). According to Ginsburg & Opper (1979, p26), school-age children are in the Concrete Operational Stage of Piaget's Stages of Cognitive Development in children[9]. In this stage, children start developing an understanding of relationships between events, things and objects. Children are also able to understand cause and effect, apply rules and regulations and distinguish between right and wrong (Ginsburg & Opper 1979, pp 26, 123, 223). School-age children also have a very basic but concrete understanding of the body and its functions. Many of the diabetes self-management skills are acquired during the school-age period (Charron-Prochownik *et al* 1993).

School-age children begin to take an interest in their diet and a sense of achievement and expressions of approval from family and health care staff are powerful motivating factors. An understanding of good nutrition and how food may be tailored to meet the needs is expected during the school-age period (Magrath & Hartland 1993). A major task of children between 10 and 12 years of age is to develop the knowledge and ability to be responsible for themselves. By 15 to 16 years of age, most children with Type 1 diabetes should be self-sufficient and no longer reliant on parental involvement in management of diabetes (Saucier & Clark 1993). The next section will review some of the studies that have been done to assess knowledge on diabetes, in children with diabetes.

[9] According to Jean Piaget there are four different stages in the cognitive development of children. The first stage is the sensorimotor stage (from birth to 2 years old) in which children experience the world through movement and senses, the preoperational stage (from 2 to 7 years old) which involves the acquisition of motor skills, the concrete operational stage (from 7 to 11 years old) in which children begin to think logically about concrete events and the formal operational stage (after 11 years old) in which children develop abstract reasoning.

2.7.2 Research on diet-related knowledge in children with Type 1 Diabetes Mellitus

Research in the area of diet-related knowledge in children with Type 1 diabetes has made use of a variety of methods to assess diet-related knowledge. Table 2.4 shows a summary of the methods that have been used to assess diabetes knowledge in children with diabetes. According to Johnson *et al* (1982), a Multiple Choice Questionnaire (MCQ) is the usual method of assessing a youngster's knowledge (Johnson *et al* 1982). This method seems to be the most popular method for assessing diet-related knowledge amongst children with Type 1 diabetes. MCQs are useful tools to assess recall of factual knowledge and basic application of knowledge. MCQs can also be used to test conceptual understanding or comprehension as well as other advanced learning outcomes. MCQs are also useful in identifying weaknesses and shortcomings in basic knowledge (Anon a 2001).

Table 2.4: A summary of the different studies that have assessed diet-related knowledge in children with diabetes

Study	Age of subjects	Country and setting	Objectives of study	Method of assessment	Main findings of study
Etzwiler (1962)	6-17 years	USA Diabetic camp	To assess knowledge on diabetes.	Multiple choice questionnaire	Deficits in knowledge on diabetes.
Etzwiler & Sines (1962)	6-15 years	USA Diabetic camp	To seek further understanding of the diabetic child as well as the disease, family, social and academic environment.	Open ended questionnaire	Deficits in knowledge on diabetes.
Collier & Etzwiler (1971)	6-17 years	USA Diabetic camp	To correlate patient knowledge and that of the parents regarding the basic fundamentals of diabetes.	Multiple choice questionnaire	Poor diet-related knowledge.
Johnson *et al* (1982)	6-18 years	USA Diabetic camp	To assess general information, problem solving and skill with regard to knowledge on diabetes.	Multiple choice questionnaire	Serious deficits in knowledge.
Lorenz *et al* (1985)	9-15 years	USA Diabetic camp	To assess diet-related knowledge, skill and adherence.	- Ability to recall meal plan. - Ability to load plate according to the meal plan. - Ability to choose a meal from a restaurant menu.	Substantial deficits in diet-related knowledge and skill.
McCowen *et al* (1986)	> 11 years	UK Diabetic clinic	To assess knowledge on diabetes.	Multiple choice questionnaire	Deficits in knowledge on diabetes.
Delamater *et al* (1988)	Mean age = 14 years	UK Diabetic clinic	To measure selected dietary skills and dietary adherence in a variety of situations.	- Ability to recall current meal plan - Ability to judge quantity and exchange equivalents	Substantial deficits in dietary skills.

Table 2.4 clearly shows that there was a common finding of substantial deficits in knowledge in all of the studies reviewed. It is also important to note that the some of the studies assessed overall knowledge on diabetes while some studies assessed only diet-related knowledge. It is important to note that knowledge in one area of diabetes does not always predict knowledge in another area (Johnson *et al* 1982). Studies by Etzwiler (1962), Etzwiler & Sines (1962), Collier & Etzwiler (1971) and Johnson *et al* (1982) all showed that there was a correlation between age and the performance in the knowledge assessment where knowledge increased with an increase in age. This suggests that there might be a specific age before which certain levels of understanding and comprehension may be lacking and that there are specific ages at which certain aspects of diabetes management should be taught for optimal comprehension and understanding by children with diabetes (Johnson *et al* 1982; Collier & Etzwiler 1971).

2.7.3 Implications of findings on the assessment of knowledge on Diabetes Mellitus

A summary of findings suggest that overall children with Type 1 diabetes, have poor knowledge of diabetes [Delamater *et al* (1988); McCowen *et al* (1986); Lorenz *et al* (1985); Johnson *et al* (1982); Collier & Etzwiler (1971); Etzwiler & Sines (1962); Etzwiler (1962)]. The finding of poor knowledge levels in children is of concern, as children spend a significant time away from home and their parents and may often need to take responsibility for their condition. It is very difficult to isolate factors that are consistently associated with poor knowledge of diabetes. Some questions have also been raised regarding patient education in the dietary management of diabetes. Lorenz *et al* (1985) suggest that the knowledge required by patients and care-givers may be too complicated while Johnson *et al* (1986) suggest that patients may be given far too much information at once and patients may forget information previously known (Johnson *et al* 1986; Lorenz *et al* 1985).

As research on diet-related knowledge has not been carried out on South African children with Type 1 diabetes, the findings from the assessment of diet-related knowledge in this study will serve as important baseline data for other researchers.

2.8 Conclusion and recommendations

With the increasing incidence of diabetes among children worldwide, the role of diet in the management of diabetes has become more important. Adherence to dietary recommendations and individual dietary prescriptions has been suggested to improve overall metabolic control and reduce the risk for development of complications, later in life. An HbA_{1c} of less than 8% is associated with reduced risk for complications so it is important to assess HbA_{1c} in children with Type 1 diabetes, on a regular basis. Studies on the dietary intake of children with Type 1 diabetes conducted in the USA and Finland have revealed that there is variation in both macronutrient and micronutrient intake as compared to dietary recommendations. Of particular concern is the finding of increased energy, fat and saturated fat intakes among children with Type 1 diabetes as compared to the recommendations, because of the increased risk for the development of obesity and cardiovascular complications. These findings further emphasise the importance of assessing dietary intake in children with Type 1 diabetes on a regular basis to ensure that dietary intake is in keeping with dietary recommendations. Studies relating to the assessment of diabetes knowledge in children have revealed substantial deficits in overall diabetes knowledge and diet-related knowledge. The findings from research on diet-related knowledge suggest that the educational efforts aimed at patients and parents may need to be reviewed and revised and that knowledge on diabetes management must be assessed on a regular basis. Height and weight should also be carefully monitored in children with Type 1 diabetes as overweight diabetics may find it more difficult to achieve good glycaemic control and may have an increased risk for developing long-term complications of diabetes, including hypercholesterolemia and hypertension. It is also important to measure height and weight of children with Type 1 diabetes in the South African context because of the high prevalence of stunting and increasing prevalence of overweight and obesity among South African children.

Given the increasing incidence of diabetes in South African children, the lack of South African studies relating to diet in children with Type 1 diabetes is of concern. There is currently no base-line data on the dietary intake of South African children with Type 1 diabetes. Of equal concern is the lack of a national register for children with Type 1 diabetes, which has also excluded South Africa from international monitoring programmes for children with diabetes. Research in the area of dietary intake and diet-related knowledge in South African children with Type 1 diabetes is greatly needed, even if this

research just acts as a platform on which other bigger and more detailed studies can be built. Findings from this research would also greatly benefit children with Type 1 diabetes, their care-givers and the Health Care Professionals that treat them.

CHAPTER 3: METHODOLOGY

3.1 Research design

The aim of this study was to assess the dietary intake, diet-related knowledge and metabolic control of children with Type 1 diabetes, aged 6-10 years attending the Paediatric Diabetic Clinics at Grey's Hospital, Pietermaritzburg and IALCH, Durban, KwaZulu-Natal. Data was collected through a cross-sectional observational survey from a total of 30 children at both sites.

3.2 Study population

At the time of data collection, there were approximately 43 children (all ages) attending the Grey's Hospital Paediatric Diabetic Clinic and 157 children (all ages) attending the IALCH Paediatric Diabetic Clinic. Out of these 200 children with diabetes, approximately 35 children from both sites were between the ages of 6-10 years with Type 1 diabetes at the time of the study. Due to the relatively small number of children between the ages of 6-10 years, it was decided that no sampling would be done and all children between the ages of 6-10 years that met the inclusion criteria for the study would be invited to participate. Of the 35 children that qualified for inclusion in the study, one child from IALCH declined to participate and one child from Grey's Hospital was unable to participate due to a reduced mental ability from a hypoglycaemic coma. A further 3 children from IALCH did not attend the clinic on their appointed dates and were only booked in again after the data collection period had ended. This resulted in a final number of 30 subjects altogether. The 30 children included in this study still represent a sample of the children with Type 1 diabetes between the ages of 6-10 years attending the Paediatric Diabetic Clinics at Grey's Hospital and IALCH, as not all of the children who qualified for inclusion into the study participated in the study.

3.3 Study methods and materials

3.3.1 3 day dietary record

Dietary intake was assessed using a 3 day dietary record validated by a 24 hour recall. On the day of data collection the instructions for completing the 3 day dietary record were discussed with both the caregiver and the subject by the researcher [see Appendix A (page A 1) for the English version and Appendix B (page A 2) for the Zulu version]. The dietary record was collected on a Friday (Day 1), the following Sunday (Day 2) and Monday (Day

3), following the day of data collection. Subjects from both clinics were asked to record their dietary intake on the same 3 days of the week so that it was standardised amongst all subjects. A set of 5 plastic measuring cups were provided to each caregiver to help record the dietary intake. The cups consisted of the following five volumes: 250ml, 125ml, 80ml, 60ml and 30ml. See Appendix C (page A 4) for a photograph of the measuring cups used in this study. Caregivers and subjects were also encouraged to use other household measures such as teaspoons and dessert spoons from home to measure dietary intake. Caregivers were also given an example of how the 3 day dietary record should be completed [See Appendix D (page A 5) for the English version and Appendix E (page A 8) for the Zulu version together with a blank 3 day dietary record for caregivers to complete [See Appendix F (page A 11) for the English version and Appendix G (page A 14) for the Zulu version. Contact telephone numbers were obtained from all caregivers. These included a cellular phone number and a landline telephone number, where possible. The caregivers were phoned the day before the start of the 3 day dietary record to remind them to start the record the next day. The caregivers were provided with an addressed, stamped envelope in which to return the 3 day dietary record to the researcher once it had been completed. The 3 day dietary records were recorded by the caregivers while the child was at home and the child was asked to recall what they had eaten at school and this was also recorded by the caregiver. The caregiver was called on the Tuesday (day after day 3 of the 3 day dietary record) in order to obtain the 24 hour recall. The caregiver was called in the late afternoon or evening so that the subject was also at home and could help the caregiver to verify the information given.

3.3.2 24 hour recall

A 24 hour recall (via telephone) of day 3 of the 3 day dietary record was compared to day 3 of the documented 3 day dietary record. All of the caregivers were able to provide either a landline telephone number or a cellular telephone number to the researcher in order to obtain the 24 hour recall. The researcher obtained a 24 hour recall by telephone from the caregiver on the Tuesday following the Monday which was the last day of the 3 day record.

3.3.3 Diet-related knowledge multiple choice questionnaire

In this study diet-related knowledge was assessed using a multiple choice questionnaire [see Appendix H (page A 17) for English version and Appendix I (page A 22) for the Zulu

version]. The multiple choice questionnaire consisted of 20 open-ended questions. Out of the 20 questions, 19 questions had only one correct answer while one question (question 10) had 2 possible correct answers. With each question there was choice of 3 possible answers with the 4th option being "I do not know" to minimise guessing. The questionnaire was developed by the researcher and consisted of diet-related knowledge questions that the researcher (a Registered Dietitian with experience in nutritional management of children with Type 1 diabetes) expected the children to be able to answer on their own after having being diagnosed for a period of 3 months or more. The questionnaire was validated by two Registered Dietitians, from Grey's Hospital and IALCH respectively who have had experience in the nutritional management of children with Type 1 diabetes. Validity refers to the ability of a method to measure what it is supposed to measure (Bowers, House & Owens 2006, p 97). The diet-related knowledge questionnaire used in this study can be said to have had face validity as it appears on the surface to be measuring what it is supposed to be measuring with simple, relevant and unambiguous questions. It is important to note that although this questionnaire was internally valid for this particular population it was not externally valid as it may not be valid when applied to another population (Bowers *et al* 2006, p 97, 99). Comments and suggested changes from both Dietitians were incorporated into the questionnaire before it was used in the study. The questionnaire was translated into Zulu by a Zulu speaking student and then back into English by another Zulu speaking student from the Discipline of Dietetics and Human Nutrition to check that the main themes were not lost during translation.

Only the researcher or research assistant (translator) and subject were present in the room when the questionnaire was being completed. Caregivers were not present in the room when the questionnaire was being completed so that they could not influence the responses in any way. Older children (above 9 years old) were able to complete the questionnaire on their own while the younger children (below 9 years old) were assisted by the researcher or research assistant. The researcher read out the questions and gave the 4 possible answers and waited for a response from the subject. In some cases the questions had to be repeated. In the case of Zulu-speaking subjects, the research assistant who also acted as the translator assisted these subjects in the same way.

3.3 4 Weight measurements

The weight measurements of the subjects were measured using the A&D Personal Precision Scale (UC-321), a digital scale which measured the weight to 2 decimal places. The actual method used is discussed in the next section: procedure for weight measurements.

3.3.5 Procedure for weight measurements

The weight of each subject was measured at the time of data collection using a digital scale, the A&D Personal Precision Scale (UC-321). The following method was used:

- Although the scale was new and had not been used before, it was calibrated using a 1 kg weight and measured correctly. According to the manufacturer it did not need to be recalibrated for use in the study.
- The scale was placed on an even surface area in the clinic.
- The scale was turned on and the researcher waited until it read 0.00 kg.
- The subject was asked to remove socks and shoes as well as any additional clothing that could contribute extra weight (i.e. jerseys, jackets, coats, sweaters).
- The subject was asked to stand in the middle of the scale with body weight equally distributed on both feet and with hands at their sides.
- The weight which flashed once on the screen at the end of the measurement process was taken as the final weight.
- The weight was recorded to 2 decimal places in kilograms.
- The weight measurement was carried out 3 times and an average value was calculated.

3.3.6 Height measurements

The height of each subject was measured at the time of data collection using a portable stadiometer with a sliding headpiece and a locking device. This stadiometer was one which was especially made to meet the International Society for the Advancement of Kinanthropometry (ISAK) Guidelines. The height measurements were measured to 2 decimal places. The actual method used is discussed in the next section: procedure for height measurements.

3.3.7 Procedure for height measurements

The height measurements were taken using a portable stadiometer with a sliding headpiece and locking device, especially made to meet the ISAK guidelines. The following method was used:

- The stadiometer was placed on an even, uncarpeted surface.
- The subject was asked to remove their socks and shoes and hair if tied up was untied.
- The subject was asked to stand with heels together, arms to the side, legs straight, shoulders relaxed and head in the Frankfort horizontal plane.[10]
- Shoulder blades, buttocks and heels had to be touching the measuring board.
- Just before the measurement was taken the subject was asked to take a deep breath and hold while maintaining an erect posture.
- The sliding headpiece was then lowered upon the highest point of the head with adequate pressure to compress the hair.
- The sliding headpiece was then locked in place and the reading was taken.
  The height measurements were read to 2 decimal places in metres and 3 readings were taken. An average value was calculated from the 3 readings.

3.3.8 HbA_{1c} values

HbA_{1c} blood tests are carried out every 3 months at both clinics. Previous HbA_{1c} values for all subjects were obtained from their medical files for the 12 months immediately prior to the date of data collection. An average value was calculated from the values over the 12 months immediately prior to the date of data collection. The most recent HbA_{1c} value as at the date of data collection was also recorded for all subjects. All values for HbA_{1c} had been obtained from the IALCH Pathology Laboratory as all blood samples for HbA_{1c} from both clinics were analysed there. The procedure for measuring HbA_{1c} at the IALCH Chemical Pathology Laboratory was obtained from the Laboratory Manager, Carol Mackintosh (Personal Communication 2007). The system used to measure HbA_{1c} at IALCH is called the VARIANT II Haemoglobin Testing System. This system provides an integrated method for the separation and determination of the relative percent of specific haemoglobins in whole blood samples. The VARIANT II Haemoglobin Testing System

[10] The Frankfort horizontal plane is an imaginary line extending from the lower margin of the orbit to the upper margin of the auditory meatus.

uses High Performance Liquid Chromatography (HPLC) which allows for rapid separation of HbA_{1c} from the minor haemoglobin components. The processed data is incorporated into a printed report which contains date and time of analysis, vial number and sample identification, samples chromatogram and a complete summary of the sample's detected components (Mackintosh 2007).

The VARIANT II Haemoglobin Testing System has been certified by the National Glycohaemoglobin Standardisation Programme (NGSP) as being similar to the Diabetes Control and Complications Trial (DCCT) reference method. The role of the NGSP is to standardise glycohaemoglobin test results so that clinical laboratory results are comparable to those reported in the DCCT, which found evidence of a relationship between mean blood glucose and risk for vascular complications. The IALCH, Chemical Pathology Laboratory has quality control limits for this procedure. The limits vary over time, depending on the various batch numbers of the control materials. Corrective actions are carried out whenever any control value falls outside the laboratory's established limits. The action taken would depend on the type and cause of the problem (Mackintosh 2007).

3.3.9 Procedure on day of data collection

Data was collected from the Grey's Hospital clinic from the 27 July 2006 until 07 September 2006 and data was collected from the IALCH clinic from 6 October 2006 until 8 November 2006. The Grey's Hospital clinic was held on the first and last Thursday of the month while the IALCH clinic was held on every Friday during the month of October and on every Wednesday during the month of November. Subjects who qualified for inclusion into the study were identified by the researcher and research assistant and caregivers[11] of the subjects were given an information document [see Appendix J (page A 26) for English version and Appendix K (page A 29) for the Zulu version] with a brief verbal explanation of what the study would involve while waiting in the waiting room for their consultation with the Doctor. Those caregivers who agreed to participate then proceeded to complete and sign the informed consent form [see Appendix L (page A 33) for English version and Appendix M (page A 35) for Zulu version]. Children over the age of 8 years who agreed to participate also completed and signed the assent form [see

[11] The caregiver is the individual who was present with the subject at the clinic on the day of the study and with whom the subject lived. In most cases the caregiver was a parent or a close relative of the subject.

Appendix N (page A 37) for English version and Appendix O (page A 39) for Zulu version].

After obtaining written and verbal consent from the caregivers the subjects were taken into a separate room and the height and weight measurements were taken by the researcher. The subjects were then asked to complete the diet-related knowledge multiple choice questionnaire. At the end the caregiver was called in and the instructions for completing the 3 day dietary record were given. A landline telephone and/or cellular phone number was obtained from each caregiver so that the 24 hour recall could be obtained over the phone. All of the caregivers were able to provide either a landline telephone or cellular phone number to the researcher. The caregivers were also asked how frequently the child carried out the self-monitoring of blood glucose during the day and which method of self-monitoring was used, as these variables were to be compared to metabolic control. In the end the subjects and their caregivers were thanked for their participation and returned to the waiting room. It took approximately 20 minutes to complete data collection for each subject. The researcher then proceeded to collect other details as well as previous HbA_{1c} values from the subject's file. All data collected including information on socioeconomic and education status of caregivers were recorded on the collation sheet [See Appendix P-page A 40].

3.3.10 Training of research assistant

The research assistant also acted as a translator in this study. The research assistant did not physically carry out any of the height or weight measurements but was involved in the recording the height and weight measurements onto the collation sheet. The research assistant was also involved in translating the English instructions of how to complete the 3 day dietary record into Zulu as well as conducting the Zulu version of the diet-related knowledge questionnaire with the Zulu-speaking subjects. The assistant was trained on how to carry out the questionnaire without leading or influencing the responses. The assistant observed the researcher carrying out the questionnaire with the first two English-speaking subjects before the assistant was able to conduct the first questionnaire with a Zulu-speaking subject. This was done to ensure that the assistant had a clear understanding of how the questionnaire should be conducted without leading or influencing the subject's responses. Before the assistant could carry out any Zulu questionnaires on her own the researcher observed the assistant conducting a Zulu questionnaire with a Zulu-speaking

subject. The assistant was asked to translate what was said into English so that the researcher could ensure that the assistant did not lead or influence subject's responses in any way.

3.3.11 Reduction of bias

The following steps were taken to minimise bias during the completion of the diet-related knowledge multiple choice questionnaire:

- The questions were worded simply and in language that the child could understand. This was verified by having the questionnaire validated by two Registered Dietitians working with children with Type 1 diabetes.
- The English questionnaire was administered by the researcher to all English-speaking subjects while the Zulu questionnaire was administered by the same translator to all of the Zulu-speaking subjects.
- Caregivers were not present in the room while the questionnaire was being completed so that they could not influence the responses given.
- The researcher and translator recorded the responses exactly as given by the subject and did not attempt to change any incorrect answers.
- The questionnaire was carried out in a room that contained no charts, posters or pamphlets with dietary information.
- No leading questions were included in the questionnaire.
- The translator was trained on how to administer the questionnaire without introducing any bias.

3.4 Pilot study

A pilot study is usually carried out prior to carrying out the main study and involves carrying out a test run of the procedures that are to be carried out in the main study. The aim of the pilot study is to identify and modify any possible problems that could arise during the data collection process (Nelson & Margetts 1997, p 45).

3.4.1 Background to pilot study

To demonstrate that the diet-related knowledge multiple choice questionnaire could differentiate between those children with Type 1 diabetes and those without, the questionnaire was piloted on a random sample of 15 non-diabetic children between the

ages of 6-11 years attending the Berg Street Primary School in Pietermaritzburg in May 2006 and 9 children over the age of 11 years with Type 1 diabetes attending the Grey's Hospital Paediatric Diabetic Clinic. Berg Street Primary School was chosen for the pilot study because the children attending this school had a similar socioeconomic, racial and age profile as the children in the main study [see Appendix Q (page A 44) for letter of approval from School Principal]. The children with Type 1 diabetes over the age of 11 years were chosen because they could not be part of the main study due to the age restriction. A pilot study of the anthropometry (height and weight measurements) was conducted on the same group of non-diabetic children attending the Berg Street Primary School in Pietermaritzburg in May 2006. The 3 day diet record and 24 hour recall was piloted on the group of 9 children over the age of 11 years with Type 1 diabetes attending the Paediatric Diabetic Clinic at Grey's Hospital during May and June of 2006. This was done with the children with Type 1 diabetes as they are familiar with the concept of recording dietary intake as this is sometimes required as part of their nutritional management at Grey's Hospital.

3.4.2 Results of pilot study

Results from the pilot study of the diet-related knowledge multiple choice questionnaires and the anthropometry are shown in Table 3.1.

Table 3.1 Summary of results from pilot study conducted in non-diabetic children attending Berg Street Primary School and children with Type 1 Diabetes Mellitus attending the Grey's Hospital Paediatric Diabetic Clinic

	Non-diabetic children	**Children with Type 1 Diabetes Mellitus**
Site	Berg Street Primary School	Grey's Hospital Paediatric Diabetic Clinic
Age range	6-11 years	11.10-14.5 years
Mean age (∀ standard deviation)(SD)	8.46 (∀ 2.15)	12.75 (∀ 1.19)
Total number of subjects	n = 13	n = 9
Total number of males	n = 4 (31%)	n = 4 (44%)
Total number of females	n = 9 (69%)	n = 5 (56%)
Diet-related knowledge MCQ score range (%)	0%-67%	76%-100%
Mean diet-related knowledge MCQ score (%) (∀ SD)	19 % (∀ 27)	88 % (∀ 9)
Mean weight in kg (∀ SD)	30.58 (∀ 8.08)	Not measured
Mean height in cm (∀ SD)	112.62 (∀ 35.98)	Not measured
Mean BMI (∀ SD) Number of subjects found to be: underweight* (% of sample) at healthy weight* (% of sample) at risk of overweight* (% of sample) overweight* (% of sample)	18.54 (∀ 4.88) 0 (0%) 10 (77%) 0 (0%) 3 (23%)	Not measured
Z-score for BMI for age (∀ SD)	0.51 (∀ 1.32)	Not measured

* According to BMI for age and Center for Disease Control (CDC) and Prevention, USA (2000).

The 3 day diet record and 24 hour recall were piloted on the group of 9 children over the age of 11 years with Type 1 diabetes attending the Paediatric Diabetic Clinic at Grey's Hospital during May and June of 2006. The subjects recorded the 3 day dietary record on the Friday (Day 1), Sunday (Day 2) and Monday (Day 3) that followed the day of data collection. The 24 hour recall of day 3 of the 3 day dietary record was taken via telephone on the Tuesday following the day of data collection. A total of 3 subjects (out of a total of 9 subjects) were able to be contacted to provide the 24 hour recall. The dietary intake was analysed for energy and percentage contribution of macronutrients to total energy only and

were compared to the ISPAD Consensus Guidelines (2002). The results are shown in Table 3.2.

Table 3.2 Mean intake of energy and macronutrients as a percentage of total energy (TE) from the 3 day dietary record and the 24 hour recall compared to the ISPAD Consensus Guidelines for children with Type 1 Diabetes Mellitus over the age of 11 years, attending the Paediatric Diabetic Clinic at Grey's Hospital

	Number of subjects	**Carbo-hydrate (% of TE)**	**Protein (% of TE)**	**Fat (% of TE)**	**Energy (kJ)**
Mean intake from the 3 day dietary record (∀ SD)	n = 9	50 (∀6)	16 (∀2)	33 (∀6)	8636 (∀3143)
Mean intake from the 24 hour recall (∀ SD)	n = 3	47 (∀7)	19 (∀5)	34 (∀2)	7040 (∀601)
ISPAD Consensus Guidelines (2002)		> 50% of TE	10-15% of TE	30-35% of TE	Sufficient for growth

3.4.3 Discussion of results from pilot study

Table 3.1 shows that the mean diet-related knowledge score was lower in the non-diabetic subjects (19%) and higher in the subjects with Type 1 diabetes (88%). This shows that the diet-related knowledge multiple choice questionnaire was able to distinguish between those subjects with diabetes and those without. This can also be seen with the difference in the range of scores between the two groups. It would be expected to find a higher diet-related knowledge score in the subjects with Type 1 diabetes as these children would have received repeated dietary education since diagnosis while the non-diabetic children might not have heard of the condition, diabetes. The pilot study also showed that children 9 years and older were able to read and complete the diet-related knowledge questionnaire on their own while children under the age of 9 years required assistance with reading and completing the questionnaire.

Table 3.2 shows that the percentage contribution of the macronutrients to total energy was quite similar for both the 3 day dietary record and the 24 hour recall. This suggests that these two methods were appropriate in measuring dietary intake in the pilot study.

Carbohydrate intake as a percentage of TE from the 24 hour recall (47%) was slightly below the ISPAD Consensus Guideline of >50% while the protein intake as a percentage of TE from the 24 hour recall (19%) was slightly over the ISPAD Consensus Guideline of 10-15% of TE. It is also important to note that the 24 hour recall was only obtained from 3 subjects. The finding that the dietary intake was generally similar to the ISPAD Consensus Guidelines (2002) in the pilot study is expected as the subjects had been diagnosed with Type 1 diabetes for a longer period and would be expected to be familiar with the dietary guidelines for diabetes.

3.4.4 Adjustments made to the main study after the pilot study

After carrying out the pilot study on the diet-related knowledge multiple choice questionnaires it was noticed that the question on the importance of fibre in the diet was repeated and the question on sources of fibre in the diet was omitted. This error was corrected in the diet-related knowledge multiple choice questionnaire that was used for the main study.

Due to difficulties with contacting the subjects on cellular phone numbers given to the researcher with the pilot study, it was decided that a landline phone number would be requested before a cellular phone number when conducting the main study on dietary intake. No other changes were made to the dietary intake component of the pilot study.

Follow-up phone calls were made to caregivers after the day of data collection to obtain information on the socioeconomic and education status of the caregivers.

3.5 Data analysis

This study aimed to assess the dietary intake, diet-related knowledge and metabolic control of children with Type 1 diabetes, aged 6-10 years attending the Paediatric Diabetic Clinics at Grey's Hospital, Pietermaritzburg and Inkosi Albert Luthuli Central Hospital, Durban, KwaZulu-Natal. Data analyses of the variables are discussed in this section.

Sub problem one: To assess the dietary intake of children with Type 1 diabetes and to compare to dietary recommendations for children with diabetes.

The 3 day dietary records and 24 hour recalls were analysed using the Medical Research Council (MRC) Food Finder 3 Programme. The additional micronutrients added to white

and brown bread flour and maize meal, as part of the National Food Fortification Programme in South Africa were accounted for. The levels in bread were obtained by obtaining the average levels from a shop survey of five different brands of bread as the subjects did not specify which brand of bread they had eaten. Table 3.3 provides a summary of the different brands of bread and the values of the micronutrients added as well as the average values obtained and used in the analysis. As can be seen from Table 3.3 the micronutrient values from the different brands of bread were very similar. The updated values for the cooked maize meal porridges were obtained from the MRC (2007) and this is shown in Table 3.4 An average of the values for both the special and super varieties were included for each type of cooked porridge eaten, as it was not known whether the subjects had consumed the special or the super varieties.

Table 3.3 Summary of the micronutrients included in the different brands of bread, per 100g as part of the South African National Food Fortification Programme and the average values used in the study

Micronutrients	Albany Bread	B Bakeries	Sasko Sam	Blue Ribbon	Woolworths	**Average**
Vitamin A [µg Retinol Equivalents (RE)]	70.0	80.0	80.0	80.0	70.0	**76 µg RE**
Vitamin B_1 (Thiamin) (mg)	0.25	0.25	0.25	0.25	0.25	**0.25 mg**
Vitamin B_2 (Riboflavin) (mg)	0.14	0.14	0.14	0.14	0.14	**0.14 mg**
Vitamin B_3 (Niacin) (mg)	4.16	2.79	2.79	2.79	4.16	**3.34 mg**
Vitamin B_6 (Pyridoxine) (mg)	0.27	0.21	0.21	0.21	0.27	**0.23 mg**
Folic acid (µg)	74.0	73.0	73.0	73.0	74.0	**73.4 µg**
Iron (mg)	3.47	3.23	3.23	3.23	3.47	**3.33 mg**
Zinc (mg)	2.01	1.53	1.53	1.53	2.01	**1.72 mg**

Table 3.4: Summary of the micronutrients included in the different cooked maize meal porridges, per 100g as part of the South African National Food Fortification Programme and the average values of each type of cooked porridge used in the study, as obtained from the Medical Research Council 2007

Micronutrients	Soft porridge SUPER	Soft porridge SPECIAL	**AVERAGE Soft porridge**	Stiff porridge SUPER	Stiff porridge SPECIAL	**AVERAGE Stiff porridge**	Crumbly porridge SUPER	Crumbly porridge SPECIAL	**AVERAGE Crumbly porridge**
Vitamin A (µg RE)	11.0	22.0	**16.5**	34.0	40.0	**37.0**	79.0	86.0	**82.5**
Vitamin B_1(Thiamin) (mg)	0.06	0.1	**0.08**	0.13	0.23	**0.18**	0.23	0.43	**0.33**
Vitamin B_2 (Riboflavin)(mg)	0.02	0.02	**0.02**	0.05	0.08	**0.07**	0.08	0.11	**0.095**
Vitamin B_3 (Niacin) (mg)	0.6	0.5	**0.55**	1.2	0.6	**0.9**	2.5	1.1	**1.8**
Vitamin B_6 (Pyridoxine)(mg)	0.058	0.066	**0.062**	0.12	0.195	**0.16**	0.23	0.305	**0.27**
Folic acid (µg)	34.0	26.0	**30.0**	46.0	52.0	**49.0**	65.0	79.0	**72.0**
Iron (mg)	0.6	0.6	**0.6**	1.3	1.4	**1.35**	2.2	2.4	**2.3**
Zinc (mg)	0.27	0.32	**0.30**	0.63	0.91	**0.77**	1.08	1.65	**1.37**
Magnesium (mg)	4.0	10.0	**7.0**	9.0	24.0	**16.5**	17.0	43.0	**30.0**
Calcium (mg)	2.0	5.0	**3.5**	2.0	4.0	**3.0**	3.0	4.0	**3.5**
Phosphorus (mg)	20.0	40.0	**30.0**	60.0	40.0	**50.0**	95.0	100.0	**97.5**

In order to compare how well the 3 day dietary record compared with the 24 hour recall, energy intake from the 3 day dietary record and the 24 hour was compared to total energy requirements using the WHO/FAO Daily Energy Requirement (DER) (2001). There are no specific dietary recommendations for children with diabetes. According to a Statement of the ADA on the Care of Children and Adolescents with Type 1 Diabetes (2005) and the Nutrition Subcommittee of the Diabetes Care Advisory Committee of Diabetes UK (2003) the dietary recommendations for children with diabetes should be the same as for healthy children of the same age. Due to the lack of specific recommendations for micronutrients in children with diabetes the levels of intake of micronutrients obtained from the subject's dietary intake were compared to the Dietary Reference Intakes (DRIs) of the Institute of Medicine, Food and Nutrition Board, United States of America (USA) and the World Health Organisation (WHO) and Food and Agriculture Organisation (FAO) of the United Nations (UN) Recommended Nutrient Intakes (RNIs) (1998). The DRIs used in this study were obtained from the following 6 references for DRIs from the Institute of Medicine, Food and Nutrition Board, USA: Dietary Reference Intakes for energy, carbohydrate, fibre, fat, fatty acids, cholesterol, and protein and amino acids (2002); Dietary Reference Intakes for vitamin A, vitamin K, arsenic, boron, chromium, copper, iodine, iron, manganese, molybdenum, nickel, silicon, vanadium and zinc (2001); Dietary Reference Intakes: Applications in dietary assessment (2000); Dietary Reference Intakes for vitamin C, vitamin E, selenium and carotenoids (2000); Dietary Reference Intakes for thiamin, riboflavin, niacin, vitamin B_6, folate, vitamin B_{12}, pantothenic acid, biotin and choline (1998); Dietary Reference Intakes for calcium, phosphorus, magnesium, vitamin D and Fluoride (1997).

