

**TO DETERMINE THE IMPACT OF DIETARY CALCIUM
FROM DAIRY, AND/OR TOTAL DAIRY INTAKE, ON THE
BODY MASS INDEX OF GRADE 2 LEARNERS IN
PIETERMARITZBURG.**

By

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ABSTRACT

Introduction: International and local figures show a steep rise in the incidence of overweight and obesity in both adults and children, with more children suffering from overweight, obesity and their associated diseases of lifestyle than ever before. The aetiology of overweight and obesity is complex, with many interrelated factors involved. The South African government implemented the Food Based Dietary Guidelines in an attempt to guide the public on making healthy food choices. One of the guidelines encourages the public to “have milk, maas or yoghurt every day” due to the beneficial health effects of these dairy products. South African studies investigating the calcium intake of different age groups have shown children to consume inadequate amounts of calcium. A recent national survey showed the age group of 7 to 8 years old in particular, to have the lowest calcium intake of all age groups studied. Several international studies have shown dairy products, and specifically milk, to have an inverse relationship with Body Mass Index (BMI) in both adult and paediatric subjects. However, other international studies have provided conflicting results. No such study has been conducted in South Africa, and so the need arose to investigate a possible association between dairy products and childrens’ BMI.

Aim: To determine the impact of dietary calcium from dairy and/or total dairy intake, on the body mass index of Grade 2 learners in Pietermaritzburg.

Objectives: To determine the following regarding Grade 2 learners: the prevalence of overweight and obesity by interpreting their BMI; their calcium intake from dairy, and their total dairy intake; the contribution of dairy products to meeting their calcium requirements; whether a relationship exists between their dietary calcium (from dairy), and/or total dairy intake and their BMI; and possible barriers to dairy intake.

Method: A cross sectional study was conducted on 91 Grade 2 learners from quintile 5 (fee-paying) schools in Pietermaritzburg. A three-part questionnaire, comprised of an anthropometric section, demographic questions, and a semi-quantitative food frequency questionnaire (FFQ) were administered to the parents/guardians of the Grade 2 learners. The BMI of the learners was compared to both the World Health Organization (WHO) and International Obesity Task Force (IOTF) classifications for overweight and obesity. The calcium intake was obtained from the FFQ, and compared to the Estimated Average Requirement (EAR) for calcium for 4 to 8 year olds. The dairy intake was also determined, and compared to the recommended national guidelines.

Results: The study population comprised 57% female and 43% male learners, of whom 40.7% were Black African, 27.5% were White, 17% were Indian and 13.2% were Coloured. Of these learners, 28.6% (WHO) and 24.2% (IOTF) were overweight and 19.8% (WHO) and 15.4% (IOTF) were obese. More female learners were overweight than male learners, but a greater percentage of male learners were obese than female learners. Calcium intake from dairy was significantly below the EAR of 800 mg per day for 75.8% (n=69) of learners, with the average intake from the FFQ recorded as 615.2 mg. The mean number of dairy servings per day was 2.03, also below the recommended number of 3 servings of dairy per day. No relationship between BMI and calcium, or BMI and total dairy intake was established. Despite the low intake of dairy, no significant barriers to the consumption of dairy were identified.

Conclusion: Grade 2 learners do not consume enough dairy products in their diet, and are therefore unable to meet the calcium requirements for their age. Greater effort is required by government, schools, health professionals and parents/guardians to promote, and encourage children to consume more dairy products. Further research on this topic is recommended, where the impact of lower fat and sugar containing dairy products on body fat (as opposed to BMI) can be investigated.

PREFACE

The work described in this dissertation was carried out in the School of Agricultural, Earth and Environmental Sciences, University of KwaZulu-Natal, from July 2016 to December 2017, under the supervision of Dr Nicola Wiles and Dr Nicola Tyler.

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Joanne Louise Galliers

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

Signed: _____ Date: _____

Dr Nicola Wiles (Supervisor)

Signed: _____ Date: _____

Dr Nicola Tyler (Co-Supervisor)

DECLARATION OF ORIGINALITY

I, Joanne Louise Galliers, hereby declare that:

- i) The research reported in this dissertation, except where otherwise indicated, is my original research.
- ii) This dissertation has not been submitted for any degree or examination at any other University.
- iii) This dissertation does not contain data, pictures, graphs or any other information sourced from other people, unless specifically acknowledged as sourced from those persons.
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Joanne Louise Galliers (Candidate)

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CHAPTER 1: INTRODUCTION, THE PROBLEM AND ITS SETTING

1.1 Importance of the study

The global incidence of people who are overweight (Body Mass Index [BMI] ≥ 25 -29.9 kg/m²) and obese (BMI ≥ 30 kg/m²) is rising at an alarming rate. It was estimated in 2014 that 41 million children under the age of 5 years old were overweight or obese, with this number almost doubling in African children from 5.4 million in 1990 to 10.3 million in 2014 (WHO 2016). Data from the comprehensive South African National Health and Nutrition Examination Survey (SANHANES-1) published in 2013 depict a similarly concerning picture in South Africa, with increasing levels of overweight and obesity noted in children, compared to data from the 2005 National Food Consumption Survey-Fortification Baseline (NFCS-FB-1). It is highly probable that an overweight or obese child will become an overweight or obese adult (Kimani-Murage, Kahn, Pettifor, Tollman, Dunger, Gomez-Olive & Norris 2010; Reilly, Methven, McDowell, Hacking, Alexander, Stewart & Kelnar 2003).

Overweight and obesity negate the rapid advances made in the medical field that contribute towards enhanced longevity; combined, they ranked as the fifth greatest contributor to mortality worldwide by the World Health Organization (WHO) in 2009. Childhood obesity has been described as the primary health problem effecting children in developed countries (Olds 2011). Metabolic alterations that occur in overweight and obesity (van der Merwe & Pepper 2006) predispose the individual to elevated risks of non-communicable diseases (NCDs) such as cardiovascular disease, in addition to type 1 and type 2 diabetes, and premature death. In South Africa, poverty (which affects access to food and dietary diversity), low education levels, crime and the raging HIV/AIDS epidemic further compound the rather complicated and multifaceted presentation of overweight, obesity and NCDs that are observed. Increasing levels of overweight and obesity will furthermore place a heavy burden on the country's already struggling health system and economy.

Despite the numerous studies that provide alarming statistics on the consequences of overweight and obesity, and respected global and local organisations calling for interventions to curb this worldwide crisis, it appears that little impact, if any at all, has been made to date.

The South African Food Based Dietary Guidelines (FBDG) were developed to assist South Africans to eat in a healthy manner. They were first introduced in 2001, and updated more

recently in 2012. In the first set of guidelines, milk and dairy products were included in the guideline that encouraged South Africans to eat animal products. However, a separate guideline specifically encouraging the daily intake of milk, maas and yoghurt was created in the revised 2012 FBDG. This was driven by the proven beneficial effects of milk on health (for both over- and undernutrition), and the recognised poor dietary intake of milk and dairy products amongst the South African population (Vorster, Wenhold, Wright, Wentzel-Viljoen, Venter & Vermaak 2013). There is limited available data on the milk and dairy intake of South African children. Of the few studies conducted, the calcium intake for children was shown to be far below the recommended intake. Secondary data analysis from the National Food Consumption Survey (NFCS) of 1999 showed that children in the 7 to 8 year age category had the lowest calcium intake compared to the other age groups of 1 to 3 years and 4 to 6 years old (Steyn, Nel, Nantel, Kennedy & Labadarios 2006), thus placing them at risk of poor skeletal accretion as they approach the crucial stage of growth and development in puberty. Of concern is the preference for carbonated beverages over milk, as seen in a study conducted on children as young as 12 to 24 months of age (Theron, Amisshah, Kleynhans, Albertse & MacIntyre 2007).

Milk is the most nutritious liquid food source available, containing over ten essential nutrients (Consumer Education Project of Milk SA 2013), and is the primary ingredient of all dairy products. From the age of 1 year old, full cream milk can contribute a substantial amount of essential macro- and micronutrients to a young child's diet (Mahan, Escott-Stump & Raymond 2012, p380). It has been recommended by the American Heart Association (AHA), and endorsed by the American Academy of Paediatrics (AAP) that full cream milk be switched to skim or low fat milk from the age of 2 years, as a direct result of the overweight and obesity crisis (Gidding, Dennison, Birch, Daniels, Gilman, Lichtenstein, Rattay, Steinberger, Stettler & van Horn 2006). Thereafter, it is recommended that milk continue to contribute to the intake of multiple nutrients throughout childhood, adolescence and adulthood (Vorster *et al* 2013).

Of great interest is the emerging evidence from international studies that suggest the intake of milk and dairy products may help protect against overweight and obesity, conferring beneficial effects on body weight, body fat and the metabolic syndrome. It has been proposed that calcium is the major role player in these observations. Zemel, Shi, Greer, Dirienzo & Zemel (2000) demonstrated how increased dietary calcium intake resulted in a decrease in adipocyte intracellular Ca²⁺, and an increase in lipolysis.

In contrast, other international studies have shown no benefit at all of milk, dairy products or calcium on weight or body fat of individuals. There is a paucity of data available on milk and dairy intake amongst the South African population, with certainly no known local study conducted on the impact they may have on BMI or body fat, especially amongst children. For this reason it was deemed necessary for this study to be conducted in order to determine dairy intake amongst children, and the impact it may have on their BMI.

The following questions therefore arise:

- What is the prevalence of overweight and obesity amongst Grade 2 learners (7 to 8 years old) in Pietermaritzburg, as measured by their BMI?
- What is the dairy and calcium intake amongst Grade 2 learners (7 to 8 years old) in Pietermaritzburg?
- Is their dietary calcium intake from dairy products close to meeting the daily requirements for calcium of 50% of a healthy population of 4 to 8 year olds, as stipulated by the Estimated Average Requirements (EAR)?
- Do these children meet their recommended dairy intake?
- Does the calcium from their dairy intake, and/or their total dairy intake have any impact on their BMI?
- What barriers exist to prevent Grade 2 learners from consuming an adequate dairy intake?

It was considered important to conduct this study as it would provide baseline data in a field of nutrition that has not previously been widely researched in this country. It was anticipated that the milk and dairy intake of school children in Pietermaritzburg, KwaZulu-Natal (KZN) would be established, to determine whether their intake is adequate in meeting their daily requirements. Furthermore, any possible link between calcium and/or dairy intake and BMI could be investigated, in light of the current overweight and obesity figures. By understanding the current dietary intake of milk and dairy products in this subgroup of school children, it was anticipated that this would help define any further nutritional intervention required by policy makers and stakeholders in improving the health of children, both in terms of over- and undernutrition.

1.2 Statement of the problem

The purpose of this study was to determine the incidence of overweight and obesity amongst Grade 2 learners in Pietermaritzburg, and if dietary calcium from their dairy intake, and/or their total dairy intake had any impact on their BMI. Furthermore, this study determined whether Grade 2 learners in Pietermaritzburg were meeting their calcium and dairy requirements (assuming they are receiving calcium from other, non-dairy sources), and if not, what barriers to obtaining an adequate dairy intake exist.

1.3 Research Objectives

The objectives of this study were:

- 1.3.1 To determine the prevalence of overweight and obesity amongst Grade 2 learners in Pietermaritzburg, as measured by their BMI.
- 1.3.2 To determine the calcium intake from dairy and the total dairy intake in Grade 2 learners in Pietermaritzburg.
- 1.3.3 To determine the contribution that dairy products made towards meeting the calcium requirements of Grade 2 learners.
- 1.3.4 To determine the relationship between the dietary calcium (from dairy) and/or total dairy intake, and the BMI of Grade 2 learners in Pietermaritzburg.
- 1.3.5 To determine possible barriers to dairy intake in Grade 2 learners in Pietermaritzburg.

1.4 Hypothesis

- 1.4.1 The intake of dietary calcium, and/or total dairy intake was inversely related to the BMI of Grade 2 learners in Pietermaritzburg.

1.5 Inclusion and exclusion criteria

1.5.1 Inclusion criteria

- All quintile 5 schools in Pietermaritzburg that fell under the Msunduzi municipality were included in this study.
- Eligible quintile 5 schools were representative of all South African race groups (Black African, White, Coloured and Indian)
- Quintile 5 schools required at least one Grade 2 class.
- Grade 2 learners were either seven (7) years old and turning eight (8) years old in 2016, or already eight (8) years old.
- Parents/caregivers of Grade 2 learners must have provided consent for participation.

1.5.2 Exclusion criteria

- All quintile 1 to 4 schools in Pietermaritzburg that fell under the Msunduzi municipality.
- Schools where all four of the main South African race groups were not represented at the eligible school.
- Grade 2 learners who were nine (9) years and older.
- Parents/caregivers who did not provide consent.

1.6 Definition of terms

Body Mass Index (BMI):	The weight (in kilograms) of an individual divided by their height (in metres squared) (Cole, Bellizzi, Flegal & Dietz 2000).
Cross-sectional study design:	A type of study that investigates relationships at a single point in time (Cade, Thompson, Burley & Warm 2002).
Dairy:	For the purpose of this study, dairy refers to milk, flavoured milk, milk-based hot drinks, yoghurt, drinking yoghurt, frozen yoghurt, cheese, maas, and desserts/puddings composed mainly of milk.