According to the Institute of Medicine, Food and Nutrition Board, USA the Estimated Average Requirement (EAR) should be used to estimate nutrient intake within a group while the Recommended Dietary Allowance (RDA) should be used to assess nutrient intake at an individual level. The mean nutrient intakes in this study were compared specifically to the Estimated Average Requirement (EAR) of the Institute of Medicine, Food and Nutrition Board, USA. In cases where an EAR had not been determined the Adequate Intake (AI) was used. For the purpose of this dissertation the DRIs to which the nutrient intakes have been compared will be indicated as USA-EAR/AI, to indicate that either the EAR or AI was used. The nutrient intakes were also compared to the Institute of Medicine, Food and Nutrition Board, USA - Tolerable Upper Intake Level (UL). The nutrient intakes from the 3 day dietary record and the 24 hour recall were also compared to

the USA-RDA to determine how the nutrient intake values compared, however this has not been reported or discussed in this dissertation. The comparison of the mean nutrient intakes from the average of the 3 days in the 3 day dietary record to the USA-RDA is shown in Appendix R (page A 45) and the mean nutrient intakes from the 24 hour recall to the USA-RDA is shown in Appendix S (page A 46).

Sub problem two: To assess diet-related knowledge of children with Type 1 diabetes.

The diet-related multiple choice questions were scored out of a total of 21. Each correct answer was allocated a score of one mark and for each incorrect response a zero was allocated. The scores out of a total of 21 were converted to a percentage to facilitate statistical analysis.

Sub problem three: To assess metabolic control, using glycosylated haemoglobin (HbA_{1c}), in children with Type 1 diabetes.

The HbA_{1c} values obtained from the medical files for the 12 months immediately prior to data collection were used to calculate a single average value for each subject. Data reported for each subject included a most recent HbA_{1c} value and an average HbA_{1c} value for the 12 months immediately prior to data collection.

Sub problem four: To determine if there is a relationship between Body Mass Index (BMI) for age and metabolic control in children with Type 1 diabetes.

Body Mass Index (BMI) for age was calculated using height and weight measurements that were taken on the day of data collection. Age-dependent anthropometric measures such as weight and height must be standardised for age before these measures can be used. Standardisation can be done using Z-scores, centiles or percentage of the median. Currently, the most common method in use involves the conversion to Z-scores, relative to a reference population (Ulijaszek 1997, p 298). The Z-score or standard deviation (SD) score refers to the difference between the value for an individual and the median value of the reference population, divided by the standard deviation for the reference population (WHO Technical Report Series-Physical Status: The Use and Interpretation of Anthropometry 1995). BMI for age Z-scores were calculated using the Epi Info Programme (2005) which is based on data from the Center for Disease Control and Prevention, USA (2000).

Sub problem five: ***To determine if there are any other relationships between the variables investigated and metabolic control.***

The variables that were used in the comparisons included age (converted to years and months), gender, frequency of self-monitoring of blood glucose, duration of diagnosis, diet-related knowledge score, hospital clinic attended, race group of subjects, monthly income per household, education level of the caregivers and completion/non completion of dietary records by subjects.

3.6 Statistical analysis

SPSS (Statistical Package for Social Sciences) version 13 (SPSS Inc., Chicago, III, USA) was used to capture and analyse data.

Sub problem one: ***To assess the dietary intake of children with Type 1 diabetes and to compare to dietary recommendations for children with diabetes.***

One sample t-tests were used to compare the mean values for each nutrient intake variable in the separate age groups to the recommended amount for that particular age group. A Bland-Altman analysis was done to compare the mean nutrient intakes from the day 3 of the 3 day dietary record to the mean nutrient intakes from the 24 hour recall. The intake on day 3 of the 3 day dietary record was also compared with the 24 hour recall using paired t-tests.

Sub problem two: ***To assess diet-related knowledge of children with Type 1 diabetes.***

Diet-related knowledge scores were compared between two groups using the two-sample t-tests and between more than 2 groups with Analysis of Variance (ANOVA) tests. Pearson correlation analysis was used to examine relationships between scores and quantitative variables. Quantitative variables are also known as metric variables and can change in value from person to person and/or over time. Quantitative or metric variables can be continuous which usually results from measuring things or discrete which are usually whole numbers that arise from counting things (Bowers *et al* 2006, pp 63-64).

Sub problem three: ***To assess metabolic control, using glycosylated haemoglobin (HbA_{1c}), in children with Type 1 diabetes.***

Paired t-tests were used to compare the two HbA_{1c} variables together (latest and mean over 12 months). Both were compared to the upper value of the normal range as used by the

IALCH Pathology Laboratory (4.8%-6.0%) as well as the ISPAD reference value (not > 7.6%) and the ADA reference value (not > 8%), using a one-sample t-test.

Sub problem four: ***To determine if there is a relationship between Body Mass Index (BMI) for age and metabolic control in children with Type 1 diabetes.***

Pearson's correlation analysis was used to examine the relationship between BMI for age-Z-scores and HbA_{1c} values (latest and mean over previous 12 months).

Sub problem five: ***To determine if there are any relationships between the other variables investigated and metabolic control.***

Pearson's correlation analysis, t-tests and ANOVA were used to determine if any associations existed between other variables and HbA_{1c} (latest and mean over previous 12 months).

3.7 Ethical considerations

Ethical approval for the study was obtained from the Biomedical Research Ethics Committee of the Nelson R Mandela School of Medicine, University of KwaZulu-Natal on the 31 March 2006 [Appendix T - page A 47]. Ethical approval was also obtained from the Hospital Manager at Grey's Hospital [Appendix U - page A 48] as well as the Hospital Manager of IALCH [Appendix V - page A 49], before data collection could commence at the respective Hospitals. Verbal approval following discussions with Medical, Nursing and Dietetic staff at both clinics was also obtained before data collection could begin. Before data collection could be carried out on any of the subjects, the caregiver was given an information document [see Appendix J (page A 26) for English version and Appendix K (page A 29) for Zulu version] and a verbal explanation of the study in either English or Zulu and was invited to allow their child/ward to participate in the study. Data collection only commenced once the informed consent [see Appendix L (page A 33) for English version and Appendix M (page A 35) for Zulu version] was signed by the caregiver and the witness. In the case of subjects over the age of 8 years an assent form was signed by the subject [see Appendix N (page A 37) for English version and Appendix O (page A 39) for Zulu version]. All of the caregivers who were invited to participate in the study were literate and were able to read and understand the documents in either English or Zulu.

3.8 Summary

The aim of this study was to assess the dietary intake, diet-related knowledge and metabolic control of children with Type 1 diabetes, aged 6-10 years attending the Paediatric Diabetic Clinics at Grey's Hospital, Pietermaritzburg and Inkosi Albert Luthuli Central Hospital, Durban, KwaZulu-Natal. No sampling was carried out due to the small study population size and all subjects who qualified for entry into the study were invited to participate in the study. Data was collected through a cross-sectional observational survey from a total of 30 children with Type 1 diabetes between the ages of 6-10 years from both clinics.

Dietary intake data was obtained by means of a 3 day dietary record completed by the caregiver and was validated by a 24 hour recall, obtained telephonically from the caregiver. The older subjects (9-10 years) completed the diet-related multiple choice questionnaires on their own while younger subjects were assisted by the Researcher and the Research Assistant (translator) in the case of Zulu-speaking subjects. All anthropometric measurements (i.e. height and weight measurements) were taken by the Researcher. The most recent HbA_{1c} values and mean HbA_{1c} values for the previous 12 months from the day of data collection were obtained from the patients medical records.

CHAPTER 4: RESULTS

Chapter 4 presents the results of the study according to the sub problems outlined in Chapter 1.

4.1 Sample characteristics

Sample characteristics according to hospital clinic attended are shown in Table 4.1 below.

Table 4.1 Sample characteristics according to hospital clinic attended by subjects (n=30)

	GREY'S HOSPITAL	IALCH	TOTAL
Number of subjects (%)*	8 (27)	22 (73)	30 (100)
Number of Females (%)*	3 (10)	10 (33)	13 (43)
Number of Males (%)*	5 (17)	12 (40)	17 (57)
Mean age in years and months [∀standard deviation (SD)]	9.26 (∀1.47)	8.31 (∀1.38)	8.56 (∀1.45)
Age range in years and months	6.83-10.92	6.25-10.83	6.25-10.92
Number of Africans (%)*	6 (20)	4 (13)	10 (33)
Number of Coloureds (%)*	1 (3)	2 (7)	3 (10)
Number of Indians (%)*	1 (3)	13 (43)	14 (47)
Number of Whites (%)*	0 (0)	3 (10)	3 (10)
Mean duration of diagnosis in years and months (∀SD)	4.97(∀3.27)	3.11 (∀1.57)	3.61 (∀2.25)

* % of total sample (n=30)

Socio-economic status was assessed by looking at the monthly household income and education status of the caregivers was assessed by looking at the highest standard/grade passed. This is shown in Table 4.2. The subjects were all found to be in the correct grade for their age so their education status is not presented here. Only 22 of the caregivers could be contacted to obtain the information on socio-economic status and education status.

Table 4.2 Sample characteristics in terms of socio-economic status and education status of caregivers (n=22)

	GREY'S HOSPITAL	IALCH	TOTAL
SOCIO-ECONOMIC STATUS: MONTHLY HOUSEHOLD INCOME			
No monthly income (%)[H]	0	0	0
Monthly income between R1-R500 (%)[H]	0	1 (5)	1 (5)
Monthly income between R501-R1000 (%)[H]	1 (5)	1 (5)	2 (9)
Monthly income between R1001-R3000 (%)[H]	3 (14)	4 (18)	7 (32)
Monthly income between R3001-R5000 (%)[H]	1 (5)	4 (18)	5 (23)
Monthly income greater than R5000 (%)[H]	0	7 (32)	7 (32)
EDUCATION STATUS (HIGHEST FORMAL EDUCATION LEVEL): HIGHEST STANDARD/GRADE PASSED BY THE CAREGIVERS			
None (%)[H]	0	0	0
Primary School (%)[H]	0	0	0
Standard 6-8 (Grade 8-10) (%)[H]	4 (18)	3 (14)	7 (32)
Standard 9-10 (Grade 11-12) (%)[H]	2 (9)	9 (41)	11 (50)
Tertiary education (%)[H]	0	4 (18)	4 (18)

[H] % of sample (n=22)

Anthropometric results for the sample are presented in Table 4.3 below according to hospital clinic attended.

Table 4.3 Anthropometric results for the sample according to hospital clinic attended (n=30)

	GREY'S HOSPITAL	IALCH	TOTAL
Number of subjects with healthy weight[Π] (%)*	6 (20)	12 (40)	18 (60)
Number of subjects underweight[H] (%)*	0	1 (3)	1 (3)
Number of subjects wasted (%)*	0	0	0
Number of subjects at risk of overweight[#] (%)*	1 (3)	8 (27)	9 (30)
Number of subjects overweight[‡] (%)*	1 (3)	1 (3)	2 (7)
Number of subjects stunted[$] (%)*	0	4 (13)	4 (13)

* % of total sample (n=30)

Π Healthy weight defined as BMI for age between 5th to less than the 85th percentile (CDC-2000).

H Underweight defined as BMI for age less than the 5th percentile (CDC-2000).

At risk of overweight defined as a BMI for age between 85th to less than the 95th percentile (CDC-2000).

‡ Overweight defined as BMI for age equal to or greater than the 95th percentile (CDC-2000).

$ Stunted defined as having a height or length-for-age more than 2 standard deviations below the median of the NCHS/WHO growth references (WHO Technical Report Series-Physical Status: The Use and Interpretation of Anthropometry 1995).

4.2 Comparison of the dietary assessment methods used in this study

4.2.1 Comparison of the mean nutrient intakes from day 3 of the 3 day dietary record and the mean nutrient intakes from the 24 hour recall

The mean nutrient intake values from day 3 of the 3 day dietary record was compared to the mean nutrient intake values from the 24 hour recall. This was done to determine how well the 24 hour recall compared to the day 3 of the 3 day dietary record as day 3 of the record applies to the same day as the 24 hour recall. Table 4.4 below shows the results of paired t-tests for those nutrients in which there were significant differences between the values for day 3 of the 3 day dietary record and the 24 hour recall. Significant differences

between the day 3 and the 24 hour recall were found for total fat (mean difference = -14.3g), saturated fat (mean difference = - 4.9g), monounsaturated fat (mean difference = -5.7g) and sucrose (mean difference = -3.6g). There were no significant differences between day 3 of the 3 day dietary record and the 24 hour recall for each of the other nutrients analysed. A complete analysis of all nutrients is shown in Appendix W (page A 50).

Table 4.4 Comparison of the mean nutrient intakes from day 3 of the 3 day dietary record and the mean nutrient intakes from the 24 hour recall

Pair	Number in sample	Nutrients	Mean Difference (g)	SD	P value[T]
Total fat	n = 11	Day 3 total fat - 24 hour recall total fat	-14.3	18.9	0.030
Saturated fat	n = 11	Day 3 saturated fat - 24 hour recall saturated fat	- 4.9	4.7	0.006
Monounsaturated fat	n = 11	Day 3 monounsaturated fat - 24 hour recall monounsaturated fat	- 5.7	5.2	0.005
Sucrose	n = 11	Day 3 sucrose - 24 hour recall sucrose	- 3.6	5.2	0.044

[T] Paired t-test

The Bland-Altman analysis[12] was done to compare the mean nutrient intakes from day 3 of the 3 day dietary record to the mean nutrient intakes from the 24 hour recall. The Bland-Altman analysis as shown in Table 4.5 revealed that there was relatively good agreement between day 3 of the 3 day record and the 24 hour recall for iron, vitamin C, thiamin, niacin and riboflavin as the bias (difference between the means of the nutrient intakes from the two methods) was relatively close to zero. There was poor agreement between day 3 of the 3 day record and the 24 hour recall for other nutrients as the bias was far off from zero.

[12] The Bland-Altman analysis is a statistical method that assesses the agreement between two methods of measurement. There is good agreement between the two methods when the difference between means is close to zero.

Table 4.5 Bland-Altman analysis to compare the mean nutrient intakes from day 3 of the 3 day dietary record and the mean nutrient intakes from the 24 hour recall (n=11)

Variable	Limits of agreement		Bias[c]	Spearman r[d]	p value[e]	SD/sm[f]
	Lower[a]	Upper[b]				
Energy (kJ)	-4058	2191	-934	-0.829	0.042	1
Protein (g)	-31	16	-8	-0.236	0.484	2
Fat (total) (g)	-51	23	-14	-0.164	0.631	1
Saturated fat (g)	-14	4	-5	-0.145	0.670	2
Monounsaturated fat (g)	-16	5	-6	-0.409	0.212	1
Sucrose (g)	-14	7	-4	-0.260	0.441	2
Carbohydrate (g)	-140	108	-16	-0.364	0.272	1
Calcium (mg)	-549	439	-55	-0.191	0.574	2
Iron (mg)	-6	6	-0	-0.200	0.555	2
Vitamin A (µg)	-658	475	-91	-0.036	0.915	2
Vitamin C (mg)	-27	28	1	0.458	0.157	1
Thiamin (mg)	-0.5	0.5	0	0.100	0.770	2
Niacin (mg)	-11	11	0	0.173	0.612	3
Riboflavin (mg)	-0.6	0.6	-0	-0.278	0.408	2

a Lower limit = mean of day 3 of 3 day record and 24 hour recall (- 2 standard deviations)

b Upper limit = mean of day 3 of 3 day record and 24 hour recall (+ 2 standard deviations)

c Bias = Difference between means

d Spearman correlation between the mean of the day 3 of the 3 day record and 24 hour recall

e Significance of the Spearman correlation

f Standard deviation of the differences/standard deviation of the mean

4.2.2 Comparison of the mean nutrient intakes from the 3 day dietary record (average of 3 days) and the mean nutrient intakes from the 24 hour recall

The mean nutrient intakes from the 3 day dietary record was compared with the mean nutrient intakes from the 24 hour recall. Table 4.6 shows only the results of the nutrients for which there was a significant difference between the 3 day dietary record and the 24 hour recall. The only nutrient which showed a significant difference was Vitamin A (mean difference = - 287.6 µg). All other nutrients showed no significant differences between the 3 day dietary record and the 24 hour recall. A complete analysis of all nutrients is shown in Appendix X (page A 52).

Table 4.6 Comparison of the mean nutrient intakes from the 3 day dietary record and the mean nutrient intakes from the 24 hour recall (n=11)

Pair	Number in sample	Nutrients	Mean difference (µg)	SD	P value[T]
Vitamin A	n = 11	Vitamin A from average of 3 days - Vitamin A from 24 hour recall	-287.6	399.9	0.038

[T] Paired t-test

4.2.3 Comparison of energy intake (from the 3 day dietary record and the 24 hour recall) compared to total energy expenditure

Another way to look at how well the 3 day dietary record compared with the 24 hour recall is to look at energy intake from the 3 day dietary record and the 24 hour recall compared to total energy requirements. Ideally, in the presence of energy balance energy intake should be equal to total energy expenditure, in adults. With children, equations to calculate energy requirements include the energy that is required for growth. In children, 6-10 years of age, energy intake should also be the same as total energy requirements in the presence of energy balance. In this study the energy intake from the 3 day dietary records and the 24 hour recalls were compared with total energy requirements using the WHO/FAO Daily Energy Requirement (2001) equations for children obtained from the FAO Food and Nutrition Technical Report Series 1: Human Energy Requirements: Report of a joint FAO/WHO/UNU Expert Consultation, in keeping with the principle that under conditions of energy balance the energy intake should be equal to total energy requirements. The next section will compare the energy intake from the 3 day records and the 24 hour recalls with the total energy requirements from the WHO/FAO Daily Energy Requirements (2001).

- **Energy intake from the 3 day dietary records compared to the WHO/FAO Daily Energy Requirements (2001)**

A paired t-test was carried out to determine the difference between the mean energy intake from the 3 day dietary record and the WHO/FAO Daily Energy Requirements (2001). Results are shown in Table 4.7.

Table 4.7 Comparison of the energy intake from the 3 day dietary record and the WHO/FAO Daily Energy Requirements (2001) (n=20)

Variables	Number in sample	Mean difference (kJ)	Standard deviation	P value[T]
Energy from 3 day dietary record – WHO/FAO Daily Energy Requirements (2001)	n = 20	-850.2	1847.8	0.054

[T] Paired t-test

Assessing the mean difference in energy from the two methods is used as an indication of the relative bias. From Table 4.7 it can be seen that there was a mean difference of - 850 kJ/day with the energy intake from the 3 day dietary records tending to be lower than the WHO/FAO Daily Energy Requirements. A p-value of 0.054 from the paired t-test suggests that these two values were not significantly different but almost reached significance at the 5% level.

- **Energy intake from the 24 hour recall compared to the WHO/FAO Daily Energy Requirements (2001)**

A paired t-test was carried out to determine the difference between the mean energy intake from the 24 hour recall and the WHO/FAO Daily Energy Requirements (2001). Results are shown in Table 4.8 below.

Table 4.8 Comparison of the energy intake from the 24 hour recall and the WHO/FAO Daily Energy Requirements (2001) (n=16)

Variables	Number in sample	Mean difference (kJ)	Standard deviation	P value[T]
Energy from 24 hour recall – WHO/FAO Daily Energy Requirements (2001)	n = 16	-114.2	1998.7	0.822

[T] Paired t-test

From Table 4.8 it can be seen that there was a mean difference of -114.2 kJ/day, between the energy intake from the 24 hour recall and the WHO/FAO Daily Energy Requirements (2001), with the energy intake from the 24 hour recall being slightly lower than the WHO/FAO Daily Energy Requirements (2001). A p-value of 0.822 from the paired t-test

suggests that there was no significant difference between the energy intake from the 24 hour recall and the WHO/FAO Daily Energy Requirements (2001). This suggests that was relatively good agreement between the energy intake from the 3 day dietary record and the WHO/FAO Daily Energy Requirements (2001) and between the energy intake from the 24 hour recall and the WHO/FAO Daily Energy Requirements (2001). This also suggests that there was relatively good agreement between the 2 methods used to assess dietary intake in this study.

4.3 A summary of the food items eaten by the subjects as determined from the 3 day dietary record and the 24 hour recall

The 3 day dietary records and the 24 hour recalls were analysed to determine the type of food items eaten, the number of children eating them and the average amount of the food item eaten per day (in grams), by those consuming the food item. This is shown for the 3 day dietary records in Table 4.9 and for the 24 hour recall in Table 4.10 in descending order.

Table 4.9 A summary of the most commonly consumed food items as determined from the 3 day dietary record (n=20)

Food item	Number of children eating the food item	Average amount eaten/day by those consuming the food items (g)
Brown bread	18	103
Fruit	18	124
Vegetables	16	81
Brick margarine	15	11
Chicken	15	96
White rice	15	88
Breakfast cereals	12	40
Cheese	12	11
Crisps	12	17
Diet cold drink	12	256
Full cream milk	12	107
Low fat milk	12	204
Maize	12	189
Pork	12	18
Sugar	12	7
Tea	12	208
Beef	9	86
Peanut butter	7	21
Sunflower oil	7	5
Egg	6	25
Mutton	6	80
Potato	6	53
Low fat yoghurt	5	68
Provita crackers	5	8

Table 4.10 A summary of the most commonly consumed food items as determined from the 24 hour recall (n=16)

Food item	Number of children eating the food item	Average amount eaten/day by those consuming the food item (g)
Brown bread	11	110
Vegetables	11	92
Breakfast cereals	10	61
Fruit	10	134
White rice	10	144
Low fat milk	9	168
Sugar	9	7
Brick margarine	8	18
Diet cold drink	8	289
Cheese	7	76
Tea	6	271
Beef	5	112
Chicken	5	200
Peanut butter	5	28
Whole milk	5	129
Crisps	4	30
Dried beans	4	175
Mutton	4	125
Potato	4	42
Maize	3	542
Pork	3	43
Sunflower oil	3	25
Low fat yoghurt	2	145
Polyunsaturated margarine	2	23
White bread	2	68

4.4 Comparison of the dietary intake of children with Type 1 Diabetes Mellitus to the dietary recommendations for children with Diabetes Mellitus

4.4.1 Introduction

According to a Statement of the ADA on the Care of Children and Adolescents with Type 1 Diabetes (Silverstein *et al* 2005) and the Nutrition Subcommittee of the Diabetes Care Advisory Committee of Diabetes UK (2003), there are no specific requirements for children with diabetes because of a lack of research in the area. The nutrient recommendations are therefore based on requirements for all healthy children. According to the International Society for Pediatric and Adolescent Diabetes (ISPAD) Consensus Guidelines (2002) the nutritional recommendations are based on adult recommendations and children over the age of 5 years of age should be encouraged to adopt adult nutritional guidelines. The values obtained from the dietary intake analysis were compared to the Estimated Average Requirement (EAR) or Adequate Intake (AI) of the Institute of Medicine, Food and Nutrition Board, USA and the World Health Organisation (WHO) and Food and Agriculture Organisation (FAO) of the United Nations (UN) Recommended Nutrient Intakes (RNIs) (1998). The DRIs used in this study were obtained from the following 6 references for DRIs from the Institute of Medicine, Food and Nutrition Board, USA: [Dietary Reference Intakes for energy, carbohydrate, fibre, fat, fatty acids, cholesterol, and protein and amino acids (2002); Dietary Reference Intakes for vitamin A, vitamin K, arsenic, boron, chromium, copper, iodine, iron, manganese, molybdenum, nickel, silicon, vanadium and zinc (2001); Dietary Reference Intakes: Applications in dietary assessment (2000); Dietary Reference Intakes for vitamin C, vitamin E, selenium and carotenoids (2000); Dietary Reference Intakes for thiamin, riboflavin, niacin, vitamin B_6, folate, vitamin B_{12}, pantothenic acid, biotin and choline (1998); Dietary Reference Intakes for calcium, phosphorus, magnesium, vitamin D and Fluoride (1997)].

In this section the percentage contribution of the macronutrients to total energy will be compared to the ISPAD Consensus Guideline (2002). The mean nutrient intakes from both the 3 day dietary record and the 24 hour recall will be compared to both the USA-EAR/AI and the WHO/FAO RNIs. The percentage of the USA-EAR/AI met and the percentage of the WHO/FAO RNIs met for nutrients from both the 24 hour recall and the 3 day dietary record will also be presented. A total of 20 completed 3 day dietary records and 16 completed 24 hour recalls were obtained by the researcher and used in the dietary analysis.

The mean nutrient intakes are presented in this section as the mean and median nutrient intake values were similar.

4.4.2 Mean percentage contribution of macronutrients to total energy as compared to ISPAD Consensus Guidelines (2002)

The mean percentage contribution of carbohydrate, sucrose, protein and fat to total energy from the 3 day dietary records and the 24 hour recall were compared to the ISPAD Consensus Guideline (2002) as shown in Table 4.11 and Figure 4.1.

Table 4.11 Mean intakes of macronutrients as a percentage of total energy for the sample from the completed 3 day dietary records (average of 3 days) and 24 hour recalls as compared to ISPAD Consensus Guidelines (2002)

Macronutrient	Number in sample	Mean intake as a percentage of total energy (∀SD)	ISPADConsensus Guideline (2002) (as a percentage of total energy)	P value$^{\Omega}$
3 day dietary records (average of 3 days)				
Carbohydrate	n = 20	52% (∀7)	> 50%	0.185
Sucrose	n = 20	2 % (∀2)	Not >10%	0.000
Protein	n = 20	16 % (∀3)	Not >15%	0.139
Fat	n = 20	32 % (∀7)	Not >35%	0.039
Macronutrient	**Number in sample**	**Mean intake as a percentage of total energy (∀ SD)**	**ISPAD Consensus Guideline (2002) (as a percentage of total energy)**	**P value$^{\Omega}$**
24 hour recalls				
Carbohydrate	n = 16	49 % (∀10)	> 50%	0.769
Sucrose	n = 16	2 % (∀2)	Not >10%	0.000
Protein	n = 16	17 % (∀4)	Not >15%	0.082
Fat	n = 16	34 % (∀8)	Not >35%	0.660

$^{\Omega}$ One sample t-test

The mean percentage contribution of sucrose to total energy from both the 3 day dietary record and 24 hour recall was significantly lower than the ISPAD Consensus Guideline (2002) (2% vs. not > 10%). The mean percentage contribution of fat to total energy from

the 3 day dietary record was significantly lower than the ISPAD Consensus Guideline (2002) (32% vs. 35%). The mean percentage contribution of protein to total energy from the 3 day dietary record (16%) and the 24 hour recall (17%) were both higher than the ISPAD Consensus Guideline (2002) (not > 15%), but this was not statistically significantly higher. The mean percentage contribution of carbohydrate, sucrose, protein and fat to total energy from the 3 day dietary records and the 24 hour recall compared to the ISPAD Consensus Guideline (2002) is also shown in Figure 4.1.

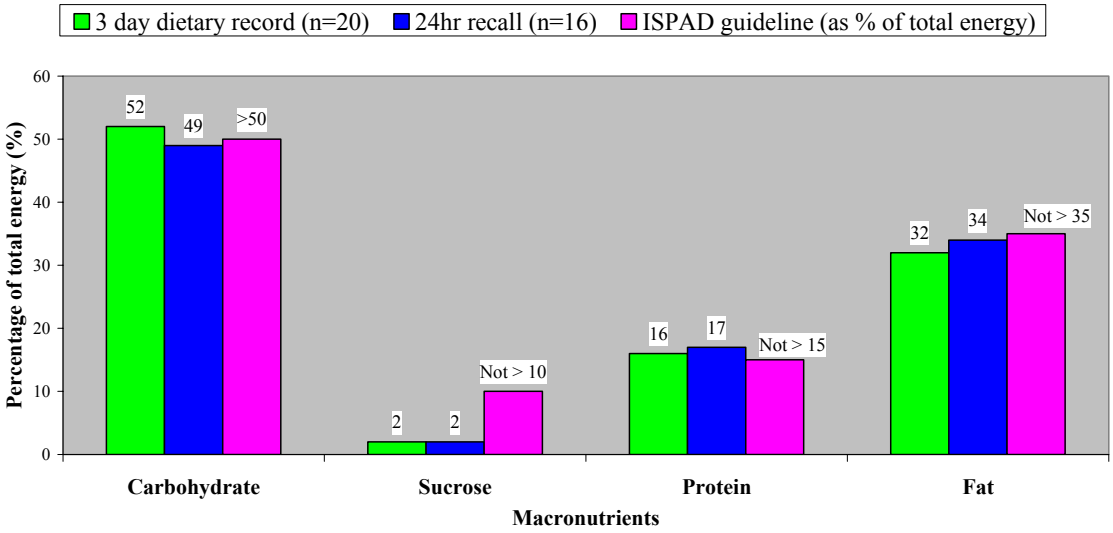

Figure 4.1: Mean intakes of macronutrients as a percentage of total energy for the sample from the 3 day dietary records and 24 hour recalls as compared to the ISPAD Consensus Guidelines (2002)

4.4.3 Mean nutrient intakes obtained from the 3 day dietary record (average of 3 days) compared to the USA-EAR/AI

Table 4.12 shows the mean nutrient intakes from the 3 day dietary records compared to the USA-EAR/AI. To facilitate the comparison with the USA-EAR/AI the subjects were divided according to age groups, i.e. ≥ 6 and < 8 years of age and ≥ 8 and ≤ 10 years of age. Only those nutrients for which the USA-EAR/AI was available are included in Table 4.12.

For the ≥ 6 and < 8 years of age group the mean intake of the following nutrients were found to be significantly lower than the USA-EAR/AI: dietary fibre (19g vs. 25g), calcium (540mg vs. 800mg) and vitamin D (3µg vs. 5µg). For the ≥ 8 and ≤ 10 years of age group

the mean intake of the following nutrients were found to be significantly lower than the USA-EAR/AI: energy (8030kJ vs. 9572kJ) and calcium (758mg vs. 1300mg). Calcium was the only nutrient that was consumed at levels significantly lower then the USA-EAR/AI in both the ≥ 6 and < 8 years of age group and the ≥ 8 and ≤ 10 years of age group.

In the ≥ 6 and < 8 years of age group the mean intakes of the following nutrients were found to be significantly higher than the USA-EAR/AI: total protein (57g vs. 15g), carbohydrate (202g vs. 100g), magnesium (218mg vs. 110mg), phosphorus (935mg vs. 405mg), iron (11.2mg vs. 4.1mg), zinc (7.6mg vs. 4.0mg), thiamin (1.1mg vs. 0.5mg), riboflavin (1.4mg vs. 0.5mg), niacin (17mg vs. 6mg), vitamin B_6 (1.6mg vs. 0.5mg), folate (255g vs. 160g), vitamin B_{12} (2.4mg vs. 1mg), vitamin C (64mg vs. 22mg), vitamin A (525µg vs. 275µg) and vitamin E (9mg vs. 6mg). In the ≥ 8 and ≤ 10 years of age group the mean intakes of the following nutrients were found to be significantly higher than the USA-EAR/AI: total protein (81g vs. 27g), carbohydrate (238g vs. 100g), magnesium (340mg vs. 200mg), iron (14.5mg vs. 5.9mg), zinc (13.1mg vs. 7mg), thiamin (1.6mg vs. 0.7mg), riboflavin (1.7mg vs. 0.8 mg), niacin (23mg vs. 9mg), folate (320mg vs. 250mg), vitamin B_{12} (5.1mg vs. 1.5mg) and vitamin A (793µg vs. 433µg).

None of the micronutrients were consumed at levels higher than the USA-Tolerable Upper Intake Level (UL). Comparison of the mean nutrient intakes from the 3 day dietary record (average of 3 days) to the USA-RDA is shown in Appendix R (page A 45).

Table 4.12 Mean nutrient intakes from the average of the 3 days in the 3 day dietary record compared to USA-EAR/AI for children ≥ 6 and < 8 years of age (n=9) and children ≥ 8 and ≤ 10 years of age (n=11)

Nutrient	Mean intake of children ≥ 6 years and < 8 years of age (n = 9) (∀SD)	USA-EAR/AI	P value [Ω]	Mean intake of children ≥ 8 and ≤ 10 years of age (n =11) (∀SD)	USA-EAR/AI	P value [Ω]
Energy (kJ)	6420 (∀1310)	7316	0.074	8030 (∀1940)	9572	0.025
Total protein (g)	57 (∀15)	15	0.000	81 (∀30)	27	0.000
Carbohydrate (g)	202 (∀57)	100	0.001	238 (∀52)	100	0.000
Dietary fibre (g)	19 (∀6)	25	0.010	28 (∀10)	31	0.322
Calcium (mg)	540 (∀210)	800	0.006	758 (∀306)	1300	0.000
Magnesium (mg)	218 (∀80)	110	0.004	340 (∀125)	200	0.004
Phosphorus (mg)	935 (∀224)	405	0.000	1330 (∀457)	1055	0.074
Iron (mg)	11.2 (∀3.6)	4.1	0.000	14.5 (∀4.7)	5.9	0.000
Zinc (mg)	7.6 (∀3.1)	4.0	0.008	13.1 (∀5.5)	7.0	0.004
Thiamin (mg)	1.1 (∀0.3)	0.5	0.001	1.6 (∀0.6)	0.7	0.001
Riboflavin (mg)	1.4 (∀0.5)	0.5	0.001	1.7 (∀0.6)	0.8	0.001
Niacin (mg)	17 (∀5)	6	0.000	23 (∀12)	9	0.004
Vitamin B_6 (mg)	1.6 (∀0.3)	0.5	0.000	3.1 (∀4.4)	0.8	0.114
Folate (µg)	255 (∀97)	160	0.019	320 (∀88)	250	0.025
Vitamin B_{12} (mg)	2.4 (∀1.1)	1.0	0.006	5.1 (∀3.4)	1.5	0.006
Vitamin C (mg)	64 (∀37)	22	0.009	47 (∀27)	39	0.361
Vitamin A (µg)	525 (∀194)	275	0.005	793 (∀523)	433	0.045
Vitamin D (µg)	3 (∀2)	5	0.003	4 (∀2)	5	0.170
Vitamin E (mg)	9 (∀3)	6	0.018	11 (∀5)	9	0.192

[Ω] One sample t-test

4.4.4 Mean nutrient intakes obtained from the 24 hour recall compared to the USA-EAR/AI

Table 4.13 shows the mean nutrient intake from the 24 hour recall compared to the USA-EAR/AI. To facilitate the comparison with the USA-EAR/AI the subjects were divided according to age groups, i.e. ≥ 6 and < 8 years of age and ≥ 8 and ≤ 10 years of age. Only those nutrients for which the USA-EAR/AI were available are included in Table 4.13.

Vitamin D intake was found to be significantly lower than the USA-EAR/AI value in both the ≥ 6 and < 8 age group (3µg vs. 5µg) and the ≥ 8 and ≤ 10 year age group (2µg vs. 5µg). Vitamin D was the only nutrient that was consumed at levels significantly lower than the USA-EAR/AI in both the age groups.

In the ≥ 6 and < 8 year age group the mean intakes of the following nutrients were found to be significantly higher than the USA-EAR/AI: total protein (74g vs. 15g), carbohydrate (227g vs. 100g), magnesium (314mg vs. 110mg), phosphorus (1261mg vs. 405mg), iron (15.3g vs. 4.1mg), zinc (11.4mg vs. 4.0mg), thiamin (1.5mg vs. 0.5mg), riboflavin (1.7mg vs. 0.5mg), niacin (22mg vs. 6mg), vitamin B_6 (2.0mg vs. 0.5mg), folate (380µg vs. 160µg), vitamin B_{12} (3.2mg vs. 1.0mg), vitamin C (50mg vs. 22mg), vitamin A (675µg vs. 275µg) and vitamin E (12mg vs. 6mg). In the ≥ 8 and ≤ 10 year age group the mean intakes of the following nutrients were found to be significantly higher than the USA-EAR/AI: total protein (86g vs. 27g), carbohydrate (245g vs. 100g), iron (14.1mg vs. 5.8mg), zinc (13.6mg vs. 7.0mg), thiamin (1.4mg vs. 0.7mg), riboflavin (1.6mg vs. 0.8mg) and vitamin B_6 (1.9mg vs. 0.8mg).

None of the micronutrients were consumed at levels higher than the USA-UL. Comparison of the mean nutrient intakes from the 24 hour recall to the USA-RDA is shown in Appendix S (page A 46).

Table 4.13 Mean nutrient intakes from the 24 hour recall compared to USA-EAR/AI for children ≥ 6 and < 8 years of age (n=10) and children ≥ 8 and ≤ 10 years of age (n=6)

Nutrient	Mean intake of children ≥ 6 and < 8 years of age (n = 10) (∀SD)	USA-EAR/AI	P value[Ω]	Mean intake of children ≥ 8 and ≤ 10 years of age (n=6) (∀SD)	USA-EAR/AI	P value[Ω]
Energy (kJ)	7768 (∀2081)	7316	0.509	8455 (∀1763)	9572	0.181
Total protein (g)	74 (∀18)	15	0.000	86 (∀32)	27	0.006
Carbohydrate (g)	227 (∀91)	100	0.002	245 (∀59)	100	0.002
Dietary fibre (g)	27 (∀17)	25	0.665	28 (∀15)	31	0.665
Calcium (mg)	746 (∀453)	800	0.717	849 (∀536)	1300	0.094
Magnesium (mg)	314 (∀160)	110	0.003	336 (∀140)	200	0.062
Phosphorus (mg)	1261 (∀426)	405	0.000	1436 (∀410)	1055	0.072
Iron (mg)	15.3 (∀5.1)	4.1	0.000	14.1 (∀4.6)	5.8	0.007
Zinc (mg)	11.4 (∀3.5)	4.0	0.000	13.6 (∀4.3)	7.0	0.014
Thiamin (mg)	1.5 (∀0.5)	0.5	0.000	1.4 (∀0.6)	0.7	0.043
Riboflavin (mg)	1.7 (∀0.8)	0.5	0.001	1.6 (∀0.6)	0.8	0.019
Niacin (mg)	22 (∀10)	6	0.001	22 (∀14)	9	0.077
Vitamin B_6 (mg)	2.0 (∀0.6)	0.5	0.000	1.9 (∀0.8)	0.8	0.020
Folate (µg)	380 (∀185)	160	0.005	342 (∀141)	250	0.170
Vitamin B_{12} (mg)	3.2 (∀1.9)	1.0	0.005	3.0 (∀1.6)	1.5	0.062
Vitamin C (mg)	50 (∀32)	22	0.023	46 (∀21)	39	0.448
Vitamin A (µg)	675 (∀376)	275	0.008	950 (∀687)	433	0.124
Vitamin D (µg)	3 (∀2)	5	0.039	2 (∀1)	5	0.001
Vitamin E (mg)	12 (∀6)	6	0.014	10 (∀10)	9	0.833

[Ω] One sample t-test

4.4.5 Mean nutrient intakes obtained from the 3 day dietary record (average of 3 days) compared to the WHO/FAO RNIs

The mean nutrient intakes from the average of the 3 days in the 3 day dietary record as compared to the WHO/FAO RNIs are shown in Table 4.14. To facilitate the comparison with the WHO/FAO RNIs the subjects were divided into 3 age groups, i.e. ≥ 6 and < 7 years of age, equal to 7 and < 9 years of age and ≥ 9 and ≤ 10 years of age. Vitamin D intake was found to be significantly lower than the WHO/FAO RNI in the ≥ 6 and < 7 years of age (1µg vs. 5µg) and in the equal to 7 and < 9 year age group (4µg vs. 5µg) while calcium intake was found to be significantly lower than the WHO/FAO RNI in the ≥ 9 and ≤ 10 year age group (664mg vs. 1300mg).

In the ≥ 6 and < 7 year age group the mean intakes of the following nutrients were found to be significantly higher than the WHO/FAO RNIs: magnesium (210mg vs. 76mg), iron (9.1mg vs. 4.2mg), thiamin (1.0mg vs. 0.6mg) and vitamin B_6 (1.6mg vs. 0.6mg). In the equal to 7 and < 9 year age group the mean intakes of the following nutrients were found to be significantly higher than the WHO/FAO RNIs: magnesium (252mg vs. 100mg), iron (12.1mg vs. 5.9mg), zinc (9.2mg vs. 5.6mg), thiamin (1.3mg vs. 0.9mg), riboflavin (1.5mg vs. 0.9mg), niacin (17mg vs. 12mg) and vitamin B_6 (2.0mg vs. 1.0mg). Mean iron intake in the ≥ 9 and ≤ 10 year age group was significantly higher than the WHO/FAO RNI (16.6mg vs. 5.9mg). Mean iron intake was significantly higher than the WHO/FAO RNI in all age groups.

Table 4.14 Mean nutrient intakes from the 3 day dietary record compared to WHO/FAO RNIs for children ≥ 6 and < 7 years of age (n=3), equal to 7 and < 9 years of age (n=11) and ≥ 9 and ≤ 10 years of age (n=6)

Nutrient	Mean intake of children ≥ 6 and < 7 years of age (n =3) (∀SD)	WHO /FAO RNI	P value$^{\Omega}$	Mean intake of children equal to 7 and < 9 years of age (n=11) (∀SD)	WHO/FAO RNI	P value$^{\Omega}$	Mean intake of children ≥ 9 and ≤ 10 years of age (n = 6) (∀SD)	WHO /FAO RNI	P value$^{\Omega}$
Energy (kJ)	6059 (∀570)	6959	0.112	7063 (∀1495)	7546.2	0.309	8373 (∀2410.7)	8984	0.562
Calcium (mg)	256 (∀256)	600	0.385	718 (∀256)	700	0.825	664(∀331)	1300	0.005
Magnesium (mg)	210 (∀19)	76	0.006	252 (∀87)	100	0.000	384 (∀152)	228	0.053
Iron (mg)	9.1 (∀0.5)	4.2	0.004	12.1(∀3)	5.9	0.000	16.6 (∀5.5)	5.9	0.005
Zinc (mg)	8.4 (∀2.1)	4.8	0.095	9.2 (∀)	5.6	0.012	14.3 (∀7.0)	8.4	0.092
Thiamin (mg)	1.0 (∀0.1)	0.6	0.049	1.3 (∀0.5)	0.9	0.047	1.7 (∀0.6)	1.2	0.116
Riboflavin (mg)	1.0 (∀0.3)	0.6	0.127	1.5 (∀ 0.4)	0.9	0.001	1.8 (∀0.8)	1.3	0.162
Niacin (mg)	16 (∀4)	8	0.069	17(∀ 4)	12	0.002	27 (∀15)	16	0.128
Vitamin B_6 (mg)	1.6 (∀0.3)	0.6	0.023	2.0 (∀0)	1.0	0.000	4.3 (∀5.9)	1.3	0.266
Folate (µg)	172 (∀16)	200	0.098	303 (∀86)	300	0.925	328 (∀97)	400	0.128
Vitamin B_{12} (mg)	2.3 (∀0.9)	1.2	0.156	3.2 (∀1.7)	2.2	0.086	6.0 (∀4.4)	2.4	0.101
Vitamin C (mg)	48 (∀25)	30	0.325	61 (∀40)	35	0.054	45 (∀19)	40	0.513
Vitamin A (µg)	539 (∀175)	450	0.471	615 (∀218)	500	0.110	844 (∀719)	600	0.444
Vitamin D (µg)	1 (∀1)	5	0.006	4 (∀2)	5	0.015	4 (∀3)	5	0.526
Vitamin E (mg)	10 (∀4)	5	0.139	9 (∀4)	7	0.077	11.6 (∀4.6)	9.6	0.330

$^{\Omega}$ One sample t-test

4.4.6 Mean nutrient intakes obtained from the 24 hour recall compared to the WHO/FAO RNIs

Table 4.15 shows that no nutrients were consumed at levels significantly below the WHO/FAO RNIs in the ≥ 6 and < 7 years of age group. The mean intake of Vitamin D was significantly lower than the WHO/FAO RNI in the equal to 7 and < 9 year age group (3µg vs. 5µg) while calcium was significantly lower than the WHO/FAO RNI in the ≥ 9 and ≤ 10 year age group (553mg vs. 1300mg).

In the ≥ 6 and < 7 years of age group none of the nutrients were consumed at levels significantly higher than the WHO/FAO RNI. In the equal to 7 and < 9 year age group the mean intakes of the following nutrients were found to be significantly higher than the WHO/FAO RNIs: magnesium (319mg vs. 100mg), iron (14.6mg vs. 5.9mg), zinc (12.4mg vs. 5.6mg), thiamin (1.4mg vs. 0.9mg), riboflavin (1.6mg vs. 0.9mg), niacin (21mg vs. 12mg), vitamin B_6 (2.0mg vs. 1.0mg) and vitamin B_{12} (3.3mg vs. 2.2mg). The mean intake of iron was significantly higher than the WHO/FAO RNI in the ≥ 9 and ≤ 10 year age group (16.1mg vs. 5.9mg).

Table 4.15 Mean nutrient intakes from the 24 hour recall compared to WHO/FAO RNIs for children ≥ 6 and < 7 years of age (n=2), equal to 7 and < 9 years of age (n=11) and ≥ 9 and ≤ 10 years of age (n=3)

Nutrient	Mean intake of children ≥ 6 and < 7 years of age (n = 2) (∀SD)	WHO /FAO RNI	P value$^{\Omega}$	Mean intake of children equal to 7 and < 9 years of age (n =11) (∀SD)	WHO /FAO RNI	P value$^{\Omega}$	Mean intake of children ≥ 9 and ≤ 10 years of age (n=3) (∀SD)	WHO /FAO RNI	P value$^{\Omega}$
Energy (kJ)	6164 (∀943)	6959	0.444	8268 (∀2102)	7546	0.281	8378 (∀1279)	8984	0.498
Calcium (mg)	558 (∀528)	600	0.929	889 (∀499)	700	0.237	553 (∀294)	1300	0.048
Magnesium (mg)	241 (∀101)	76	0.261	319 (∀155)	100	0.001	390 (∀161)	228	0.225
Iron (mg)	14.4 (∀8.0)	4.2	0.323	14.6 (∀5.3)	5.9	0.000	16.1 (∀1.2)	5.9	0.005
Zinc (mg)	9.4 (∀2.4)	4.8	0.227	12.4 (∀3.7)	5.6	0.000	13.5 (∀5.3)	8.4	0.239
Thiamin (mg)	1.2 (∀0.5)	0.6	0.318	1.4 (∀0.5)	0.9	0.017	1.9 (∀0.3)	1.2	0.069
Riboflavin (mg)	1.6 (∀1.5)	0.6	0.502	1.6 (∀0.7)	0.9	0.004	1.9 (∀0.7)	1.3	0.247
Niacin (mg)	18 (∀5)	8	0.229	21 (∀10)	12	0.019	30 (∀16)	16	0.265
Vitamin B_6 (mg)	2.2 (∀0.4)	0.6	0.103	2.0 (∀1)	1.0	0.002	2.0 (∀0.6)	1.3	0.760
Folate (µg)	285 (∀171)	200	0.609	389 (∀184)	300	0.138	335 (∀115)	400	0.428
Vitamin B_{12} (mg)	2.4 (∀2.5)	1.2	0.630	3.3 (∀1.6)	2.2	0.047	2.9 (∀2.1)	2.4	0.706
Vitamin C (mg)	60 (∀16)	30	0.224	43 (∀31)	35	0.402	59 (∀20)	40	0.232
Vitamin A (µg)	1052 (∀216)	450	0.158	643 (∀358)	500	0.213	1090 (∀987)	600	0.481
Vitamin D (µg)	2 (∀3)	5	0.430	3 (∀2)	5	0.010	2 (∀2)	5	0.066
Vitamin E (mg)	10 (∀4)	5	0.337	11 (∀6)	7	0.086	13.8 (∀15.1)	10	0.677

$^{\Omega}$ One sample t-test

4.4.7 Percentage of the USA-EAR/AI met from the 24 hour recall and the 3 day dietary record for children ≥ 6 and < 8 years of age

Figure 4.2 shows the percentage of the USA-EAR/AI met for nutrients from the 24 hour recall and the 3 day dietary record in children ≥ 6 and < 8 years of age. The percentage of the USA-EAR/AI met was above 100% for all nutrients from both the 24 hour recall and the 3 day dietary record with the exception of vitamin D (68% and 52%) and calcium (93% and 67%). The USA-EAR/AI was exceptionally well met for Vitamin B_6 (400% and 320%) and total protein (493% and 380%).

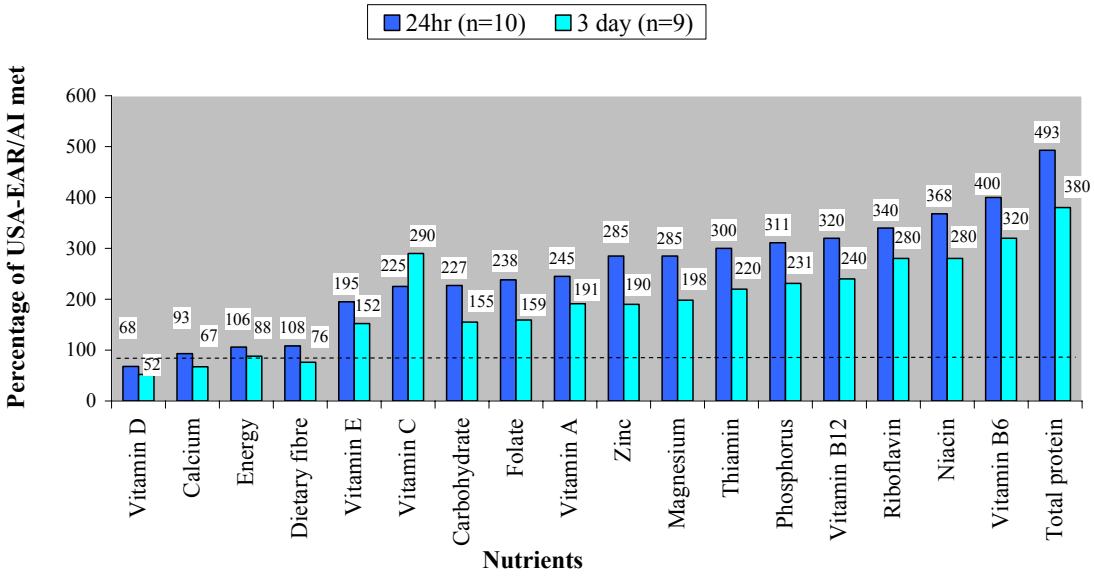

Figure 4.2: Percentage of the USA-EAR/AI met from the 24 hour recall and the 3 day dietary record for children ≥ 6 and < 8 years of age

4.4.8 Percentage of USA-EAR/AI met from the 24 hour recall and the 3 day dietary record for children ≥ 8 and ≤ 10 years of age

Figure 4.3 shows that the percentage of the EAR/AI met was above 100% for all nutrients from both the 24 hour recall and the 3 day dietary record except for, vitamin D (36% and 80%), calcium (65% and 58%), energy (88% and 84%) and dietary fibre (90% and 90%). Total protein (319% and 300%) was exceptionally well met.

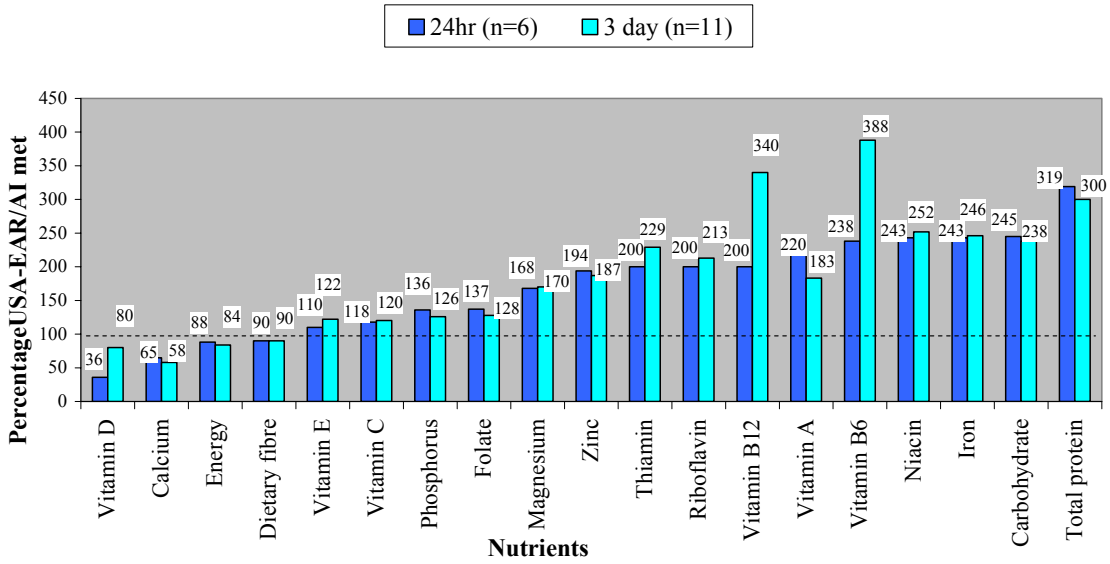

Figure 4.3: Percentage of USA-EAR/AI met from the 24 hour recall and the 3 day dietary record for children greater than and equal to 8 and less than and equal to 10 years of age

4.4.9 Percentage of WHO/FAO RNIs met from the 24 hour recall and the 3 day dietary record for children ≥ 6 and < 7 years of age

Figure 4.4 shows the percentage of the WHO/FAO RNIs met from the 24 hour recall and the 3 day dietary records for children ≥ 6 and < 7 years of age. The percentage of the WHO/FAO RNI met was above 100% from both the 24 hour recall and the 3 day dietary record for all nutrients, except for vitamin D (49% and 22%), energy (89% and 87%) and calcium (93% and 43%). Magnesium (316% and 276%), iron (344% and 216%) and vitamin B_6 (360% and 258%) were exceptionally well met.

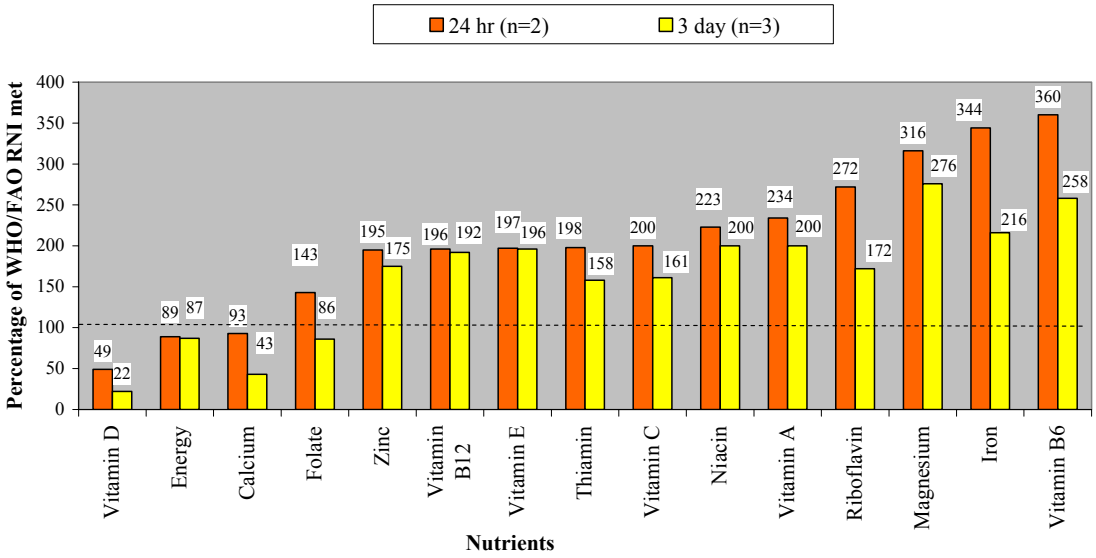

Figure 4.4: Percentage of WHO/FAO RNIs met from the 24 hour recall and the 3 day dietary record for children ≥ 6 and < 7 years of age

4.4.10 Percentage of WHO/FAO RNIs met from the 24 hour recall and the 3 day dietary record for children equal to 7 and less than 9 years of age

Figure 4.5 shows the percentage of the WHO/FAO RNIs met from the 24 hour recall and the 3 day dietary record for children equal to 7 and less than 9 years of age. The only nutrient that did not meet 100% of the WHO/FAO RNI from both the 24 hour recall and the 3 day dietary record was vitamin D (62% and 70%). Iron (247% and 205%) and magnesium (319% and 252%) were exceptionally well met.

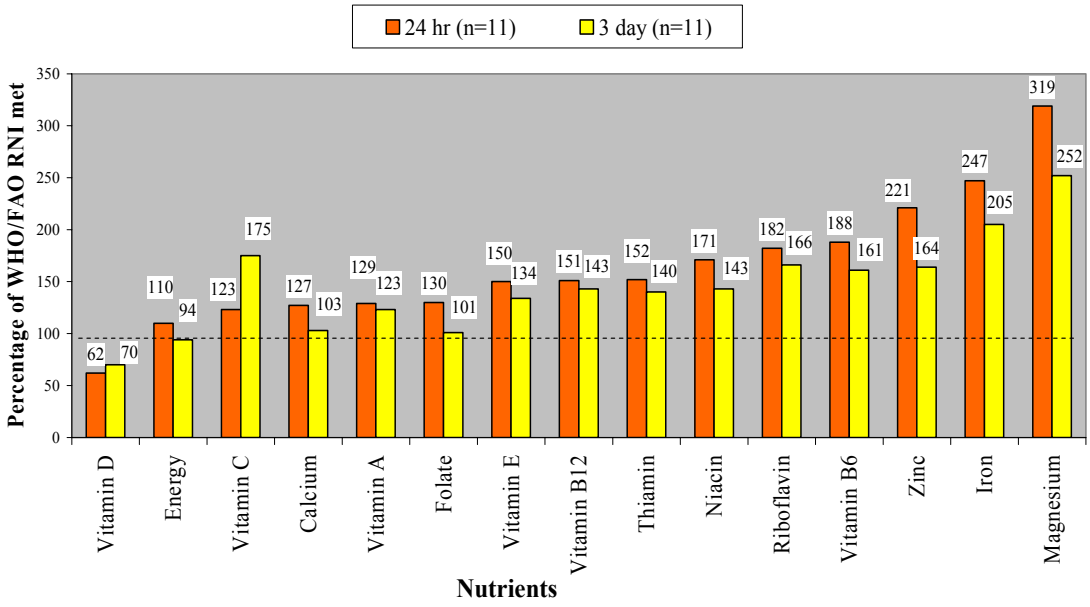

Figure 4.5: Percentage of WHO/FAO RNIs met from the 24 hour recall and the 3 day dietary record for children equal to 7 and less than 9 years of age

4.4.11 Percentage of WHO/FAO RNIs met from the 24 hour recall and the 3 day dietary record for children ≥ 9 and ≤ 10 years of age

Figure 4.6 below shows the percentage of the WHO/FAO RNIs met from the 24 hour recall and 3 day dietary record for children ≥ 9 and ≤ 10 years of age. The percentage of the WHO/FAO RNI met was less than 100% from both the 24 hour recall and the 3 day dietary record for vitamin D (38% and 85%), calcium (43% and 51%), folate (84% and 82%) and energy (93% and 93%). The WHO/FAO RNI was exceptionally well met for iron (272% and 281%).

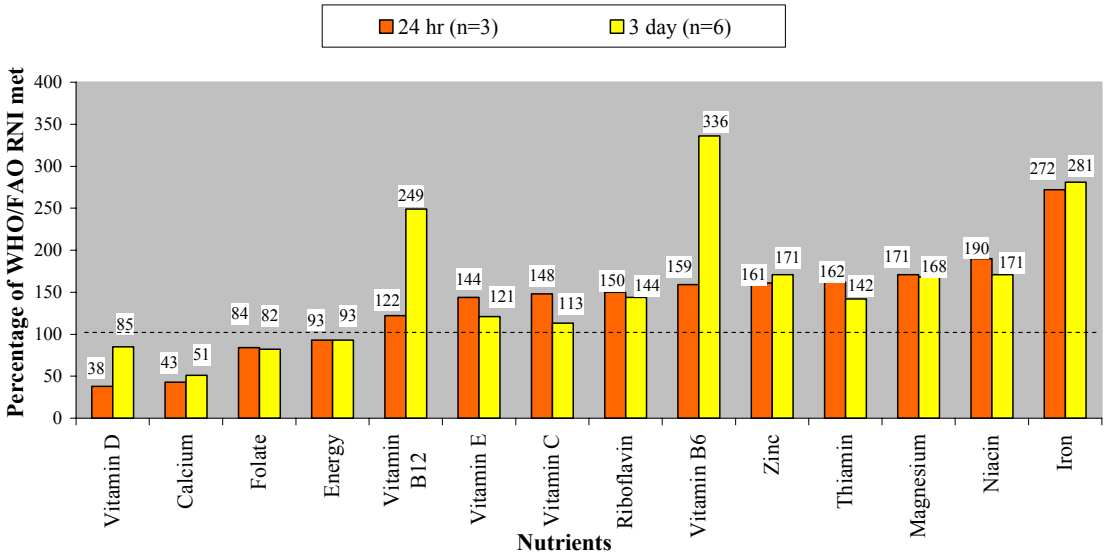

Figure 4.6: Percentage of WHO/FAO RNIs met from the 24 hour recall and the 3 day dietary record for children ≥ 9 and less than and equal to 10 years of age

4.5 Diet-related knowledge in children with Type 1 Diabetes Mellitus

All of the subjects in the sample answered the diet-related knowledge MCQ. The mean diet-related knowledge total score for the sample was 67% with a standard deviation of 18% and a range of 30% to 100%. This is shown in Table 4.16 below.

Table 4.16 Mean diet-related knowledge score, standard deviation and range for the sample

Number of subjects	Mean diet-related knowledge total score (%)	Standard deviation	Range of scores (%)
n = 30	67	∀18	30 -100

When the sample was split at 8 years there was a significant difference between the mean score of those ≥ 6 and < 8 years of age and those ≥ 8 and ≤ 10 years of age (p=0.028), with the children ≥ 8 and ≤ 10 years of age scoring higher than the children ≥ 6 and < 8 years of age (76% vs. 61%). This is shown in Table 4.17 below.

Table 4.17 Difference in diet-related knowledge scores between children ≥ 6 and < 8 years of age (n=18) and children ≥ 8 and ≤ 10 years of age (n=12)

Age group	Number of subjects	Mean score (%)	Standard deviation	Standard error of mean	P value[∃]
≥ 6 and < 8 years of age	n = 18	61	∀ 15	3	0.028
≥ 8 and ≤ 10 years of age	n = 12	76	∀ 20	6	

[∃] Independent samples t-test

There were no differences in the mean diet-related knowledge scores between males and females (64% vs. 72%; p=0.242) or race groups [Africans=57%, Coloureds=73%, Indians= 74%, Whites=63%); (p=0.151)]. The hospital clinic which the subjects attended made a significant difference to the score (p=0.038), with those from IALCH having a higher mean score than the subjects from the Grey's Hospital clinic (71% vs. 56%), as shown in Table 4.18.

Table 4.18 Differences in diet-related knowledge scores of subjects attending the Grey's Hospital (n=8) and IALCH Paediatric Diabetic Clinics (n=22)

Hospital Clinic	Number of subjects	Mean score (%)	Standard deviation	Standard error of mean	P value[∃]
Grey's Hospital	n = 8	56	∀ 23	8	0.038
IALCH	n = 22	71	∀ 15	3	

[∃] Independent samples t-test

Figure 4.7 below shows a scatter plot of diet-related knowledge scores for children ≥ 6 and < 8 years of age and children ≥ 8 and ≤ 10 years of age attending the IALCH and Grey's Hospital Paediatric Diabetic Clinics.

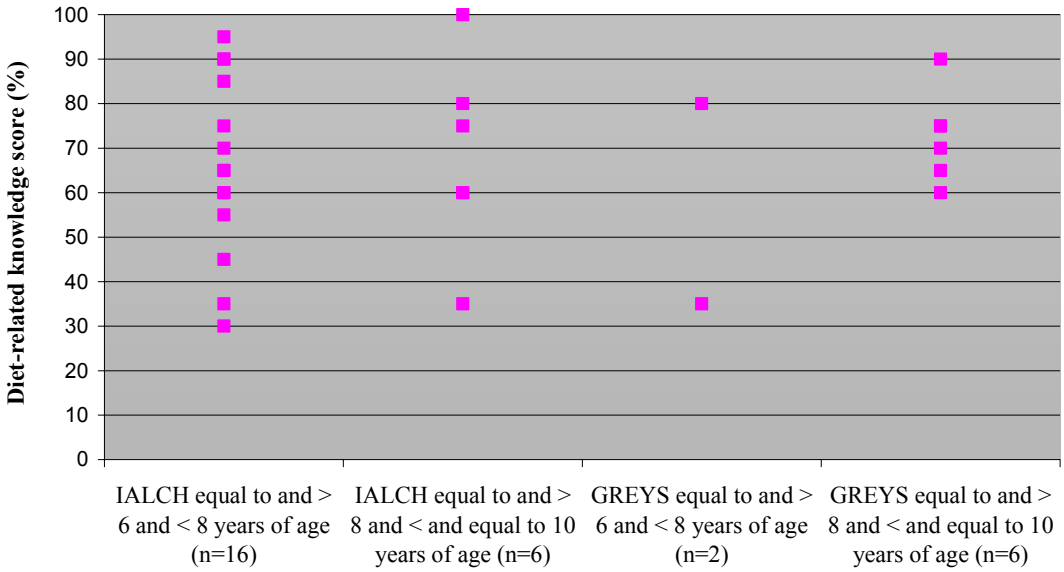

Figure 4.7: Diet-related knowledge scores of children ≥ 6 and < 8 years of age and children ≥ 8 and ≤ 10 years of age attending the IALCH and Grey's Hospital Paediatric Diabetic Clinics

There were no significant relationships between the diet-related knowledge score and duration of diagnosis (r = - 0.150; p= 0.430), Z-score for BMI for age (r = - 0.924; p=0.115), latest HbA_{1c} values (r = 0.036; p=0.850) or the mean HbA_{1c} values over the previous 12 months (r = 0.019; p=0.922). There was also no significant relationship between the diet-related knowledge score and the monthly income per household (r = 0.246; p=0.269) or the education level of the care-givers (r = 0.101; p=0.654). The percentage correct questions for diet and insulin related questions were also analysed and this is shown in Table 4.19. There was a slightly greater level of knowledge about insulin (71%) as compared to diet (66%).

Table 4.19 Percentage correct answers for diet-related questions and insulin-related questions for all subjects

	Percentage correct answers for diet-related questions (%) (n=30)	**Percentage correct answers for insulin-related questions (%) (n=30)**
Mean	66	71
Standard deviation	∀ 19	∀ 26
Minimum	24	0
Maximum	100	100

4.6 Metabolic control based on HbA_{1c} in children with Type 1 Diabetes Mellitus

Metabolic control was assessed by using the latest HbA_{1c} value and the mean HbA_{1c} value over the previous 12 months as at the time of the study. Table 4.20 below shows that the latest HbA_{1c} value and the mean HbA_{1c} value over the previous 12 months as at the time of the study were very similar. There were no significant differences between the two means (paired t-test, p=0.585).

Table 4.20 Latest HbA_{1c} and mean HbA_{1c} over the previous 12 months as at the time of the study for all subjects

		Latest HbA_{1c} (%) (n=30)	**Mean HbA_{1c} over 12 months (%) (n=30)**
Mean		9.7	9.6
Median		9.7	9.6
Standard Deviation		1.7	1.5
Minimum		6.6	7.0
Maximum		12.7	12.5
Percentiles	25	8.1	8.5
	50	9.7	9.6
	75	11.0	10.9

The HbA_{1c} values were compared to three reference values i.e. the reference range used at the IALCH Pathology Laboratory (4.8%-6%), the ISPAD recommendation (not > 7.6%) and the ADA guideline (not > 8%), using one sample t-tests. These results are shown in Table 4.21. The mean HbA_{1c} and the mean HbA_{1c} value over the previous 12 months were found to be significantly greater than the IALCH reference range ($p<0.001$), the ISPAD reference value ($p<0.001$) and the ADA reference value ($p<0.001$) for HbA_{1c}, as shown in Table 4.21.

Table 4.21 Latest HbA_{1c} and mean HbA_{1c} over the previous 12 months from the time of the study compared to the IALCH Pathology Laboratory reference range, ISPAD reference value and the ADA reference value for HbA_{1c}

	No. of subjects	**Mean (%)**	**IALCH reference range (%)**	**P value$^{\Omega}$**	**ISPAD reference Value (%)**	**P value$^{\Omega}$**	**ADA reference value (%)**	**P value$^{\Omega}$**
Latest HbA_{1c}	n = 30	9.7	4.8%-6%	0.000	Not > 7.6%	0.000	Not > 8%	0.000
Mean HbA_{1c} over the previous 12 months	n = 30	9.6	4.8%-6%	0.000	Not > 7.6%	0.000	Not > 8%	0.000

$^{\Omega}$ One sample t-test

4.7 Relationship between BMI for age and metabolic control in children with Type 1 Diabetes Mellitus

Z-scores for BMI for age were compared to the latest HbA_{1c} values and the mean HbA_{1c} values over the previous 12 months. Table 4.22 below shows that no correlation was found between the latest HbA_{1c} values and the Z-score for BMI for age (r = 0.045; p=0.814) and between the mean HbA_{1c} over the previous 12 months and the Z-score for BMI for age (r = - 0.012; p=0.951).

Table 4.22 Comparison between the latest HbA_{1c} and the mean HbA_{1c} value over the previous 12 months as at the time of the study and Z-score for BMI for age

		Z-score for BMI for age (n=30)
Latest HbA_{1c}	Pearson Correlation	0.045
	P value	0.814
Mean HbA_{1c} over 12 months	Pearson Correlation	- 0.012
	P value	0.951

4.8 Relationships between other variables investigated and metabolic control

Possible relationships between metabolic control and the following variables were investigated: age, gender, frequency of self-monitoring of blood glucose, duration of diagnosis, diet-related knowledge score, hospital clinic attended, race group of subjects, monthly income per household, education level of the caregivers and completion/non completion of dietary records by subjects. Only those variables which showed significant relationships with metabolic control are reported in this section.

4.8.1 Relationship between age and metabolic control

There was a significant positive correlation between age of the participant and the latest HbA_{1c} value (r = 0.473, p=0.008) but this was not a very strong correlation, as seen in Table 4.23. This indicated that as age increased so did the latest HbA_{1c} value. There was no correlation between mean HbA_{1c} over 12 months and age (r = 0.316; p=0.089).

Table 4.23 Relationship between age and metabolic control using HbA_{1c} values

		Age (n=30)
Latest HbA_{1c}	Pearson Correlation	0.473(**)
	Sig. (2-tailed)	0.008
Mean HbA_{1c} over 12 months	Pearson Correlation	0.316
	Sig. (2-tailed)	0.089

** Pearson's correlation is significant at the 0.01 level (2-tailed).

When age was split at 8 years, there was a significant difference between the age groups in terms of both the latest HbA_{1c} values (p=0.005) and the mean HbA_{1c} over 12 months (p=0.037). The children ≥ 8 and ≤ 10 years of age had higher HbA_{1c} values than the children ≥ 6 and < 8 years of age years of age. This is shown in Table 4.24.