Estimated Average Requirement:	The average intake needs of the general population. The distribution of dietary intakes should be compared to the EAR to determine the proportion below the EAR, which is an estimate of the prevalence of inadequacy (Murphy, Guenther & Kretsch 2006).
Food frequency questionnaire:	A questionnaire commonly used to determine any association between dietary intake and disease, where the number of participants is large. A list of food items, beverages and supplements is given, and the respondent indicates their frequency of consumption (Johansson 2006).
Grade 2 learner:	Any child who is expected to be seven (7) years old turning eight (8) in 2016, or already eight (8) years old.
Metabolic Syndrome:	The name given to a cluster of risk factors (abdominal obesity, elevated triglycerides, low HDL cholesterol, elevated blood pressure and elevated fasting glucose) that increase an individual's chance of developing heart disease, diabetes, and stroke. Three or more of these risk factors need to be present for metabolic syndrome to be confirmed (Grundy, Brewer, Cleeman, Smith & Lenfant 2004).
Non-Communicable Diseases:	Diseases that increase the risk of mortality, but are not infectious, such as cardiovascular disease, diabetes, stroke and hypertension.
Obesity:	International BMI cut-off value corresponding to a BMI ≥ 30 kg/m ² at age 18 for each gender (Cole <i>et al</i> 2000).

Observational study:	A type of study whereby subjects are observed and the particular variables of interest are measured, without the subject's receiving any treatment.
Overfat:	Excess adiposity (Cameron & Getz 1997). It is based on the sum of the triceps and subscapular skinfold thicknesses \geq 85th percentile (overfat) (Frisancho 1990).
Overweight:	International BMI cut-off value corresponding to a BMI \geq 25 kg/m ² at age 18 for each gender (Cole <i>et al</i> 2000). Excess weight, irrespective of the composition of that weight (Cameron & Getz 1997).
Quintile:	The categorisation of government schools into quintiles 1 to 5, with quintile 1 being the poorest of schools, and requiring the most financial assistance from the government. These schools are non-fee paying schools. Quintile 5 schools are on the opposite end of the scale- they are the most well-resourced government schools, and are fee-paying (Department of Education, Pretoria 2004).
Rural:	Living outside of a town or city.
Semi-quantitative food frequency questionnaire:	A unique type of food frequency questionnaire which includes the portion sizes of the food items of interest. The frequency of which each food item is consumed is multiplied by the nutrient content of the average portion size specified, to determine the amount of a particular nutrient consumed (Johansson 2006).
Urban:	Living in a town or city.

1.7 Abbreviations

AAP:	American Academy of Paediatrics
BMI:	Body Mass Index
CLA:	Conjugated Linoleic Acid
DOE:	Department of Education
DRI:	Dietary Recommended Intake
FAO/WHO/UNU:	Food and Agriculture Organisation/ World Health
FBDG:	Food Based Dietary Guidelines
IOTF:	International Obesity Task Force
KZN:	KwaZulu-Natal
NFCS-FB-1:	National Food Consumption Survey- Fortification Baseline
NCD:	Non-Communicable Disease
RDA:	Recommended Dietary Allowance
SANHANES-1:	South African National Health and Nutrition Examination Survey
UN:	United Nations
WHO:	World Health Organisation

1.8 Assumptions

The following assumptions were made:

- Each school sent out informed consent forms and questionnaires to all parents and guardians of Grade 2 learners, and no eligible Grade 2 learners were omitted (either intentionally or accidentally).
- Parents/guardians of Grade 2 learners were aware of their learner's dietary intake.
- Parents/guardians of Grade 2 learners answered the questionnaire as truthfully and accurately as possible.
- Grade 2 teachers kept a record of learners' allocated research codes, and returned the correct completed questionnaire to the learner once the research team had arrived to take anthropometric measurements.
- Fieldworkers took consistent anthropometric measurements in the correct manner, as per their training.
- Results from the food frequency questionnaire closely resembled the learner's true average daily intakes.

1.9 Summary

The incidence of overweight and obesity, both globally and locally, is increasing in an exponential manner. Within South Africa, the emerging predominant malnutrition problem is one of overnutrition. Overweight and obesity contribute greatly to the risk of developing NCDs, which can increase mortality rate and place an additional burden on struggling health facilities already battling to cope with the HIV/AIDS epidemic and TB. Although the causes of overweight and obesity are multifactorial, a change in dietary habits is urgently required to assist the population in attaining a healthy BMI. Milk and dairy products contain many beneficial dietary components, and a daily intake of these food products is recommended to achieve optimal health. Conflicting results on the role of calcium and dairy products in weight control have emerged from several international studies, but no similar studies have been conducted in the Southern African region. Furthermore, there is a dearth of literature available on the dairy and calcium intake of children in South Africa. It was anticipated that this study would provide evidence of the dietary calcium and dairy intake amongst a subgroup of the paediatric population in KZN, South Africa, and any relationship between calcium and/or dairy intake on their weight be identified. Should an inverse relationship between calcium and/or

dairy intake and the BMI of children be shown, it would provide an exciting opportunity for further research into this area, as part of a multi-pronged approach to tackling the overweight and obesity crisis in South Africa.

1.10 Dissertation overview

This dissertation consists of six chapters. Chapter one provides an overview of the overweight and obesity problem, briefly mentions the beneficial effects of milk and dairy products and presents the objectives of the study. Chapter two is a literature review that includes the aetiology of overweight and obesity, and the various mechanisms behind the favourable effects of milk and dairy. International studies that have looked into the effect of calcium or dairy on weight status in children are reviewed. Chapter three explains the methodology used in the current study, whilst the fourth chapter presents the results following statistical analyses. Chapter five discusses the results of the study and relates them back to the literature reviewed in Chapter two. Chapter six concludes the dissertation and provides recommendations for future research based on the results obtained.

1.11 Referencing style

This dissertation was written using the referencing style that is followed by the Discipline of Dietetics and Human Nutrition, University of KwaZulu-Natal (UKZN).

CHAPTER 2: LITERATURE REVIEW

This literature review covers the extent and impact of overnutrition (overweight and obesity) both globally, and locally in South Africa. Emphasis is placed on the many studies conducted on the South African paediatric population. The aetiology of childhood obesity is explained, and the corresponding changes in dietary patterns are analysed. Milk and dairy products are reviewed, with particular focus placed on the beneficial role that they play in contributing towards good health in children. Any barriers to ensuring an adequate dairy intake in children are covered. International paediatric studies conducted on the effect of milk and dairy products on weight and body fat are evaluated. This chapter is then concluded with a summary outlining the importance of this study.

2.1 A background to the global problem of malnutrition

Overnutrition, a positive nutrient balance, can be a form of malnutrition (Stratton, Green & Elia 2003) characterised by an “excess and imbalance of a wide range of nutrients”. The Global Nutrition Report (2016) refers to malnutrition as resulting from “the interaction of poor-quality diets and poor-quality health and care environments and behaviours, which are shaped in part by a host of underlying factors, such as political instability, poor economic development, conflict, inequality, and some dimensions of globalization” (International Food Policy Research Institute 2016).

Momentum for good nutrition is gaining strength, with more and more organisations, governments and stakeholders realising the importance of tackling the biggest risk factor to the global burden of disease (International Food Policy Research Institute 2016). In the last few years, targets were set by multiple global organisations to tackle the multifaceted issue of malnutrition. The World Health Assembly announced its 2025 Global Targets for Maternal, Infant and Young Child Nutrition in 2012, further adding targets to reduce NCDs the following year. In 2015, the UN Sustainable Development Goals announced the intention of eradicating malnutrition by the year 2030, and the UN recently declared 2016-2025 to be a Decade of Action on Nutrition (International Food Policy Research Institute 2016).

The most recent statistics portray a dismal picture indicating that “one in three people are malnourished in one form or another” (International Food Policy Research Institute 2015a). Almost two billion adults are overweight or obese and 41 million children under five years of

age are overweight (Development Initiatives 2017; WHO 2016). In addition to the psychological implications of depression and poor self-image (Rossouw, Grant & Viljoen 2012), the condition of overweight and obesity may lead to the development of NCDs such as cardiovascular disease, diabetes, hypertension, stroke, respiratory disease and cancer, which further compound the person's health status and disability-adjusted-life-years (Mayosi, Flisher, Lalloo, Sitas, Tollman & Bradshaw 2009).

Economists have demonstrated the detrimental impact of malnutrition on a country's economy, by showing malnutrition in all its forms to cause a 10% annual loss of Gross Domestic Product (GDP) (International Food Policy Research Institute 2015). In the United States of America (USA), obesity and its associated NCDs were shown to cause an additional annual healthcare cost of 8% annual income in an average American household, as well as increased absenteeism from work, decreased employment opportunities, less disposable income and poor quality of life (Su, Huang, Chen, Iacobucci, Mocarski, Dall & Perreault 2015). In 2012, the subsequent loss in productivity directly from diabetes cost the USA government \$69 billion (American Diabetes Association 2013). The prevalence of diabetes in China has dramatically increased in the last 30 years where they now have the largest diabetic population in the world, and healthcare and psychosocial implications of diabetes have directly resulted in an annual 16.3% loss of income to the average household (Liu & Zhu 2014).

Children from developing countries have not been immune to the rapid dietary changes and increasingly sedentary lifestyle observed in many countries, with levels of paediatric obesity recorded as 41.8% in Mexico, 22.1% in Brazil, 22% in India and 19.3% in Argentina (Gupta, Goel, Shah & Misra 2012).

The Global Nutrition Report (2017) states that most countries are not on track to meet their targets for reducing overweight and obesity, and have urged countries to prioritise these targets (Development Initiatives 2017). Not enough money spent on improving nutrition has been cited as one of the contributing problems for not meeting the targets. In 2015, only one percent (1%) of global donor's overall contributions were allocated towards tackling obesity and NCDs (Development Initiatives 2017), despite the fact that nutrition-related NCDs contributed to more than half of all disabilities and deaths in low- and middle-income countries (LMIC) (International Food Policy Research Institute 2016). Other areas requiring improvement are the nutrition targets set by countries where only 30% of countries have targets to tackle obesity, diabetes and the reduction of dietary salt intake, and of those targets only two thirds are

SMART ('Specific', 'Measurable', 'Achievable', 'Relevant', and 'Time-bound'). Despite the WHO's recommendations for healthy diets, specifically reducing salt, reducing trans- and saturated fats and regulating the marketing of foods and non-alcoholic beverages to children, most countries have made no progress in executing these recommendations. Nutrition plays a pivotal role in health, education, employment, poverty, inequality and female empowerment, and should be incorporated into other governmental sectors, where a higher budget can be allocated. Investment in nutrition must be seen as a way to improve economic growth, as opposed to the current way of thinking where economic growth will lead to good nutrition (International Food Policy Research Institute 2016). The incidence of overweight and obesity in South Africa, will be discussed in the next section.

2.2 Overweight and obesity in South Africa

The prevalence of overweight, obesity, and their associated NCDs in South Africa is very similar to the trends observed in other developing countries undergoing economic transition, with increasing rates noted across all population groups, socioeconomic levels and ages (Popkin 2003). The impact of the rapid socioeconomic progress that occurred in South Africa in the latter half of the 1990's is showing itself in the form of unprecedented levels of overweight and obesity, closely pursued by the resultant NCDs. According to the WHO, the burden from NCDs in South Africa is two to three fold greater than in developed countries, with heart disease, diabetes and stroke contributing to the second most common cause of death in South African adults (Mayosi *et al* 2009). Based on projections made by Abegunde, Mathers, Adam, Ortegon & Strong (2007), the researchers estimate that in 2015 South Africa's GDP loss due to the impact of NCDs on the country's economy will be US \$21 million (Abegunde *et al* 2007).

Aided by the improved roll-out of antiretroviral therapy, it is predicted that South Africans will have an increased life expectancy, with the number of South African children aged 0 to 14 years old increasing by 10% in the next decade, and the number of people 60 years and older expected to increase by 189% in the next decade (Mayosi *et al* 2009). With the population living for longer, action needs to be taken to stem the rise in NCDs, due to the detrimental impact they will have on the struggling health system and the economy. With adolescent fertility being three times greater in LMIC's compared to high income countries, there are the additional risks arising from maternal overweight and obesity, which can lead to increased birth complications, preterm delivery, and increased infant mortality (Black, Victora, Walker,

Bhutta, Christian, de Onis, Ezzati, Grantham-McGregor, Katz, Martorell, Uauy and the Maternal and Child Nutrition Study Group 2013). This further compounds the burden that has already been placed on health care facilities battling to cope with HIV/AIDS, TB, undernutrition, NCDs, trauma and violence.

Numerous studies conducted on the South African population have shown an increasing tendency towards overweight and obesity amongst both adults and children. Studies specifically conducted on South African children have been reviewed, summarised and presented in order of data collection in Table 2.1.

Table 2.1: Summary of studies on the prevalence of overweight and obesity in children and adolescents in South Africa.