Table 4.24 Relationship between children ≥ 6 and < 8 years of age and children ≥ 8 and ≤ 10 years of age and metabolic control

	Age group	Number of subjects	Mean (%)	SD	Standard error of mean	P value[∃]
Latest HbA_{1c}	≥ 6 and < 8 years of age	n = 18	9.0	1.7	0.4	0.005
	≥ 8 and ≤ 10 years of age	n = 12	10.8	1.3	0.4	
Mean HbA_{1c} over 12 months	≥ 6 and < 8 years of age	n = 18	9.2	1.6	0.4	0.037
	≥ 8 and ≤ 10 years of age	n = 12	10.3	1.1	0.3	

[∃] Independent samples t-test

4.8.2 Relationship between hospital clinic attended and metabolic control

The hospital clinic attended made a significant difference to the HbA_{1c} values. Subjects that attended the Grey's Hospital clinic had higher mean values for both the latest HbA_{1c} and the mean HbA_{1c} over 12 months as compared to the children attending the IALCH clinic. This is shown in Table 4.25. A two factor ANOVA test revealed that the differences in metabolic control between the two hospital clinics was related to the hospital clinic attended (p=0.020) and not to race groups (p=0.708).

Table 4.25 Relationship between hospital clinic attended and metabolic control

	Hospital	Number of subjects	Mean (%)	SD	Standard error of mean	P value[∃]
Latest HbA_{1c} available	Grey's Hospital	n = 8	11.4	1.6	0.6	0.001
	IALCH	n = 22	9.1	1.4	0.3	
Mean HbA_{1c} over 12 months	Grey's Hospital	n = 8	10.6	1.7	0.6	0.035
	IALCH	n = 22	9.3	1.3	0.3	

[∃] Independent samples t-test

Figure 4.8 shows a scatter plot of the latest HbA_{1c} values for children ≥ 6 and < 8 years of age and children ≥ 8 and ≤ 10 years of age attending the IALCH and Grey's Hospital Paediatric Diabetic Clinics.

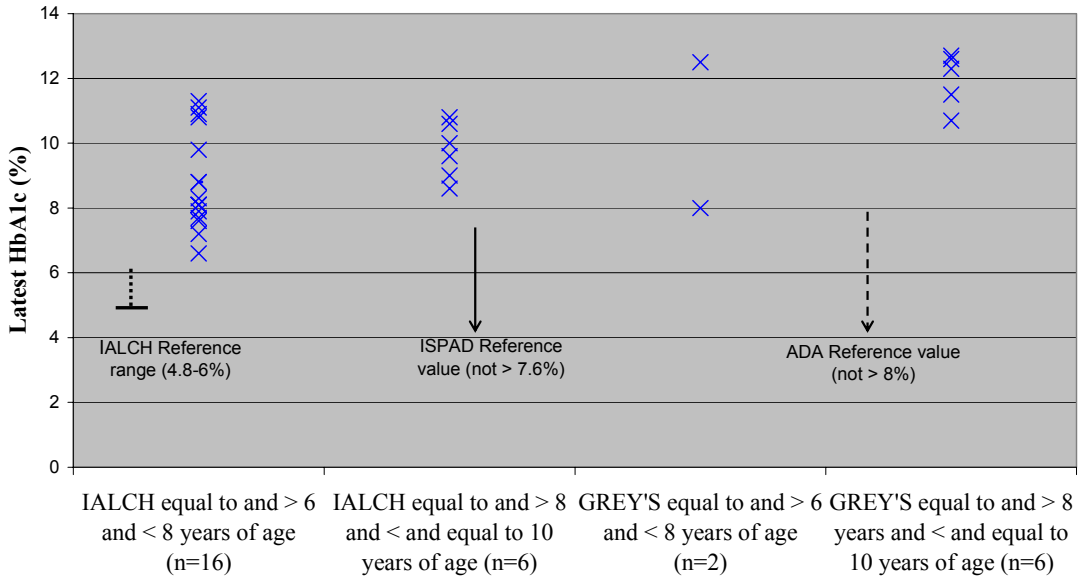

Figure 4.8: Latest HbA_{1c} for children ≥ 6 and < 8 years of age and children ≥ 8 and ≤ 10 years of age from the IALCH and Grey's Hospital Paediatric Diabetic Clinics

Figure 4.9 shows a scatter plot for the mean HbA_{1c} values over the previous 12 months from the date of data collection for children ≥ 6 and < 8 years of age and children ≥ 8 and ≤ 10 years of age attending the IALCH and Grey's Hospital Paediatric Diabetic Clinics.

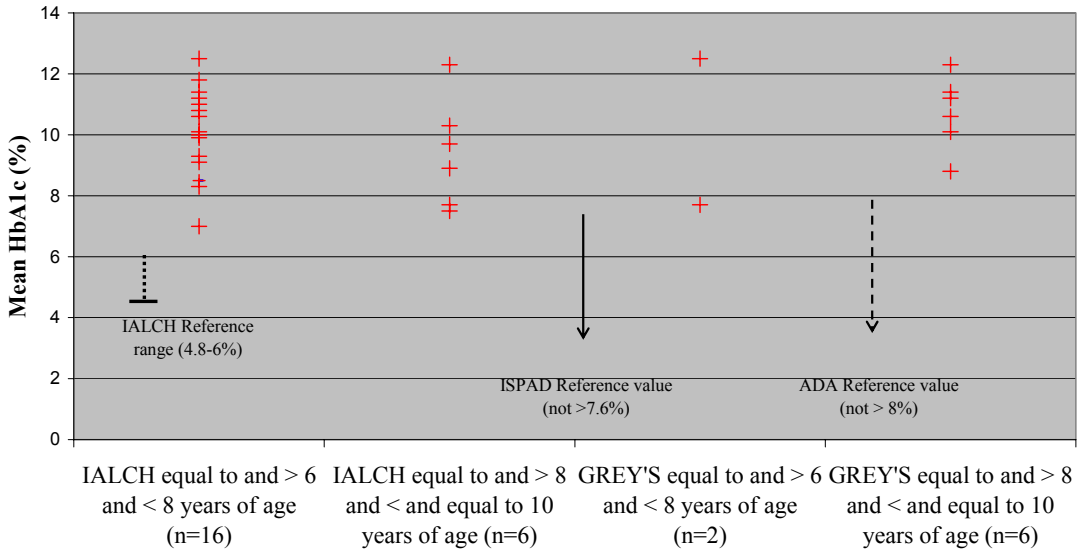

Figure 4.9: Mean HbA_{1c} over the previous 12 months from the date of data collection for children ≥ 6 and < 8 years of age and children ≥ 8 and ≤ 10 years of age from the IALCH and Grey's Hospital Paediatric Diabetic Clinics

Comparisons of the latest HbA_{1c} value as well as the diet-related knowledge scores for each hospital clinic attended are shown in Figure 4.10. A combined reference range (4.8%-8%) was obtained by combining the reference ranges for HbA_{1c} from IALCH (4.8%-6%), ISPAD (not > 7.6%), and the ADA (not > 8%). Figure 4.10 clearly shows that the hospital (IALCH) with the higher diet-related knowledge scores also had the lower latest HbA_{1c} values and that the hospital (Grey's) with the lower diet-related knowledge scores also had the higher latest HbA_{1c} values.

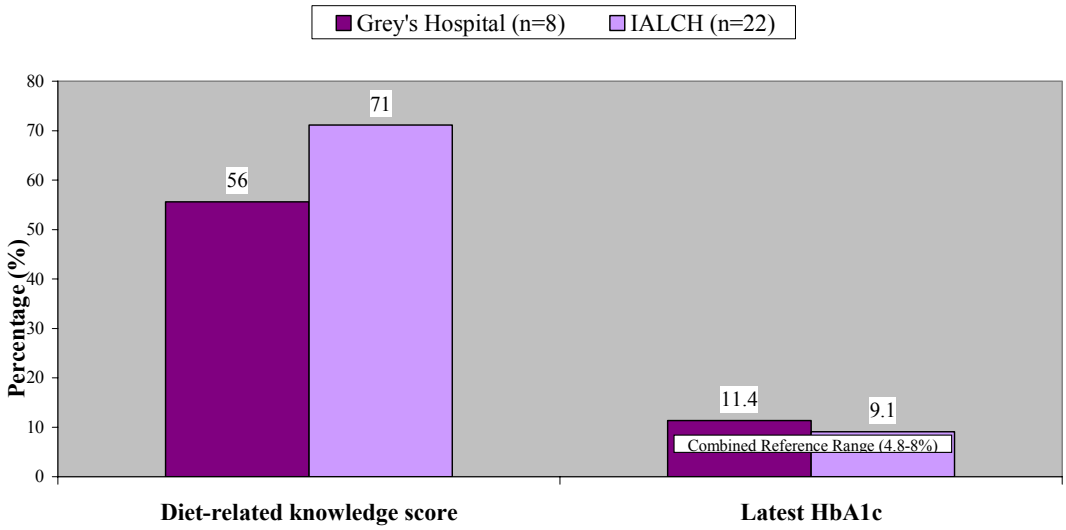

Figure 4.10: Diet-related knowledge score and latest HbA1c for the sample according to hospital clinic attended

4.8.3 Relationship between race groups of subjects and metabolic control

The latest HbA_{1c} values and the mean HbA_{1c} values over 12 months for the sample according to hospital and race groups is shown in Table 4.26. The sample size was too small to show any statistically significant differences in metabolic control between the race groups within the individual clinics.

Table 4.26: Latest HbA_{1c} and mean HbA_{1c} over 12 months for subjects according to race groups and hospital clinic attended

	Number of subjects	**Latest HbA_{1c} (%) [± SD]**	**Mean HbA_{1c} (%) over 12 months [± SD]**
GREY'S HOSPITAL (n=8)			
African	n = 6	11.3 [± 1.8]	10.7 [± 2.0]
Coloured	n = 1	12.6	10.6
Indian	n = 1	10.8	10.1
White	n = 0	-	-
IALCH (n=22)			
African	n = 4	10.0 [± 1.7]	10.6 [± 1.2]
Coloured	n = 2	9.6 [± 2.1]	9.7 [± 1.9]
Indian	n =13	8.7 [± 1.3]	8.9 [± 1.2]
White	n = 3	9.3 [± 1.3]	9.1 [± 0.7]

An ANOVA test revealed that the race group of the subjects was associated with differences in the latest HbA_{1c} values (p=0.043) and the mean HbA_{1c} values over 12 months (p=0.045) for the entire sample, as shown in Table 4.27. Bonferroni post hoc tests[13] revealed that the significant difference lay between African and Indian children respectively for the latest HbA_{1c} (p=0.043) and mean HbA_{1c} values over 12 months (p=0.045), with higher values in African children.

Table 4.27 Relationship between race groups of subjects and metabolic control

		Sum of Squares	Degrees of freedom (df)	Mean Square	F *	P value∀
Latest HbA_{1c}	Between Groups	23.373	3	7.791	3.117	0.043
	Within Groups	64.989	26	2.500		
	Total	88.362	29			
Mean HbA_{1c} over 12 months	Between Groups	16.923	3	5.641	3.077	0.045
	Within Groups	47.666	26	1.833		
	Total	64.590	29			

***** Ratio of sum of difference between groups to the sum of difference within groups
∀ P value for ANOVA

4.8.4 Relationship between education level of caregivers and metabolic control

There was a significant negative correlation between the education level of the caregivers and the latest HbA_{1c} (r = - 0.578; p=0.005) and the mean HbA_{1c} level over 12 months (r = - 0.496; p=0.019) in subjects, as shown in Table 4.28. This suggests that as the education level of the caregiver increased the HbA_{1c} values in subjects tended to decrease. This also suggests that as the education level of the caregiver increased the metabolic control of the subjects improved.

[13] The Bonferroni post hoc test is a multiple comparison test that is based on the student's t-test and adjusts the observed significance level for the fact that multiple comparisons are made.

Table 4.28 Relationship between education level of caregivers and metabolic control of subjects

		Education level of caregivers (n=22)
Latest HbA_{1c} of subjects	Pearson Correlation	-0.578(**)
	Sig. (2-tailed)	0.005
Mean HbA_{1c} of subjects over 12 months	Pearson Correlation	-0.496(*)
	Sig. (2-tailed)	0.019

** Pearson's correlation is significant at the 0.01 level (2-tailed)
* Pearson's correlation is significant at the 0.05 level (2-tailed)

4.8.5 Relationship between completion of dietary records and metabolic control

Due to the fact that there was poor overall metabolic control in spite of macronutrient intake being similar to the ISPAD Consensus Guidelines (2002) it was decided to look at if there were any differences in metabolic control between those that had completed the dietary records and those that did not. Table 4.29 shows the latest HbA_{1c} and the mean HbA_{1c} over 12 months according to the subjects that completed the 3 day dietary record and/or the 24 hour recall and those that did not complete any dietary records at all.

Table 4.29: Latest HbA_{1c} and mean HbA_{1c} over 12 months for the sample according to dietary records completed

	Number of subjects	Latest HbA_{1c} (%) [∀ SD]	P value[a]	Mean HbA_{1c} (%) over 12 months [∀SD]	P value[a]
3 day dietary records					
Completed	n = 20	10.3 [∀1.7]	0.011	10.0 [∀1.6]	0.039
Not completed	n = 10	8.6 [∀1.2]		8.9 [∀1.0]	
24 hour recall					
Completed	n = 16	9.8 [∀1.7]	0.770	9.7 [∀ 1.4]	0.700
Not completed	n = 14	9.6 [∀1.9]		9.5 [∀ 1.7]	
Completed 3 day dietary records and/or 24 hour recall	n = 25	9.8 [∀1.8]	0.396	9.7 [∀ 1.5]	0.444
No dietary records completed at all	n = 5	9.1 [∀1.5]		9.2 [∀ 1.2]	

[a] Two-sample independent t-test

According to Table 4.29 there was a significant difference in the latest HbA_{1c} between those subjects that completed the 3 day dietary records and those that did not (p=0.011). There was also a significant difference in the mean HbA_{1c} over 12 months between those subjects that completed the 3 day dietary records and those that did not (p=0.039).There were no significant differences in latest HbA_{1c} (p=0.770) or mean HbA_{1c} over 12 months (p=0.700) between those that completed the 24 hour recall and those that did not. There were also no significant differences in latest HbA_{1c} (p=0.396) or mean HbA_{1c} over 12 months (p=0.444) between those that completed either the 3 day dietary record and/or the 24 hour recall and those that completed no dietary records at all.

There was no significant differences in HbA_{1c} between the genders for the latest HbA_{1c} (p=0.353) and the mean HbA_{1c} over 12 months (p=0.092). Duration of diagnosis was not correlated with latest HbA_{1c} values (r = 0.291, p=0.119) or the mean HbA_{1c} over 12 months (r = 0.179, p=0.343). There was no correlation between BMI for age and latest HbA_{1c} (r = 0.203, p=0.282) or mean HbA_{1c} over 12 months (r = 0.101, p=0.594). Z score for BMI for age was also not correlated with latest HbA_{1c} (r = 0.045, p=0.814) or mean HbA_{1c} over 12 months (r = - 0.012, p=0.951). Diet-related knowledge also did not correlate with latest HbA_{1c} (r = 0.036, p=0.850) or mean HbA_{1c} over 12 months (r = 0.019, p=0.922). There was also no correlation between the monthly household income and latest HbA_{1c} values (r = - 0.211; p=0.346) or mean HbA_{1c} over 12 months (r = - 0.229; p=0.306).

4.9 Summary of results

4.9.1 Sample characteristics

Out of the total of 30 subjects, there were 13 females (43%) and 17 males (57%). There were 10 Africans (33%), 3 Coloureds (10%), 14 Indians (47%) and 3 Whites (10%). The mean age of the sample was 8.56 years with an age range of 6.25-10.92 years. The mean duration of diagnosis was 3.61 years. Out of the total of 30 subjects, 8 (27%) were from Grey's Hospital and 22 (73%) were from IALCH.

4.9.2 Comparison of the dietary assessment methods used in this study

- **Comparison of the mean nutrient intakes from day 3 of the 3 day dietary record and the mean nutrient intakes from the 24 hour recall**

Significant differences between the day 3 of the 3 day dietary record and the 24 hour recall were found for total fat (mean difference = - 14.3g), saturated fat (mean difference = - 4.9g), monounsaturated fat (mean difference = - 5.7g) and sucrose (mean difference = - 3.6g). There were no significant differences between the day 3 values and the 24 hour recall values for each of the other nutrients analysed. The Bland-Altman analysis showed that there was relatively close agreement between the day 3 of the 3 day dietary record and the 24 hour recall for iron, vitamin C, thiamin, niacin and riboflavin.

- **Comparison of the mean nutrient intakes from the 3 day dietary record (average of 3 days) and the mean nutrient intakes from the 24 hour recall**

The only nutrient which showed a significant difference between the mean of the 3 day dietary record and the 24 hour recall was Vitamin A (mean difference = - 287.6µg). All other nutrients showed no significant differences between the 3 day dietary record and the 24 hour recall.

4.9.3 Comparison of energy intake from the 3 day dietary record and the 24 hour recall compared to total energy requirements

The energy intake from the 3 day dietary record and the 24 hour recall was compared to the total energy requirements using the WHO/FAO Daily Energy Requirement (2001) equations for children, in keeping with the principle that under conditions of energy balance the energy intake should be equal to total energy requirements.

- **Energy intake from the 3 day dietary records compared to the WHO/FAO Daily Energy Requirements (2001)**

A paired t-test was carried out to determine the difference between the mean energy intake from the 3 day dietary record and the total energy requirements (WHO/FAO Daily Energy Requirements -2001). There was a mean difference of – 850.2 kJ/day with the energy intake from the 3 day dietary records tending to be lower than the WHO/FAO Daily Energy Requirements (2001). A p-value of 0.054 from the paired t-test suggests that these two values were not significantly different but almost reached significance at the 5% level.

- **Energy intake from the 24 hour recall compared to the WHO/FAO Daily Energy Requirements (2001)**

A paired t-test was carried out to determine the difference between the mean energy intake from the 24 hour recall and the total energy requirements calculated using the WHO/FAO Daily Energy Requirements (2001). There was a mean difference of -114.2 kJ/day, between the energy intake from the 24 hour recall and the WHO/FAO Daily Energy Requirements (2001), with the energy intake from the 24 hour recall being slightly lower than the WHO/FAO Daily Energy Requirements (2001). A p-value of 0.822 from the paired t-test suggested that there was no significant difference between the energy intake from the 24 hour recall and the WHO/FAO Daily Energy Requirements (2001).

This suggests that there was relatively good agreement between the energy intake from the 3 day dietary record and the WHO/FAO Daily Energy Requirements (2001) and between the energy intake from the 24 hour recall and the WHO/FAO Daily Energy Requirements (2001). This also suggests that there was relatively good agreement between the 2 methods used to assess dietary intake in this study, i.e. the 3 day dietary record and the 24 hour recall.

4.9.4 A summary of the food items eaten by the subjects as determined from the 3 day dietary record and the 24 hour recall

The 3 day dietary records and the 24 hour recalls were analysed to determine the type of food items eaten, the number of children eating them and the average amount of the food item eaten per day (in grams), by those consuming that food item. Some of the most commonly consumed food items from the 3 day dietary record were: brown bread, fruit, vegetables, brick margarine, chicken and white rice. From the 24 hour recall the most

commonly consumed food items were: brown bread, vegetables, breakfast cereals, fruit and white rice.

4.9.5 Comparison of the dietary intake of children with Type 1 Diabetes Mellitus to the dietary recommendations for children with Diabetes Mellitus

- **Mean percentage contribution of macronutrients to total energy as compared to ISPAD Consensus Guidelines (2002)**

The mean percentage contribution of the macronutrients to total energy from the 3 day dietary record were carbohydrate (52%), sucrose (2%), protein (16%) and fat (32%) and from the 24 hour recall as follows: carbohydrate (49%), sucrose (2%), protein (17%) and fat (34%). The mean percentage contribution of sucrose to total energy was significantly lower than the ISPAD Consensus Guideline (2002) from both the 3 day dietary record and 24 hour recall ($p=0.000$). The mean percentage contribution of fat to total energy from the 3 day dietary record was significantly lower than the upper range of 35% of total energy ($p=0.039$).

- **Mean nutrient intakes obtained from the 3 day dietary record (average of 3 days) and the 24 hour recall compared to the USA-EAR/AI**

Table 4.30 presents a summary of the comparison of the mean nutrient intakes from the 3 day dietary record to the USA-EAR/AI and Table 4.31 shows a summary of the comparison of the mean nutrient intakes from the 24 hour recall to the USA-EAR/AI. Table 4.30 highlights the trend towards statistically significantly low calcium intakes and Table 4.31 shows the trend towards statistically significantly low vitamin D intake.

Table 4.30: Summary of mean nutrient intakes statistically significantly different from the USA-EAR/AI from the 3 day dietary record (n=20)

Age group of subjects	Mean nutrient intakes statistically significantly below the USA-EAR/AI	Mean nutrient intakes statistically significantly above the USA-EAR/AI
3 DAY DIETARY RECORD (n=20)		
Subjects ≥ 6 and < 8 years of age	• Dietary fibre • Calcium • Vitamin D	• Total protein • Carbohydrate • Dietary fibre • Magnesium • Phosphorus • Iron • Zinc • Thiamin • Riboflavin • Niacin • Vitamin B_6 • Folate • Vitamin B_{12} • Vitamin C • Vitamin A • Vitamin E
Subjects ≥ 8 and ≤ 10 years of age	• Energy • Calcium	• Total protein • Carbohydrate • Magnesium • Iron • Zinc • Thiamin • Riboflavin • Niacin • Folate • Vitamin B_{12} • Vitamin A

Table 4.31: Summary of mean nutrient intakes statistically significantly different from the USA-EAR/AI from the 24 hour recall (n=16)

Age group of subjects	Mean nutrient intakes statistically significantly below the USA-EAR/AI	Mean nutrient intakes statistically significantly above the USA-EAR/AI
24 HOUR RECALL (n=16)		
Subjects ≥ 6 and < 8 years of age	• Vitamin D	• Total protein • Carbohydrate • Magnesium • Phosphorus • Iron • Zinc • Thiamin • Riboflavin • Niacin • Vitamin B_6 • Folate • Vitamin B_{12} • Vitamin C • Vitamin A • Vitamin E
Subjects ≥ 8 and ≤ 10 years of age	• Vitamin D	• Total protein • Carbohydrate • Iron • Zinc • Thiamin • Riboflavin • Vitamin B_6

- **Mean nutrient intakes obtained from the 3 day dietary record (average of 3 days) and the 24 hour recall compared to the WHO/FAO RNIs**

A summary of the comparison of the mean nutrient intakes from the 3 day dietary record and the 24 hour recall to the WHO/FAO RNIs is shown in Table 4.32. Once again this summary in Table 4.32 highlights the statistically significantly low intakes of vitamin D and calcium.

Table 4.32: Summary of mean nutrient intakes statistically significantly different from the WHO/FAO RNIs from the 3 day dietary record (n=20) and the 24 hour recall (n=16)

Age group of subjects	Mean nutrient intakes statistically significantly below the WHO/FAO RNIs	Mean nutrient intakes statistically significantly above the WHO/FAO RNIs
3 DAY DIETARY RECORD (n=20)		
Subjects ≥ 6 and < 7 years of age	• Vitamin D	• Magnesium • Iron • Thiamin • Vitamin B_6
Subjects equal to 7 and < 9 years of age	• Vitamin D	• Magnesium • Iron • Zinc • Thiamin • Riboflavin • Niacin • Vitamin B_6
Subjects ≥ 9 and ≤ 10 years of age	• Calcium	• Iron
24 HOUR RECALL (n=16)		
Subjects ≥ 6 and < 7 years of age	None	None
Subjects equal to 7 and < 9 years of age	• Vitamin D	• Magnesium • Iron • Zinc • Thiamin • Riboflavin • Niacin • Vitamin B_6 • Vitamin B_{12}
Subjects ≥ 9 and ≤ 10 years of age	• Calcium	• Iron

- **Percentage of the USA-EAR/AI met from the 24 hour recall and the 3 day dietary record for children ≥ 6 and < 8 years of age**

The percentage of the USA-EAR/AI met was above 100% from both the 24 hour recall and the 3 day dietary record for all nutrients with the exception of vitamin D (68% and 52%) and calcium (93% and 67%). The USA-EAR/AI was exceptionally well met for Vitamin B_6 (400% and 320%) and total protein (493% and 380%).

- **Percentage of the USA-EAR/AI met from the 24 hour recall and the 3 day dietary record for children ≥ 8 and ≤ 10 years of age**

The USA-EAR/AI met was above 100% for all nutrients from both the 24 hour recall and the 3 day dietary record except, for vitamin D (36% and 80%), calcium (65% and 58%), energy (88% and 84%) and dietary fibre (90% and 90%). Total protein (319% and 300%) was exceptionally well met.

- **Percentage of WHO/FAO RNIs met from the 24 hour recall and the 3 day dietary record for children ≥ 6 and < 7 years of age**

The percentage of the WHO/FAO RNI met was above 100% for all nutrients from both the 24 hour recall and the 3 day dietary record, except for vitamin D (49% and 22%), energy (89% and 87%) and calcium (93% and 43%). Magnesium (316% and 276%), iron (344% and 216%) and vitamin B_6 (360% and 258%) were exceptionally well met.

- **Percentage of WHO/FAO RNIs met from the 24 hour recall and the 3 day dietary record for children equal to 7 and < 9 years of age**

The only nutrient that did not meet 100% of the WHO/FAO RNI from both the 24 hour recall and the 3 day dietary record was vitamin D (62% and 70%). Iron (247% and 205%) and magnesium (319% and 252%) were exceptionally well met.

- **Percentage of WHO/FAO RNIs met from the 24 hour recall and the 3 day dietary record for children ≥ 9 and ≤ 10 years of age**

The percentage of the WHO/FAO RNI met was less than 100% from both the 24 hour recall and the 3 day dietary record for vitamin D (38% and 85%), calcium (43% and 51%), folate (84% and 82%) and energy (93% and 93%). The WHO/FAO RNI was exceptionally well met for iron (272% and 281%).

4.9.6 Diet-related knowledge in children with Type 1 Diabetes Mellitus

The mean diet-related knowledge score for the sample was 67% with a range of 30% to 100%. When the sample was split at 8 years of age there was a significant difference between the mean score of those subjects ≥ 6 and < 8 years old and those ≥ 8 and ≤ 10 years old, with the children ≥ 8 and ≤ 10 years old scoring higher than the children ≥ 6 and < 8 years old. The hospital clinic which the subjects attended made a significant difference

to the score with those from IALCH having a higher mean score than those subjects that attended the Grey's Hospital clinic. There was a higher level of knowledge about insulin as compared to diet in both groups.

4.9.7 Metabolic control based on HbA_{1c} in children with Type 1 Diabetes Mellitus

The mean latest HbA_{1c} was 9.7% and the mean HbA_{1c} over the previous 12 months was 9.6%. The mean HbA_{1c} and the mean HbA_{1c} value over the previous 12 months were found to be highly significantly greater than the IALCH reference range, the ISPAD reference value and the ADA reference value for HbA_{1c} in children with Type 1 diabetes.

4.9.8 Relationship between BMI for age and metabolic control in children with Type 1 Diabetes Mellitus

There was no correlation between the latest HbA_{1c} values and the Z-score for BMI for age and between the mean HbA_{1c} over the previous 12 months and the Z-score for BMI for age.

4.9.9 Relationships between other variables investigated and metabolic control

- **Relationship between age and metabolic control**

There was a significant positive correlation between age of the participant and the latest HbA_{1c} value but this was not a very strong correlation. This indicated that as age increased so did the latest HbA_{1c} value. When age was split at 8 years, there was a significant difference between the age groups in terms of both the latest HbA_{1c} values and the mean over 12 months with the children ≥ 8 and ≤ 10 years of age having higher HbA_{1c} values than children ≥ 6 and < 8 years of age.

- **Relationship between hospital clinic attended and metabolic control**

The hospital clinic attended made a significant difference to the HbA_{1c} values. Subjects that attended the Grey's Hospital clinic had higher mean values for both the latest HbA_{1c} and the mean HbA_{1c} over 12 months as compared to the children attending the IALCH clinic.

- **Relationship between race groups of subjects and metabolic control**

The race groups of the subjects were associated with differences in the latest HbA_{1c} values and the mean HbA_{1c} values over 12 months. Significant differences were found between

African and Indian children respectively for the latest HbA_{1c} and mean HbA_{1c} values over 12 months, with higher values in African children.

- **Relationship between education level of caregivers and metabolic control**

There was a significant negative correlation between the education level of the caregivers and the latest HbA_{1c} in subjects and the education level of the caregivers and the mean HbA_{1c} level in subjects over 12 months. This suggests that as the education level of the caregiver increased the HbA_{1c} values in subjects tended to decrease. This also suggests that as the education level of the caregiver increased the metabolic control of the subjects improved.

- **Relationship between completion of dietary records and metabolic control**

Subjects who did not complete the 3 day dietary records had significantly lower latest HbA_{1c} values and mean HbA_{1c} values over 12 months as compared to the subjects that completed the 3 day dietary records.

The results that have been presented here will be discussed in the next chapter.

CHAPTER 5: DISCUSSION

5.1 Introduction

In South Africa congenital heart disease, neurological disorders, HIV and asthma are the most prevalent chronic conditions among South African children (Bradshaw *et al* 2003). Type 1 diabetes is also a chronic disease in childhood for which the incidence in South African children is unknown due to the lack of a national register (South African Health Review 2006-Chronic Conditions in Children). In many parts of the world the incidence of Type 1 diabetes in children is increasing by 3-5% per year, making Type 1 diabetes the most common endocrine disease in childhood (Silink 2002a). In South Africa there is a lack of studies on dietary intake and diet-related knowledge in children with Type 1 diabetes. The National Food Consumption Survey (1996) conducted in South African children aged 1-9 years provided some insight into the dietary intake of South African children. This survey revealed that the mean energy intake of children in all provinces in South Africa was below the recommended energy for age while the mean protein intakes in all groups and in all provinces was greater than the RDA. Fat contributed less than 30% of total energy while protein contributed less than 15% of total energy. Carbohydrate intake was greater than 65% of total energy in all provinces except for the Western Cape. The dietary intakes of the following nutrients were found to be less than 67% of the RDA: calcium, iron, zinc, selenium, vitamin A, vitamin D, vitamin E, riboflavin, niacin and vitamin B_6. Overall the great majority of children consumed a diet deficient in energy with poor micronutrient density (NFCS -1999).

The purpose of this study was to assess the dietary intake, diet-related knowledge and metabolic control of children with Type 1 diabetes, aged 6-10 years attending the Paediatric Diabetic Clinics at Grey's Hospital, Pietermaritzburg and Inkosi Albert Luthuli Central Hospital, Durban, KwaZulu-Natal. This was a cross sectional, observational study, which included a total of 30 children with Type 1 diabetes between the ages of 6-10 years from both sites. In the next section the limitations of the study will be discussed first, followed by the results of the study according to the sub problems outlined in Chapter 4.

5.2 Limitations of the study

The sample size in this study was relatively small due to the study parameters and the fact that this was a cross-sectional study done at one point in time with the subjects only being

seen once. The age restriction of 6-10 years resulted in many older children with Type 1 diabetes being excluded from the study and this further contributed to the small sample size. In this study there was a 71% response rate with the 3 day dietary record due to the unreliability of the postal service in some areas of KwaZulu-Natal. With the 24 hour recall there was a 57% response rate due to the unreliability of cellular phone numbers given by the caregivers and the inability of the researcher to contact caregivers on cellular phones on the day that the 24 hour recall needed to be conducted. This reduced the total number of subjects with both the 3 day dietary record and 24 hour recall completed that could be used to report on dietary intake in this study. A total of 25 out of 30 subjects (83%) had completed either a 3 day dietary record and/or 24 hour recall and were able to provide some dietary information for use in the study. Due to the small sample size and the small number of subjects that had completed both the 3 day dietary record and the 24 hour recall the results of this study should be interpreted with caution.

The dietary intake of the subjects in this study was recorded by the caregivers. There is the possibility that the caregivers did not report the dietary intake accurately or honestly which could have influenced the results obtained for dietary intake. The 3 days that were used to record the 3 day dietary record were Friday, Sunday and Monday with the Sunday and Monday being consecutive days. At the time of data collection it was decided to use these days because it was convenient for the caregivers to start data collection on the day following the clinic visit and to complete the record as soon as possible. Ideally the 3 days that make up a 3 day dietary record should be non-consecutive days to minimise the effect of the consumption of leftover food from the previous day. In this study the use of the Sunday and Monday meant that consecutive days were used, which was not ideal.

In the age group studied (6-10 years), the younger children were not able to read and complete the diet-related knowledge questionnaire on their own and required the assistance of the researcher or the translator. This could possibly have affected the responses and the overall diet-related knowledge scores in the younger children. In this study there were other variables that were not recorded that could have had an impact on the diet-related knowledge scores and the metabolic control in the sample. Other variables that could have been included are frequency of clinic visits, frequency of dietetic consults, insulin regime activity level and social history.

Although the majority of the children with Type 1 diabetes in the 6-10 age group from both sites were included in the study it still remains to be seen whether all the children with Type 1 diabetes aged 6-10 years in KwaZulu-Natal requiring treatment at a Provincial Hospital were included in this study. It is very likely that children from a poor socio-economic background may have been omitted from the study because they were not able to attend either the Grey's Hospital or IALCH clinics due to transport costs and a lack of social support. It is likely that only those patients who are financially more stable are in a position to attend the clinics for treatment. This implies that there may be a gap in the understanding of what is happening in poorer children with Type 1 diabetes.

5.3. Sample characteristics

A larger number of subjects were seen at the IALCH clinic (n=22) as compared to the Grey's Hospital clinic (n=8). This was due to the fact that the IALCH clinic had approximately 157 children in total attending the clinic, while Grey's Hospital had approximately 43 children in total attending the clinic. Most of the children in the 6-10 year age group attending the 2 clinics were included in the study as a total of 30 out of a possible 35 children between 6-10 years attending the 2 clinics were included in the study. There was a slightly higher number of males at both clinics and in the total sample [n=17 (57%)]. This could suggest that Type 1 diabetes in children between the ages of 6-10 years attending the Paediatric Diabetic Clinics at Grey's Hospital and IALCH is more prevalent in males than females but this needs to be confirmed with a larger sample size. The mean age in the sample was 8.56 years with a similar age range in both clinics. Although the sample size was small (n=30) this was the maximum number of subjects which could be obtained for this age group as there were only 2 sites (Grey's Hospital and IALCH) from which the subjects could be drawn. It was also necessary to keep to the 6-10 year age group to avoid including subjects who had already reached puberty.

At Grey's Hospital, African subjects made up the majority of the sample [n=6/8 (75%)], while Indian subjects made up the majority of the sample at the IALCH clinic [n=13/22 (59%)]. This could be due to the racial breakdown of the areas that the clinics serve and also the fact that Africans make up 84.9% of the total KwaZulu-Natal population while Indians make up the second highest with 8.5% of the total population in KwaZulu-Natal. Furthermore, in Durban, Africans account for the highest proportion of the total population at 68.3% while Indians account for the second highest of the total population at 19.9% (SA

Census 2001). Indian subjects also contributed to the majority of the total sample [n=14 (47%)] followed by African subjects [n=10 (33%)], Coloured subjects [n=3 (10%)] and White subjects [n=3 (10%)]. It is interesting to note that Indian subjects made up the highest percentage of the sample [n=14 (47%)] and according to the South African Demographic and Health Survey [SADHS-(2003)] conducted in men and women over the age of 15 years, the Indian community had the highest self-reported prevalence of diabetes in South Africa (23.9%) followed by Whites (9.7%), Coloureds (8.6%) and Africans (5.4%) [SADHS-2003].