Researchers	Main objectives	Sample	Measuring tool	Outcome
Cameron & Getz (1997)	To investigate the prevalence and gender differences in obesity in rural African adolescents.	n= 447 Age: 7 to 18.9 years Males: 57% Females: 43% Area: rural, Ubombo, Northern Mpumalanga Date: 1985-1990	BMI (Popkin, Richards & Monteiro1996; HANES III) Sum of skinfolds ('overfat') Ratio trunk: limb skinfolds	Males: <u>Overweight:</u> 2% (10 to 11 years old) <u>Overfat:</u> 16% (18 to 19 years old) Females: <u>Overweight:</u> 11% (14 to 17 years old) <u>Overfat:</u> 14% (18 to 19 years old)
Jinabhai, Taylor & Sullivan (2003)	To investigate the relationship between stunting and levels of overweight/obesity among South African school children, using two definitions of overweight and obesity, based on the WHO and International Obesity Task Force (IOTF) criteria.	n= 802 Age: 8 to 11 years old Males and females Area: rural, Vulamehlo, KZN Date: 1995	BMI-for-age (WHO/NCHS standard based on 85 th and 95 th centiles) BMI-for-age (IOTF) (Cole <i>et al</i> 2000)	Males: <u>Overweight:</u> WHO 85%: 5.1%, IOTF 1.95% <u>Obese:</u> WHO 95%: 0%, IOTF: 0% Females: <u>Overweight:</u> WHO 85%: 5.45%, IOTF:4.9% <u>Obese:</u> WHO 95%: 1.3%, IOTF: 0.7%

Table 2.1: Continued

Researchers	Main objectives	Sample	Measuring tool	Outcome
Monyeki, van Lenthe & Steyn (1999)	To determine the development of total body fatness in rural South African children during the preschool years and first years of formal schooling.	n= 1336 Age: 3 to 10 years old Males: 51% Females: 49% Area: Rural, Ellisras, Limpopo Province Date: 1996	BMI (>85 th centile of NHANES III) Sum of skinfolds	Males: <u>Total overweight or obese:</u> BMI 0.55% Sum of skinfolds 4.15% Females: <u>Total overweight or obese:</u> BMI 1% Sum of skinfolds 1.1%
Labadarios, Steyn, Maunder, MacIntyre, Gericke, Swart, Huskisson, Dannhauser, Vorster, Nesmvuni & Nel (2005)	To determine the nutrient intakes and anthropometric status of children (1-9 years old), as well as factors that influence their nutrient intake.	n= 2894 Age: 1 to 9 years old Area: National Date: 1999	BMI-for-age (United States National Centre for Health Statistics) (NCHS)	Males and females combined <u>Overweight:</u> Total: 12.1% Rural 11.6%, Urban 12.5% <u>Obese:</u> Total: 5% Rural 3.7%, Urban 6.1%
Somers (2004) (Abstract)	To determine the prevalence of overweight and obesity amongst learners attending schools in specific communities within the City of Cape Town, South Africa.	n= 338 Age: 10 to 16 years old Male: 42.31% Female: 57.69% Race: Black and coloured Area: Western Cape Province	BMI (CDC)	<u>Overweight:</u> Total: 8.31% Males: 2.8% Females: 12.3% <u>Obese:</u> Total: 2.97% Males: 2.8% Females: 3.09%

Table 2.1: Continued

Researchers	Main objectives	Sample	Measuring tool	Outcome
Mukuddem-Petersen & Kruger (2004) (the THUSA BANA study)	To investigate the relationship between stunting and overweight among 10- to 15 year old children of the North West province in South Africa.	n = 1250 Age: 10 to 15 years old Males: 48.3% Females: 51.7% Race: Black, White, Coloured Area: 35.8% rural, 46.4% urban, 17.8% informal (NW Province)	BMI-for-age (IOTF) (Cole <i>et al</i> 2000) Sum of skinfolds	Prevalence of overweight and obesity combined: Total 7.9% Males: 5.6%, Females: 10.1% White 14.2%, Black 7.1%, Indian 6.4%, Mixed ancestry 2.9%
Armstrong, Lambert, Sharwood & Lambert (2006)	To determine the prevalence of overweight and obesity in a sample of South African children aged 6 to 13 years.	n= 10195 Age: 6 to 13 years Males: 55% Females: 45% Race: 47.6% Black, 32.46% White, 17.8% Coloured Area: 5 provinces, children from different socioeconomic status, rural and urban. Date: 2001-2004	BMI-for-age (IOTF) (Cole <i>et al</i> 2000)	Males: <u>Overweight:</u> All boys: 10.8%, White boys: 15.4%, Black boys: 7.6%, Coloured boys: 8.7%, <u>Obese:</u> All boys 3.2%, White boys: 4.3%, Black boys: 2.1%, Coloured boys: 3%, Females: <u>Overweight:</u> All girls: 13%, White girls: 15.5%, Black girls: 12.3%, Coloured girls: 10.7% <u>Obese:</u> All girls: 4.9%, White girls: 7.8%, Black girls: 4.7%, Coloured girls: 4.8%

Table 2.1: Continued

Researchers	Main objectives	Sample	Measuring tool	Outcome
Labadarios, Swart, Maunder, Kruger, Gericke, Kuzwayo, Ntsie, Styen, Schloss, Dhansay, Jooste & Dannhauser (2008)	The anthropometric and selected micronutrient status of children aged 1-9 years (amongst other objectives).	Age: 1 to 9 years old Area: national Date: 2005	BMI-for-age	Total overweight: 10% Total obese: 4%
Kruger, Venter, Vorster & Margetts (2006) (the THUSA study)	To investigate the determinants of overweight and obesity among 10- to 15 year-old school children in a population in the transitional phase in the North West Province of South Africa.	n= 1257 Age: 10 to 15 years Males: 48% Females: 52% Race: Black 73.1% White 15.2%, Coloured 6.2% Area: 35.8% rural, 46.4% urban, 17.8% informal North West (NW) province	BMI-for-age (IOTF) (Cole <i>et al</i> 2000) Sum of skinfolds	<u>Overweight:</u> White 11.6%, Black 5.7%, Coloured: 2.9%, Indian 3.8% <u>Obese:</u> White 2.6%, Black 1.4%, Coloured: 0%, Indian 2.6%
Kimani-Murage, Kahn, Pettifor, Tollman, Dunger, Gomez-Olive & Norris (2010)	To investigate the prevalence and patterns of stunting and overweight/obesity, and hence risk for metabolic disease, in a group of children and adolescents in rural South Africa	n= 3489 Age: 1 to 20 years old Males: 49.4% Females: 50.6% Race: Black (Tsonga) Area: Agincourt sub-district, Mpumalanga Date: 2007	BMI-for-age (IOTF) (Cole <i>et al</i> 2000)	<u>Overweight:</u> Total: 6% 1 to 4 years old: 7% ; 5 to 9 years old: 4% 10 to 14 years old: 6% ; 5 to 20 years old: 8% <u>Obese:</u> Total: 2% 1 to 4 years old: 1% ; 5 to 9 years old: 1% 10 to 14 years old: 2% ; 15 to 20 years old: 4%

Table 2.1: Continued

Researchers	Main objectives	Sample	Measuring tool	Outcome
Truter, Pienaar & Du Toit (2010)	To determine relationship between overweight, obesity and physical fitness of 9 to 12 year old South African children.	n= 280 Age: 9 to 13 years old Males: 45.7% Females: 54.3% Area: 2 primary schools in Potchefstroom, NW Province	BMI-for-age (IOTF) (Cole <i>et al</i> 2000)	<u>Overweight</u> : Total: 15.5% Males: 15.6%, Females: 15.1% <u>Obese</u> : Total 6.5% Males: 5.5%, Females: 7.2%
Puckree, Naidoo, Pillay & Naidoo (2011)	To determine whether school children in the eThekweni district in KwaZulu-Natal, South Africa, were underweight or overweight.	n= 120 Age: 10 to 12 years old Males: 40% Females: 60% Race: Indian 76%, Black 24% Area: urban, KZN Date: 2006	BMI-for-age (WHO)	<u>Overweight</u> : Total: 5.03% <u>Overweight for age</u> : Age 10 years: 1.7% Age 11 years: 0.8% Age 12 years: 2.5% <u>Obese</u> : 1 of 120 children
Kemp, Pienaar & Schutte (2011)	To determine the prevalence of hypertension in Grade 1 learners in the North West province of South Africa, and to investigate the association between blood pressure (BP) and body composition of these children.	n= 816 Age: mean 6.78 years old Males: 51.3% Females: 48.7% Race: Black 69%, White 26.7%, Coloured: 0.02%, Indian 0.01% Area: NW province	BMI-for-age (IOTF) (Cole <i>et al</i> 2000)	<u>Overweight</u> : Total: 7.8% Males: 6.4%, Females: 9.3% <u>Obese</u> : Total: 3.8% Males: 3.3%, Females: 2.8%

Table 2.1: Continued

Researchers	Main objectives	Sample	Measuring tool	Outcome
Shisana, Labadarios, Rehle, Simbayi, Zuma, Dhansay, Reddy, Parker, Hoosain, Naidoo, Hongoro, Mchiza, Steyn, Dwane, Makoe, Maluleke, Ramlagan, Zungu, Evans, Jacobs, Faber & SANHANES-1 Team (2013)	To determine (amongst others): 1) the health status of children under the age of five years 2) the health status of children aged 2 to 9 years old with respect to physical and /or mental disabilities.	n= 8634 Age: 0 to 14 years old Race: Black, White, Coloured, Indian Area: national Date: 2012	BMI-for-age (IOTF) (Cole <i>et al</i> 2000)	<u>Overweight:</u> (6 to 9 years old) Males: 4.5%, Females: 12.3% <u>Obese:</u> (6 to 9 years old) Males: 2.7%, Females: 4.1%
Tathiah, Moodley, Mubaiwa, Denny & Taylor (2013)	To describe the prevalence of malnutrition among female learners in the Nongoma and Ceza districts in Zululand, KwaZulu-Natal (KZN).	n= 959 Age: 9 to 12 years old Gender: Female Race: Black African Area: Nongoma (18 schools) and Ceza (13 schools), Zululand, KZN	BMI-for-age, weight-for-age and height-for-age Z scores (WHO) BMI-for-age (IOTF) (Cole <i>et al</i> 2000)	<u>Overweight:</u> (WHO) 9% (IOTF): 8 yrs: 5.3%, 9 yrs: 9.3%, 10 yrs: 10.3%, 11 yrs: 7.2%, 12 yrs: 5.6% <u>Obese:</u> (WHO) 3.8% (IOTF): 8 yrs: 0%, 9 yrs: 2.4% 10 yrs: 2.4%, 11 yrs: 1.3% 12 yrs: 2.75%
Wiles, Green & Veldman (2013)	To determine the anthropometric characteristics of grade 4 learners in relation to their tuck-shop purchasing practices.	n= 311 Age: mean 9.9 years old Males: 44% Females: 56% Race: Black, White, Coloured, Indian Area: Pietermaritzburg, KZN	BMI-for-age (WHO)	<u>Overweight:</u> Total: 26.7% Males: 29% Females: 24.9% <u>Obese:</u> Total: 27.3% Males: 24.6% Females: 29.5%

Many of the South African studies reviewed in Table 2.1 did not consistently use the same methods of interpreting nutritional status. Either the WHO (Table 2.2) or the IOTF interpretation (Appendix A, p133) of BMI-for-age were used to classify children as overweight or obese. In some studies, both methods of classification were used. The WHO childhood BMI charts for 5 to 19 years of age were published in 2007, based on the United States National Centre for Health Statistics (NCHS) 1977 reference curves (De Onis & Lobstein 2010). They are based on Z-score growth curves ranging from -3 to +3 standard deviations (SD) from the ideal BMI growth curve (0 SD), where greater than +1SD represents overweight, and greater than +2SD represents obesity (De Onis, Onyango, Borghu, Siyam, Nishida & Siekmann 2007).

Table 2.2: Interpretation of WHO BMI-for-age growth charts (WHO 2007)

WHO Classification : Birth up to 5 years old					5 to 19 years old
Z Score	HFA	WFA	WFH/Length	BMI for age	BMI for age
Above 3	Very tall-usually no problem. Possible Endocrine disorder.	May be a growth problem. Assess using weight for length/height and BMI for age.	Obese	Obese	Obese
Above 2	Normal	May be a growth problem. Assess using weight for length/height and BMI for age.	Overweight	Overweight	Obese
Above 1	Normal		Possible risk of overweight		Overweight
0 (Median)	Normal	Normal	Normal	Normal	Normal
Below -1	Normal	Normal	Normal	Normal	Normal
Below -2	Stunted	Underweight	Wasted	Wasted	Wasted
Below -3	Severely stunted	Severely underweight	Severely wasted	Severely wasted	Severely wasted

The IOTF definitions of overweight and obesity were derived by Cole *et al* (2000), who utilised internationally recognised adult BMI cut off points for overweight and obesity. These cut off points were extrapolated backwards from adulthood to 18 years of age, to predict risk of overweight ($BMI \geq 25-29.9 \text{ kg/m}^2$) and obesity ($BMI \geq 30 \text{ kg/m}^2$) in children. In order to develop these BMI cut off points for children, paediatric BMI data was taken from six countries in large, nationally representative surveys, namely the Netherlands, Brazil, Singapore, Hong Kong, the USA and the United Kingdom (UK). The IOTF overweight and obesity cut off points are much higher than other, centile-based cut offs, which explains why the IOTF overweight and obesity figures are lower than for other definitions (for example, the WHO classification),

and why IOTF based overweight and obesity cut off points are considered more serious compared to other definitions (Cole & Lobstein 2012). The cut off points were not expressed as centiles or Z-scores until much later on when unpublished data was used to define the cut-offs as centiles corresponding to each BMI value. This enabled the international cut-offs to be compared to other BMI references (Cole & Lobstein 2012). Although the IOTF BMI cut off points are regularly used, the authors who developed them caution their application in children of African descent, as the data used to develop these cut off points was not representative of children from Africa (Cole *et al* 2000).

The WHO Z-score for BMI-for-age, and the IOTF BMI cut off points for thinness (Appendix B, p135) can also be used to classify children according to the opposite spectrum, namely “severely wasted”, “wasted” or “normal” BMI (WHO classification), or “thinness grades 1, 2 or 3” (IOTF classification).

Other differences noted in the South African studies in Table 2.1 were the targeted age groups, socioeconomic backgrounds, and geographical areas of study. However, it was clear from the results that overnutrition is a major health problem in South Africa, with an increasing trend in the number of overweight and obese children observed over the 16-year period. Data from the most recent national survey, the SANHANES-1, revealed that overweight and obesity amongst 6 to 9 year old boys (n=626) was 4.5% and 2.7% respectively, and amongst 6 to 9 year old girls (n=594), 12.3% were overweight and 4.1% were obese (Shisana *et al* 2013). More children (6 to 9 years old) were overweight and obese (8.4% and 3.4%) compared to the NFCS-FB-1 in 2005 (7.8% and 2.5% respectively) (Shishana *et al* 2013; Labadarios *et al* 2008), and children living in KZN had the highest weights amongst all provinces surveyed. A common thread throughout the studies on the South African paediatric population showed females to be consistently more overweight and obese than males.

The causes of overweight and obesity amongst South African children will be explained in the next section.

2.3 Aetiology of overweight and obesity

Overweight and obesity are intricate disease conditions with multiple causes. Dietz (1994) linked obesity to four significant stages in human development, namely *in utero*, infancy, adiposity rebound, and adolescence, suggesting that if obesity were to occur at any one of these four stages, it would increase the risk of lifelong obesity (Dietz 1994).

The relationship between obesity, genetics and the environment has been explored, with the authors suggesting that certain individuals can be genetically susceptible towards weight gain if found to be in an environment that promotes a positive energy balance (easily accessible energy dense foods, excessive energy consumption and sedentary behavior) (Benton 2004; Maffei 2000). Without much change in the human genome in the last few decades, it is highly likely that the environment is the largest contributing factor (Hill & Peters 1998). The multiple causes of paediatric overweight and obesity in developing countries are reviewed in Figure 2.1

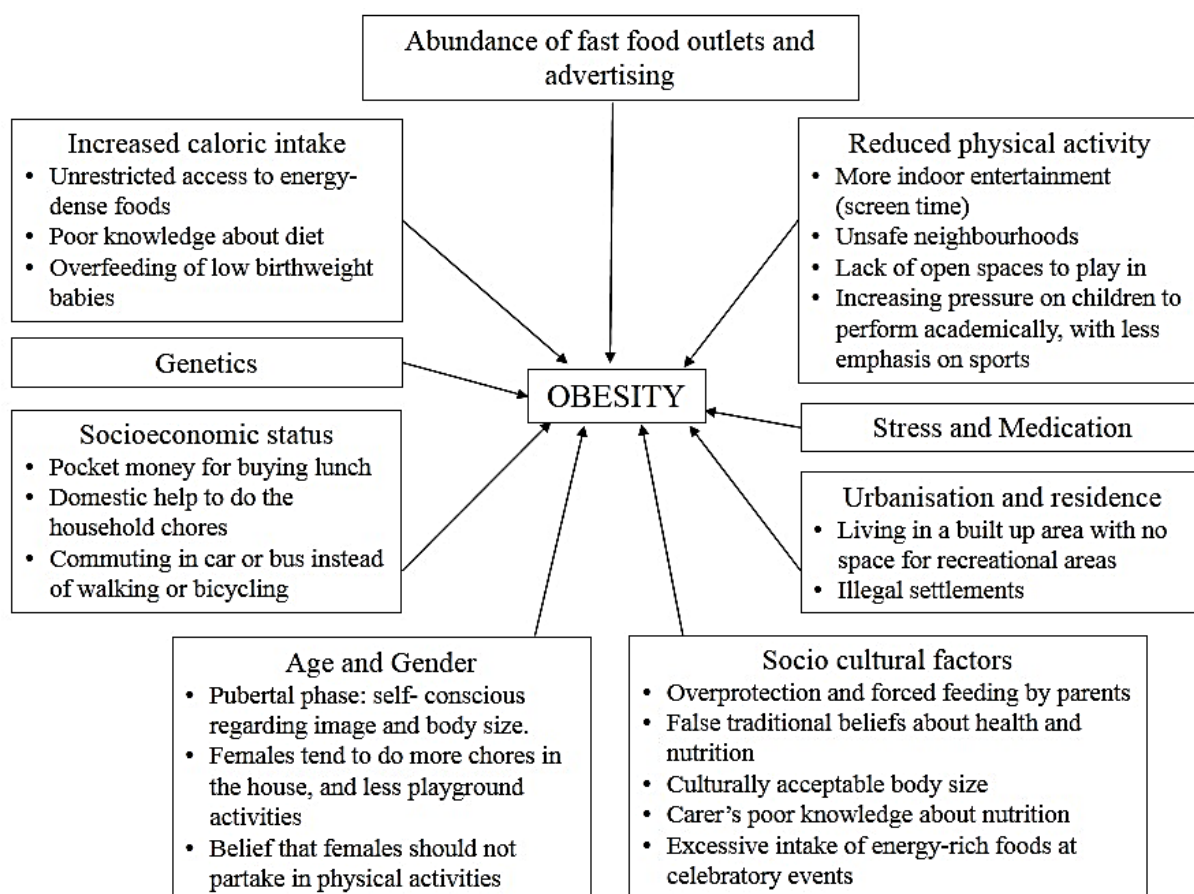


Figure 2.1: Principle determinants of paediatric obesity (adapted from Gupta *et al* 2012)

2.3.1 Dietary intake

Diet is one of the first factors considered when determining the cause of obesity. A lack of dietary knowledge on both the parents and child's part may easily lead to the wrong food choices being made both at home, and outside of the home. A key factor in predicting the probability of a child becoming an obese adult is their parents' weight status (Maffeis 2000). From birth, adults are responsible for the type and amount of foods made available to infants, toddlers and young children. In addition, they are also responsible for the food preferences these children develop (Maffeis 2000). School cafeterias, tuck shops and vending machines often stock large portions of energy-dense, nutrient-poor food options, and sweetened beverages. Due to the fast-paced lifestyle of many parents, there is a heavy reliance on low cost, processed, convenience foods for the main meal of the day. Ebbeling, Pawlak & Ludwig (2002) described how television viewing can also encourage the passive consumption of calorie-dense food items. Through watching television, children are also more likely to be exposed to marketing of the Western lifestyle and diet. Those children living in urban areas have unlimited access to fast food outlets and convenience stores on their doorstep, thus making the Western diet more accessible (Gupta *et al* 2012).

2.3.2 Nutrition Transition

A distinct phenomenon known as the Nutrition Transition (Figure 2.2) has been termed to describe the shift in dietary patterns and physical activity experienced in many developing countries due to urbanisation and enhanced technology. It is considered a major contributing factor to the paradoxical "double burden" of malnutrition noted in developing countries such as South Africa (Kimani-Murage *et al* 2010), and has been noted in other developing countries such as Kuwait (Moussa, Shaltout, Nkansa-Dwamena, Mourad, AlSheikh, Agha & Galal 1998), China and Chile, where increasing income levels have been associated with obesity and its related co-morbidities in children (Amuna & Zotor 2008). When members of society previously consuming a more traditional diet derived from plant-based foods high in carbohydrate and fibre, and low in fat, move to urban areas seeking employment, their diets adapt to the more "Western" diet profile, typified by high intakes of animal protein, processed foods high in saturated fats and sugar, and low in fibre (Popkin 2003). Black South Africans are more affected by nutrition transition than any other race group within South Africa (Bourne, Lambert & Steyn 2002).

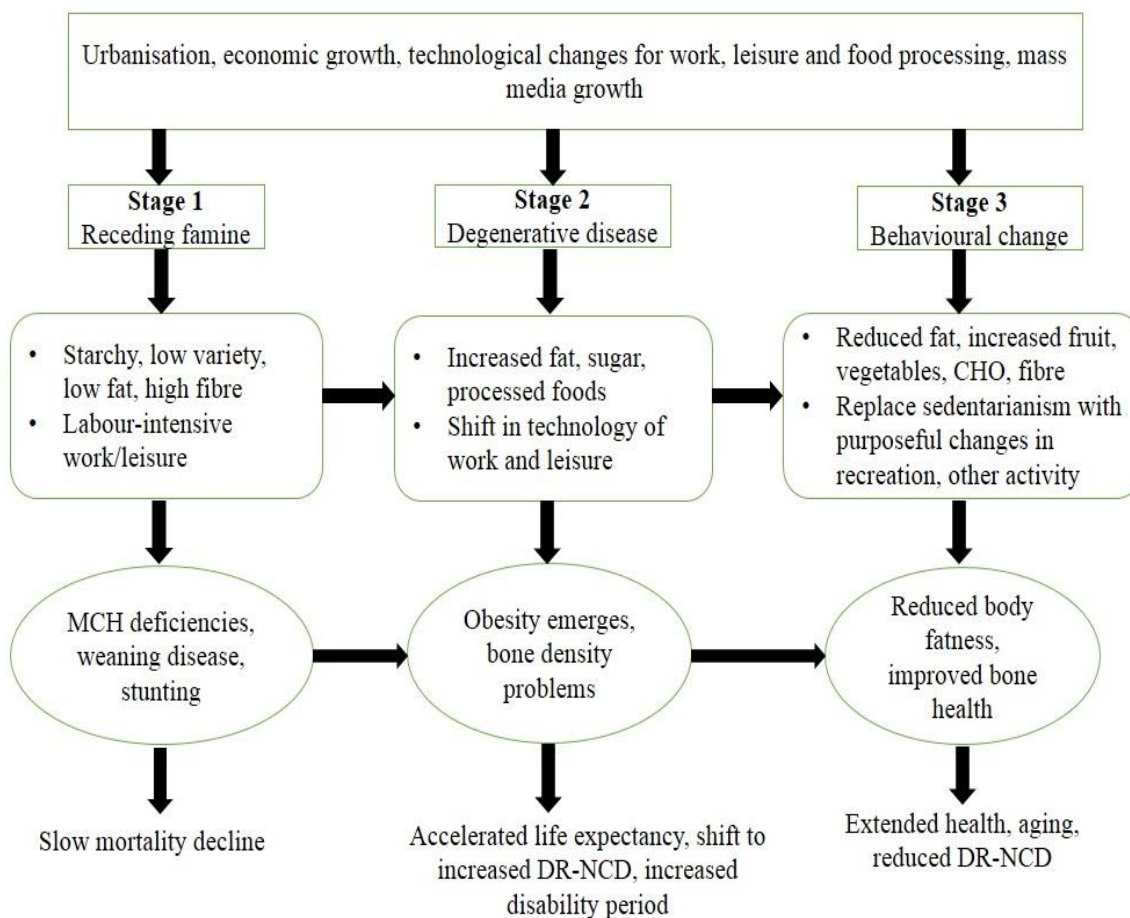


Figure 2.2: Stages of the Nutrition Transition (Popkin 2003)

Several studies spanning a fifty-year period, from the 1940's to the 1990's, have considered the impact of urbanisation on the diet of Black Africans in South Africa (Bourne *et al* 2002; Bourne, Langenhoven, Steyn, Jooste, Laubscher & van der Vyver 1993; Albertse, Neethling & de Villiers 1990; Fox 1941 p28). In a study of African income and expenditure in 1940, Fox disclosed the macro- and micronutrient composition of Black African diets, living in urban locations surrounding Johannesburg. Whilst only able to analyse the macronutrient and micronutrient content of food "as purchased", it was reported that the carbohydrate content of their diet contributed as much as 70% of the total energy consumed, while protein comprised 14% of the total energy consumed, and fat 16% of the total energy of the diet. Calcium intake was 225 mg per day, which was well below the recommended intakes for both adults and children (Fox 1941, p28).

When comparing the dietary intake of the urban black population in Johannesburg in 1940 (Fox 1941, p28) to a study conducted on 983, 15 to 64 year old men and women in the Cape

Peninsula 50 years later (Bourne *et al* 1993), a clear shift in macronutrient intake was noted. A significant decrease of 10.9% in carbohydrate intake, and a significant increase of 59.7% in dietary fat intake (from a low intake of 16.4% total energy in 1940 to a fat intake of 26.2% total energy in 1990) was observed (Bourne *et al* 1993). Furthermore, a significant decrease in the intake of plant protein was recorded, with a simultaneous increase in the intake of animal protein (high in saturated fat) (Bourne *et al* 1993). The population group followed a nutritionally deplete diet, with most individuals failing to meet two thirds of the RDA of several micronutrients.

A study by Walker, Walker & Walker (1992) further reinforced how the composition of the Black African diet has changed over time. In 1989, the diets of elderly rural Black African women were compared to the dietary intakes of a similar group in a nearby rural village twenty years previously. The results showed an increase in their dietary fat intake (fat contributed 24% of total energy in 1989, compared to 19% of total energy in 1969), and protein (comprising 14% of total energy in 1989, compared to 12% of total energy in 1969), with a respective increase in the consumption of animal and dairy products of 75% and 20%. Fruit and vegetable consumption increased considerably by 40%, but the dietary intake of sugar was triple that of twenty years previously. Significant rises in BMI and cholesterol were noted (Walker *et al* 1992).