The low number of White and Coloured subjects in the sample could suggest that Type 1 diabetes is less prevalent in children in these two racial groups or it may be that there are more diagnosed but are being managed privately. Although there is no national register for children with Type 1 diabetes in South Africa the racial profile of children with Type 1 diabetes between the ages of 6-10 years attending the Paediatric Diabetic Clinics at Grey's Hospital, Pietermaritzburg and Inkosi Albert Luthuli Central Hospital in KwaZulu-Natal could be a good indication of the overall racial profile of children with Type 1 diabetes between the ages of 6-10 years in KwaZulu-Natal. The mean duration of diagnosis of children attending the Grey's Hospital clinic was higher (4.97 years) as compared to the subjects attending the IALCH clinic (3.11 years). This may suggest that the IALCH clinic is seeing more newly diagnosed patients than the Grey's Hospital clinic. This is also likely as IALCH services a larger area in KwaZulu-Natal (Ganie 2007) and there are likely to be more newly diagnosed cases on a regular basis.

Socioeconomic status and education status of caregivers

Information on socioeconomic status and education status could only be obtained from 22 caregivers as the rest of the caregivers could not be contacted by telephone. The mean monthly income varied from between R1-R500 and greater than R5000. Twelve out of the 22 caregivers (55%) had a monthly income of greater than R3000 while 10 caregivers (45%) had a monthly income of less than R3000. This suggests that the socioeconomic status of the caregivers and subjects was relatively good. Lower monthly incomes were generally due to unemployment of one or both of the caregivers. The overall conclusion on the socioeconomic status of the caregivers and subjects can be confirmed by looking at the food items that were most commonly consumed by the subjects. According to the 3 day

dietary record (n=20) fruit, vegetables and chicken, which are relatively expensive food items, were amongst the most commonly consumed food items.

Seven caregivers (32%) had a highest formal education level of between standard 6-8 (grade 8-10) while 11 (50%) had a highest formal education level of between standard 9-10 (grade 11-12). Four caregivers (18%) were educated at tertiary level and 15 of the caregivers (68%) had a highest formal education level of standard 9 (grade 11) and above. This suggests that the caregivers were relatively well educated with the majority [n=15 (68%)] having a standard 9 (grade11) pass and above.

Anthropometric status of subjects

A total of 18 subjects (60%) had a healthy weight [defined as BMI for age between 5th to less than the 85th percentile (CDC-2000)] while 1 subject (3%) was underweight [defined as BMI for age less than the 5th percentile (CDC-2000)]. Nine subjects (30%) were at risk for overweight [defined as a BMI for age between the 85th to less than the 95th percentile (CDC-2000)] while 2 subjects (7%) were overweight [defined as BMI for age equal to or greater than the 95th percentile (CDC-2000)]. It is also interesting to note that 4 subjects (13%) were found to be stunted. This shows that the sample had a very diverse anthropometric status. This is in keeping with the finding that in South Africa, children with moderate stunting, or overweight, or obesity may be found in the same population (Jinabhai *et al* 2005).

Stunting in children with Type 1 diabetes may result from chronic inadequate energy intake especially in younger children where caregivers may restrict their dietary intake in an attempt to achieve good metabolic control. In a study by Virtanen *et al* (2000), the authors found that energy intake in diabetic children under 6 years of age was lower than in children of the same age without diabetes and this was thought to be due to greater control imposed on younger children with diabetes by caregivers. It is also likely that stunting in children with diabetes may be seen more often in younger children with a longer duration of diagnosis because of chronic inadequate energy intake. In this study the 4 children that were found to be stunted had a mean age of 7.81 years and had a mean duration of diagnosis of 4.33 years (range = 2.25-5.75 years). The mean duration of diagnosis in the total sample was 3.61 years (range = 0.83-10.92 years). It is possible that the stunting seen in these younger subjects with a relatively longer duration of diagnosis as compared to the

mean duration of diagnosis in the total sample could possibly be due to a longer period of energy restriction imposed by caregivers. The number of children at risk for overweight (n=9) and the number of children overweight (n=2) is of concern as an overweight diabetic may find it more difficult to achieve good glycaemic control (McCough 2004).

5.4 Comparison of the dietary assessment methods used in this study

5.4.1 Comparison of the mean nutrient intakes from day 3 of the 3 day dietary record and mean nutrient intakes from the 24 hour recall

It is important to bear in mind that neither the estimated 3 day dietary record nor the 24 hour recalls are regarded as "gold standards" in assessing dietary intake in children, and these methods were chosen for use in this study because they were practical and feasible within the constraints of this study. It is very likely that there was some degree of underreporting and/or overreporting of intake due to the fact that the dietary intake was recorded by caregivers and not the children themselves. Generally underreporting is more prevalent than overreporting when carrying out dietary assessment, especially with energy intake, and researchers seem to focus more on underreporters of energy intake as compared to overreporters of energy intake (Gibson 2005, p 109).

The nutrients for which there were significant differences between the 3 day dietary record and the 24 hour recall were: total fat, saturated fat, monounsaturated fat and sucrose with the mean intake from the 24 hour recall being higher than the mean intakes from the 3 day dietary record with all of these nutrients. A common factor amongst all these nutrients is that they are contained naturally within foods and are also added to food items during cooking and preparation or prior to eating e.g. table sugar, sweeteners, fat spreads and cooking oil. These items are commonly omitted when subjects record dietary intake on their own. The larger values for total fat, saturated fat, monounsaturated fat and sucrose from the 24 hour recall as compared to the 3 day dietary record in this study could be due to the fact that the 24 hour recalls were conducted by a Registered Dietitian who may have been able to obtain a more accurate account of fat and sucrose intake by the subjects, through the use of probing questions while conducting the recall.

The Bland-Altman analysis revealed that there was relatively good agreement between day 3 of the 3 day record and the 24 hour recall for iron, vitamin C, thiamin, niacin and riboflavin as the bias (difference between the means of the two methods) was relatively

close to zero. There was poor agreement between day 3 of the 3 day record and the 24 hour recall for other nutrients as the bias was far off from zero. This again may have been due to underreporting or overreporting of dietary intake. According to O'Connor *et al* (2001), inaccurate reporting of dietary intakes in children may be due to deliberately failing to record all items eaten or forgetting to report all items eaten. Another point to consider is that the caregivers may deliberately alter the child's intake so that it is more in line with what the caregiver believes is "ideal." Children also spend a significant time away from their caregivers and researchers may have to rely on reports of dietary intake from the child or other caregivers who may not be aware of the need for accurate reporting of dietary intake for the study (O'Connor *et al* 2001). In this study the child was not always present when the 24 hour recall was being taken from the caregiver, by the researcher over the telephone, so a consensus recall in which the mother, father and child report together was not always possible. According to Eck *et al* (1989) the consensus recall, produced the most accurate estimate of the child's observed dietary intake and it also appeared to reduce the tendency to over-report low intakes and under-report high intakes (Eck *et al* 1989).

5.4.2 Comparison of the mean nutrient intakes from the 3 day dietary record (average of 3 days) and the mean nutrient intakes from the 24 hour recall

The only nutrient which showed a significant difference was vitamin A (mean difference = - 287.6µg). All other nutrients showed no significant differences between the 3 day dietary record and the 24 hour recall. One of the reasons for the significant differences in vitamin A levels could be due to the fact that vitamin A is found in concentrated amounts in some foods such animal liver, fish oil, milk and milk products and fortified cereals while other foods may contain very little or no active vitamin A. A change in intake of vitamin A-rich sources from one day to the other by the subjects could have resulted in a significant difference in vitamin A intake between days.

5.4.3 Comparison of energy intake (from the 3 day dietary record and the 24 hour recall) compared to total energy requirements

The mean difference between the energy intake from the 3 day dietary record and the WHO/FAO Daily Energy Requirement (2001) was – 850.2 kJ/day with the energy intake from the 3 day dietary records tending to be lower than the WHO/FAO Daily Energy Requirements (2001). There was a mean difference of -114.2 kJ/day, between the energy

intake from the 24 hour recall and total energy requirements using the WHO/FAO Daily Energy Requirements (2001), with the energy intake from the 24 hour recall being slightly lower than the WHO/FAO Daily Energy Requirements (2001). Neither of these values was significantly different which suggested that there was relatively good agreement between the reported energy intake and the energy requirements. This suggests that the reported energy intake from the 3 day dietary record was similar to the reported energy intake from the 24 hour recall.

5.4.4 Overall conclusion on methods used to assess dietary intake in this study

The method used to assess nutrient intake in a study depends mainly on the objectives of the study with the understanding that no method is free from errors or prevents a change in the eating habits of the subjects. A level one study objective which is to measure the mean nutrient intake of a group can be met by measuring the dietary intake of each subject using a single 24 hour recall or a 1 day food record, provided that subjects are representative of the study population and all days are equally represented. A level 2 study objective which involves identifying a population at risk of inadequate nutrient intakes, can be met by replicating observations on each individual or a subsample using 24 hour recalls or weighed or estimated 1 day food records. A level 3 study objective involves ranking individuals within a group according to nutrient intake and can be met with multiple replicates of 24 hour recalls or food records or semi-quantitative food frequency questionnaires. A level 4 study objective is usually the most difficult to obtain and involves obtaining usual nutrient intakes in individuals for correlation or regression analysis. This involves the use of a larger number of recalls or records for each individual or a semiquantitive food frequency questionnaire or diet history (Gibson 2005, p55-58). The methodology used in this study i.e. single 24 hour recall and estimated food record allows one to assess the mean nutrient intake of a group but does not allow for identification of populations at risk for inadequate intake, ranking of individuals within a group according to usual intakes or carrying out correlation or regression analysis (Gibson 2005, p 55).

A study by O'Connor *et al* (2001) which aimed to compare energy intake from diet records and total energy expenditure from the doubly labelled water method in order to investigate misreporting of energy intake made use of the same dietary methodology as used in this current study. O'Connor *et al* (2001) conducted the study in 47 Australian children aged 6-9 years and made use of an estimated 3 day diet record with 3 consecutive days using two

weekdays and one weekend day. Household measures were used to describe quantities of food items eaten and caregivers were given a booklet to record the food and drink intake together with a sample of a completed record and a set of metric measuring cups and spoons. O' Connor *et al* (2001) concluded that the 3 day diet record lacked precision in describing dietary intake at an individual level but was suitable for describing dietary intake at the group level (O' Connor *et al* 2001). This confirms that the use of the estimated 3 day dietary record to assess dietary intake in this study was suitable and appropriate for the purposes of this study.

Results from the Bland-Altman analysis and the comparisons between day 3 of the 3 day dietary record and the 24 hour recall and the mean of the 3 day dietary record and the 24 hour recall suggests that there were significant differences in intake of some nutrients between the 3 day record and the 24 hour recall. There was a tendency for the nutrient intake values from the 24 hour recall to be higher than the 3 day record because the recall was obtained by a Registered Dietitian while the 3 day dietary record was recorded by the caregivers. The fact that the energy intakes from the 3 day dietary record and the 24 hour recall were similar to the energy requirements does suggest that the two methods provided similar results on energy intake. Although there were some differences in nutrient intake between the two methods the use of both the 3 day dietary record and the 24 hour recall in this study has provided a better overall estimation of dietary intake in these subjects.

5.5 A summary of food items eaten by the subjects as determined from the 3 day dietary record and the 24 hour recall

According to the 3 day dietary record the 6 most commonly eaten food items were brown bread, fruit, vegetables, brick margarine, chicken and white rice and according to the 24 hour recall the 7 most commonly eaten food items were brown bread, vegetables, breakfast cereals, fruit, white rice, low fat milk and sugar. Brown bread, fruit, vegetables and white rice featured among the most commonly eaten food items from both the 3 day dietary record and the 24 hour recall. These findings are very different to findings of the NFCS (1999) which found that the 5 most commonly consumed food items in non-diabetic South African children aged 1-9 years were maize, sugar, tea, whole milk and brown bread. Only brown bread and sugar which were commonly consumed food items from the NFCS (1999) seem to feature among the most commonly consumed items in this study. The fact that brown bread was the most commonly eaten food item from both the 3 day dietary

record and the 24 hour recall in this study confirms that bread is an excellent choice as a food vehicle for micronutrient fortification in South Africa. It is interesting to note that although sugar featured well among the most commonly eaten food items from the 24 hour recall in this study, the mean percentage contribution of sugar to total energy for the sample was only 2% compared to the ISPAD Guideline of not > 10% of total energy (ISPAD Consensus Guideline 2002). The type of food items most commonly consumed also gives an indication of the socio-economic status of the caregivers and subjects. Vegetables, fruit and chicken were among the most commonly eaten food items in this study and these tend to be relatively expensive items. This confirms that the caregivers and subjects had a relatively good socioeconomic status.

5.6 Comparison of the dietary intake of children with Type 1 Diabetes Mellitus to the dietary recommendations for children with Diabetes Mellitus

Dietary intake data in this study was obtained from a 3-day dietary record and was validated by taking a 24 hour recall of the 3rd day of the 3-day dietary record. Only 20 completed 3 day dietary records were received by post. One subject was ill during the data collection period and did not complete the record while one subject did not remember to take home the materials needed to complete the record. The relatively low number of completed records received could have been due to the unreliability of the postal service as most caregivers that were contacted were able to confirm that the records were posted but these were not received by the researcher. Only 16 completed 24-hour recalls were obtained by telephone. This was due to the unreliability of cellular phone numbers and the fact that most caregivers who were only contactable by cellular phone had their phones switched off when the 24-hour recall needed to be obtained. However a total of 25 out of 30 subjects (83%) had completed either the 3 day dietary record and/or 24 hour recall and were able to provide some dietary information that could be used in this study.

In the next section the percentage contribution of the macronutrients to total energy as compared to the ISPAD Consensus Guidelines (2002) will be discussed. The comparison of the mean dietary intake values from the 3 day dietary record and the 24 hour recall to the USA-EAR/AI and the WHO/FAO RNIs will also be discussed. Due to the lack of specific recommendations for micronutrients in children with diabetes the levels of intake of micronutrients obtained from the subject's dietary intake were compared to the Dietary Reference Intakes (DRIs) of the Institute of Medicine, Food and Nutrition Board, United

States of America (USA) (1997-2002) and the World Health Organisation (WHO) and Food and Agriculture Organisation (FAO) of the United Nations (UN) Recommended Nutrient Intakes (RNIs) (1998).

5.6.1 Mean percentage contribution of macronutrients to total energy as compared to ISPAD Consensus Guidelines (2002)

In this section the mean percentage contribution of macronutrients to total energy as compared to the ISPAD Consensus Guidelines (2002) will be discussed as well as mean percentage contribution of macronutrients to total energy from other studies which have been conducted in children with Type 1 diabetes in the USA and Finland.

- **Carbohydrate**

The mean contribution of carbohydrate to total energy from the 3 day dietary record and the 24 hour recall was 52% and 49% respectively which compared well to the ISPAD Consensus Guideline (2002) of > 50%. This suggests that the subjects were consuming adequate amounts of carbohydrate and were not at risk for hypoglycaemia with inadequate carbohydrate intake or hyperglycaemia with excessive carbohydrate intake. These findings were also in keeping with reported carbohydrate intakes as a percentage of total energy in children with Type 1 diabetes, by the following researchers: Randecker *et al* (1996)[14] [53%], Virtanen *et al* (2000)[15] [52%], Mayer-Davis *et al* (2006)[16] [49%] and Patton *et al* (2007)[17] [53%].

- **Sucrose**

Mean intake of sucrose as a percentage of total energy was 2% from both the 3 day dietary record and the 24 hour recall and this was significantly lower than the ISAPD Consensus Guideline (2002) of not greater than 10% of total energy. The low intake of sucrose could be due to the fact that the use of sucrose in the diabetic diet has traditionally been associated with increased blood sugar levels (Coulston 1994) and many caregivers may be restricting the intake of sugar to prevent a rise in blood sugar levels. However it is also

[14] Study conducted in 66 children with Type 1 Diabetes Mellitus aged 4-9 years in the United States of America.
[15] Study conducted in 39 children with Type 1 Diabetes Mellitus under the age of 6 years in Finland.
[16] Study conducted in 740 children with Type 1 Diabetes Mellitus between 10-14 years in the United States of America.
[17] Study conducted in 33 children with Type 1 Diabetes Mellitus between 2-8 years in the United States of America.

likely that the sucrose intake in this study may have been underreported as the children spent a significant time away from their caregivers whilst attending school and it is possible that sucrose intake during this time period was not adequately or honestly reported by the children to the caregivers. Although not many studies have reported sucrose intake in children with Type 1 diabetes, Virtanen *et al* (2000) also reported a low sucrose intake of 3% of total energy (Virtanen *et al* 2000).

- **Protein**

The mean percentage contribution of protein to total energy from the 3 day dietary record and the 24 hour recall in this study were 16% and 17% respectively. Although this was higher than the ISPAD Consensus Guideline (2002) of not > 15% of total energy it was not significantly higher. The percentage contribution of protein to total energy in this study is similar to findings by other researchers. Randecker *et al* (1996) and Mayer-Davis *et al* (2006) reported protein intakes of 17% and 16% of total energy respectively, in children with Type 1 diabetes.

- **Fat**

The mean percentage contribution of fat to total energy from the 3 day dietary record and the 24 hour recall in this study were 32% and 34% respectively. This was still lower than the ISPAD Consensus Guideline (2002) of not > 35% of total energy. Other researchers have also reported similar fat intakes in terms of percentage of total energy in children with Type 1 diabetes i.e. Randecker *et al* (1996) [32%] and Patton *et al* (2007) [34%]. Although the fat intake in this study was below 35% of total energy it is still important to monitor fat intake in children with Type 1 diabetes as fat intake may be increased to account for the reduced energy resulting from a simple carbohydrate restriction (Kinmonth *et al* 1989). Increased fat and specifically saturated fat intake in children with Type 1 diabetes may increase the risk of cardiovascular problems and may aggravate already increased lipid and lipoprotein levels (Schmidt *et al* 1992).

This study compared the mean percentage contribution of macronutrients to total energy to the ISPAD Consensus Guidelines (2002) to assess whether dietary intake was similar to dietary recommendations for children with Type 1 diabetes. The dietary data obtained from this sample as at the time of data collection suggest that there was compliance with dietary intake as the mean percentage contribution of macronutrients to total energy was similar to

the ISPAD Consensus Guidelines (2002). There are however other factors related to dietary intake that could possibly affect metabolic control that were not investigated in this study. This includes meal frequency, form in which carbohydrate was eaten, glycaemic index of the meal, insulin dose and regime.

5.6.2 Mean nutrient intakes obtained from the 3 day dietary record and the 24 hour recall compared to the USA-EAR/AI and the WHO/FAO RNIs

A summary of the nutrients consumed at levels statistically significantly below the USA-EAR/AI and the WHO/FAO RNIs from the 3 day dietary record and the 24 hour recall are shown in Table 5.1. Table 5.1 highlights the fact that calcium and vitamin D were consumed in amounts statistically significantly lower than the USA-EAR/AI and the WHO/FAO RNI from both the 3 day dietary record and the 24 hour recall in most of the age groups.

Table 5.1: Mean nutrient intakes statistically significantly below the USA-EAR/AI* and the WHO/FAO RNIs** from the 3 day dietary record and the 24 hour recall

Age group of subjects	**Mean nutrients intakes statistically significantly below the USA-EAR/AI**
3 day dietary record	
Subjects ≥ 6 and < 8 years of age	• Dietary fibre • Calcium • Vitamin D
Subjects ≥ 8 and ≤ 10 years of age	• Energy • Calcium
24 hour recall	
Subjects ≥ 6 and < 8 years of age	• Vitamin D
Subjects ≥ 8 and ≤ 10 years of age	• Vitamin D
Age group of subjects	**Mean nutrients intakes statistically significantly below the WHO/FAO RNIs**
3 day dietary record	
Subjects ≥ 6 and < 7 years of age	• Vitamin D
Subjects equal to 7 and < 9 years of age	• Vitamin D
Subjects ≥ 9 and ≤ 10 years of age	• Calcium
24 hour recall	
Subjects ≥ 6 and < 7 years of age	None
Subjects equal to 7 and < 9 years of age	• Vitamin D
Subjects ≥ 9 and ≤ 10 years of age	• Calcium

* DRIs from the Institute of Medicine, Food and Nutrition Board, Washington DC:

- Dietary Reference Intakes for energy, carbohydrate, fibre, fat, fatty acids, cholesterol, and protein and amino acids (2002).
- Dietary Reference Intakes for vitamin A, vitamin K, arsenic, boron, chromium, copper, iodine, iron, manganese, molybdenum, nickel, silicon, vanadium and zinc (2001).
- Dietary Reference Intakes: Applications in dietary assessment (2000).
- Dietary Reference Intakes for vitamin C, vitamin E, selenium and carotenoids (2000).
- Dietary Reference Intakes for thiamin, riboflavin, niacin, vitamin B_6, folate, vitamin B_{12}, pantothenic acid, biotin and choline (1998).
- Dietary Reference Intakes for calcium, phosphorus, magnesium, vitamin D and Fluoride (1997).

** World Health Organisation (WHO) and Food and Agriculture Organisation (FAO) of the United Nations (UN) Recommended Nutrient Intakes (RNIs) (1998).

Inadequate intakes of calcium and vitamin D have also been reported by other researchers investigating dietary intake in children with Type 1 diabetes. Patton *et al* (2007) found that less than 50% of children with Type 1 diabetes aged 2-8 years met 100% of the daily USA-EAR/AI for calcium while Randecker *et al* (1996) and Virtanen *et al* (2000) also reported low intakes of vitamin D in children with Type 1 diabetes. Patton *et al* (2007) also reported significantly low intakes of vitamin B_{12} while Randecker *et al* (1996) also reported low intakes of zinc. Intake of all other micronutrients either met or exceeded the recommendations (Patton *et al* 2007; Virtanen *et al* 2000; Randecker *et al* 1996). One would not expect to find low intakes of micronutrients in these studies as the studies were conducted in developed countries such as the USA and Finland. It is also interesting to note that the low intakes of micronutrients were seen in countries like the USA and Finland where malnutrition is not as widespread as in the case of developing countries. The low intake of micronutrients seen in these studies could be due to the fact that the subjects with Type 1 diabetes were consuming special diets and that the close supervision of caregivers could have resulted in an overly restricted dietary intake.

From the South African NFCS (1999) micronutrients that were consumed at levels below 67% of the RDA included iron, zinc, selenium, vitamin A, vitamin C, vitamin E, riboflavin, niacin and vitamin B_6 as well as calcium and vitamin D (NFCS 1999). After looking at the micronutrient intakes from the NFCS (1999), one would have expected to

see significantly low intakes of other micronutrients in this study. The fact that only calcium and vitamin D were consumed at levels significantly lower than the USA-EAR/AI and the WHO/FAO-RNIs in this study suggest that the intake of other micronutrients were adequate due to the mandatory fortification of bread flour and maize meal with vitamin A, thiamin, riboflavin, niacin, vitamin B_6, folate, zinc and iron in South Africa. It is also important to note that the socioeconomic status of the subjects included in the NFCS (1999) was very different to the socioeconomic status of the subjects included in this study. One possible explanation for the low vitamin D intake in this study could be due to the fact that vitamin D is a fat soluble vitamin and children with Type 1 diabetes may be more conscious of reducing their total dietary fat intake. This is also likely due to the fact that the intake of fat as a percentage of total energy in this study (32% from the 3 day dietary record and 34% from the 24 hour recall) was below the ISPAD Consensus Guideline (2002) of not more than 35% of total energy. The low intake of vitamin D by the subjects in this study must be interpreted with caution and it must not be assumed that a low intake of vitamin D is necessarily associated with a vitamin D deficiency. This is because vitamin D is actually a prohormone and can be synthesised naturally in the skin after exposure to ultraviolet-B radiation from the sun (Greer 2004). Although the amount of sunlight exposure required to prevent vitamin D deficiency in children is determined by the environment and skin pigmentation, it is widely accepted that in sunny countries like South Africa vitamin D deficiency is unlikely to be caused by inadequate exposure to sunlight (Greer 2004; Pettifor 2004). There is currently a debate on the concentration of serum 25 hydroxyvitamin D required to prevent adverse outcomes such as osteomalacia, rickets, increased fracture risk, decreased bone density and colon cancer (Vieth, Bischoff-Ferrari, Boucher, Dawson-Hughes, Garland, Heaney, Holick, Hollis, Lamberg-Allardt, McGrath, Norman, Scragg, Whiting, Willett & Zitterman 2007). It has also been suggested that lower serum concentrations of 25 hydroxyvitamin D may be associated with increased risk for diabetes and increased HbA_{1c} levels in adults in the United Kingdom (Hypponen & Power 2007). It would therefore be interesting to measure the levels of serum 25 hydroxyvitamin D in the subjects in this study especially in view of the low intakes of vitamin D.

The low intakes of calcium in this study can also be confirmed by looking at the intake of milk and milk products which are good sources of calcium. According to the 3 day dietary record, milk (including skim, low fat and full cream) was consumed by all 20 subjects with

a mean intake of 176g/day. From the 24 hour recall, milk (including skim, low fat and full cream) was consumed by all 16 subjects with a mean intake of 143g/day. Low intakes of calcium in children may be due to the replacement of milk and milk products with soft drinks or fruit juices. In this study 12 out of 20 subjects consumed an average of 256g of diet soft drinks per day from the 3 day dietary record while 8 out of 16 subjects consumed an average of 289g of diet soft drinks per day from the 24 hour recall. The mean daily intake of milk was lower than the mean daily intakes of diet soft drinks from both the 3 day dietary record and the 24 hour recall. Low calcium intakes as reported in this study is of concern as low calcium intakes in children from developing countries can result in reduced bone density and nutritional rickets (Pettifor 2004).

5.7 Diet-related knowledge in children with Type 1 Diabetes Mellitus

The mean diet-related knowledge score for the sample was 67% with a range of 30%-100%. This suggests that the diet-related knowledge in this sample was relatively good. This is in contrast to findings from Johnson *et al* (1982), Collier & Etzwiler (1971), Etzwiler (1962) & Etzwiler & Sines (1962) who all found deficits in knowledge on diabetes in children with diabetes. When the sample was split at 8 years in this study there was a significant difference between the means score of those ≥ 6 and < 8 years of age and those ≥ 8 and ≤ 10 years of age. This suggests that diet-related knowledge increased with age in the sample and is in keeping with findings from other researchers. Studies by Johnson *et al* (1982), Collier & Etzwiler (1971), Etzwiler (1962) & Etzwiler & Sines (1962) showed that there was a correlation between age and the performance in the knowledge assessment where diabetes knowledge increased with an increase in age. This suggests that there might be a specific age before which certain levels of understanding and comprehension may be lacking and that there are specific ages at which certain aspects of diabetes management should be taught for optimal comprehension and understanding by children with diabetes (Johnson *et al* 1982; Collier & Etzwiler 1971).

The hospital clinic which the subjects attended made a significant difference to the diet-related knowledge score, with those from IALCH having a higher mean score (71%) than those subjects that attended the Grey's Hospital clinic (56%). It is also important to note that 4 out of 22 subjects attending the IALCH clinic had diet-related knowledge scores below 50% while 1 out of 8 subjects attending the Grey's Hospital clinic had a diet-related knowledge score below 50%. This may have resulted in a skewed result for the Grey's

Hospital subjects. It is also interesting to note that the subjects attending the Grey's Hospital clinic had a longer mean duration of diagnosis (4.97 years) than the subjects attending the IALCH clinic (3.11 years), yet the Grey's clinic subjects had a lower mean diet-related knowledge score. One would expect the diet-related knowledge score to have been higher in those subjects with a longer duration of diagnosis as the subjects would have been exposed to dietary education for a longer period and should have been more familiar with the basic dietary guidelines for diabetes. There was no statistically significant relationship between the mean duration of diagnosis and the mean diet-related knowledge scores.

The frequency of dietetic consultations and the availability of the Dietitian at the clinic for dietary education may also have contributed to the difference in diet-related knowledge between the two clinics. During data collection it was noticed that a Dietitian was almost always physically present at the IALCH clinic on each clinic visit while the Dietitian at the Grey's clinic may not have been physically present at each clinic visit, due to staff shortages and other job commitments. The higher mean diet-related knowledge score in the IALCH subjects could also be attributed to the fact that the subjects at the IALCH clinic attend the clinic more often as compared to the subjects that attend the Grey's Hospital clinic (Ganie 2007; McKerrow 2007). More frequent visits to the clinic by the IALCH subjects is most likely associated with more frequent dietetic consultations which could also have contributed to the higher mean diet-related knowledge score in the IALCH subjects. It would have been useful to compare the frequency of dietetic consultations with the diet-related knowledge scores, but the frequency of dietetic consultations was not recorded for the purposes of this study. The fact that the IALCH clinic has a Paediatric Trained Diabetic Nurse Educator in the clinic (Ganie 2007) while the Grey's Hospital clinic does not may also have contributed to the higher mean diet-related knowledge scores in the IALCH subjects. Another factor that may contribute to the higher diet-related knowledge scores in the IALCH patients is the fact that is sometimes compulsory for the child and the caregiver to see the Dietitian before leaving the IALCH clinic, if the Doctor feels that there is a need for a Dietetic consultation. This is controlled by holding back the prescription for medication until the child and caregiver have consulted with the Dietitian (Moodley 2007). This may result in an increased frequency of Dietetic consultations at the IALCH clinic.

The subjects displayed a higher level of knowledge about insulin questions (mean score of 71%) as compared to diet-related questions (mean score of 66%). This could be due to the fact that insulin-related knowledge is required on a daily basis for preventing acute complications of diabetes as compared to diet-related knowledge. As a result subjects may have acquired a greater insulin-related knowledge as compared to diet-related knowledge.

5.8 Metabolic control based on HbA_{1c} in children with Type 1 Diabetes Mellitus

The mean latest HbA_{1c} value for the sample was 9.7% and the mean HbA_{1c} over the 12 months immediately prior to data collection was 9.6%. Both these values were significantly higher than the reference range used at the IALCH Pathology Laboratory (4.8-6.0%), the ISPAD recommendation (not > 7.6%) and the ADA Guideline (not > 8%). Only 17% (n=5) of subjects had a mean latest HbA_{1c} value of less than 8% while only 17% (n=5) had a mean HbA_{1c} over 12 months that was lower than 8%. The mean latest HbA_{1c} and the mean HbA_{1c} over 12 months from this study are similar to HbA_{1c} values reported by other researchers investigating metabolic control in children with Type 1 diabetes. Mortensen & Hougaard (1997) reported a mean HbA_{1c} value of 8.6% with only 34% of patients achieving an HbA_{1c} value of less than 8% while Dorchy *et al* (1997) reported a mean HbA_{1c} of 6.6%. A study by Rosilio *et al* (1998) reported a mean HbA_{1c} value of 8.97% with only 33% of subjects achieving an HbA_{1c} of less than 8%. Patton *et al* (2007) reported a mean HbA_{1c} of 8.3%. Although aiming for an HbA_{1c} of < 8% is desirable, it is also very difficult to achieve. According to the Diabetes Control and Complication Trial Research Group (1994) less than 50% of the adolescents receiving intensive treatment in the trial achieved a mean HbA_{1c} of less than 8%.

Although the mean HbA_{1c} from the other studies (Patton *et al* 2007; Rosilio *et al* 1998; Mortensen & Hougaard 1997) was higher than 8%, the mean latest HbA_{1c} value from this study was still higher than the mean HbA_{1c} values reported by Patton *et al* (2007), Rosilio *et al* (1998) and Mortensen & Hougaard (1997). According to the ISPAD Consensus Guidelines (2002), an HbA_{1c} of between 7.6%-9.0% is regarded as being suboptimal while an HbA_{1c} of over 9.0% is regarded as high risk with action being required (ISPAD Consensus Guidelines 2002). The mean HbA_{1c} values reported in this study are of concern as the United Kingdom Prospective Diabetes Study (UKPDS) showed that the risks of complications associated with diabetes can be significantly lowered when HbA_{1c} values are less than 8.0% while the Diabetes Control and Complications Trial (DCCT) showed that a

rise in HbA_{1c} above 7.5% was found to be associated with an increased risk of later micro vascular complications [Position Statement of the ADA: Implications of the United Kingdom Prospective Diabetes Study (UKPDS) (2000); Position Statement of the ADA: Implications of the DCCT (2000)]. Although these findings were applicable to adult subjects with diabetes it is important to remember that children with diabetes have a lifetime of diabetes to manage and having an HbA_{1c} that is above the optimal can increase the risk for long-term complications in this group of children.

5.9 Relationship between BMI for age and metabolic control in children with Type 1 Diabetes Mellitus

Although it has been suggested that BMI for age in children with diabetes may be related to metabolic control, the results from this study showed that there was no significant correlation between the Z-score for BMI for age and the mean latest HbA_{1c} values or the Z-score for BMI for age and the mean HbA_{1c} values over the previous 12 months as at the date of data collection. This could possibly be due to the diverse anthropometric status of the subjects in this study. This finding was also in keeping with the results from other studies as Schmidt *et al* (1992) also failed to find a significant correlation between BMI for age and metabolic control in a study of 69 subjects with Type 1 diabetes between the ages of 4-18 years old.

5.10 Relationships between other variables investigated and metabolic control

Possible relationships between age, gender, frequency of self-monitoring of blood glucose, duration of diagnosis, diet-related knowledge score, hospital clinic attended, race group of subjects, monthly income per household, education level of the caregivers and completion/non completion of dietary records by subjects and metabolic control were investigated. It was not possible to look at relationships between metabolic control and diet as the dietary assessment methods used in this study did not allow for this. Only those variables for which significant findings were obtained are discussed in the next section.

5.10.1 Relationship between age and metabolic control

There was a significant positive correlation between age of the participant and the latest HbA_{1c} value. Although this was not a very strong correlation, this indicated that as age increased so did the latest HbA_{1c} value. There was no correlation between mean HbA_{1c} over 12 months and age which is in keeping with the idea that the mean HbA_{1c} over 12

months is less closely related to age than the mean latest HbA_{1c}. When age was split at 8 years, there was a significant difference between the age groups in terms of both the latest HbA_{1c} values and the mean over 12 months. The children ≥ 8 and ≤ 10 years of age had higher values than the children ≥ 6 and < 8 years of age.

Similar findings of a positive correlation between increasing age and HbA_{1c} was also reported by Daneman *et al* (1981), Mortensen & Hougaard (1997), Levine *et al* (2001) and Haller *et al* (2004) The positive correlation between HbA_{1c} values and age seen in this study could be explained by the hormonal changes taking place in the older subjects, with pubertal development. A decrease in compliance with treatment routines and greater deviations from the diabetic diet as the child gets older could also explain the positive correlation between HbA_{1c} and age. Another possible explanation for the positive correlation between HbA_{1c} and age could be due to reduced parental supervision and increased self-care as the child with Type 1 diabetes gets older and seeks greater independence. With the difference in HbA_{1c} values being found at 8 years it is possible that the factors mentioned above may be appearing in these children at about 8 years of age.