Data from SANHANES-1 (2013) showed a higher fat and sugar intake (23.1% of participants) in urban formal areas compared to urban-informal, rural-formal and rural-informal areas, with only 9.8-15.1% of participants in non-urban formal areas having a high fat intake, and 11.7-18.2% of participants in non-urban formal areas having a high sugar intake. People living in urban-formal areas were also able to maintain a higher intake of fruit and vegetables (34.5% of participants) compared to people living in urban-informal, rural-formal and rural-informal areas (22.2%, 24.5% and 20.9% respectively) (Shisana *et al* 2013).

South Africa is one of Coca Cola's™ largest markets in the world (Chopra, Galbraith & Darnton-Hill 2002), with South Africans consuming 260 servings (237ml) per person in 2012, compared to the worldwide consumption of 94 servings per person (<http://www.statista.com>). Carbonated beverages were found to be the third most frequently consumed food/beverage item by very young urban children aged 12 to 24 months old, after maize meal and tea (Theron *et al* 2007). Small shops and street vendors are prolific in rural and township areas, where fruit, full cream dairy products, high fat meats, fatty snacks such as potato chips and vetkoek, cakes,

biscuits and cool drinks are the main choices on offer (Steyn & Labadarios 2011; Mosupye & von Holy 2000), with little salad and vegetables available. Whilst fruit is an acceptable snack, the other foods listed are often fried, high in saturated fat, and low in fibre. With 19% of Black Africans consuming such foods more than twice a week (Steyn & Labadarios 2011) there is a probable deleterious effect on their weight and health status.

2.3.3 Physical activity

Sedentary lifestyles are on the rise with an increased amount of time spent viewing television, playing games on computers and iPads, and the internet (Sigman 2012). The AAP (2001) recommended that no more than 1 to 2 hours per day be dedicated to quality screen viewing time (Bar-On, Broughton, Buttross, Corrigan, Gedissman, De Rivas, Rich, Shifrin, Brody, Wilcox, Hogan, Holroyd, Reid, Sherry, Strasburger & Stone 2001). The South African Medical Research Council reported that with many South African schools not offering physical education, and more than three hours per day spent viewing television and playing video/computer games (Reddy, James, Sewpaul, Koopman, Funani, Sifunda, Josie, Masuka, Kambaran & Omardien 2010), some school children have become accustomed to an indoor lifestyle. In households where parents work long hours, television has in turn replaced many carers as the primary source of information to youngsters on eating habits, preferences and behaviour (Renzaho 2004). Many other factors play a role in reduced physical activity in South Africa such as the crime rate and lack of facilities available to exercise in (Reddy *et al* 2010). As previously mentioned, many schools do not offer physical education as part of their curriculum, whilst other schools may place more emphasis on academics as opposed to sports. In urban built up areas there is also limited open space available for children to be physically active.

2.3.4 Socioeconomic status

It has been shown that the higher the socioeconomic status, the greater the chance of obesity. Factors related to this include domestic help to assist with household chores (which is a form of physical activity), more pocket money to buy food at school, and greater reliance on motorised transport to get to school and social activities, instead of walking or bicycling (Gupta *et al* 2012).

The opposite is also true for people from a lower socioeconomic background. In Brazil, it has been observed that women in the lowest income quartile are either underweight or overweight. Their excess weight may be attributed to them joining the workforce to earn a living, and thus forgoing the time available at home to cook a healthy meal (Caballero 2005). The result is reliance on cheap, commercially available food for themselves and their family. In developing countries, such as Brazil and South Africa, food costs can amount up to 50% of the family's income, forcing people to opt for cheaper, mass-produced, nutrient poor food (Caballero 2005). In a study conducted on 3 to 17 year old children and adolescents in Germany, Kleiser, Rosario, Mensink, Prinz-Langenohl & Kurth (2009) showed children and adolescents from a lower socioeconomic status to have a higher incidence of obesity (26.6%, n=3655), compared to other subjects from a middle socioeconomic status (20.3%, n=6121) and a high socioeconomic status (14.5%, n=3326). A low socioeconomic status is also associated with obesity in South Africa, as demonstrated by Steyn, Labadarios, Maunder, Nel & Lombard (2005) where an elevated BMI in children aged 1 to 9 years old was associated with living in a traditional house and having a flush toilet. Senekal, Steyn & Nel (2003) demonstrated a link between a low education level and a higher BMI in a group of economically active South Africans representative of four different ethnic groups. Poor education can manifest in a deficit of nutrition knowledge, which may lead parents to offer and encourage unhealthy food options. Kruger *et al* (2006) discussed a higher prevalence of overweight and obesity occurring in urban areas, smaller households, and in children of parents with either low- or high-income occupations. Furthermore, Puoane, Steyn, Bradshaw, Laubscher, Fourie, Lambert & Mbananga (2002) demonstrated a significant relationship among adult women with no education, and those with more than 12 years education, having higher BMI values, compared to those women who had between one to 12 years of education (Puoane *et al* 2002).

Poverty remains a problem in South Africa, with many people unable to consume an adequate and diverse diet. In addition to poor nutrition, pregnant women living in poverty are more likely to experience many other stressors such as unemployment, over-crowding and unhygienic living conditions, which all have a profound effect on the unborn child. The risks of intrauterine growth retardation and preterm labour are higher in such living conditions, and often result in low birth weight babies (Larson 2007). A low birth weight can predispose an infant to future central obesity through metabolic alterations that occur *in utero* (Oken & Gillman 2003), especially if they experience accelerated catch up growth in their infancy and early childhood (Lanigan & Singhal 2009).

2.3.5 Culture

Caprio, Daniels, Drewnowski, Kaufman, Palinkas, Rosenbloom & Schwimmer (2008) report that “Culture provides meaning to a set of rules for behaviour that are normative (what everyone should do) and pragmatic (how to do it). Culture, unlike instinct, is learned.” With the migration of many different ethnic groups around the world, a change in dietary patterns have been observed as a result of acculturation. Unger, Reynolds, Shakib, Spruijt-Metz, Sun & Johnson (2004) demonstrated how first-generation Asian and Latino adolescents previously had higher fruit and vegetable consumption, and lower consumption of soda beverages than White adolescents in North America. With each subsequent generation, the intake of these items by Asians remained stable. However, the fruit and vegetable consumption by Latinos decreased and their intake of soda increased to the extent that by the third generation their nutritional intake was poorer than that of Whites (Unger *et al* 2004).

Cultural beliefs are a contributing element to the obesity epidemic in South Africa. Overprotective parents may force their children to finish their meals, thus rendering their hunger-satiety cues obsolete (Gupta *et al* 2012). Many South African social gatherings are centred round large-scale food consumption. Foods high in sugar and fat are considered a luxury in South Africa, and are associated with elevated status, power and wealth. These foods, such as animal meats, fried foods, chocolate, biscuits, and soft drinks (Renzaho 2004) are offered, and consumed in large quantities at family gatherings and important events.

2.3.6 Gender

As demonstrated in the reviewed South African studies, females show a greater propensity for overweight and obesity, which could be attributed to hormones present during adolescence (Kruger *et al* 2006). Cameron & Getz (1997) observed more ‘overweight’ females clustered around the period before adolescence (8 to 9 years old) and the onset of menarche (after 14 years old) up to 18 years of age. Adiposity rebound (5 to 7 years of age) and puberty are both developmental stages of life associated with a rapid growth spurt and corresponding release of hormones, raising queries whether these hormones encourage the deposition of fat, and why females are more susceptible to this phenomenon than males (Cameron & Getz 1997). Dietz (1994) linked the presence of androgens released by the adrenal cortex with the deposition of both adipose tissue and lean muscle mass during growth spurts (Dietz 1994). Cameron & Getz (1997) further explained that following the onset of puberty, the increased levels of oestrogen

and progesterone in female subjects encouraged the deposition of fat both centrally and peripherally, leading to gynoid (pear shaped) obesity and the incorrect supposition of 'benign obesity'. In male subjects, the presence of testosterone reduced excess fat deposition and centralized the fat stores, resulting in android (apple shaped) obesity, and the associated increase in morbidity.

It has been noted that amongst the Black African culture it is desirable for females to be overweight, as it reflects on their husband's ability to look after his family (Puoane *et al* 2002). It also implies happiness and good health, and is an important external image with the raging HIV/AIDS epidemic prevalent on the African continent (Mvo, Dick & Steyn 1999). However, females exposed to Western media, where a thinner body image is promoted as the ideal are more likely to aspire to a lower BMI (Tovée, Swami, Furnham & Mangalparsad 2006). In areas where females from different ethnic backgrounds have a similar culture, as may be in the case of urban Black African females acculturated to the Western way of thinking, adaptive behaviour is demonstrated whereby the ideal Western body image is strived for. This was investigated by Tovée *et al* (2006), who discussed how females of African descent living in the UK preferred a slimmer body image and lower BMI compared to Zulu females from the Mshwathi-Mpolweni area in KZN. In addition, girls are also expected to help with domestic chores, thus preventing them from engaging in more rigorous outdoor physical activities (Gupta *et al* 2012).

2.3.7 Stress

Many theories exist on the link between obesity and stress. Frequent exposure to a stressful environment can induce weight gain through the altered release of hormones, and hyperactivation of the hypothalamic-pituitary-adrenal axis (HPA axis) (Drapeau, Therrien, Richard & Tremblay 2001). The subsequent increase in cortisol levels precedes a cascade of hormonal and enzymatic actions resulting in fat accumulation in adipocytes in the abdominal region (Drapeau *et al* 2001). Post-traumatic stress is an important issue amongst South African children (Kaminer, Grimsrud, Myer, Stein & Williams 2008), in addition to other stressors in childhood such as abuse and neglect (Sher, Gershuny, Peterson & Raskin 1997; Lissau & Sorensen 1994), parental divorce (Sandler, Tein & West 1994), poor self-esteem (Strauss 2000), anxiety and depression (Pine, Goldstein, Wolk & Weissman 2001).

As obesity in childhood often tracks into adulthood (WHO 2007) it is apparent that obesity prevention initiatives should be focused on children to ensure the adoption of a healthy lifestyle from an early age (Kruger *et al* 2006). With the most recent nationally representative study, SANHANES-1 (2013) confirming 11.8% of 2 to 14 year old children are obese (Shishana *et al* 2013), intervention urgently needs to start at a young age, with the emphasis on identification of dietary risk factors for overweight and obesity. As children approach the adolescent phase they become more autonomous in their eating choices, and their bodies start to lay down the nutrients required for the rapid growth and maturation they are about to undergo. It is essential that focus is placed on a nutritious and balanced dietary intake in order for them to attain a healthy weight, and increased physical activity for optimal growth and development. The next section will discuss how the South African government has encouraged a healthy food intake.

2.4 Encouraging a healthy diet in South Africa

The first Food Based Dietary Guidelines (FBDG) developed for South Africa were published in 2001, with the aim of promoting healthy eating amongst all South Africans. Milk and dairy products were initially incorporated into the guideline on animal foods, due to concerns regarding the cost of dairy, and lactose intolerance amongst the Black African population (Vorster *et al* 2013). However, results from subsequent local studies (Theron *et al* 2007; Steyn *et al* 2006; MacKeown, Cleaton-Jones & Norris 2003; MacIntyre, Kruger, Venter & Vorster 2002) revealed low dietary intakes of calcium and potassium, and high rates of NCDs such as hypertension prevalent amongst the South African population. Due to the recognition that milk and dairy products have attained in their role of reducing the risk of NCDs, the working group assigned to revising the FBDGs a decade later, recommended that milk and dairy products have their own specific guideline. The revised FBDGs were released in 2012, with the guideline “Have milk, maas or yoghurt every day” encouraging the population to include dairy in their daily diet. Cheese was not included in the guideline due to its high sodium content, and emphasis was placed on low fat milk and dairy, in light of the obesity problem in South Africa (Vorster *et al* 2013).

The 2012 South African Food Based Dietary Guidelines include:

- 1) Enjoy a variety of foods.
- 2) Make starchy food part of most meals.
- 3) Fish, chicken, lean meat or eggs could be eaten daily.
- 4) ***Have milk, maas or yoghurt every day.***

- 5) Eat plenty of vegetables and fruit every day.
- 6) Eat dry beans, split peas, lentils and soya regularly.
- 7) Use salt and food high in salt sparingly.
- 8) Use fat sparingly; choose vegetable oils rather than hard fats.
- 9) Use sugar, and food and drinks high in sugar sparingly.
- 10) Drinks lots of clean, safe water.
- 11) Be active!

In South Africa, the recommended number of milk and dairy servings per day for 4 to 8 year old children is 3 cups, or serving equivalents, which provides approximately 900 mg calcium (Consumer Education Project of Milk SA 2013). South Africa follows the Metric System where one cup of fluid is the equivalent to 250 ml. America still makes use of the Imperial system, where one cup of fluid is the equivalent to 240 ml (Maryland Metrics 2017). Where studies have investigated the effect of milk measured as 'one cup', the volume of milk is indicated in addition.

If South African children aged 4 to 8 years old consumed the recommended three servings of milk and/or dairy products per day (750 ml), it would be possible for them to meet the EAR for calcium of 800mg per day, and up to 50% of their potassium requirements. The potassium intake is a considerable contribution to the requirements of a population who also do not meet their recommended fruit and vegetable intake (Vorster *et al* 2013). Table 2.3 shows the amount of calcium derived from various single servings in commonly consumed milk and dairy products.

Table 2.3: Calcium content of a single serving of milk and dairy products (Smit, Smith, Schönfeldt & Heinze 1998)

Product	Amount	Calcium (mg)	%EAR for 4-8 years old
Milk, full cream	250 ml	300	37.5%
Milk, low fat	250 ml	305	38%
Yoghurt, sweetened, low fat	200 ml	290	36%
Yoghurt, plain, low fat	200 ml	298	37%
Drinking yoghurt	200 ml	284	35.5%
Maas	200 ml	324	40.5%
Cheese, cheddar	40 g	215	27%
Cheese, gouda	40 g	322	40%

2.5 The benefits of milk and dairy products

Cow's milk is a highly nutritious food item that is encouraged from the age of one year old (Mahan *et al* 2012, p380). It is the main ingredient of dairy products such as yoghurt, maas, ice-cream, custard, milk-based desserts, and cheese. Plain cow's milk is available in differing fat content, and was re-marketed in 2016 to give consumers a fourth option, namely "medium fat" milk. This was in order for South Africa to align itself with international legislation that dictates low fat milk cannot exceed 1.5% fat (Burger 2016). The amount of fat found in the various types of cow's milk is presented in Table 2.4. Whilst American literature refers to whole milk (3.5% fat), for the purpose of this literature review it is referred to as full cream milk.

Table 2.4: Approximate nutritional composition of fresh milk in South Africa (per 100 g) (Department of Agriculture, Forestry and Fisheries 2015, p7)

Class	Energy (kJ)	Protein (g)	Carbohydrate (g)	Fat (%) (Previous legislation R2581)	Fat (%) (New legislation R260)	Ca (mg)
Full cream milk	260	3.25	4.63	3.3-4.5%	>3.3-4.5%	120
Medium fat milk	N/A	N/A	N/A	N/A	>1.5-3.3%	N/A
Low fat milk	208	3.26	4.68	0.5-2.5%	>0.5-1.5%	122
Fat-free milk	146	3.41	4.85	≤0.5%	≤0.5%	123

The energy content of milk is mainly determined by the fat content. The addition of sucrose, fruit pieces, fruit pulp, and chocolate pieces, as is in the case of flavoured yoghurt and flavoured drinking yoghurts, further adds to the energy contribution of a particular dairy product. Milk and dairy offer a valuable, energy dense product to different groups of people who have their own unique needs; namely young children with small stomach capacity and high nutrient requirements; growing older children and adolescents; physically active people participating in sports; and the elderly suffering from poor appetites.

Cow's milk offers a high biological value protein source that is easily digestible and contains all nine of the essential amino acids that the body is unable to synthesise. The protein content of cow's milk is affected by the breed, year of birth, parity and lactation phase of the dairy cow, and the season (Czajkowska, Sitkowska, Piwczynski, Wójcik & Mroczkowski 2015). On average there is approximately 3.3% protein in cow's milk; with casein being the predominant protein component, contributing 80% of the total protein, and whey making up approximately 20% of the protein source (Kukovics & Németh 2013), with additional minor proteins present. The different physical properties of casein and whey lead to different physiological effects on the body. The casein fraction is digested slowly, resulting in delayed gastric emptying and reduced post-prandial blood glucose and insulin response. The whey component is digested more rapidly, resulting in a faster, but short-lived increase in plasma amino acids. Both casein and whey are responsible for contributing to satiety, which may play an essential role in the fight against overweight and obesity (Luhovyy, Akhavan & Anderson 2007).

Bioactive peptides present in milk are protein hydrolysates, which show potential to confer a degree of protection upon the body once digested (Choi, Sabikhi, Hassan & Anand 2012). Such

is their health promoting impact on multiple systems within the body that it was recommended dairy be considered a natural functional food that should be included as part of the daily diet (Choi *et al* 2012). The bioactive peptides are inactive until cleaved from the protein by enzymatic proteolysis during digestion, upon which they then exert their effects, either by binding to receptors in the gastrointestinal tract, or entering the bloodstream and targeting specific organs and tissues (Luhovyy *et al* 2007). The bacteria cultures added to fermented dairy products further assist in the proteolysis and release of bioactive peptides (Meisel 2005).

The wide-ranging positive effects of bioactive peptides on organ systems will be presented in the subsections that follow.

2.5.1 The cardiovascular system

Bioactive peptides exert an anti-hypertensive, anti-thrombotic, hypocholesterolaemic and antioxidant effect (Kukovics & Németh 2013). They display their anti-hypertensive action in the inhibition of angiotensin-1- converting enzyme (ACE), which is responsible for regulating peripheral blood pressure. The result is an enhanced vasodilatory effect, and a decrease in both systolic and diastolic blood pressure (Meisel 2005). Calder, Ahluwalia, Brouns, Buetler, Clement, Cunningham, Esposito, Jönsson, Kolb, Lansink, Marcos, Margioris, Matusheski, Nordmann, O'Brien, Pugliese, Rizkalla, Schalkwijk, Tuomilehto, Wärnberg, Watzl & Winklhofer-Roob (2011) noted that the intake of dairy products exerted a positive effect on C-reactive protein and adiponectin, both markers of low-grade inflammation associated with overweight and obesity. These effects were related to the dairy-derived bioactive peptides.

2.5.2 The immune system

Bioactive peptides can exert anti-microbial, immune-modulatory and cyto-modulatory activities (Korhonen & Pihlanto 2006). The peptide, lactoferricin, displays potent bactericidal properties, with its small size enabling it to reach specific target sites on microorganisms (Meisel 2005). Both casein and whey demonstrate immune stimulating properties, with whey proteins enhancing immune cell proliferation and antibody synthesis (Meisel 2005), which is of particular importance in the development of a newborn's immune system. Cytomodulatory activities, whereby milk protein-derived peptides have demonstrated the ability to reduce proliferation of cancer cells, is an area of great interest (Meisel 2005).

2.5.3 The gastrointestinal system

Within the oral cavity, peptides have displayed an anti-cariogenic effect, preventing demineralisation and assisting with the remineralisation of tooth enamel (Meisel 2005). Peptides derived from casein can inhibit the growth of plaque-forming bacteria (Korhonen & Pihlanto 2006). Some of these peptides are found in chewing gums and toothpastes (Aimutis 2004), as well as other personal hygiene products (Choi *et al* 2012). Phosphorylated peptides regulate mineral absorption, such as calcium, iron and zinc, and are thought to be responsible for the enhanced bioavailability of calcium (Meisel, 2005), reduced risk of osteoporosis, dental caries, hypertension and anaemia (Korhonen & Pihlanto 2006). Certain peptides found in the small and large intestine display anti-diarrhoeal action via the net absorption of water and electrolytes (Meisel, 2005). Peptides are also involved in the regulation of hyperglycaemia (Luhovyy *et al* 2007) and contribute to satiety by assisting with the release of cholecystokinin, a hormone involved in controlling food intake and digestion (Korhonen & Pihlanto 2006). Bioactive peptides may independently, or synergistically together with calcium, also be responsible for lipolysis (Zemel 2003).

2.5.4 The nervous system

Opioid receptors are found in the nervous, endocrine, immune and gastrointestinal systems (Korhonen & Pihlanto 2006). Opioid peptides display both agonist and antagonist opioid activities within the nervous system, such as controlling gastrointestinal smooth muscle contractions, which affect the transit time of food (Korhonen & Pihlanto 2006).

Whilst the beneficial effects of milk-derived proteins and peptides have been acknowledged, their impact is often as a result of a synergistic interaction with other components of milk, such as calcium. The impact of peptides and calcium on reduced body fat and weight, for example, is far greater than for calcium supplementation alone (Luhovyy *et al* 2007).

Carbohydrates account for approximately 31% of the total energy provided by full cream milk (Vorster *et al* 2013). Lactose is the predominant carbohydrate found in milk, and enhances the absorption of calcium and phosphorous from the intestine (Allman-Farinelli & Amanatidis 2002).

There is 12.5 g of lactose per 240 ml serving of milk (Savaiano, Boushey & McCabe 2006). Lactose is a disaccharide that is hydrolysed to glucose and galactose by the lactase enzyme, but this process is hindered in people who experience lactose intolerance. The undigested lactose that subsequently ferments in the gut of some people from African, Asian, Middle Eastern, Australian Aboriginal and Southern European origins causes uncomfortable symptoms such as bloating, flatulence, diarrhoea and pain. Lactose intolerance can often result in an inadequate dairy intake in order to avoid such unpleasant side effects. However, Savaiano *et al* (2006) demonstrated that up to 1 cup (240 ml) of milk per day can be tolerated in lactose intolerant individuals, with an improved experience gained when dairy is consumed as part of a meal, and by consuming fermented dairy products such as yoghurt.

Milk fat is comprised of approximately 400 different fatty acids, with 60% of milk fat being saturated fat, 33% monounsaturated fat, and less than 5% polyunsaturated fat (Allman-Farinelli & Amanatidis 2002). It is an excellent source of energy, fat-soluble vitamins and essential fatty acids. Although some concern exists over the effect of saturated fat on LDL-cholesterol, Griffin (2011) noted that the link between dairy and cardiovascular disease has never been proven in prospective cohort studies, and dairy actually exerts a protective effect on cardiovascular disease, thought to be due to the actions of bioactive peptides and calcium. In addition to the anti-hypertensive effects of bioactive peptides, calcium is thought to bind to, and sequester, saturated fatty acids and bile salts in the gut, whereupon there is an increase in the faecal excretion of saturated fat and bile salts (Griffin 2011). Simply limiting or completely removing dairy from the diet in an attempt to reduce saturated fat intake is not likely to offer any benefit overall (Givens 2010). Conjugated linoleic acid (CLA) is one of the fatty acids in milk receiving much attention for its perceived health benefits. Although milk is a good source of dietary CLA's, the amount of CLA's present is thought to be inadequate to enjoy any of its claimed benefits, with a presence of only 0.2-3.7% CLA in milk (Gordon 2013). The body is able to synthesise its own source of CLA's, through the desaturation of vaccenic acid to CLA, increasing the total CLA available to the body quite considerably over and above the dietary intake alone (Gordon 2013). There have been conflicting findings regarding the role that CLA plays in the human body, with reports of CLA decreasing plasma blood glucose levels, and increasing insulin sensitivity. This is in contrast to the findings that it enhances insulin resistance (Gordon 2013). Small studies displaying CLA's anti-carcinogenic, anti-atherosclerotic and anti-obesity properties have not produced convincing results, and further research is required (Gordon 2013).

The beneficial impact of milk-derived proteins and peptides is often as a result of synergistic interaction with other components of milk, such as calcium. Calcium is an essential nutrient required for many biological processes within the human body, such as mitosis, nerve conduction, muscle contraction, blood coagulation, support of the skeleton (Miller & Anderson 1999), and most importantly in growing children for the mineralization of bones (Mahan *et al* 2012 p380). The EAR for calcium for children aged 4 to 8 years old is 800 mg per day (the amount expected to achieve the levels of calcium needed for bone accretion) (Ross, Taylor, Yaktine & Del Valle 2011). Milk and dairy products are the main sources of calcium in young children's diets. Additional, non-dairy sources of dietary calcium include bony fish, leafy green vegetables, cereals, legumes, fortified foods and beverages, and supplements, food items that are often not popular options amongst toddlers and children. Furthermore, the calcium found in milk and dairy products has a high bioavailability and is well absorbed, unlike the calcium found in non-dairy food products. A much greater volume of non-dairy calcium needs to be ingested in order to obtain the same calcium intake as that found in dairy products. The presence of phytates in cereals, oxalates in spinach, and tannins in tea further decrease the bioavailability of calcium (Miller, Jarvis & McBean 2001). Through its various physiological roles, calcium is responsible for reducing the risk of certain chronic diseases such as hypertension and osteoporosis. The DASH diet (Dietary Approaches to Stop Hypertension), which recommends a low fat diet high in fruit and vegetables, and low fat dairy (two to four servings per day), has shown promising results in reducing hypertension, especially amongst the African-American population, who historically have a low calcium intake (Jarvis & Miller 2002). It is commonly thought that the calcium component within dairy products is responsible for the success of the DASH diet in reducing hypertension (Vorster *et al* 2013).

If children do not consume an adequate amount of calcium in their daily diet, their body will draw on reserves stored in their skeleton, predisposing them to an increased risk of low peak bone mass, increased risk of bone fractures and osteoporosis later on in life (Cavadini, Siega-Riz & Popkin 2000). International studies conducted on the impact of milk and dairy products on obesity pinpoint the beneficial effects of dairy on body weight, body fat and the metabolic syndrome to the role of calcium. Zemel *et al* (2000) demonstrated how increasing dietary calcium intake suppressed the release of calcitriol, resulting in the decreased movement of calcium into adipocytes and subsequent decrease in lipogenesis, with an increase in lipolysis observed (Zemel *et al* 2000). This effect was noted when caloric intake was restricted (Zemel

2003). Supplementing with calcium and calcium-fortified products does not seem to produce the same weight loss results (Zemel 2003).

The benefits of calcium are undisputed. The challenge is ensuring an ideal intake of this “super-nutrient” (Miller *et al* 2001). Vorster, Oosthuizen, Jerling, Veldman & Burger (1997) reviewed the nutritional status of the South African population based on literature from 1975-1996 for the Health Systems Trust. Analysis of diets showed calcium intake to be low for all age groups except children 0 to 1.9 year old, and White, Coloured and Indian children 2 to 5.9 years old. The Birth-to-Ten Study (BTT) showed more than 70-90% of children surveyed between 1995 and 2000 were below the RDA for calcium (MacKeown *et al* 2003).