5.10.2 Relationship between hospital clinic attended and metabolic control

The hospital clinic attended made a significant difference to the HbA_{1c} values. Subjects that attended the Grey's Hospital clinic had higher mean values for both the latest HbA_{1c} and the mean HbA_{1c} over 12 months as compared to the children attending the IALCH clinic. This finding needs to be interpreted with caution due to the small sample size and the possibility of confounding factors. It is possible that the finding of higher HbA_{1c} values in the subjects attending the Grey's Hospital clinic could be due to the fact that this clinic had a higher number of African subjects [n=6/8 (75%)] and African subjects were found to have significantly higher HbA_{1c} values in the sample. However the sample size was too small to determine if the racial breakdown of the individual clinics contributed to the difference in metabolic control between the two hospital clinics. It was shown statistically that the differences in metabolic control between the two hospital clinics were significantly related to the hospital clinic attended and not to race groups. There are considerable differences between the two clinics in terms of the management of children with Type 1 diabetes which could account for the difference in metabolic control between the two groups of children with Type 1 diabetes. Many of the differences between the two clinics can be attributed to differences in the resources available. At the Grey's Hospital clinic

there is only one Registered Nursing Sister in charge of the entire Paediatric Clinic whereas at IALCH there are many Registered Nursing Sisters available at the Paediatric Clinic. Furthermore the Paediatric Diabetic Clinic at IALCH has a Paediatric Trained Diabetic Nurse Educator on duty on clinic days but the Grey's Hospital clinic does not. The availability and workload of the Medical Staff may also contribute to the degree of management afforded to patients and the difference in metabolic control between the two clinics. At IALCH there are usually two Registrars and a Paediatrician at each clinic visit while there may only be one Registrar/Paediatrician at each clinic visit at Greys Hospital.

The frequency of dietetic consultations and the availability of the Dietitian at the clinic for dietary education may also contribute to the difference in the metabolic control between the two clinics. A Dietitian is physically present at the IALCH clinic on each clinic visit while the Dietitian at the Grey's clinic may not be physically present at each clinic visit, due to staff shortages and other job commitments. Although the frequency of Dietetic consultations were not recorded for the purpose of this study it would be interesting to determine whether the frequency of Dietetic consultations has any effect on metabolic control, in future studies.

The frequency with which the children attend the clinic may also influence the metabolic control and again there is a difference between the two clinics. The children at the IALCH clinic are required to attend the clinic once every month while the children at the Grey's Hospital clinic may have their visits reduced to once every 3 months if there is evidence of good metabolic control. According to Dr NH McKerrow, Chief Specialist and Head: Paediatrics and Child Health: Pietermaritzburg Complex (2007), the children at Grey's Hospital are not being seen at the clinic as frequently as they should be. This may be due to transport costs as local children need to get to the clinic at their own costs while children from out of town need to get transport to their local hospital at their own cost before being transported to Grey's Hospital with hospital transport. A lack of understanding of the need for strict metabolic control and the implications of poor metabolic control may also be contributing to the poor clinic attendance at Grey's Hospital (McKerrow 2007).

Another factor that may be contributing to the better metabolic control in subjects at IALCH is that the blood glucose values obtained through self-monitoring are cross-checked against the blood glucose values stored in the memory of the glucometer, by the

Paediatric Trained Diabetic Nurse Educator. This is done to reduce deliberate under reporting of blood glucose readings by the subjects and caregivers. This is however not done at Grey's Hospital due to the shortage of nursing staff.

5.10.3 Relationship between race groups of subjects and metabolic control

The race group of the subjects was associated with differences in the latest HbA_{1c} values and the mean HbA_{1c} values over 12 months. A significant difference was found between African and Indian children for the latest HbA_{1c} and mean HbA_{1c} values over 12 months, with higher values in African children. It is difficult to speculate on the explanation for this finding due to the lack of research on children with Type 1 diabetes in South Africa. Some possible explanations for the differences between the two groups could be related to dietary differences, the level of management of diabetes by the caregivers at home and social background. The differences in metabolic control between race groups should be viewed with caution as the sample size is small and there are also differences between the two clinics as well as other confounding factors that could account for this finding. It would be useful to investigate the differences in metabolic control according to race groups, in future studies with larger sample sizes.

5.10.4 Relationship between education level of caregivers and metabolic control

There was a significant negative correlation between the education level of the caregivers and the latest HbA_{1c} in subjects and the education level of the caregivers and the mean HbA_{1c} level in subjects over 12 months. This suggests that as the education level of the caregiver increased the HbA_{1c} values in subjects tended to decrease. This also suggests that as the education level of the caregiver increased the metabolic control of the subjects improved. Although no other studies have reported similar findings, this is an interesting finding. It would be expected to see better metabolic control in subjects whose caregivers had a higher level of education. A higher level of education may possibly lead to a better overall understanding of the condition and better overall management of the condition.

5.10.5 Relationship between completion of dietary records and metabolic control

Subjects who did not complete the 3 day dietary records were found to have significantly lower latest HbA_{1c} and the mean HbA_{1c} over 12 months as compared to the subjects that completed the 3 day dietary record. One would have expected to see higher HbA_{1c} values in those subjects that did not complete the 3 day dietary records as it may have been a

reflection of poor compliance and management of the condition. However it is also important to remember that it is possible that these subjects did complete and post the 3 day dietary records but these were not received by the researcher due to problems with the postal service. It is therefore unlikely that the overall metabolic control was linked to the completion or incompletion of the dietary records.

5.11 Recommendations for future research

- More sites should be included in future studies to increase the sample size in the same age group of 6-10 years.
- This study was a cross-sectional study with a small sample size. Future longitudinal studies with adequate follow-up of subjects are recommended to validate the findings of the current study.
- Other variables such as frequency of clinic visits, frequency of dietetic consultations, insulin regime and social history could possibly impact on diet-related knowledge and metabolic control in children with diabetes and should be included in future studies.
- Future studies should include teenagers and adolescents with Type 1 diabetes because of potential difficulty with achieving good metabolic control and dietary adherence due to the psychological and physiological changes taking place in teenagers and adolescents.
- It may also be useful to include children with Type 1 diabetes who are treated privately to look at differences in dietary intake, diet-related knowledge and metabolic control between children that are treated privately and those that are treated at provincial institutions.
- Although this study only looked at children with Type 1 diabetes it would be useful to conduct a similar study in children with Type 2 diabetes.
- There is a lack of comprehensive guidelines for the nutritional management of childhood diabetes in South Africa. Future studies should focus on the development of comprehensive guidelines for the nutritional management of childhood diabetes for use by Registered Dietitians in South Africa.

5.12 Summary

The purpose of this study was to assess the dietary intake, diet-related knowledge and metabolic control in children with Type 1 diabetes aged 6-10 years attending the Paediatric Diabetic Clinics at Grey's Hospital and IALCH in KwaZulu-Natal. In terms of the contribution of the macronutrients to total energy intake was found to be similar to the ISPAD Consensus Guidelines (2002). In contrast to national studies micronutrient intakes were found to be adequate except for calcium and vitamin D which were found to be low for the sample. There may be a gap in the understanding of what is happening in the poorer children with Type 1 diabetes as it is likely that poorer subjects may be unable to get to the Public Health Facility Specialist Paediatric Diabetic Clinics for treatment due to transport costs. Both diet-related knowledge and HbA_{1c} were found to increase with age. Overall metabolic control was poor, with the mean HbA_{1c} being associated with a high risk for the development of complications of diabetes. Although it is thought that diet influences HbA_{1c} and overall metabolic control in diabetes it is interesting to note that in this study metabolic control was poor despite the reported dietary intake being within the dietary guidelines for diabetes and the diet-related knowledge being good. This also suggests that there may be other variables that were not accounted for in this study that could be contributing to the poor metabolic control in this sample. Activity level was not recorded in this study and it is possible that activity level could be a factor influencing metabolic control. Metabolic control was found to have been poorer in African subjects as compared to the other race groups and better in those subjects whose caregivers had a higher level of education. Subjects from Grey's Hospital had a significantly lower diet-related knowledge as well as poorer metabolic control than the subjects from IALCH which may be related to the different management practices between the two clinics. It is important to bear in mind that the results of this study should be interpreted with caution as the sample size was small and that studies with a larger sample size should be undertaken to confirm the findings of this study. This study could be used to calculate the number of subjects that would be needed in future studies to show more significant findings.

CHAPTER 6: CONCLUSION AND RECOMMENDATIONS

The aim of this study was to assess the dietary intake, diet-related knowledge and metabolic control in children with Type 1 diabetes aged 6-10 years attending the Paediatric Diabetic Clinics at Grey's Hospital and IALCH.

6.1 Conclusion

This study had provided very useful and important baseline data on dietary intake, diet-related knowledge and metabolic control in children aged 6-10 years with Type 1 diabetes, an area that has not been well researched in South Africa. Further studies in this area using larger sample sizes should be carried out to confirm the findings of this current study and to expand on current research in this area.

Overall the mean percentage contribution of macronutrients to total energy in the sample was found to be appropriate for children with Type 1 diabetes as it was close to the International Society for Pediatric and Adolescent Diabetes (ISPAD) Consensus Guidelines (2002). The micronutrient intake of the sample was adequate for all micronutrients with the exception of vitamin D and calcium which were found to be consumed at significantly low levels. The diet-related knowledge for the sample was found to be good with higher scores in subjects over the age of 8 years. Although the sample had an appropriate macronutrient intake and good diet-related knowledge, the overall metabolic control was poor as the latest HbA_{1c} for the sample was 9.7%. There was no significant relationship between BMI for age and metabolic control. The HbA_{1c} values in the sample were also found to increase with age. There were also differences with metabolic control between race groups with poorer metabolic control being found in African subjects. Metabolic control was also seen to improve in subjects whose caregivers were more highly educated. Overall there were significant differences in diet-related knowledge and metabolic control between the two clinics. The diet-related knowledge was higher and the metabolic control was better among subjects attending the IALCH clinic as compared to subjects attending the Grey's Hospital clinic. The finding of differences in metabolic control between race groups and hospital clinics needs to be treated with caution as the numbers in the subgroups become so small that it is difficult to determine the major effect. These findings need to be confirmed with studies using larger sample sizes.

6.2 Recommendations

The recommendations made in this section are based on the overall results and conclusions of this study.

The finding of low calcium and low vitamin D intakes in the sample is important and needs to be addressed during the Dietetic consultations at the clinic visits. It is especially important to correct the low calcium intakes because of the risk of bone disease later on in life. In order to improve calcium intake nutrition education should focus on reducing the high intake of diet soft drinks and improving the intake of milk and milk products.

Although the diet-related knowledge for the sample was good this could be further improved by recommending that basic dietary education on diabetes be repeated in all subjects on at least a biannual basis to ensure that the basic concepts are well understood and implemented. Regular assessment of diet-related knowledge is also recommended to identify gaps in knowledge and to better direct dietary education towards meeting individual requirements. Due to the lower diet-related knowledge in the younger subjects (< 8 years of age) it may be beneficial to repeat dietary education on a more regular basis in younger subjects so that fewer concepts are covered in a session and the child is not overwhelmed with too much new information at once.

Due to the fact that the subjects at the Grey's Hospital clinic had poorer diet-related knowledge and poorer metabolic control than the subjects at IALCH, it is recommended that the overall management of children with Type 1 diabetes at Grey's Hospital be thoroughly reviewed. Staff shortages (Nursing, Dietetic and Medical) should be addressed at institution level to improve the availability of staff and overall management of these children. It is also recommended that the children attending the Grey's Hospital Paediatric Diabetic Clinic should be seen more frequently as compared to what is currently being done.

It is important to address shortcomings in the management of Type 1 diabetes in childhood as diabetes is a life-long condition and poor management in childhood may lead to the development of complications and poor quality of life in adulthood.

REFERENCES

Akerblom HK, Vaarala O, Hyoty H, Ilonen J, Knip M (2002). Environmental factors in the etiology of Type 1 Diabetes. **American Journal of Medical Genetics** 115: 18-29.

Anon a (2001). RMIT University: Frequently asked questions. Preparing to use multiple choice questions. http://www.1ts.rmit.edu.au/renewal/assess/faq1.htm (accessed 21/04/2005).

Armstrong MEG, Lambert MI, Sharwood KA, Lambert EV (2006). Obesity and overweight in South African primary school children-the Health of the Nation Study. **South African Medical Journal** 96(5): 439-444.

Babbie E, Mouton J (2001). **The practice of social research**, 1st ed. South Africa: Oxford University Press.

Bantle JP, Laine DC, Thomas JW (1986). Metabolic effects of dietary fructose and sucrose in Types 3 and 33 diabetic subjects. **Journal of the American Medical Association** 256 (23): 3241-3246.

Baranowski T, Domel SB (1994). A cognitive model of children's reporting of food intake. **American Journal of Clinical Nutrition** 59(3): 212S-217S.

Berdanier CD (1994). Genetic errors that result in Diabetes Mellitus. **Nutrition Today** 29(1): 17-24.

Bini V, Celi F, Berioli MG, Bacosi ML, Stella P, Giglio P, Tosti L, Falorni A (2000). Body mass index in children and adolescents according to age and pubertal stage. **European Journal of Clinical Nutrition** 54:14-218.

Bowers D, House A, Owens D (2006). **Understanding clinical papers**, 2nd ed. England: John Wiley & Sons.

Bradshaw D, Bourne D, Nannan N (2003). What are the leading causes of death among South African children? **Medical Research Council Policy Brief** No 3.

Calvo MS, Whiting SJ (2005). Overview of the Proceedings from Experimental Biology 2005 Symposium: Vitamin D Insufficiency: A Significant Risk Factor in Chronic Diseases and Potential Disease-Specific Biomarkers of Vitamin D Insufficiency (2005). **Journal of Nutrition** 135(1): 301-303.

Casey PH, Goolsby SLP, Lensing SY, Perloff BP, Bogle ML (1999). The use of telephone interview methodology to obtain 24-hour dietary recalls. **Journal of the American Dietetic Association** 99(11): 1406-1411.

Census 2001. Statistics South Africa. http://www.statsa.gov.za/census01/html/default.asp (accessed 22/03/2007).

Center for Disease Control and Prevention: Department of Health and Human Services. Body Mass Index: BMI for Children and Teens. http://www.cdc.gov/nccdphp/dnpa/bmi/bmi-for-age.htm (accessed 21/04/2005).

Charron-Prochownik D, Becker MH, Brown MB, Liang W, Bennet S (1993). Understanding young children's health beliefs and diabetes regimen adherence. **The Diabetes Educator** 19(5): 409-418.

Christensen NK, Terry RD, Wyatt S, Pichert JW, Lorenz RA (1983). Quantitative assessment of dietary adherence in patients with insulin-dependent diabetes mellitus. **Diabetes Care** 6(3): 245-250.

Collier BN, Etzwiler DD (1971). Comparative study of diabetes knowledge among juvenile diabetics and their parents. **Diabetes** 20(1): 51-57.

Connell JE, Thomas-Dobersen D (1991). Nutritional management of children and adolescents with insulin-dependent diabetes mellitus: A review by the Diabetes Care and Education dietetic practice group. **Journal of the American Dietetic Association** 91(12):1556-1564.

Coulston AM (1994). Nutrition considerations in the control of Diabetes Mellitus. **Nutrition Today** 29(1): 6-11.

Craig MR, Kristal AR, Cheney CL, Shattuck AL (2000). The prevalence and impact of "atypical" days in 4-day food records. **Journal of the American Dietetic Association** 100(4): 421- 427.

Crawford PB, Obarzanek E, Morrison J, Sabry ZI (1994). Comparative advantage of 3-day food records over 24-hour recall and 5-day food frequency validated by observation of 9 and 10 year old girls. **Journal of the American Dietetic Association** 94(6): 626-630.

Daneman D, Wolfson DH, Becker DJ, Drash AL (1981). Factors affecting glycosylated hemoglobin values in children with insulin-dependent diabetes. **The Journal of Pediatrics** 99(6): 847-853.

Delamater AM, Smith JA, Kurtz SM, White NH (1988). Dietary skills and adherence in children with Type 1 Diabetes Mellitus. **The Diabetes Educator** 14(1): 33-36.

Diabetes Control and Complications Trial Research Group (1994). Effect of intensive diabetes treatment on the development and progression of long-term complications in adolescents with insulin-dependent diabetes mellitus: Diabetes Control and Complications Trial. **The Journal of Pediatrics** 125(2): 177 -188.

Dillman DA (1978). **Mail and telephone surveys: The Total Design Method**, 1st ed. John Wiley & Sons: United States of America.

Domel SB (1997). Self reports of diet: how children remember what they have eaten**.** **American Journal of Clinical Nutrition** 65(4): 1148S-1152S.

Domel SB, Thompson WO, Baranowski T, Smith AF (1994). How children remember what they have eaten. **Journal of the American Dietetic Association** 94(11): 1267-1272.

Dorchy H, Roggemans M, Willems D (1997). Glycated hemoglobin and related factors in diabetic children and adolescents under 18 years of age: a Belgian experience. **Diabetes Care** 20(1): 2-6.

Drozda DJ, Dawson VA, Long DJ, Freson LS, Sperling MA (1990). Assessment of the effect of a comprehensive diabetes management program on hospital admission rates of children with Diabetes Mellitus. **The Diabetes Educator** 16(5): 389-393.

Eck LH, Klesges RC, Hanson CL (1989). Recall of a child's intake from one meal: are parents accurate? **Journal of the American Dietetic Association** 89(6): 784-789.

Emmons L, Hayes M (1973). Accuracy of 24-hour recalls of young children. **Journal of the American Dietetic Association** 62(4): 409-416.

Etzwiler DD (1962). What the juvenile diabetic knows about his disease. **Pediatrics** 29: 135-141.

Etzwiler DD, Sines LK (1962). Juvenile Diabetes and Its Management: Family, Social, and Academic Implications. **Journal of the American Medical Association** 181(4): 304-308.

Farris RP, Frank GC, Webber LS, Berenson GS (1985). A group method for obtaining dietary recalls of children. **Journal of the American Medical Association** 85(10): 1315-1320.

Faulkner MS, Clark FS (1998). Quality of life for parents of children and adolescents with Type 1 Diabetes. **The Diabetes Educator** 24(6): 721-727.

Forlani G, Galuppi V, Santacroce G, Braione AF, Giangiullio S, Ciavarella A, Vannini P (1989). Hyperglycemic effect of sucrose ingestion in IDDM patients controlled by artificial pancreas. **Diabetes Care** 12 (4): 296-298.

Franz M (1981). Attitudes towards dietary management of diabetes among diabetic youngsters at camp. **Diabetes Educator** 7: 30-33.

Franzese A, Valerio G, Spagnuolo MI (2004). Management of diabetes in childhood: are children small adults? **Clinical Nutrition** 23(3): 293-305.

Ganie Y (2007). Paediatrician. Department of Paediatrics: Maternal and Child Health, Nelson R Mandela School of Medicine, University of KwaZulu-Natal. Personal communication.

Gibson RS (2005). **Principles of Nutritional Assessment,** 2nd ed. Oxford University Press: New York.

Gilbertson HR, Brand-Miller JC, Thorburn AW, Evans S, Chondros P, Werther GA (2001). The effect of flexible low glycemic index dietary advice versus measured carbohydrate exchange diets on glycemic control in children with type 1 diabetes. **Diabetes Care** 24(7):1137-1143.

Gilbertson HR, Thorburn AW, Brand-Miller JC, Chondros P, Werther GA (2003). The Effect of low-glycemic-index dietary advice on dietary quality and food choice in children with type 1 diabetes. **American Journal of Clinical Nutrition** 77(1): 83-90.

Ginsburg H, Opper S (1979). **Piaget's Theory of Intellectual Development**, 2nd ed. New Jersey: Prentice Hall, Inc.

Glowinska B, Urban M, Koput A, Galar M (2003). New atherosclerosis risk factors in obese, hypertensive and diabetic children and adolescents. **Atherosclerosis** 167(2): 275-286.

Goldstein DE, Little RR, Wiedmeyer H, England JD, McKenzie EM (1986). Glycated hemoglobin: methodologies and clinical applications. **Clinical Chemistry** 32(10B): B64-B70.

Green A, Gale EAM, Patterson CC (1992). Incidence of childhood-onset insulin-dependent diabetes mellitus: the EURODIAB ACE study. **The Lancet** 339: 905-909.

Greer FR (2004). Issues in establishing vitamin D recommendations for infants and children. **American Journal of Clinical Nutrition** 80(suppl): 1759S-1762S.

Grey's Hospital-KwaZulu-Natal, Department of Health. http://www.kznhealth.gov.za/greyshospital.htm (date accessed 29/05/2007)

Hackett AF, Court S, McCowen C, Parkin JM (1986). Dietary survey of diabetics. **Archives of Disease in Childhood** 61: 67-71.

Hackett AF, Court S, McCowen C, Parkin JM (1988). Dietary variation in diabetics. **Archives of Disease in Childhood** 63: 794-798.

Haller MJ, Atkinson MA, Schatz D (2005). Type 1 Diabetes Mellitus: etiology, presentation and management. **Pediatric Clinics of North America** 52: 1553-1578.

Haller MJ, Stalvey MS, Silverstein JH (2004). Predictors of control of diabetes: monitoring may be the key. **The Journal of Pediatrics** 144(5): 660-661.

Hypponen E, Power C (2007). Hypovitaminosis D in British adults at age 45 y: nationwide cohort study of dietary and lifestyle predictors. **American Journal of Clinical Nutrition** 85: 860-868.

Inkosi Albert Luthuli Central Hospital-KwaZulu-Natal, Department of Health. http://ialch.co.za/sp/internetshow.asp?pageId=282

Institute of Medicine (2000). **Dietary Reference Intakes: Applications in Dietary Assessment.** Food and Nutrition Board. Washington DC. National Academy Press.

Institute of Medicine (1997). **Dietary Reference Intakes for calcium, phosphorus, magnesium, vitamin D and Fluoride**. Food and Nutrition Board. Washington DC. National Academy Press.

Institute of Medicine (2002). **Dietary Reference Intakes for energy, carbohydrate, fibre, fat, fatty acids, cholesterol, and protein and amino acids**. Food and Nutrition Board. Washington DC. National Academy Press.

Institute of Medicine (1998). **Dietary Reference Intakes for thiamin, riboflavin, niacin, vitamin B_6, folate, vitamin B_{12}, pantothenic acid, biotin and choline**. Food and Nutrition Board. Washington DC. National Academy Press.

Institute of Medicine (2001). **Dietary Reference Intakes for vitamin A, vitamin K, arsenic, boron, chromium, copper, iodine, iron, manganese, molybdenum, nickel, silicon, vanadium and zinc**. Food and Nutrition Board. Washington DC. National Academy Press.

Institute of Medicine (2000). **Dietary Reference Intakes for vitamin C, vitamin E, selenium and carotenoids**. Food and Nutrition Board. Washington DC. National Academy Press.

International Society for Pediatric and Adolescent Diabetes (ISPAD) Consensus Guidelines for the Management of Type 1 Diabetes Mellitus in Children and Adolescents (2002). http://www.diabetesguidelines.com/health/dwk/pro/guidelines/ispad/01.asp (accessed 12/01/2007).

Jenner DA, Neylon K, Croft S, Beilin LJ, Vandongen R (1989). A comparison of methods of dietary assessment in Australian children aged 11-12 years. **European Journal of Clinical Nutrition** 43(10): 663-673.

Jinabhai CC, Taylor M, Sullivan KR (2005). Changing patterns of under and over nutrition in South African children-future risks of non-communicable diseases. **Annals of Tropical Paediatrics** 25: 3-15.

Johnson SB, Pollak T, Silverstein JH, Rosenbloom AL, Spillar R, McCallum M, Harkavy J (1982). Cognitive and behavioral knowledge about insulin-dependent diabetes among children and parents. **Pediatrics** 69(6): 708-713.

Kaufman FR (1998). Diabetes in children and adolescents: areas of controversy. **Medical Clinics of North America** 82(4): 721-738.

Karvonen M, Tuomilehto J, Libman I, LaPorte R (1993). A review of the recent epidemiological data on the worldwide incidence of Type 1(insulin-dependent) diabetes mellitus. **Diabetologia** 36: 883-892.

Karvonen M, Viik-Kajander M, Moltchanova E, Libman I, LaPorte R, Tuomilehto J (2000). Incidence of Childhood Type 1 Diabetes Worldwide. **Diabetes Care** 23(10): 1516-1526.

Kinmonth A-L, Angus RM, Jenkins PA, Smith MA, Baum JD (1982). Whole foods and increased dietary fibre improve blood glucose control in diabetic children. **Archives of Disease in Childhood** 57: 187-194.

Kinmonth A-L, Magrath G, Reckless JPD (1989). Dietary recommendations for children and adolescents with diabetes. **Diabetic Medicine** 6: 537-547.

Krall EA, Dwyer JT (1987). Validity of a food frequency questionnaire and a food diary in a short-term recall situation. **Journal of the American Dietetic Association** 87(10): 1374-1376.

Krall EA, Dwyer JT, Coleman KA (1988). Factors influencing accuracy of dietary recall. **Nutrition Research** 8(7): 829-841.

Krantz JS, Mack WJ, Hodis HN, Liu C, Liu C, Kaufman FR (2004). Early onset of subclinical atherosclerosis in young persons with type 1 diabetes. **The Journal of Pediatrics** 145(4): 452-457.

KwaZulu-Natal, Department of Health (2001). Map of KwaZulu-Natal Health Districts. http://www.kznhealth.gov.za/ (date accessed 19/04/2007).

LaPorte RE, Tuomilehto J, King H (1990). WHO Multinational Project for Childhood Diabetes. **Diabetes Care** 13(10): 1062-1068.

Levine B, Anderson BJ, Butler DA, Antisdel JE, Brackett J, Laffel LMB (2001). Predictors of glycemic control and short-term adverse outcomes in youth with type 1 diabetes. The **Journal of Pediatrics** 139(2): 197-203.

Livingstone MBE, Prentice AM, Coward WA, Strain JJ, Black AE, Davies PSW, Stewart CM, McKenna PG, Whitehead RG (1992). Validation of estimates of energy intake by weighed dietary record and diet history in children and adolescents. **American Journal of Clinical Nutrition** 56(2): 29-35.

Lorenz RA, Christensen NK, Pichert JW (1985). Diet-related knowledge, skill and adherence among children with insulin-dependent diabetes mellitus. **Pediatrics** 75(5): 872-876.

Love P (2003). Food-based dietary guidelines for the patient with diabetes. **Continuing Medical Education** 21(10): 564-570.

Lytle LA, Nichaman MZ, Obarzanek E, Glovsky E, Montgomery D, Nicklas T, Zive M, Feldman H (1993). Validation of 24-hour recalls assisted by food records in third-grade children. **Journal of the American Dietetic Association** 93(12): 1431-1436.

Mackintosh C (2007). Laboratory Manager, Inkosi Albert Luthuli Central Hospital laboratory, Inkosi Albert Luthuli Central Hospital. Personal Communication.

Magrath G, Hartland BV (1993). Dietary recommendations for children and adolescents with diabetes: An implementation paper. **Diabetic Medicine** 10(9): 874-885.

Mascarenhas MR, Zemel B, Stallings VA (1998). Nutritional assessment in pediatrics. **Nutrition** 14(1): 105-115.

Maunder EMW (2007). Head of Discipline: Dietetics and Human Nutrition-University of KwaZulu-Natal and Director of 1999 South African National Food Consumption Survey (KwaZulu-Natal). Personal Communication.

Mayer-Davis EJ, Nichols M, Liese AD, Bell RA, Dabelea DM, Johansen JM, Pihoker C, Rodriguez BL, Thomas J, Williams D (2006). Dietary intake among youth with diabetes: The SEARCH for diabetes in youth study. **Journal of the American Dietetic Association** 106(5): 689-697.

McCowen C, Hackett AF, Court S, Parkin JM (1986). Are families of diabetic children adequately taught? **British Medical Journal** 292: 1361.

McGough N (2004). New dietary guidelines for people with diabetes. **Dietetic Adviser (**April): 7-8.

McKerrow NH (2006). Chief Specialist and Head: Paediatrics and Child Health: Pietermaritzburg Complex. Personal Communication.

McPherson RS, Hoelscher DM, Alexander M, Scanlon KS, Serdula MK (2000). Dietary assessment methods among school-aged children: Validity and Reliability. **Preventive Medicine** 31(2): S11-S33.

Medlin C, Skinner JD (1988). Individual dietary intake methodology: A 50-year review of progress. **Journal of the American Dietetic Association** 88(10): 1250-1257.

Moodley S (2007). Principal Dietitian: Inkosi Albert Luthuli Central Hospital. Personal Communication.

Mortensen HB, Hougaard P (1997). Comparison of metabolic control in a cross-sectional study of 2,873 children and adolescents with IDDM from 18 countries. **Diabetes Care** 20(5): 714-720.

Muntoni S, Cocco P, Aru G, Cucca F, Muntoni S (2000). Nutritional factors and worldwide incidence of childhood type 1 diabetes. **The American Journal of Clinical Nutrition** 71(6): 1525-1529.

National Food Consumption Survey (NFCS)-children aged 1-9 years, South Africa, 1999. **South African Journal of Clinical Nutrition** 14(2): 62-75.

Nelson M (1997). The validation of dietary assessment. In: Nelson M, Margetts BM. **Design Concepts in Nutritional Epidemiology**, 2nd. New York: Oxford University Press.

Nelson M, Margetts BM (1997). **Design Concepts in Nutritional Epidemiology**, 2nd ed. New York: Oxford University Press.

Nutrition Subcommittee of the Diabetes Care Advisory Committee of Diabetes UK (2003). The implementation of nutritional advice for people with diabetes. **Diabetic Medicine** 20: 786-807.

O'Connor J, Ball EJ, Steinbeck KS, Davies PSW, Wishart C, Gaskin KJ, Baur LA (2001). Comparison of total energy expenditure and energy intake in children aged 6-9 years. **American Journal of Clinical Nutrition** 74: 643-649.

Patton SR, Dolan LM, Powers SW (2007). Dietary adherence and associated glycemic control in families of young children with type 1 diabetes**. Journal of the American Dietetic Association** 107(1): 46-52.

Pettifor JM (2004). Nutritional rickets: deficiency of vitamin D, calcium, or both? **American Journal of Clinical Nutrition** 80(Suppl): 1725S-1729S.

Position Statement of the American Diabetes Association: Care of children with diabetes in the school and day care setting (2000). **Diabetes Care** 23(Suppl 1): S100-S103.

Position Statement of the American Diabetes Association: Implications of the Diabetes Control and Complications Trial (2000). **Diabetes Care** 23(Suppl 1): S24-S26.

Position Statement of the American Diabetes Association: Implications of the United Kingdom Prospective Diabetes Study (2000). **Diabetes Care** 23(Supp 1): S27-S31.

Position Statement of the American Diabetes Association: Nutrition recommendations and principles for people with diabetes mellitus (2000). **Diabetes Care** 23(Supp 1): S43-S46.

Position Statement of the Association for Dietetics in Southern Africa (ADSA)-Dietary Management of People with Diabetes Mellitus (1997). **The South African Journal of Food Science and Nutrition** 9(1): 36-37.

Power C, Lake JK, Cole TJ (1997). Measurement and long-term health risks of child and adolescent fatness. **International Journal of Obesity** 21: 507-526.

Price KJ, Lang JD, Eiser C, Tripp JH (1993). Prescribed versus unrestricted carbohydrate diets in children with Type 1 Diabetes. **Diabetic Medicine** 10: 962-967.

Price DA, Pokorny CS (2002). Investigating the child with hyperglycaemia. **Modern Medicine of South Africa** 27(5): 53-60.

Randecker GA, Smiciklas-Wright H, McKenzie JM, Shannon BM, Mitchell DC, Becker DJ, Kieselhorst K (1996). The Dietary Intake of Children With IDDM. **Diabetes Care** 19(12): 1370-1374.

Recommendations for the nutritional management of patients with diabetes mellitus: The Diabetes and Nutrition Study Group (DNSG) of the European Association for the Study of Diabetes (EASD) (2000). **European Journal of Clinical Nutrition** 54(1): 353-355.

Rockett HRH, Colditz GA (1997). Assessing diets of children and adolescents. **American Journal of Clinical Nutrition** 65 (Suppl): 1116S-1122S.

Rosilio M, Cotton J, Wieliczo M, Gendrault B, Carel J, Couvaras O, Ser N, Gillet P, Soskin S, Garandeau P, Stuckens C, Le Luyer B, Jos J, Bony-Trifunovic H, Bertrand A, Leturcq F, Lafuma A, The French Pediatric Diabetes Group, Bougneres P (1998). Factors associated with glycemic control: A cross-sectional nationwide study in 2,579 French children with type 1 diabetes. **Diabetes Care** 21(7): 1146-1053.

Saucier CP, Clark LM (1993). The relationship between self-care and metabolic control in children with insulin-dependent diabetes mellitus. **The Diabetes Educator** 19(2): 133-135.

Schmidt LE, Klover RV, Arfken CL, Delamater AM, Hobson D (1992). Compliance with dietary prescriptions in children and adolescents with insulin-dependent diabetes mellitus. **Journal of the American Dietetic Association** 92(1): 567-570.

Silink M (2002a). Foreward: International Society for Pediatric and Adolescent Diabetes (ISPAD) Consensus Guidelines for the Management of Type 1 Diabetes Mellitus in Children and Adolescents. http://www.diabetesguidelines.com/health/dwk/pro/guidelines/ispad/01.asp (accessed 12/01/2007).

Silink M (2002b). Childhood diabetes: A global perspective. **Hormone Research** 57 (Suppl):1-5.

Silverstein J, Klingensmith G, Copeland K, Plotnick L, Kaufman F, Laffel L, Deeb L, Grey M, Anderson B, Holzmeister LA, Clark N (2005). A Statement of the American Diabetes Association: Care of Children and Adolescents With Type 1 Diabetes. **Diabetes Care** 28: 186-212.

Silverstein JH, Malone JI (2000). Strict glycemic control is necessary but not practical in most children with type 1 diabetes. **The Journal of Clinical Endocrinology and Metabolism** 85(2): 518-522.

Sobo EJ, Rock CL, Neuhouser ML, Maciel TL, Neumark-Sztainer D (2000). Caretaker-child interaction during children's 24-hour dietary recalls: who contributes what to the recall record? **Journal of the American Dietetic Association** 100(4): 428-433.

South African Demographic and Health Survey: Full Report [SADHS] (2003). Department of Health (South Africa)/Medical Research Council of South Africa. http://www.doh.gov.za (date accessed 20/04/2007).

South African Health Review (2006). Chronic conditions in children. In: Ijumba P, Padarath A Eds. South Africa: Health Systems Trust.

South African Vitamin A Consultative Group (SAVACG) (1996). Children aged 6 to 71 months in South Africa, 1994: their anthropometric, Vitamin A and iron status. **Medical Update** Number 26 – part 1 and 2.

Stuff JE, Garza C, O' Brian Smith E, Nichols BL, Montandon CM (1983). A comparison of dietary methods in nutritional studies. **American Journal of Clinical Nutrition** 37: 300-306.

Stunkard AJ, Waxman M (1981). Accuracy of self-reports of food intake. **Journal of the American Dietetic Association** 79(5): 547-551.

Thompson FE, Byers T (1994). Dietary assessment resource manual. **Journal of Nutrition** 124 (Suppl): 2245S-2317S.

Tran KM, Johnson RK, Soultanakis RP, Matthews DE (2000). In-person vs. telephone-administered multiple-pass 24-hour recalls in women: validation with doubly labeled water. **Journal of the American Dietetic Association** 100(7): 777-783.

Ulijaszek SJ (1997). Anthropometric measures, 2nd ed. In: Margetts BM, Nelson M, eds. **Design Concepts in Nutritional Epidemiology**. New York: Oxford University Press.