Steyn *et al* (2006) conducted a secondary analysis of data from the National Food Consumption survey (NFCS) of 1999 to determine whether the dietary diversity score of South African children’s diets was a good indicator of nutrient adequacy. Their findings on the dietary intake of calcium amongst the 7 to 8 year age group was discouraging, with a nutrient adequacy ratio (the intake of a nutrient divided by the recommended intake for that nutrient) of 46.1%. This was the lowest intake amongst the three age groups studied (1 to 3 years old, 4 to 6 years old and 7 to 8 years old).

Theron *et al* (2007) compared the dietary intake of urban stunted and non-stunted children aged 12 to 24 months, to rural stunted and non-stunted children and showed all four groups to have very low calcium intakes well below the EAR of 500 mg per day for their age group. The urban non-stunted group had a calcium intake of 242 mg and the urban stunted group had an intake of 333 mg of calcium per day. The rural non-stunted group of children had a calcium intake even lower of 194 mg, and the rural stunted group had an intake of 217 mg per day, excluding the calcium found in breast milk. Fresh cow’s milk was the fourth most common food item consumed in their diets, preceded by cooked maize meal, tea and carbonated cold drinks (Theron *et al* 2007).

Diets lacking in calcium are often low in many other vital nutrients. One serving (250 ml) of fresh, full cream milk ensures the following nutritional requirements for a 4 to 8 year old child are met: 42.7% of RDA for protein, 27% Vitamin A, 67% riboflavin, 92% Vitamin B12, 30% calcium, 20% zinc, 22% magnesium, and 17% potassium. However, little impact is made on overall energy consumption (655 kJ versus requirements of 6785 to 7523 kJ per day for moderately active 7 to 8 year old boys, and 6300 to 7000 kJ per day for moderately active 7 to

8 year old girls) (FAO/WHO/UNU 1985) and weight (Miller *et al* 1999). Increased dietary intake of milk and dairy products is encouraged in preference to obtaining calcium from fortified foods, beverages, and supplements due to the many other essential nutrients offered when consuming dairy (Miller *et al* 1999). Various obstacles to ensuring an adequate dairy intake exist, and these will be discussed in the next section.

2.6 Barriers towards milk and dairy intake

Several barriers to attaining an adequate milk, dairy and calcium intake have been identified. These include replacing milk for sugar-sweetened beverages, the family environment (Racey, Bransfield, Capello, Field, Kulak, Machmueller, Preyde & Newton 2017), eating away from the home setting (Miller *et al* 2001), skipping meals (Racey *et al* 2017), food practices and preferences based on culture, perceived lactose intolerance, milk allergy, animal rights beliefs (Jarvis & Miller 2002), concern about the fat content (Racey *et al* 2017), and poor awareness of the beneficial effects of dairy (Wham & Worsley 2003). In developing countries, the cost of milk and dairy products may be an obstacle to their adequate consumption (Scholtz, Vorster, Matshego & Vorster 2001).

Interestingly, a steady decline in the international consumption of milk with a subsequent increase in the consumption and portion size of sweetened beverages such as juice and soda drinks over the past few decades has been associated with an increased caloric intake and incidence of overweight and obesity (Nielsen & Popkin 2004). Additional concern lies in the fact that soft drinks offer empty calories, devoid of the essential nutrients needed for the accelerated growth experienced by children.

Cavadini *et al* (2000) studied trends in USA adolescent food intake spanning from 1965 to 1996. There was a substantial decrease in milk consumption amongst both males and females, with males consuming just under 1200 g per day in 1965, declining to approximately 750 g in 1996. Females consumed approximately 850 g per day in 1965, but this decreased to less than 500 g per day in 1996. The average US Food Guide Pyramid serving for milk was two and a half servings per day (600 ml) in 1965, subsiding to two servings per day (480 ml) in 1996. Calcium intake amongst the 11 to 18 year old subjects declined from 1100 mg in 1965 to 960 mg in the 1994-96 survey, with only one third of males meeting their calcium requirements, and only 20% of females meeting their calcium requirements in 1996. Over the three decades

reviewed, low fat milk often replaced full cream milk. A subsequent increase in soft drinks, diet soft drinks and fruit drinks was observed.

Drawing on a similar database, French, Lin & Guthrie (2003) observed trends in soft drink consumption from the National Food Consumption Survey (NFCS) 1977/78 and the Continuing Survey of Food Intakes by Individuals 1994/96 data, showing an 88% increase in soft drink consumption amongst 6 to 10 year old males, and a 77% increase amongst 6 to 10 year old females. Furthermore, the overall contribution of soft drinks to the children's energy intake increased substantially over the 20-year period studied, with 6 to 10 year old males experiencing a 68% increase in energy intake from soft drinks, and 6 to 10 year old females experiencing a 59% increase in energy intake from soft drinks. Tam, Garnett, Cowell, Campbell, Cabrera & Bauer (2006) showed soft drinks and cordials intake amongst 8 year old Australian children to be associated with weight gain five years later. Whilst the home environment was identified as the most common source of supply for soft drinks, restaurants and fast food outlets were increasingly shown to be a site of soft drink consumption, reaffirming the current trends for eating outside of the home (French *et al* 2003). To further compound the problem of an inadequate dairy and calcium intake, restaurant and fast food meals are known to have a much lower dietary calcium content compared to home-made meals (Lin, Guthrie & Frazão 1999).

Wham & Worsley (2003) reaffirmed the decrease in milk consumption amongst the New Zealand population, citing several reasons. These included the decrease in breakfast consumption, "milk is expensive compared to fizzy drinks", misperceptions that "fruit juice is better for you than milk" due to the fat content of milk, the "discontinuation of the subsidized school milk scheme in 1967, removal of the government milk subsidy in 1985, and the impact of dairy export returns on milk prices". Another component of decreased milk and dairy product intake that needs to be considered, and has already been briefly mentioned, is the misperception that milk and dairy products are "fattening", and are thus often avoided, especially amongst adolescent females striving for a thinner body shape (Miller *et al* 2001).

Racey *et al* (2017) highlighted the importance of taste as either a facilitator or barrier to dairy intake amongst 10 to 12 year old school going boys and girls. In a study conducted by Palacios, Badran, Spence, Drake, Reisner & Moskowitz (2010) the researchers measured the acceptance of milk products amongst 8 to 16 year old children. The younger aged children seemed less critical of the products tested, compared to the older children studied. It is because of these

early learned preferences in food taste that it is necessary to expose a child to, and encourage an adequate, culturally appropriate dairy intake early on life to ensure a greater chance of dairy product acceptability throughout the individual's life. Racey *et al* (2017) reported that 10 to 12 year old females who did not meet their dairy requirements cited one of the reasons as parental influence, with one of the subjects admitting her father wanted her to drink more dairy, but her mother did not like it.

In South Africa, the consumption of milk and dairy products is dependent on the price of the product, as can be demonstrated by the sale of fresh, pasteurised milk versus Ultra Heat Treated (UHT) milk. A 14.4% increase in the sales of long life UHT milk in South Africa was recorded in 2015, and was directly related to the reduced cost of the product. A simultaneous decrease in the sale of fresh milk was noted, with price conscious consumers clearly driven by cost effective purchasing practices. For the January to December 2015 period, sales of other dairy products increased compared to the previous year, with flavoured milk sales increasing by 6.7%, yoghurt sales increasing by 6.5%, sales of maas increasing by 8.6%, pre-packaged cheese increasing by 7.2%, butter sales increasing by 5% and cream by 9.8%. The prices of fresh milk, UHT milk, maas and pre-packaged cheese were less in December 2015 than their retail prices in December 2014 (Le Roux *et al* 2016). In South Africa, the cost of raw milk is usually increased in the first half of each year (Le Roux *et al* 2016), with further factors influencing the cost of dairy products, such as the severe drought recently experienced, which pushed the cost of animal feeds up. The price of international dairy products and the exchange rate may enhance foreign competition within the dairy industry, thus further contributing to the affordability of milk and other dairy products in South Africa (Le Roux *et al* 2016).

With the observed global decrease in dairy intake, subsequent increase in sugar-sweetened beverage intake and alarming rise in obesity, speculation has arisen that these factors are inextricably linked. The next section will discuss the relationship between obesity and the consumption of dairy products.

2.7 Dairy intake and obesity

Whilst physiological evidence exists for the beneficial effect of dietary calcium on body fat, and weight management in adult subjects (Zemel, Thompson, Milstead, Morris & Campbell 2004; Zemel 2003; Pereira, Jacobs, Van Horn, Slattery, Kartashov & Ludwig 2002; Shi, Dirienzo & Zemel 2001; Davies Heaney, Recker, Lappe, Barger-Lux, Rafferty & Hinders

2000; Lin, Lyle, McCabe, McCabe, Weaver & Teegarden 2000; Zemel *et al* 2000), the mechanism has not yet been studied in children. Both children and adolescents differ to adults in their metabolism, changes in body composition, hormone levels and growth patterns (Dror 2014). Several international studies conducted on children and adolescents to ascertain if any relationship exists between their milk or dairy intake, and their body fat and/or BMI have been published. The results of these studies are inconclusive; it appears that dairy may offer a protective effect in adolescents, but not in children. One of the theories suggested to support these findings is that dairy may influence weight and height patterns during periods of growth that occur in defined life stages (Wiley 2010). During adolescence when a rapid growth spurt occurs, in conjunction with enhanced hormonal levels, milk may exert its effect more noticeably on body fat (Dror 2014). Studies on milk or dairy intake in children of a similar age group to this intervention study have been summarized in the order of publication, in Table 2.5.

Table 2.5: Summary of studies on dairy intake and BMI in children

Researchers	Sample	Objectives	Study design	Dairy exposure	Method	Outcome	Results
Tanasescu, Ferris, Himmelgreen, Rodriguez & Perez-Escamilla (2000) USA	53 7 to 10 years	1) Do the diets of obese children differ from those of non-obese children in terms of energy, macronutrients and food group intake? 2) Do obese children have different TV viewing and activity and inactivity patterns than non-obese children? 3) Is maternal obesity associated with child's obesity? 4) Do obese children have different birth weights and infant feeding profiles compared with their non-obese counterparts? 5) Does socioeconomic status influence the likelihood of childhood obesity? 6) Is obesity associated with negative health consequences during childhood?	Observational case control	Dairy (intake expressed as means \pm SD)	Obese versus control, 24-hr recall and FFQ	BMI percentiles (BMI \geq 85 th percentile)	Significant inverse association between dairy intake and BMI.
Carruth & Skinner (2001) USA	53 0 to 8 years	To assess preschool children's food consumption (24 ± 60 months) and relate these findings to body composition at 70 ± 2 months.	Longitudinal	Dairy (serving sizes based on calcium equivalent of 240 ml milk)	24-hour recall	BMI, body fat	Significant inverse relationship between dietary calcium and body fat.

Table 2.5: Continued

Researchers	Sample	Objectives	Study design	Dairy exposure	Method	Outcome	Results
Forshee & Storey (2003) USA	3311 6 to 19 years	1) To examine total beverage consumption among children and adolescents. 2) To examine their beverage choices. 3) To understand the relationships between beverage consumption and choice as influenced by age, gender, race/ethnicity, and BMI (i.e. body size).	National longitudinal survey	Milk (grams)	CSFII 1994-1996, 1998	BMI	Significant inverse association between milk intake and BMI only in girls.
Phillips, Bandini, Cyr, Colclough-Douglas, Naumova & Must (2003) USA	196 girls 8 to 12 years	To examine the relation of dairy food intake with relative weight status and percentage body fat (%BF).	Longitudinal study	Dairy (serving sizes 'of natural units or typical serving sizes')	FFQ, Bioelectrical impedance analysis	% BF, BMI Z score	No association observed.
Barba, Troiano, Russo, Venezia & Siani (2005) Italy	975 7.5 ± 2.1 years	To investigate the relationship between frequency of milk consumption and body mass.	Observational	Milk (classified according to frequency of consumption)	FFQ	BMI Z score	Significant inverse association between milk and BMI.

Table 2.5: Continued

Researchers	Sample	Objectives	Study design	Dairy exposure	Method	Outcome	Results
Dixon, Pellizon, Jawad & Tershakovec (2005) USA	342 4 to 10 years	To examine whether intake of calcium and dairy foods was associated with BMI and skinfold measures in hypercholesterolaemic and normocholesterolaemic children, ages 4 to 10 years, at baseline and over the course of 1 year.	Longitudinal	Dairy (standard serving sizes for 4 to 10 year olds: 1 cup milk/ 240 ml = 1 serving)	3 x 24-hour recalls	BMI Z-score, sum of skinfold thicknesses	Number of servings per day of dairy inversely associated with BMI.
Berkey, Rocket, Willett, Colditz (2005) USA	12829 9 to 14 years	To assess the associations between milk, calcium from foods and beverages, dairy fat, and weight change over time	Longitudinal (Growing Up Today Study)	Milk (servings/day)	Self-administered FFQ	BMI (IOTF) (Cole <i>et al</i> 2000)	Higher milk intake (>3 servings/day) associated with larger weight gain; children that drank 1% and skim milk had larger weight gain; dietary calcium positively associated with weight gain; dairy fat not associated with weight gain.
Moreira, Padez, Mourão & Rosado (2005) Portugal	3044 7 to 9 years	To assess nutritional intake in school children and relate calcium intake to BMI.	Cross sectional analysis	Dietary calcium (mg)	24-hr recall	BMI (IOTF) (Cole <i>et al</i> 2000)	Inverse relationship between calcium and BMI only in girls.