Vieth R, Bischoff-Ferrari H, Boucher BJ, Dawson-Hughes B, Garland CF, Heaney RP, Holick MF, Hollis BW, Lamberg-Allardt C, McGrath JJ, Norman AW, Scragg R, Whiting AJ, Willett WC, Zitterman A. The urgent need to recommend an intake of vitamin D that is effective. **American Journal of Clinical Nutrition** 85: 649-650.

Virtanen SM, Ylonen K, Rasanen L, Ala-Venna E, Maenpaa J, Akerblom HK (2000). Two year prospective dietary survey of newly diagnosed children with diabetes aged less than 6 years. **Archives of Diseases in Childhood** 82: 21-26.

Waldron S, Swift PGF, Raymond NT, Botha JL (1997). A survey of the dietary management of children's diabetes. **Diabetic Medicine** 14(8): 698-702.

World Health Organisation Expert Committee. Technical Report Series. **Physical Status: The Use and Interpretation of Anthropometry** (1995).

World Health Organisation and Food and Agriculture Organisation of the United Nations. **Joint WHO/FAO Expert Consultation on Human Vitamin and Mineral Requirements** (1998).

World Health Organisation and Food and Agricultural Organisation of the United Nations. **FAO Food and Nutrition Technical Report Series 1: Human Energy Requirements: Report of a joint FAO/WHO/UNU Expert Consultation** (2004).

Wild S, Roglic G, Green A, Sicree R, King H (2004). Global Prevalence of Diabetes: Estimates for the year 2000 and projections for 2030. **Diabetes Care** 27(5): 1047-1053.

Wolever TMS (1999). Dietary recommendations for diabetes: high carbohydrate or high monounsaturated fat? **Nutrition Today** 34(2): 73-77.

APPENDIX A: INSTRUCTIONS FOR COMPLETING THE 3 DAY DIETARY RECORD IN ENGLISH

INSTRUCTIONS ON HOW TO FILL IN THE 3 DAY DIETARY RECORD FORM

Dear Parents / Guardians

Please help your child/ward to fill out this form. Please be as honest and accurate as possible as this information is of great value.

1. From the time the child wakes up in the morning until they go to bed at night record everything that they eat and drink on the paper provided.

2. If your child takes a vitamin/mineral supplement during the day please also record the name of the supplement and how much they took in the day.

3. Please keep the record for the days as given to you by the researcher.

4. Please also record the time of day and the name of the meal. (See example)

5. When recording the food item please try to describe the food as fully as possible. Also include how the food was prepared or cooked. (See example)

6. Measure out the food using the measuring cups provided, where possible.

7. Also record the volume of the measuring cup (see volume on the handle).

8. Please use a flattened measuring cup i.e. not a heaped measuring cup.

9. Also indicate how many of each cup was used.

10. You can also use teaspoons and table spoons to measure if needed.

11. Please look at the example provided.

12. The researcher will phone you the day after completing the record to get the 24 hour recall for the last day.

13. Please keep the record for the days as given to you by the researcher.

14. Once you have finished the record for all 3 days and the researcher has taken the 24 hour recall for the third day by phone, please put the record into the addressed envelope provided and post it to the researcher.

15. You may keep the measuring spoons once you have finished the record. You do not have to return it to me.

Thank you for your participation and cooperation!

Kirthee Pillay
University of KwaZulu-Natal
033-2605674
083 785 3072

APPENDIX B: INSTRUCTIONS FOR COMPLETING THE 3 DAY DIETARY RECORD IN ZULU

IMININGWANE YOKUGCWALISA IFOMU LENDLELA YOKUDLA NGEZINSUKU EZINTATHU

Mzali

Ngicela isize ingane yakho ukugcwalisa leli phepha. Ngicela uthembeke futhi uphendule impendula ewungqo njengoba lolu lwazi lubalulekile

1. Bhala phansi yonke into ingane eyidlayo neyiphuzayo kusukela ngesikhathi ingane ivuka ehuseni kuze kube ngesikhathi iya kolala ebusuku kuleli phepha loinikiwe.

2. Uma ingane yakho iphuza amavitamini noma amasaplamenti osukwini. Bhala igama lawo nakuthi iphuza into engakanani.

3. Bhala yonke imininingwane yazo zonke izinsuku njengoba unikezwe ngumphenyi.

4. Bhala isikhathi osukwini kanye nesikhathi sokudla (Bona isibonelo).

5. Zama ukuchazisisa ukudla ngokuphelele futhi ubhale nokuthi ukudla kuphekwe noma kwenziwe kanjani (Bona isibonelo).

6. Kala ukudla usebenzise izinkomishi zokukala ozinikeziwe; lapho kungenzeka khona.

7. Bhala nesisindo senkomishi yokukala (Bona iphepha lesi sindo)

8. Ungayiqongisi inkomishi yokukala.

9. Yisha ukuthi usebenzise izinkomishi ezingaki.

10. Ungasebenzisa izinkezo uma udinga ukukala

11. Bheka izibonelo ozinikiwe

12. Umphenyi uzokushayela ucingo osukwini olulandela lolu oqede ngalo imininingwane ukuthola imininingwane yangayizolo.

13. Gcina imininingwane yakho yezinsuku ozinikiwe.

14. Uma usuqedile ukugcwalisa imininingwane yezinsuku ezintathu umphenyi eseyithathile imininingwane yosuku ngocingo; faka imininingwane oyigcwalisile kule muilophu oyinikeziwe bese uyiposela umphenyi.

15. Ungazigcina izipuni zokukala uma usuqedile awudingi ukuyibuyisa.

Ngiyabonga ngokuba yingxenye yalolu phenya!

Kirthee Pillay
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APPENDIX C: PHOTOGRAPH OF MEASURING CUPS USED IN THE STUDY

APPENDIX D: EXAMPLE OF A COMPLETED 3 DAY DIETARY RECORD IN ENGLISH

NAME: John Smith FILE NUMBER: 99 02 05

EXAMPLE

THREE-DAY DIETARY RECORD

DAY 1 FRIDAY **DATE:** 26 May 2006

MEAL AND TIME	FOOD/FLUID/SUPPLEMENT	AMOUNT
6:00 am Breakfast	All Bran Flakes	250ml
	Full Cream Milk	125ml
	Sugar	1 teaspoon (level)
9:30 am Snack	Apple, raw with skin	1 medium
12:30 pm Lunch	Brown bread	2 slices
	Margarine	1 teaspoon (level)
	Tuna (canned in oil)	80ml
	Mayonnaise - regular	30ml
	Salad - tomato, lettuce + cucumber	125ml
3:30 pm Snack	Pear, raw with skin	1 medium
	Tea	250ml
	Full cream milk	80ml
	Sugar	1 teaspoon (level)
6:30 pm Supper	Rice, white	250ml
	Beef mince, cooked	125ml
	Mixed vegetable, boiled	125ml
	Coke	1 can (340ml)

NAME :_____ FILE NUMBER:_____

DAY 2 SUNDAY **DATE:** 28 May 2006

MEAL AND TIME	FOOD/FLUID/SUPPLEMENT	AMOUNT
7:00 am Breakfast	Oats porridge, cooked	250ml
	Milk, full cream	125ml
	Brown bread	1 slice
	Jam	1 teaspoon (heaped)
9:00 am Snack	Low fat Yoghurt	250ml
12:00 pm Lunch	Mealie Meal, stiff pap	250ml
	Tomato + Onion mix, cooked	80ml
	Sausage, Beef	2 medium
3:00 pm Snack	Apple, raw with skin	1 small
6:30 pm Supper	Pasta, macaroni	250ml
	Chicken, fried	1 drumstick (medium)
	Carrots, cooked	80ml
	Apple Juice, Ceres	250ml

NAME : _____ FILE NUMBER: _____

DAY 3 MONDAY **DATE:** 29 May 2006

MEAL AND TIME	FOOD/FLUID/SUPPLEMENT	AMOUNT
6:00 am Breakfast	Corn Flakes	250ml
	Lav fat Milk	125ml
	Sugar	2 teaspoons (level)
9:30 am Snack	Brown Bread	1 slice
	Jam, strawberry	2 teaspoons (level)
12:30 pm Lunch	Simba Chips - Nik Naks	1 packet (small). 24g
	Coke	1 Can (340ml)
	Banana	1 large
3:30 pm Snack	Grapes, Black with Seeds	10 grapes
6:30 pm Supper	Fried potatoes	2 small
	Chicken, roasted	1 thigh 1 drumstick
	Peas, cooked	80ml
	Orange Juice, Liqui Fruit	1 cup (250ml)

APPENDIX E: EXAMPLE OF A COMPLETED 3 DAY DIETARY RECORD IN ZULU

IGAMA : Thandi Mkhize INOMBOLO YEFAYELA: 990306

ISIBONELO

UKUDLA OKUKHETHIWEYO NGEMITHETHO YOKUDLA KWEZINSUKU EZINTATHU OKUBHALWE PHANSI

(ILANGA)

USUKU LOKUQALA Ulwesihlanu **USUKU**

ISIDLO NESIKHATHI	UKUDLA/OKULUKETSHEZI/UKUDLA OKWELEKIWE	INANI
6:00 Ekuseni Ukudla kwasekuseni	Iphalishi lempuphu Ubisi Ushukela, amhlophe	inkomishi eyodwa Uhhafu wenkomishi Uhhafu wokhezo
9:30 Emini yasekuseni Umbambandlala (Snack)	I-aphula; elincsikhumba futhi lingaphekwanga	Elilodwa eliphakathi nendawo
12:30 Emini Ukudla kwasemini	Isinkwa esinsundu Ibhotela Amasoseji enyama yenkamo athoswe ngamafutha Isosi katamatisi	Izingcezu ezimbili Uhhafu wokheza Amabili aphakathi nendawo Ukhezo olulodwa
3:30 ntambama Umbambandlala (Snack)	Amabhiskidi eProrita Itiye Ubisi Ushukela omhlophe	Amabili Inkomishi eyodwa 80ml Ukheza olulodwa
6:30 Kusihlwa Ukudla kwaku-sihlwa	Ilayisi elimhlophe Isitshulu senkukhu Usaladi katamatisi ulethisi nokhukhumba Isprite yedayethi	Inkomishi eyodwa Inkomishi eyodwa Uhhafu wenkomishi Ikani elilodwa (340 ml).

IGAMA :_____ INOMBOLO YEFAYELA:_____

UKUDLA OKUKHETHIWEYO NGEMITHETHO YOKUDLA KWEZINSUKU EZINTATHU OKUBHALWE PHANSI

(ILANGA)

USUKU LWESIBILI Isonto **USUKU:**

ISIDLO NESIKHATHI	UKUDLA/OKULUKETSHEZI/UKUDLA OKWELEKIWE	INANI
7:00 Ekuseni		
Ukudla kwasekuseni	Iphalishi le-oats ; ephekiwe	Inkomishi eyodwa
	Ubisi	Uhhafu wenkomishi
	Isinkwa esinsundu	Ucezu olulodwa
	Ujamu	Uhhafu wokhezo
9:00 Emini yasekuseni Umbombandlala (snack)	Iyogathi enamafutha Amancane	Inkomishi Eyodwa
12:00 Emini		
Ukudla kwasemini	Istiv' papa	Inkomishi eyodwa
	Ushatini ophekiwe	80ml
	Amasaseji enyama yenkomo	Amabili, ap nendawo
3:00 Ntambama Umbombandlala (snack)	I-aphula elinesikhumba elingaphekwanga	Elilodwa Elincane
6:30 Kusihlwa	Imakharoni	Inkomishi eyodwa
Ukudla kwaku-sihlwa	Inyama yenkukhu	Ithanga elilodwa eliphakathi nendawo
	Ukhevothi	80ml
	Ujusi we-aphula ; iCeres	Inkomishi eyodwa

IGAMA :_____ INOMBOLO YEFAYELA:_____

UKUDLA OKUKHETHIWEYO NGEMITHETHO YOKUDLA KWEZINSUKU EZINTATHU OKUBHALWE PHANSI

ILANGA

USUKU LWESITHATHU Umsombuluko **USUKU**

ISIDLO NESIKHATHI	UKUDLA/OKULUKETSHEZI/UKUDLA OKWELEKIWE	INANI
6:00 Ekuseni Ukudla kwasekuseni	Amakhon Fleksi	Inkomishi eyodwa
	Ubisi olunamafutha amancane	Uhhafu wenkomishi
	Ushukela	Ukhezo olulodwa
9:30 Emini yasekuseni Umbombodlala (snack)	Isinkwa esinsundu	Ucezu dulodwa
	Ujamu we strobheri	Ukhezo olulodwa
12:30 Emini Ukudla kwasemini	AmaNik-Naksi	Iphoketha elilodwa elincane
	Ikhokhi	Ikani elilodwa (340ml)
	Ubhanana	Owodwa, omkhulu
3:30 Ntambama Umbombodlala	Amagrebhisi omnyama onezinhlamvu	Ayishumi
6:30 Kusihlwa Ukudla kwasihlwa	Amazambane athosiwe	Amabili, amancane
	Inyama yenkukhu, erostiwe	Ithanga elilodwa Umlenze owodwa
	Uphizi ophekiwe	80ml
	Ujuzi we-olintshi ; Liquifruit	Inkomishi eyodwa.

APPENDIX F: BLANK 3 DAY DIETARY RECORD IN ENGLISH FOR CAREGIVERS TO COMPLETE

NAME: _____

THREE-DAY DIETARY RECORD

DAY 1 **DATE:**

MEAL AND TIME	FOOD/FLUID/SUPPLEMENT	AMOUNT

DAY 2 **DATE:**

MEAL AND TIME	FOOD/FLUID/SUPPLEMENT	AMOUNT

DAY 3 **DATE:**

MEAL AND TIME	FOOD/FLUID/SUPPLEMENT	AMOUNT

APPENDIX G: BLANK 3 DAY DIETARY RECORD IN ZULU FOR CAREGIVERS TO COMPLETE

IGAMA: _____

UKUDLA OKUKHETHIWEYO NGEMITHETHO YOKUDLA KWEZINSUKU EZINTATHU OKUBHALWE PHANSI

(ILANGA)

USUKU LOKUQALA **USUKU**

ISIDLO NESIKHATHI	UKUDLA/OKULUKETSHEZI/UKUDLA OKWELEKIWE	INANI

UKUDLA OKUKHETHIWEYO NGEMITHETHO YOKUDLA KWEZINSUKU EZINTATHU OKUBHALWE PHANSI

(ILANGA)

USUKU LWESIBILI **USUKU:**

ISIDLO NESIKHATHI	UKUDLA/OKULUKETSHEZI/UKUDLA OKWELEKIWE	INANI

UKUDLA OKUKHETHIWEYO NGEMITHETHO YOKUDLA KWEZINSUKU EZINTATHU OKUBHALWE PHANSI

ILANGA

USUKU LWESITHATHU **USUKU**

ISIDLO NESIKHATHI	UKUDLA/OKULUKETSHEZI/UKUDLA OKWELEKIWE	INANI

APPENDIX H: DIET-RELATED KNOWLEDGE MULTIPLE CHOICE QUESTIONNAIRE IN ENGLISH

NAME: _____ FILE NUMBER: _____

HOSPITAL: _____ GENDER: _____

AGE: _____ SCORE: _____

DIET-RELATED KNOWLEDGE-MULTIPLE CHOICE QUESTIONNAIRE

Below are a list of questions that relate to diet in diabetes. Read each question and choose the answer that you feel is correct. Please put a circle around the letter you have chosen. If you do not know the answer please choose letter "D"

1. Why is a properly planned diet important in people with diabetes?
   - A. It keeps blood sugar at the right level
   - B. It means you don't have to take insulin
   - C. It makes diabetes go away
   - D. I do not know

2. How often must you take your insulin injections?
   - A. Only when my sugar level is low
   - B. Only when my sugar level is high
   - C. Everyday, according to the Doctor's instruction
   - D. I do not know

3. What can happen if you don't take your insulin injection every day?
   - A. Blood sugar level can go down
   - B. Nothing will happen
   - C. I can get sick – DKA (blood sugar levels go up and may need to be admitted to hospital)
   - D. I do not know

4. How often should you check your blood sugar levels?
   - A. Before every meal
   - B. Once a day
   - C. Once a week
   - D. I do not know

5. How many meals should you eat in a day?
   A. 1
   B. 2
   C. At least 3
   D. I do not know

6. If you do not eat for a long time or skip a meal, what happens to your blood sugar levels?
   A. Blood sugar levels go up
   B. Blood sugar levels go down
   C. Nothing happens to blood sugar levels
   D. I do not know

7. What must you do if your blood sugar levels are low?
   A. Take insulin
   B. Have a rest and wait for the blood sugar levels to come up on its own
   C. Have a sweet or something sweet to drink and a snack afterwards
   D. I do not know

8. What can happen to your blood sugar if you eat too many sweets when you are hungry?
   A. Blood sugar levels go down
   B. Blood sugar levels go up
   C. Nothing happens to blood sugar levels
   D. I do not know

9. Why is it important to have a late night snack (before bed time)?
   A. To keep blood sugar levels at the right level while sleeping
   B. To stay awake
   C. To help sleep at night
   D. I do not know

10. If you want to have a sweet when can you have it?

There is more than one correct answer for this question

A. After eating a meal

B. Whenever I like to have it

C. When blood sugar level is low

D. I do not know

11. Which of the following foods are examples of starch or carbohydrate?

A. Chicken; fish; eggs

B. Margarine; butter; oil

C. Rice; bread; potatoes

D. I do not know

12. What happens to your blood sugar levels if you eat too much starch or carbohydrate?

A. Blood sugar levels go down

B. Blood sugar levels go up

C. Nothing happens to the blood sugar levels

D. I do not know

13. Which of the foods below are examples of fat?

A. Rice, potatoes, bread

B. Apples, carrots, brown bread

C. Margarine, cooking oil, butter

D. I do not know

14. Why is it important not to eat too much fat?

A. It makes sugar levels go down

B. It makes you gain weight and have heart problems later on

C. It makes blood sugar levels go up

D. I do not know

15. Why is it important to have enough fibre from the foods you eat?
    A. It keeps blood sugar levels well controlled
    B. It tastes good
    C. It can make diabetes go away
    D. I do not know

16. Which of the following foods contain the most fibre?
    A. Whole wheat bread; dried beans; vegetables; fruits
    B. Eggs; chicken; fish; meat
    C. Milk; cheese; yoghurt; ice-cream
    D. I do not know

17. If you want to have an apple as a snack, how much should you have at a time?
    A. One small apple
    B. More than one apple
    C. As much as I like
    D. I do not know

18. If you had to choose a plate of food to eat, which of the following would be the best to choose?
    A. A plate with rice and chicken
    B. A plate with rice, carrots and chicken
    C. A plate with rice only
    D. I do not know

19. If you want to buy something from the Tuck-shop at school, which would be the best to buy?
    A. Coke
    B. A small fruit
    C. Sweets
    D. I do not know

20. If you want to do sport, when would be the best time to have a snack?

A. Before sport

B. After sport

C. During sport

D. I do not know

END OF MULTIPLE CHOICE QUESTIONNAIRE

APPENDIX I: DIET-RELATED KNOWLEDGE MULTIPLE CHOICE QUESTIONNAIRE IN ZULU

IMIBUZO EKHETHISANAYO EMAYELANA NENDLELA YOKUDLA

Ngaphansi kukhona uhla lwemibuzo ephathelene nendlela yokudla kubantu abanesifo sikashukela. Funda umbuzo bese ukhetha impendulo ocabango ukuthi yiyo. Yenza indilingi enhlamvini oyikhethile. Uma ungayazi impendulo khetha u "D".

1. Yini kubalulekile ukudla okuhlelwe kahle kubantu abanesifo sikashukela?

A. Kugcina izinga likashukela lisesimweni esiyiso
B. Kuchaza ukuthi awudingi ukusebenzisa umjovo
C. Kwenza ushukela uphele
D. Angazi

2. Kumelwe uwusebenzise kangaki umjovo wesifo sikashukela?

A. Uma izinga likashukela liphansi
B. Uma izinga likashukela liphezulu
C. Njalo; njengokusha kukadokotela
D. Angazi

3. Kungenzekani uma ungawusebenzisi njalo umjovo wesifo sikashukela?

A. Izinga likashukela lingehla
B. Ngeke kwenzeke lutho
C. Ngingagula
D. Angazi

4. Kumelwe ulihlole kangaki izinga likashukela osukwini?

A. Njalo ngaphambi kokudla
B. Kanye ngosuku
C. Kanye ngesonto
D. Angazi

5. Kumelwe udle izikhathi ezingaki asukwini?

A. Kanye
B. Kabili
C. Noma kathathu
D. Angazi

6. Uma ungadli isikhathi eside noma weqe isikhathi sokudla kwenzakalani ezingeni likashukela?

A. Izinga likashukela liyanyuka
B. Izinga likashukela liyehla
C. Ayikho into eyenzeka ezingeni likashukela
D. Angazi

7. Kumelwe wenzenjani uma izinga likashukela lehlile?

A. Sebenzisa umjovo wesifo sikashukela
B. Phumula bese ulinda ukuthi izinga likashukela lizehlikele
C. Yidla uswidi noma uphuze into enoshukela bese udla umbambandlala (snack)
D. Angazi

8. Kwenzekani ezingeni likashukela uma udla uswidi omningi ngesikhathi ulambile ?

A. Izinga likashukela liyehla
B. Izinga likashukela liyanyuka
C. Ayikho into eyenzeka ezingeni likashukela
D. Angazi

9. Yini kubalulekile ukudla umbambandlala (snack) ngaphambi kokuba ulale?

A. Ukuze izinga likashukela lihlale lisezingeni esifanele ngenkathi ulele
B. Ukuze uhlale uphapheme
C. Ukuze ulale kahle ebusuku
D. Angazi

10. Uma ufuna ukudla iswidi kumelwe uwudle nini?
Impendulo eyiyo ayiyedwa kulo mbuzo

A. Emva kokudla
B. Noma nini uma uthanda ukuwudla
C. Uma izinga likashukela liphansi
D. Angazi

11. Ikuphi ukudla okuyizibonelo zesitashi?

A. Inyama yenkukhu; inhlanzi; amaqanda
B. Imajarini; ibhotela; amafutha
C. Ilayisi; isinkwa; amazambane
D. Angazi

12. Kwenzakalani ezingeni likashukela uma udla isitashi esiningi?

A. Izinga likashukela liyanyuka
B. Izinga likashukela liyehla
C. Ayihko into eyenzeka ezingeni likashukela
D. Angazi

13. Yikuphi ukudla okuyizibonelo zamafutha?

A. Ilayisi; amazambane; isinkwa
B. I-apula; ukhelothi; isinkwa esinsundu
C. Imajarini; amafutha; ibhotela
D. Angazi

14. Yini kubalulekile ukudla ukudla okunamafutha amancane?

A. Kwenza izinga likashukela lehle
B. Kwenza ukhuluphale bese uba nenkinga yenhliziyo ngokuhamba kwesikhathi
C. Kwenza izinga likashukela linyuke
D. Angazi

15. Yini kubalulekile ukuba ukudla okudlayo kube mahhadlahhadla (fibre)?

A. Kugcina izinga likashukela lisesimweni esifanele
B. Kunambitheka kamnandi
C. Kwenza isifo sikashukela siphele
D. Angazi

16. Yikuphi ukudla okumahhadlahhadla kulokhu?

A. Isinkwa sikakolweni; ubhontshisi owamisiwe; izitshalo (vegetables); izithelo
B. Amaqanda; inyama yenkukhu; inhlanzi; inyama
C. Ubisi; ushizi; iyogathi; u-ayskhrimu
D. Angazi

17. Uma ufuna ukudla i-aphula phakathi kwesikhathi sokudla; kumelwe udle elingakanani ngesikhathi?

A. I-aphula elincane elilodwa
B. Angaphezu kweli lodwa
C. Ngingadla amaningi ngokuthanda
D. Angazi

18. Uma bekumelwe ukhethe ukudla ongakudla; yiliphi obu ngalikhetha kulawa?

A. Ilayisi elinenyama yenkukhu
B. Ilayisi; ukhelothi nenyama yenkukhu
C. Ilayisi lodwa
D. Angazi

19. Uma ufuna ukuthenga esitolo sasesikaleni; ikuphi okungcana ongakuthenga?

A. Ikhokhi
B. Isithelo esincane
C. Amaswidi
D. Angazi

20. Uma ufuna ukudlala isiphi isikhathi esifanele ukuba udle ngaso umbambandlala (snack)?

A. Ngaphambi kwezemidlalo
B. Ngemuva kwezemidlalo
C. Ngesikhathi sezemidlalo
D. Angazi

APPENDIX J: INFORMATION DOCUMENT GIVEN TO CAREGIVERS IN ENGLISH

INFORMATION DOCUMENT

Study title: Dietary intake, diet-related knowledge and metabolic control of children with Type 1 DM, aged 6-10 years attending the paediatric diabetic clinics at Grey's Hospital, Pietermaritzburg and Inkosi Albert Luthuli Central Hospital (IALCH), Durban, KwaZulu-Natal.

Good day. My name is Kirthee Pillay. I am a researcher and a Student at the University of KwaZulu-Natal.

Introduction:

I am doing research on Children with Type 1 Diabetes. Research is just the process to learn the answer to a question. In this study I want to learn whether children with Type 1 Diabetes are eating in the correct way and how much they know about the foods that they eat. I am also going to look at how much the children weigh (how heavy they are) and how tall they are. I am also going to look at how well the diabetes is being controlled and the amount of fat in the blood. Because this is research, some of these things are being done for the first time and is extra to what is normally done with your child.

Invitation to participate: I am asking permission for your child to be included in this study.

Ethics approval

This study has received ethics approval from the University of KwaZulu-Natal, Nelson R Mandela School of Medicine, Research Ethics Committee. Reference Number H263/05.

What is involved in the study – With this study, all children with Type 1 Diabetes, between the ages of 6-10 years who attend the Children's Diabetic Clinic at Grey's Hospital in Pietermaritzburg and Inkosi Albert Luthuli Hospital in Durban, will be invited to take part in this study. Altogether there will be about sixty (60) children taking part in this study. The following things that the child will have to do as part of the study will be extra or new:

1. The children who take part in this study will be asked to write down all the food that they have eaten over 3 days. This will also include anything that they have had to drink, for example tea, juice, milk. This information will be written down in a booklet given to the child and will be posted to the researcher.
2. The child will also be asked to answer a list of questions relating to the foods that they should be eating for the diabetes. Each question will have four choices and the child will have to choose one.
The following things will form part of what is normally done:
3. The weight of the child will also be measured using a scale and the height (how tall the child is) will also be measured.

The child will come to the diabetic clinic on the day that they have an appointment with the Doctor. All of this information will be collected by the person carrying out the study, on the same day. The child will not have to come to the clinic especially for this study. The child will be involved in this study on only one clinic visit and will record intake of food and drink for 3 separate days.

Risks: There are no risks or inconveniences with being involved in this study.
Benefits: Children involved with this study will get to know whether or not they are eating in the correct way for their diabetes and what they may need to change. Children involved with the study will also get to know how much they know about the diet for diabetes and what they still need to learn. Children will also get to know how well the diabetes is being controlled. The height and weight measurements will also give an idea of whether the child is overweight, underweight or at normal weight.

There are no alternative procedures or courses of treatment that might be advantageous to the subject.

The subject will be given important information on the study while involved in the study and after the results are available.

Participation is voluntary, that means that your child can take part in the study only if you want them to. If you do not wish for your child to take part in the study, you and your child will not be negatively affected in any way and you will not lose out on any benefits

from being involved in the diabetic clinic. Your child may stop taking part in the study at any time without any negative effects.

Reimbursements: Participants will not receive any payment for taking part in the study and there will be no additional costs to participants.

Results: If Parents/Guardians and/or participants wish to know the results of the study, Parents/Guardians must provide the researcher with contact details so that they can be given the results.

Confidentiality: Every effort will be made to keep personal information confidential. Absolute confidentiality cannot be guaranteed. Personal information may be revealed if required by law. The Ethics Committee and other relevant authorities may be granted access to the participant's original medical records for verification of study procedures and/or results

Please feel free to ask the Researcher any further questions before deciding on whether to give consent or not.

If any problems arise during the research please contact the researcher, Kirthee Pillay on 033-2605674.
Any problems or complaints with regard to the research can also be reported to the Medical Research Office at the Nelson R Mandela School of Medicine at 031-2604604.

APPENDIX K: INFORMATION DOCUMENT GIVEN TO CAREGIVERS IN ZULU

UMBHALO MBIKO

ISIHLOKO SESIFUNDO: Okuphathelene nemithetho yokudla okukhethiwayo esikudlayo; futhi nokuphatha indlela okwakhiwa ngayo imizimba yabantwana abene Type 1 DM abaneminyaka eyisithuphu kuya kweyishumi nanye (6-10) abaya emtholampilo wabantwana abanesifo sikashukela (diabetes) esibhedlela i-Grey's eMgungundlovu nase Inkosi Albert Luthuli Central Hospital (IALCH); eThekwini; KwaZulu Natal.

Ngiyanibingelela. Igama lami ngingu Kirthee Pillay.Ngingumcwaningi futhi ngingumfundi wasesikhungweni semfundo ephakeme KwaZulu-Natal.

ISETHULO

Ngenza ukwaningo ngezingane ezine sifosikashukela ukwaningo luyinqubo yokufunda impendulo kumbuzo.

Ngifuna ukufunda ukuthi yini izingane ezine Type 1 Diabetes eziyidlayo futhi zazi kangakanani mayelana nokudla ezikudlayo. Ngizophinda ngibheke (ngibuke) ukuthi zishaya bani esikalini (zisinda kangakanani) futhi zinde kangakanani. Ngizophinda ngibheke ukuthi inakekelwa kahle kangakanani i-Diabetes futhi nenani lamafutha egazini. Okuningi kwalezizinto ziyingxenye yokunakekela umtwana wakho okwejwayelekile. Ngokuba ucwaningo lolu, ezinye zalezizinto ziyaqala ukwenziwa futhi kwengezwe kokujwayelwe ukwenziwa enganeni yakho.

ISIMEMO SOKUZIBANDAKANYA: Ngicela imvume yengane yakho ukuba ihlanganiswe kwisifundo.

IMVUME YENKAMBO ELUNGILEYO: Umcwaningo uthole imvume yenkambo elungileyo esikhunngweni esiphakeme sokufunda ya KwaZulu-Natal; iNelson Mandela School of Medicine; ibandla lenkambo elungileyo yocwaningo H263/05

YINI ETHINTEKAYO KULOKHU OKUFUNDWAYO: Zonke izingane ezine Type 1 Diabetes; ezineminyaka ephakathi ka 6-10 eziya emtholampilo wezingane ezine diabetic esibhedlela e-Grey's eMgungundlovu nasesibhedlela Inkosi Albert Luthuli eThekwini;

zizomenywa ukuba zibeyingxenye kulokhu okufundwayo. Sezihlangene zonke izingane eziyingxenye yalokukufunda zizoyela emashumini ayisithupha (60). Lokhu okulandelayo ingane kuzomele ikwenze njengengxenye yezifundo

1. Izingane ezizobe ziyingxenye yalokhu okufundwayo zizocelwa ukuba zibhale phansi konke ukudla ezikudlile ezinsukwini ezintathu (3). Lokhu kuzophinda kuhlanganise noma ngabe yini abayiphuzile; isibonelo itiye ijusi noma ubisi. Lemininingwane izobhalwa phansi ebhukwaneni izoiyikwa ingane ngumuntu ophethe (noma oqhuba) lokhu okufundwayo. Ingane kuzomele ifike nayo lencwajana ezobe isigcwalisiwe ngosuku olunqunyiwe ukuba ifike ngalo emtholampilo.

2. Ingane izophinde icelwe ukuba iphendule uhla lwemibuzo oluhlobene nokudla okumele kudliwe abanesifo sikashukela (diabetes). Umbuzo umunye uzobe unezimpendulo ezine lapho ingane ikhetha khona impendulo eyodwa.

3. Zivumele kuthathwe igazi ukuze kukalwe izinga lamafutha egazini

LOKU OKULANDELAYO KUZOBA YINGXENYE YOKWEJWAYELEKILE OKWEZIWAYO

4. Isisindo sengane sizokalwa kusetshenziswa isikali futhi nobude (yinde kangakanani ingane) buzokalwa.

5. Kuzothathwa igazi ukuzekukalwe ukuthi isifo sikashukela (diabetes) siyiphethe kanjani.

Ingane izoza emtholampilo wabanesifo sikashukela (diabetes) ngosuku okuqunyelwene ngalo nodokotela. Yonke lemininingwane izoqoqwa umuntu ophethe (noma oqhuba) okufundwayo ngosuku olufanayo. Asikho isidingo sokuthi ingane ize emtholampilo ngenxa yalesisifundo. Ingane izozibandakanya nalesisifundo ngezinsuku ezimbili iyakashele umtholampilo futhi imininingwane yokudla neziphuzo ekudlile ngezinsuku ezintathu ezehlukene kuzobhalwa phansi

UBUNGOZI: Abukho ubungozi noma ukuhlukumezeka ngokuzibandakanya nalesisfundlo

USIZO: Izingane ezibandakanyekayo kulokhu okufundwayo zizothola ukwazi ukuthi ingabe zidla ngendlela eyamukelekile kwabanesifo sikashukela (Diabetes) futhi yini okungadingeka ishintshwe. Izingane ezibandakanyekayo kulesisifundo zizobuye zithole ukwazi ukuthi zazi kangakanani mayelana nokudla okukhethelwe abanesifo sikashukela (diabetes) nokuthi yikuphi okusamele bakufunde. Izingane zizobuye zaziswe ukuthi siphathwa kanjani kahle isifo sikashukela (diabetes). Ukuhlolwa kwezinga lamafutha emzimbeni lizobuye lisitshele; mangakanani amathuba okuthi ingane ithole isinesifo senhliziyo. Ukukalwa kobude nesisindo kuzobuye kunikeze ukuthi ingane yondile; ikhuluphele noma inesisindo esifanelekile

AZIKHO EZINYE IZINDLELA ZOKUQHUBA: noma amasu okwelapha angahle abe usizo kumuntu osetshenziswayo

Umuntu osetshenziswayo uzonikwa imininingwane ebalulekile ngesifundo ngenkathi ebandanyeka kulesisifundo futhi ngemuva kokuba imiphumela isitholakele

UKUHLANGANYELA KUYISENZO OKUYINTANDO YAKHO

Lokho kuchaza ukuthi ingane yakho ingaba yingxenye yesifundo kuphela uma ufuna.

Uma ungasifi ingane yakho ibe yingxenye yesifundo wena nengane yakho angeke nithinteke ngendlela engamukelekile futhi ngeke nilahlekelwe yinoma iluphi usizo ngokuzibandakanya nomtholampilo wabanesifo sikashukela (diabetes). Ingane ingayeka ukuba yingxenye yesifundo noma yingasiphi isikhathi ngaphandle kokuthi iphatheke ngokungamukelekile.

IZINDLEKO: Abahlanganyeli ngeke banikwe inkokhelo ngokuba yingxenye yalesisifundo futhi ngeke kube nokukhokhelwa okungaphezulu kubahlanganyeli

IMIPHUMELA: Uma abazali/ abaphathi futhi/ noma abayingxenye befisa ukwazi imiphumela yesifundo; abanzali/ abaphathi kuzomele banikeze umcwaningi imininingwane abathinteka kuyona ukuze banikwe imiphumela. Imiphumela yegazi

engavamile izodluliselwa kudokotela owelaphayo ophethe abaphathi bengane futhi kuzobuye kwaziswe nabazali/abaphathi.

OKUYIMFIHLO : Kuzokwenziwa yonke imizamo yokugcina imininingwane yomuntu iyimfihlo. Imfihlo yemininingwane yomuntu angeke iqiniseke imininingwane yomuntu ingavezwa uma kusho umthetho. Ibandla lenkambo elungileyo nabanye abanegunya abahlangene banganikwa intuba yokuthola izincwadi okuyizo qobo ezibhalwe ngokwelashwa komhlanganyeli ukuze kuginiseke inqubo yesifundo futhi/noma nemiphumela

Uyacelwa ukuba ukhululeke ukubuza umcwaningi eminye imibuzo ngaphambi kokunquma ukuthi ingabe uyavuma noma cha.

Uma kunezinkinga noma imibuzo evukayo ngesikhathi ucwaningo luqhubeka uyacelwa uthinte umcwaningi uKirthee Pillay ku 033-2605674 noma ngabe yiziphi izinkinga noma izikhalo maqondana nocwaningo kungabikwa eMedical Research Office eNelson Mandela School of Medicine ku 031-2604604.

APPENDIX L: INFORMED CONSENT FOR PARENTS/GUARDIANS OF MINORS IN ENGLISH

INFORMED CONSENT FOR PARENTS/GUARDIANS OF MINORS

I hereby confirm that I have been informed by the Researcher (Kirthee Pillay) about the nature, conduct, benefits and risks of the study below.

Study title: Dietary intake, diet-related knowledge and metabolic control of children with Type 1 DM, aged 6-10 years attending the paediatric diabetic clinics at Grey's Hospital, Pietermaritzburg and Inkosi Albert Luthuli Central Hospital (IALCH), Durban, KwaZulu-Natal.

Consent to Participate in Research

You have been asked for permission for your child to participate in a research study.

You have been informed about the study by Kirthee Pillay.

You have been informed about any available compensation or medical treatment for your child/ward, if injury occurs as a result of study-related procedures.

You may contact Kirthee Pillay at 033-2605674 any time if you have questions about the research or if your child/ward is injured as a result of the research.

You may contact the Medical Research Office at the Nelson R Mandela School of Medicine at
031-260 4604 if you have questions about the rights of your child/ward, as a research subject.

- I have received read and understood the information document and have had the opportunity to discuss the study with the Researcher.
- I am aware that I am agreeing for my child/ward to participate in a research study where there may be no personal benefit for my child/ward or me.
- I am aware that the findings from the study, including personal details will be anonymously processed into a study report and will remain confidential.
- I am willing to give the Ethics Committee at the Nelson R Mandela School of Medicine complete access to my child's/ward's medical records, if needed.
- I am willing to give the Researcher and Research Assistant complete access to my child's/ward's Medical records for the duration of the study.
- I understand that the participation of my child/ward is voluntary and I can at any stage, withdraw my consent for my child/ward to participate in the study, without losing benefits or being penalised.
- I understand that if I do not give permission for my child/ward to participate in the study, he/she will not lose benefits or be penalised in any way.

- I understand that if I agree to give consent for my child/ward to participate in the study, I will be given a signed copy of this document and the information document, which is a written summary of the research.
- The research study, including the above information, has been described to me orally. I understand what the involvement of my child/ward is in the study means and I voluntarily agree for him/her to participate.

NAME OF PARENT/GUARDIAN (PRINTED): _____

SIGNATURE OF PARENT/GUARDIAN_____

DATE: _____

ON BEHALF OF THE PATIENT (minor): _____ (Print full name)

NAME OF WITNESS (PRINTED): _____

CONTACT PHONE NUMBER: _____

SIGNATURE OF WITNESS: _____DATE: _____

APPENDIX M: INFORMED CONSENT FOR PARENTS/GUARDIANS OF MINORS IN ZULU

ISAZISO SEMUME SABAZALI/ ABAPHATHI BABANCANE

Ngilapha ukuqiniseka ukuthi ngazisiwe ngumcwaningi Kirthee Pillay mayelana nemvelo inkambo nobungazi besifundo ngezansi

ISIHLOKO SESIFUNDO
Ukudla okukhetiwe ngemithetho yokudla; ulwazi oluhlobene nokudla okukhethiweyo nokuphata indlela yokwakha umzimba wabantwana ngokudliwa abane Type 1 DM abaneminyaka eyisithupa kuya kweyishumi nanye (6-10) abaya emtholampilo wezingane ezinesifo sikashukela (Diabetes) esibhedlela iGrey's; eMgungdlovu nasesibhedlela Inksosi Albert Luthuli Central (IALCH) e-Thekwini; KwaZulu-Natal.

IMVUME YOKUHLANGANYELA KUCWANINGO
Uceliwe ukuba uvumele ingane yakho ukuba ihlanganyele kucwaningo sifundo.
Wazisiwe mayelana nesifundo ngu Kirthee Pillay
Waziziwe mayelana nenhlawulo ekhona noma nemithi eyelaphayo yengane yakho/iwodi _____ uma kwenzeka kukhona olimalayo ngenxa yocwaningo
Ungethintana no Kirthee Pillay ku 033-2605674 noma yingasiphi isikathi uma unemibuzo mayelana nocwaningo noma uma ingane/ilimala ngenxa yocwaningo

Ungathintana neMedical Research Office eNelson Mandela School of Medicine ku 031-2064604 uma unemibuzo mayelana namalungelo engane yakho

- Ngiyitholile incwadi mbiko; ngayifunda ngase ngiyiqonda futhi ngalithola nethuba lo kuxoxisana nomcwaningi ngesifundo
- Ngiyazi ukuthi ngivumela ingane yami/iwodi ukuzibandakanya nocwaningo sifundo lapho kungenzeka mina nengane yami/iwodi singabi nanzuzo
- Ngiyazi ukuthi okutholiwe kulesisifundo; kanye nemininingwane yami kuzodluliswa ngendlela eyimfihlo kumbiko wesifundo futhi kuzohlale kuyimfihlo
- Ngizimisele ukunika ibandla lenkambo elungleyo e Nelson R Mandela School of Medicine imvume ephelele ukubona izincwadi zokwelashwa zengane yami/iwodi uma kudingeka.
- Ngizimiseleukunika umcwaningi nosekela mcwaningi ubuniningwane obuphelele ezincwadini zokulashwa kwengane yami/iwodi ngesikhathi isifundo siqhubeka
- Ngiyaqonda ukuthi ukuzibandakanya kwengane yami/iwodi kungentando futhi noma yinini ngingayinoxisa invume yami yokuthi ingane yami izibandakanye nesifundo ngaphandle kokulahlekelwa isizo noma ngijeziswe.
- Ngiyaqonda ukuthi uma ngingavumi ingane yami/iwodi izibandakanye nesifundo; ngeke ilahlekelwe usizo noma ijeziswe noma ngayiphi indlela
- Ngiyaqonda ukuthi uma ngivuma ukunikeza ingane yami/imvume yokuzibandakanya nesifundo; ngizonikezwa isifanekiso salencwadi esayiniwe kanye nombhalo mbiko ofinyeziwe wocwaningo
- Ucwaningo sifundo kuhlangene nemininingwane engenhla; ikhulunywe yachazwa ngomlomo. Ngiyaqonda ukuthi kuchaza ukuthini ukuzihlanganisa kwengane yami nesifundo futhi ngiyavuma ukuthi ingane yami izibandakanye

IGAMA LOMZALI/UMPHATHI (printa) _____

IGAMA LOMUNTU ELILOTSHWE NGUYE (SAYINA)
LOMZALI/UMPHATHI_____ USUKU
_____

ESIKHUNDLENI SESIGULU (SOMCANE) _____ (printa igama ngokugcwele)

IGAMA LIKAFAKAZI (printa) _____

INOMBOLO YOCINGO _____

IGAMA LOMUNTU ELILOTSHWE NGUYE (sayina) LIKAFAZI
_____

USUKU _____

APPENDIX N: INFORMED ASSENT FOR MINORS (UNDER 18 YEARS OF AGE) IN ENGLISH

INFORMED ASSENT FOR MINORS (UNDER 18 YEARS)

I agree to take part in a research study and have spoken to the Researcher (Kirthee Pillay) about the nature, conduct, benefits and risks of this study. (Reference number H 263/05).

- I have received, read and understood the written information (information document) and have had a chance to speak to the Researcher about the study.

- I am aware that the results from this study, including personal details will be anonymously put together into a study report and will remain confidential.

- I am willing to allow the Ethics Committee at the Nelson R Mandela School of Medicine full access to my medical records, if needed.

- I am willing to allow the Researcher and Research Assistant full access to my medical records during the study.

- I understand that I may at any stage, withdraw my consent to take part in the study without losing any benefits or being penalised in any way.

- I understand that I may contact Kirthee Pillay, the Researcher on 033-2605674 at any time if I have questions about the study.

- I am willing to be a part of this study and have informed my doctor and parent/guardian.

- I understand that if I agree to participate, I will be given a signed copy of this document and the information document, which is a written summary of the research.

- The research study, including the information given above, has been described to me orally. I understand what my involvement in the study means and I voluntarily agree to participate.

NAME OF PATIENT (PRINTED):_____
SIGNATURE OF PATIENT: _____
DATE: _____

NAME OF WITNESS (PRINTED):_____
SIGNATURE OF WITNESS: _____
CONTACT NUMBER FOR WITNESS: _____
DATE: _____

APPENDIX O: INFORMED ASSENT FOR MINORS (UNDER 18 YEARS OF AGE) IN ZULU

ISAZISO SEMVUME YABANCANE (ABANGAPHANSI KWEMINYAKA EYISHUMI NESISHIYAGALOMBILI (18)

Ngiyavuma ukuba yingxenye yocwaningo sifundo futhi ngikhulumile nomcwaningi (Kirthee Pillay) mayelana nemvelo ingubo usizo kanye balesisifundo H263/05

- Ngiwutholile, ngawufunda futhi ngawunqonda umbikoobhaliwe (umbhalombiko) futhi ngalithola nethuba lokukhuluma nomcwaninginingi mayelana nokufundwayo

- Ngiyazi ukuthi imphumela yalesisifundo ihlanganisa imininingwane ephathelene nomuntu izohlanganiswa ndawonye ngokuyimfihlo kumbiko wesifundo futhi iyimfihlo

- Ngizimisele ukuvumela ibandla lenkambo elungileyo e Nelson Mandela School of Medicine ubuninigwane obuphelele ezincwadini zami zokwelashwa

- Ngizimisele ukuvumela umcwaningi ubungeno obuphelele ezincwadini zami zokwelashwa ngesikhathi isifundo siqhubeka

- Ngiyaqonda ukuthi noma ngabe yinini; imvume yami ngingayihoxisa nokuzibandakanya nesifundo ngaphandle kokulahlekelwa usizo noma ngijeziswe noma ngayiphi indlela

- Ngiyaqonda ukuthi ngingathintana no Kirthee Pillay; umcwaningi ku 033-2605674 noma yingasiphi isikhati uma nginemibuzo mayelana nokufundwayo

- Ngizimisele ukuba yingxenye yokufundwayo la futhi ngimazisile udokotela wami nomzali/umphathi

- Ngiyaqonda ukuthi uma ngivuma ukuzibandakanya; ngizonikezwa isifanekiso salencwadi kanye nombhalo mbiko; ofinyeziwe wocwaningo

- Ucwaningo sifundo uhlanganisa umbiko onikiwe ngenhla ulhazwe wakhulunywa ngolome. Ngiyaqonda ukuthi ukuzibandakanya kwami kulesisifundo kuhlangene nani futhi ngivuma ngokuzinikela ukuzibandakanya nawo.

IGAMA LOMZALI (printa) _____

IGAMA LOMUNTU ELIBHALWENGUYE (sayina) LESIGULI_____

USUKU _____

IGAMA LIKAFAKAZI (printa) _____

IGAMA LOMUNTU ELIBHALWENGUYE (sayina) _____

INOMBOLO YOCINGO KAFAZI _____

USUKU _____

APPENDIX P: COLLATION SHEET

DATE: _____ **HOSPITAL:** _____

FIRST NAME: _____ **SURNAME:** _____

FILE NUMBER: | | **DATE OF BIRTH**: / / dd / mm / yyyy

AGE: _____ Years; _____Months **GENDER**: Male Female

dd / mm / yyyy

DATE OF DIAGNOSIS: / / **DURATION OF DIAGNOSIS**: ____Yrs; ___ months

MEDICAL BACKGROUND:

_____

_____

_____

INSULIN DOSE AND REGIME: _____

FREQUENCY OF BLOOD GLUCOSE MONITORING: _____

METHOD OF BLOOD GLUCOSE MONITORING: _____

1. ANTHROPOMETRY

Weight (kg)	1.	2.	3.	Average
Height (m)	1.	2.	3.	Average
BMI		WEIGHT STATUS		

2. BIOCHEMICAL VALUES

HbA1c

DATE	HbA1c values (%)

3. DIET-RELATED KNOWLEDGE QUESTIONNAIRE

MARK	Score (%)

4. SOCIO-DEMOGRAPHIC QUESTIONNAIRE

SOCIO-ECONOMIC STATUS

1. What is the employment status of the parents?

1.	2.	3.	4.	5.
Both employed	Both unemployed	One employed	Both self-employed	One self-employed

2. How many people contribute to the total income (money) in the household?

1.	2.	3.	4.	5.
0 person	1 persons	2 persons	3-4 persons	More than 4

3. What is the total household income per month (including wages, rent, grants etc)?

1.	2.	3.	4.	5.	6.	7.
None	R1-R500	R501-R1000	R1001-R3000	R3001-R5000	Over R5000	Don't know

4. Is this the usual income of the household?

1.	2.	3.	If no specify what other income is available:
Don't know	Yes	No	

5. Is this more or less the income you have had over the last 6 months?

1.	2.	3.	4.	5.
Don't know	More	Less	The same	Specify if more or less

EDUCATION STATUS

6. What grade is the child in currently?

_____

7. What is the highest formal education level of the caregiver?

1.	2.	3.	4.	5.
None	Primary School	Std 6-8 Grade 8-10	Std 9-10 Grade 11-12	Tertiary education

APPENDIX Q: LETTER OF APPROVAL FROM BERG STREET PRIMARY SCHOOL TO CARRY OUT PILOT STUDY

BERG STREET PRIMARY SCHOOL
"SOARING TOWARDS EXCELLENCE"
KWAZULU-NATAL - DEPARTMENT OF EDUCATION & CULTURE

ADDRESS : 509 BERG STREET PIETERMARITZBURG 3201
IKHELI : P O BOX 8957 CUMBERWOOD 3235
TELEPHONE : 033 - 394 3931
FAX : 033 - 394 3931

2006-05-09

Ms Jill Meaker
Acting Head of Discipline
Dietetics & Human Nutrition
University of KZN
PIETERMARITZBURG
3200

Dear Madam

PILOT STUDY - KIRTHEE PILLAY

Please be informed that Ms Kirthee Pillay has been granted permission to carry out her Pilot Study on some of the learners at our school. This, however, will entail height and weight measurements of learners as well as the completion of a multiple choice questionnaire.

We wish Kirthee all the success in her pilot study.

Yours faithfully

D.H. JEEBODH
DEPUTY PRINCIPAL

KWAZULU-NATAL
DEPARTMENT OF EDUCATION AND CULTURE
BERG STREET
PRIMARY SCHOOL
509 BERG STREET
PIETERMARITZBURG 3201
KWAZULU-NATAL
DEPARTMENT OF EDUCATION AND CULTURE

APPENDIX R Mean nutrient intakes from the average of the 3 days in the 3 day dietary record compared to USA-RDA values for children ≥ 6 and < 8 years of age and children ≥ 8 and ≤ 10 years of age

Nutrient	Mean intake of children ≥ 6 years and < 8 years of age (n = 9) (∀SD)	USA -RDA	P value Ω	Mean intake of children ≥ 8 and ≤ 10 years of age (n =11) (∀SD)	USA -RDA	P value Ω
Energy (kJ)	6420 (∀1310)	7316	0.074	8030 (∀1940)	9572	0.025
Total protein (g)	57 (∀15)	19	0.000	81 (∀30)	34	0.000
Carbohydrate (g)	202 (∀57)	130	0.005	238 (∀52)	130	0.000
Dietary fibre (g)	19 (∀6)	25	0.010	28 (∀10)	29	0.734
Calcium (mg)	539.5 (∀210.2)	800	0.006	757.3 (∀305.8)	1300	0.000
Magnesium (mg)	218.3 (∀80.1)	130	0.011	339.8 (∀124.5)	240	0.024
Phosphorus (mg)	934.7 (∀224.1)	500	0.000	1329.5 (∀456.7)	1250	0.576
Iron (mg)	11.2 (∀3.6)	10	0.351	14.5 (∀4.7)	8	0.001
Zinc (mg)	7.6 (∀3.1)	5	0.035	13.1 (∀5.5)	8	0.012
Thiamin (mg)	1.1 (∀0.3)	0.6	0.003	1.6 (∀0.6)	0.9	0.006
Riboflavin (mg)	1.4 (∀0.1)	0.6	0.002	1.7 (∀0.6)	0.9	0.003
Niacin (mg)	16.8 (∀4.8)	8	0.001	22.7 (∀12.2)	12	0.015
Vitamin B6 (mg)	1.6 (∀0.3)	0.6	0.000	3.1 (∀4.4)	1	0.145
Folate (µg)	254.7 (∀96.6)	200	0.128	320.1 (∀88.2)	300	0.468
Vitamin B12 (mg)	2.4 (∀1.1)	1.2	0.014	5.1 (∀3.4)	1.8	0.010
Vitamin C (mg)	63.9 (∀37.1)	25	0.014	46.9 (∀27.4)	45	0.822
Vitamin A (µg)	524.7 (∀193.9)	400	0.090	793.3 (∀522.5)	600	0.248
Vitamin D (µg)	2.6 (∀1.8)	5	0.003	4.0 (∀2.2)	5	0.170
Vitamin E (mg)	9.1 (∀3.1)	7	0.079	11.0 (∀4.7)	11	0.984

Ω One sample t-test

APPENDIX S Mean nutrient intakes from the 24 hour recall compared to USA-RDA values for children ≥ 6 and < 8 years of age and children ≥ 8 and ≤ 10 years of age

Nutrient	Mean intake of children ≥ 6 and < 8 years of age (n = 10) (∀SD)	USA -RDA	P value$^{\Omega}$	Mean intake of children ≥ 8 and ≤ 10 years of age (n=6) (∀SD)	USA -RDA	P value$^{\Omega}$
Energy (kJ)	7768 (∀2081)	7316	0.509	8455 (∀1763)	9572	0.181
Total protein (g)	74 (∀18)	19	0.000	86 (∀32)	34	0.011
Carbohydrate (g)	227 (∀91)	130	0.008	245 (∀59)	130	0.005
Dietary fibre (g)	27 (∀17)	25	0.665	28 (∀15)	29	0.906
Calcium (mg)	746.3 (∀453.2)	800	0.717	848.9 (∀536.3)	1300	0.094
Magnesium (mg)	313.9 (∀160.3)	130	0.005	336.4 (∀139.8)	240	0.152
Phosphorus (mg)	1260.6 (∀426.3)	500	0.000	1436.2 (∀410.1)	1250	0.317
Iron (mg)	15.3 (∀5.1)	10	0.010	14.1 (∀4.6)	8	0.024
Zinc (mg)	11.4 (∀3.5)	5	0.000	13.6 (∀4.3)	8	0.025
Thiamin (mg)	1.5 (∀0.5)	0.6	0.000	1.4 (∀0.6)	0.9	0.109
Riboflavin (mg)	1.7 (∀0.8)	0.6	0.002	1.6 (∀0.6)	0.9	0.031
Niacin (mg)	22.1 (∀9.7)	8	0.001	21.9 (∀14.2)	12	0.149
Vitamin B6 (mg)	2.0 (∀0.6)	0.6	0.000	1.9 (∀0.8)	1	0.042
Folate (µg)	380.1 (∀185.3)	200	0.013	342.3 (∀141.2)	300	0.496
Vitamin B12 (mg)	3.2 (∀1.9)	1.2	0.008	3.0 (∀1.6)	1.8	0.113
Vitamin C (mg)	49.6 (∀31.9)	25	0.037	46.0 (∀20.8)	45	0.911
Vitamin A (µg)	675.1 (∀376.2)	400	0.046	949.9 (∀686.9)	600	0.267
Vitamin D (µg)	3.4 (∀2.1)	5	0.039	1.8 (∀1.1)	5	0.001
Vitamin E (mg)	11.7 (∀6.0)	7	0.034	10.0 (∀10.4)	7	0.814

Ω One sample t-test

APPENDIX T **LETTER OF ETHICS APPROVAL FROM THE BIOMEDICAL RESEARCH ETHICS COMMITTEE, NELSON R MANDELA SCHOOL OF MEDICINE, UNIVERSITY OF KWAZULU-NATAL**

UNIVERSITY OF
KWAZULU-NATAL

31 March 2006

Mrs K Pillay
Dietetics and Human Nutrition
PIETERMARITZBURG

Dear Mrs Pillay

PROTOCOL: Dietary intake, diet-related knowledge and metabolic control of children with Type 1 diabetes mellitus, aged 6-11 years attending the Paediatric Diabetic Clinics at Grey's Hospital, Pietermaritzburg and Inkosi Albert Luthuli Central Hospital (IALCH), Durban, KwaZulu-Natal. K Pillay, Dietetics and Human Nutrition.
Ref: H263/05

Thank you for your responses dated 20 March 2006 to queries raised on 13 March 2006.

I wish to advise you the above study was considered by the Biomedical Research Ethics Committee on 14 February 2006 and approved together with amendments pending appropriate responses to queries. These conditions have now been met and the study is given full ethics approval and may begin as at today's date 31 March 2006.

This approval is valid for one year from 31 March 2006. To ensure continuous approval, an application for recertification should be submitted a couple of months before the expiry date. In addition, when consent is a requirement, the consent process will need to be repeated annually.

I take this opportunity to wish you everything of the best with your study. Please send the Biomedical Research Ethics Committee a copy of your report once completed.

Yours sincerely

DR J MOODLEY
Chair: Biomedical Research Ethics Committee

**Nelson R Mandela School of Medicine, Faculty of Health Sciences,
Medical Research Administration**

Postal Address: Private Bag 7, Congella 4013, South Africa
Telephone: +27 (0)31 260 4495 **Facsimile:** +27 (0)31 260 4529 **Email:** borresen@ukzn.ac.za **Website:** www.ukzn.ac.za
Founding Campuses: Edgewood Howard College Medical School Pietermaritzburg Westville

APPENDIX U: LETTER OF APPROVAL FROM GREY'S HOSPITAL TO CARRY OUT RESEARCH

DEPARTMENT OF HEALTH

PROVINCE OF KWAZULU-NATAL

GREY'S HOSPITAL
OFFICE OF THE HOSPITAL MANAGER
Townbush Road
Private Bag X9001, Pietermaritzburg, 3200
Tel.: 033 8973321, Fax.: 033 342 2324
Email.:MEIRINGV@dohgreys.kzntl.gov.za

05 April 2006

ATTENTION: MRS K. PILLAY
DIETETICS AND HUMAN NUTRITION
PIETERMARITZBURG

FAX: 033 – 260 6270

Dear Mrs Pillay

RE: PROTOCOL: DIETARY INTAKE, DIET-RELATED KNOWLEDGE AND METABOLIC CONTROL OF CHILDREN WITH TYPE 1 DIABETES MELLITUS, AGED 6-11 YEARS ATTENDING THE PAEDIATRIC DIABETIC CLINICS AT GREY'S HOSPITAL AND INKOSI ALBERT LUTHULI CENTRAL HOSPITAL (I.A.L.C.H), DURBAN, KWAZULU-NATAL. K. PILLAY, DIETETICS AND HUMAN NUTRITION. REF: H263/05

1. Your correspondence dated 31 March 2006 with respect to the above refers.

2. Kindly be advised that further to your correspondence from the Biomedical Research Ethics Committee whereby full ethics approval was granted for you to carry out research and your discussion's with Dr Muller, permission is hereby granted for you to carry out the above-mentioned research at Grey's Hospital.

Thanking you

DR K. NAIDU
HOSPITAL MANAGER

AUTHORISED SECRETARY
TO: THE HOSPITAL MANAGER
GREY'S HOSPITAL

Cc: DR F. J MULLER

SIGNED ON BEHALF OF DR K. NAIDU

APPENDIX V: LETTER OF APPROVAL FROM INKOSI ALBERT LUTHULI CENTRAL HOSPITAL TO CARRY OUT RESEARCH

PERMISSION TO CONDUCT A RESEARCH STUDY/TRIAL

This must be completed and submitted to the Medical Superintendent/s / Hospital Manager/s for signature.

For King Edward VIII Hospital (KEH) and Inkosi Albert Luthuli Central Hospital (IALCH) studies please submit the document together with the following:

1. Research proposal and protocol.
2. Letter giving provisional ethical approval.
3. Details of other research presently being performed by yourself if in the employ of KEH, (individually or as a collaborator).
4. Details of any financial or human resource implications to KEH, including all laboratory tests, EEGs, X-rays, use of nurses, etc. (See Addendum 1)
5. Declaration of all funding applications / grants, please supply substantiating documentation.
6. Complete the attached KEH Form – *"Research Details"*

Once the document has been signed it should be returned to Ms C Borresen, Medical Research Administration, Room 115 Old MRC Building.

To: Chief Medical Superintendent / Hospital Manager
Dr Joshua - Inkosi Albert Luthuli Central Hospital

Permission is requested to conduct the above research study at the hospital/s indicated below:

Site 1 address:
Inkosi Albert Luthuli Central Hospital- Paediatric Diabetic Clinic

Investigator/s:
Principal: Kirthee Pillay (Mrs)
Co-investigator: Prof EMW Maunder (UKZN)
Co-Investigator: Dr KL Naidoo (Grey's Hospital)

Signature of Chief Medical Superintendent/Hospital Manager :

Date: 05/09/06

Site 2 address:

Investigator/s
Principal: _____
Co-investigator: _____
Co-Investigator: _____

Signature of Chief Medical Superintendent / Hospital Manager :

Date: _____

NB: Medical Superintendent/s / Hospital Manager/s to send a copy of this document to Natalia

APPENDIX W: COMPARISON OF THE MEAN NUTRIENT INTAKES FROM DAY 3 OF THE 3 DAY DIETARY RECORD AND THE 24 HOUR RECALL

Pair	Number in sample	Nutrients	Mean difference	SD	P value[T]
Energy (kJ)	n = 11	Day 3 energy-24 hour recall energy	-933.5	1594.0	0.081
Total protein (g)	n = 11	Day 3 total protein-24 hour recall total protein	-7.7	12.0	0.059
Protein as a percentage of total energy (%)	n = 11	Day 3 protein as a percentage of total energy-24 hour recall protein as a percentage of total energy	- 0.06	1.93	0.916
Plant protein (g)	n =11	Day 3 plant protein-24 hour recall plant protein	-2.2	10.0	0.485
Animal protein (g)	n = 11	Day 3 animal protein-24 hour recall animal protein	-5.6	9.1	0.071
Total fat (g)	n = 11	Day 3 total fat-24 hour recall total fat	-14.3	18.9	0.030
Total fat as a percentage of total energy (%)	n = 11	Day 3 total fat as a percentage of total energy - 24 hour recall total fat as a percentage of total energy	- 3.3	6.3	0.115
Polyunsaturated fatty acids (PUFA) (g)	n = 11	Day 3 PUFA – 24 hour recall PUFA	-3.7	12.7	0.361
Saturated fatty acids (SFA) (g)	n = 11	Day 3 SFA-24 hour recall SFA	- 4.9	4.7	0.006
Monounsaturated fatty acids (MUFA) (g)	n = 11	Day 3 MUFA- 24 hour recall MUFA	- 5.7	5.2	0.005
Cholesterol (mg)	n =11	Day 3 cholesterol-24 hour recall cholesterol	- 5.7	64.1	0.773
PUFA:SFA ratio	n = 11	Day 3 PUFA:SFA ratio – 24 hour recall PUFA:SFA ratio	0.0091	0.5	0.996
Carbohydrate (g)	n = 11	Day 3 carbohydrate-24 hour recall carbohydrate	-16.0	63.1	0.421
Carbohydrate as a percentage of total energy (%)	n = 11	Day 3 carbohydrate as a percentage of total energy-24 hour recall carbohydrate as a percentage of total energy	3.4	6.3	0.106
Sucrose (g)	n = 11	Day 3 sucrose – 24 hour recall sucrose	-3.6	5.2	0.044

[T] Paired t-test

Pair	Number in sample	Nutrients	Mean difference	SD	P value[T]
Sucrose as a percentage of total energy (%)	n = 11	Day 3 sucrose as a percentage of total energy-24 hour recall sucrose percentage of total energy	- 0.5	0.9	0.124
Dietary fibre (g)	n = 11	Day 3 dietary fibre-24 hour recall dietary fibre	- 2.0	8.7	0.475
Calcium (mg)	n = 11	Day 3 calcium-24 hour recall calcium	- 54.6	252.0	0.488
Magnesium (mg)	n = 11	Day 3 magnesium-24 hour recall magnesium	-18.2	66.0	0.381
Phosphorus (mg)	n = 11	Day 3 phosphorus-24 hour recall phosphorus	-92.1	190.7	0.140
Iron (mg)	n = 11	Day 3 iron-24 hour recall iron	- 0.2	3.0	0.864
Zinc (mg)	n = 11	Day 3 zinc-24 hour recall zinc	- 0.9	2.8	0.297
Thiamin (mg)	n = 11	Day 3 thiamin – 24 hour recall thiamin	0.03	0.3	0.737
Riboflavin (mg)	n = 11	Day 3 riboflavin-24 hour recall riboflavin	- 0.02	0.31	0.808
Niacin (mg)	n = 11	Day 3 niacin-24 hour recall niacin	0.1	5.5	0.955
Vitamin B_6 (mg)	n = 11	Day 3 vitamin B6-24 hour recall vitamin B6	- 0.1	0.7	0.741
Folate (µg)	n = 11	Day 3 folate-24 hour recall folate	- 34.5	139.3	0.430
Vitamin B_{12} (mg)	n = 11	Day 3 vitamin B12-24 hour recall vitamin B12	0.04	0.70	0.867
Vitamin C (mg)	n = 11	Day 3 vitamin C-24 hour recall vitamin C	0.9	14.0	0.834
Vitamin A (µg)	n = 11	Day 3 vitamin A-24 hour recall vitamin A	- 91.4	289.1	0.319
Vitamin D (µg)	n = 11	Day 3 vitamin D-24 hour recall vitamin D	- 0.09	1.72	0.860
Vitamin E (mg)	n = 11	Day 3 vitamin E-24 hour recall vitamin E	- 2.1	11.3	0.558

[T] Paired t-test

APPENDIX X: COMPARISON OF THE MEAN NUTRIENT INTAKES FROM THE AVERAGE OF THE 3 DAY DIETARY RECORD AND THE 24 HOUR RECALL

Pair	Number in sample	Nutrients	Mean difference	SD	P value[T]
Energy (kJ)	n = 11	Average energy from 3 day dietary record-24 hour recall energy	-847.7	1594.1	0.108
Total protein (g)	n = 11	Average total protein from 3 day dietary record-24 hour recall total protein	- 4.4	19.9	0.484
Protein as a percentage of total energy (%)	n = 11	Average protein as a percentage of total energy from 3 day dietary record -24 hour recall protein as a percentage of total energy	0.5	3.3	0.610
Plant protein (g)	n =11	Average plant protein from 3 day dietary record -24 hour recall plant protein	- 4.2	9.8	0.192
Animal protein (g)	n = 11	Average animal protein from 3 day dietary record -24 hour recall animal protein	-1.5	19.8	0.807
Total fat (g)	n = 11	Average total fat from 3 day dietary record -24 hour recall total fat	-10.0	17.3	0.084
Total fat as a percentage of total energy (%)	n = 11	Average total fat as a percentage of total energy from 3 day dietary record -24 hour recall total fat as a percentage of total energy	- 1.8	5.5	0.297
Polyunsaturated fatty acids (PUFA) (g)	n = 11	Average PUFA from 3 day dietary record – 24 hour recall PUFA	-0.8	12.0	0.827
Saturated fatty acids (SFA) (g)	n = 11	Average SFA from 3 day dietary record -24 hour recall SFA	- 4.5	6.8	0.052
Monounsaturated fatty acids (MUFA) (g)	n = 11	Average MUFA from 3 day dietary record - 24 hour recall MUFA	- 3.6	6.7	0.109

[T] Paired t-test

Pair	Number in sample	Nutrients	Mean difference	SD	P value[T]
Cholesterol (mg)	n =11	Average cholesterol from 3 day dietary record -24 hour recall cholesterol	32.2	136.9	0.454
Carbohydrate as a percentage of total energy (%)	n =11	Average carbohydrate as a percentage of total energy from 3 day dietary record -24 hour recall carbohydrate as a percentage of total energy	1.3	6.3	0.502
Sucrose (g)	n = 11	Average sucrose from 3 day dietary record – 24 hour recall sucrose	-3.0	7.7	0.225
Sucrose (as a percentage of total energy) (%)	n = 11	Average sucrose percentage of total energy from 3 day dietary record -24 hour recall sucrose percentage of total energy	- 0.4	1.5	0.426
Dietary fibre (g)	n = 11	Average dietary fibre from 3 day dietary record -24 hour recall dietary fibre	- 4.0	8.9	0.162
Calcium (mg)	n = 11	Average calcium from 3 day dietary record -24 hour recall calcium	- 157.4	379.9	0.199
Magnesium (mg)	n = 11	Average magnesium from 3 day dietary record -24 hour recall magnesium	-36.3	83.6	0.181
Phosphorus (mg)	n = 11	Average phosphorus from 3 day dietary record -24 hour recall phosphorus	-122.1	331.0	0.249
Iron (mg)	n = 11	Average iron from 3 day dietary record -24 hour recall iron	- 0.9	3.5	0.417
Zinc (mg)	n = 11	Average zinc from 3 day dietary record -24 hour recall zinc	- 1.5	2.9	0.115
Thiamin (mg)	n = 11	Average thiamin from 3 day dietary record – 24 hour recall thiamin	0.03	0.49	0.854

[T] Paired t-test

Pair	Number in sample	Nutrients	Mean difference	SD	P value[T]
Vitamin B_6 (mg)	n = 11	Average vitamin B6 from 3 day dietary record -24 hour recall vitamin B6	1.0	4.4	0.460
Folate (µg)	n = 11	Average folate from 3 day dietary record -24 hour recall folate	- 78.8	138.8	0.089
Vitamin B_{12} (mg)	n = 11	Average vitamin B12 from 3 day dietary record -24 hour recall vitamin B12	1.6	3.7	0.189
Vitamin C (mg)	n = 11	Average vitamin C from 3 day dietary record -24 hour recall vitamin C	11.5	34.3	0.294
Vitamin A (µg)	n = 11	Average vitamin A from 3 day dietary record -24 hour recall vitamin A	- 287.6	399.9	0.038
Vitamin D (µg)	n = 11	Average vitamin D from 3 day dietary record -24 hour recall vitamin D	0.9	3.6	0.403
Vitamin E (mg)	n = 11	Average vitamin E from 3 day dietary record -24 hour recall vitamin E	- 1.3	9.0	0.643

[T] Paired t-test