Table 2.5: Continued

Researchers	Sample	Objectives	Study design	Dairy exposure	Method	Outcome	Results
Fiorito, Ventura, Mitchell, Smiciklas-Wright & Birch (2006) USA	166 girls and their parents 5 to 15 years	To assess whether beverage intake at age 5 years predicted energy intake, adiposity, and weight status across childhood and adolescence.	Longitudinal	Milk (servings per day; 1 serving = 8 oz/ 240 ml)	3 day diet recall, DXA	%BF	No association between milk intake and % BF from 5 to 15 years.
Moore, Bradlee, Gao & Singer (2006) USA	92 3 to 6, to 13 years	To estimate the effect of dairy intake in early childhood on the acquisition of body fat throughout childhood.	Longitudinal	Dairy (serving sizes: 1 cup (240 ml) milk/ yoghurt, 1.5 oz natural cheese, 2 oz processed cheese. Cream/ cottage cheese: amount needed to provide the same calcium as 1 cup milk)	15 day food record	Sum of skinfold thicknesses	Inverse relationship between dairy intake and body fat gain.
Tam <i>et al</i> (2006) Australia	436 7.7± 0.6 years to 13 ± 0.2 years	To determine: 1) The relation between soft drink/cordial and fruit juice/drink consumption in mid-childhood, and BMI status in early adolescence. 2) Whether sweetened beverage intake displaced milk intake.	Longitudinal	Milk (ml/day)	3 day food record	BMI	Milk intake at baseline not associated with BMI

Table 2.5: Continued

Researchers	Sample	Objectives	Study design	Dairy exposure	Method	Outcome	Results
Johnson, Mander, Jones, Emmett & Jebb (2007) UK	833 5, or 7 to 9 years	To assess whether high SSB consumption at age 5 or 7 years was a risk factor for increased fat mass at age 9 years.	Longitudinal	Milk (g/day) (1 serving = 180 g)	3 day food record, DXA	Fat mass	Milk intake at 5 and 7 years inversely associated with change in fat mass at 9 years.
LaRowe, Moeller & Adams (2007) USA	793 6 to 11 years	To determine whether specific beverage patterns were associated with overall diet quality and whether beverage patterns in preschool and school-aged children were related to BMI.	Longitudinal cross-sectional survey	Milk (g/day)	NHANES 2001-2002 24-hr recall	BMI	Full cream milk intake had a significantly inverse association with BMI.
Murphy, Douglass, Johnson & Spence (2008) USA	2097 6 to 11 years	To compare nutrient intakes and body measures among children and adolescents drinking flavoured milk (with or without plain milk), exclusively plain milk, and no milk.	Longitudinal cross-sectional survey	Milk (abstract only)	NHANES 1999-2002 24-hr recall	BMI Z score	No significant association between milk intake (plain and flavoured) and BMI.
Moore, Singer, Qureshi & Bradlee (2008) USA	6095 5 to 11 years	To explore the relation between dairy intake and body fat among children and adolescents	Longitudinal cross-sectional survey	Dairy (1 serving = 8 oz/ 240 ml milk/yoghurt, 1.5 oz natural cheese, 2 oz processed cheese)	NHANES 1998-1994, 1999-2002 24-hr recall	BMI Z score, sum of skinfold thicknesses	No significant difference between dairy intake and BMI noted.

Table 2.5: Continued

Researchers	Sample	Objectives	Study design	Dairy exposure	Method	Outcome	Results
Kelishadi, Zemel, Hashemipour, Hosseini, Mohammadifard & Pursafa (2009) Iran	21 111 scholars 6 to 18 years	To determine the long-term effect of a randomised controlled trial of a dairy-rich diet on generalised and abdominal obesity, as well as on the components of the metabolic syndrome, among obese and prepubescent children.	Cross-sectional study	Dairy (times/week)	6 months dairy rich diet, energy restriction, control group	BMI Z score, waist circumference	BMI and waist circumference significantly lower in dairy-rich group compared with control group at 3 year follow up.
Eriksson & Strandvik (2010) Sweden	114 children 8 years	To analyse food intake and the relationship to anthropometry at the age of 8 years.	Cohort study	Milk (times/ week)	FFQ and 24-hr recall	BMI (IOTF) (Cole <i>et al</i> 2000)	Significantly lower BMI in those that drank full cream milk regularly (versus those who drank low fat or skim milk), compared to those who seldom/never drank full cream milk.
Bradlee, Singer, Qureshi & Moore (2010) USA	3761 5 to 11 years	To explore mean food group intakes associated with central obesity anthropometry among children and adolescents enrolled in the NHANES.	Longitudinal	Dairy (1 serving = 1 cup/ 240 ml milk/yoghurt, 1,5 oz natural cheese, 2 oz processed cheese).	NHANES 1988-1994, 1999-2002	Waist circumference, sum of skin fold thicknesses	Dairy products were inversely associated with central body fat amongst adolescents only.

Table 2.5: Continued

Researchers	Sample	Objectives	Study design	Dairy exposure	Method	Outcome	Results
Wiley (2010) USA	2526 5 to 10 years	To test the hypothesis that milk or total dairy product consumption is associated with higher BMI percentiles.	Longitudinal	Milk (in grams) Dairy (in kilojoules)	NHANES 1999-2004	BMI percentile	No relationship between dairy intake and BMI.
Abreu, Santos, Moreira, Santos, Vale, Soares-Miranda, Mota, Moreira (2012) Portugal	1001 15 to 18 years	To examine the independent association between dairy product intake, body mass index (BMI), and percentage body fat (%BF) in adolescents.	Cross sectional	Milk (250 ml), yoghurt (200 g), cheese (40 g)	Self-administered FFQ	BMI %BF	Milk negatively associated with BMI and %BF only in girls. No significant association between yoghurt and cheese, and BMI or %BF
Danyliw, Vatanparast, Nikpartow & Whiting (2012) Canada	3613 6 to 11 years	To examine the relationship between beverage intake patterns and overweight and obesity among Canadian children.	Cross-sectional study	Milk (in grams)	24-hr diet recall	BMI percentile	No significant association between milk intake and BMI.

Table 2.5: Continued

Researchers	Sample	Objectives	Study design	Dairy exposure	Method	Outcome	Results
Lin, Tarrant, Hui, Kwok, Lam, Leung, Schooling (2012) Canada	5968 11 to 13 years	To examine the associations of milk or other dairy product consumption with adolescent obesity.	Longitudinal	Milk/milk powder, yoghurt, cheese	Self-administered FFQ	BMI (Z score) Waist-to-hip ratio	BMI (Z score) Waist-to-hip ratio
Fayet, Ridges, Wright & Petocz, (2013) Australia	896 5 to 8 years	To compare the nutrient intake, likelihood of meeting calcium requirement, and anthropometric measurements among Australian children on the basis of milk intake patterns, with a focus on milk drinking.	Cross-sectional study	Milk (in grams)	2 day diet recall	BMI, waist circumference	No significant association between milk intake and BMI.
Gunther, Branscum, Kennel, Klein, Monnat & Kaye (2013) USA	101 8 to 13 years	To assess the relationships of dairy product and calcium intake with BMI percentiles in children.	Cross-sectional secondary analysis of baseline data	Dairy (1 cup /240 ml equivalents per day) and calcium (mg/day)	24-hour recall	BMI percentiles	Significant inverse association between dairy intake and BMI in underweight and normal weight children. No association with overweight and obese children.

McCarron, Morris, Henry and Stanton (1984) discovered an inverse relationship between dietary calcium and body weight indirectly, when studying the effect of nutrient intake on blood pressure. Zemel (2000) then demonstrated the physiological changes that occurred in adult human adipocytes when dietary calcium was consumed in large amounts, namely decreased lipogenesis and increased lipolysis. The researchers showed that when dietary calcium intake increased, the intracellular Ca^{2+} levels dropped via suppression of calcitropic hormone activity, stimulating lipolysis and weight loss. Conversely, when a diet low in calcium was consumed, there was an increase in calcitriol levels, promoting the influx of Ca^{2+} into the cells. Raised intracellular levels of calcium stimulated lipogenesis and triglyceride accumulation in the cells, leading to weight gain and enhanced adiposity. Furthermore, Zemel *et al* (2000) suggested that elevations in intracellular Ca^{2+} may also be responsible for insulin resistance and hypertension, with the beneficial effects of calcium noted when caloric intake is restricted (Zemel, 2003). However, supplemental sources of calcium were not found to have a similar anti-obesity effect as the calcium from dairy sources, possibly due to the lack of other ingredients such as bioactive compounds found in milk that may act on adipocyte metabolism (Zemel 2002).

In light of Zemel's (2000) laboratory findings, further studies were conducted reanalysing data collected in previous studies to see if an association between milk, or dairy, and body weight, or body fat, could be identified. The studies reviewed differed from one another in multiple ways, and it was impossible to demonstrate a definitive outcome, with no clear consensus on the relationship between dairy products and BMI reached.

Many inconsistencies were noted amongst the studies reviewed. There was a wide range in age of subjects studied, as well as different ethnic groups from diverse, socioeconomic backgrounds. Not all studies included subjects with a range of BMI values, with one study only including participants of a normal weight (Forshee & Storey 2003). It has been suggested that the impact of supplementing with dairy may only be noticeable in overweight or obese individuals who have a regularly low calcium intake (less than 600 mg per day) (Zemel *et al* 2004). The study design varied from observational, longitudinal, or case control, and the methodology for collecting dietary information was either in the form of a 24-hour recall, food frequency questionnaire (either self-administered or interviewer-administered), food record, or a combination of two of these methods. Either total milk intake, or total dairy intake was measured, with the understanding of what constitutes total dairy differing amongst studies.

Some researchers chose to include high fat, high-energy dairy-based desserts, milkshakes and sundaes in addition to yoghurt, cheese and mixed meals (Phillips *et al* 2003). These energy dense food items may increase BMI and body fat stores, which is why it is necessary that energy intake be adjusted for (Louie, Flood, Hector, Rangan & Gill 2011).

The measurement of total milk or total dairy intake also differed amongst the studies, with the exposure variable expressed either in 'millilitres', 'grams' or 'servings per day'. Discrepancies were also noted between the researcher's definition of a serving, with Carruth & Skinner (2001) defining a single serving as '240 ml milk' (Carruth & Skinner 2001), Dixon *et al* (2005) and Moore *et al* (2006) using '1 cup of milk', and Johnson *et al* (2007) using '180g' as a single serving (Louie *et al* 2011). This makes it difficult to compare results when the serving size of dairy products differs.

The anthropometric measurement outcomes varied, with either BMI, body fat in grams, body fat percentage, or waist circumference investigated. Statistical tests carried out differed, and confounding factors such as energy intake, physical activity of subjects, screen time, and parental BMI were not always considered. Forshee & Storey (2003), Moreira *et al* (2005) and Abreu *et al* (2012) demonstrated an inverse relationship between dietary calcium and BMI only in girls. Moreira *et al* (2005) noted that the male subjects were much more physically active than the female subjects, and because males have a lower body fat percentage than females, it was suggested that dietary calcium may have had little or no effect on the boys, as they had much less body fat to show a change in body composition. The duration for follow up of the studies also varied.

Some study limitations that were observed were the accuracy of dietary recall, with the researchers discussing the risk of over- or under-reporting dietary intake (Johnson *et al* 2007; Moreira *et al* 2005; Phillips *et al* 2003). Other limitations included the lack of regulation in serving size of milk or dairy products consumed, the potential error in estimating dairy intake from mixed dishes (Dixon *et al* 2005), the accuracy of the anthropometric measurements, especially the skinfold measurements taken in children likely to be in the adiposity rebound phase (Dixon *et al* 2005), and the fact that some of the studies did not commence with the original objective of confirming whether a relationship between milk and/or dairy and BMI existed or not, but were rather reanalyses of old data from larger national surveys. Dixon *et al* (2005) suggested a potential threshold effect of calcium, with intakes ≥ 963 mg per day not showing any benefit to older children, or obese children predisposed to developing Metabolic

Syndrome (Dixon *et al* 2005). The majority of studies indicated that full cream milk may be more beneficial than low fat milk, and that milk alone was more likely to be associated with changes in weight than total dairy products (Louie *et al* 2011).

2.8 Summary

The rapid increase in the extent of paediatric overweight and obesity requires urgent attention. Calcium in milk has shown to regulate lipogenesis and lipolysis in adult human adipocytes; however, several international paediatric studies have shown inconclusive evidence on the association between milk and/or dairy on weight and body fat. Furthermore, most of these studies were performed in the USA, and their results cannot be extrapolated to other developing countries. Therefore, the need arose for a similar study to be conducted on South African children. The following chapter will discuss and support the methodology chosen for the study conducted on a subset of the paediatric population in KZN, South Africa.

CHAPTER 3: METHODOLOGY

In this chapter the following sections will be presented: the survey design and sample population; the literature supporting the methodology; the study method; the training of the fieldworkers; the pilot study, statistical analyses of the data, and ethical considerations.

3.1 Type of study

A cross-sectional observational survey was conducted to investigate the effect of dietary calcium from dairy, and the total dairy intake, on the BMI of Grade 2 learners of all race groups, from quintile 5 schools in Pietermaritzburg.

3.2 Background information to the study area

Pietermaritzburg is the capital city of KZN, and is home to several government and private schools. The government schools are graded in five quintiles, according to the perceived poverty of the school community (Department of Education 2004). Quintile 1 schools represent the poorest of the province's learners, and have limited resources. These schools rely completely on government funding to operate. No school fees are charged, and these schools are often located in the poorer communities (Department of Education 2004). With ascending order of quintile, the amount of government funding and subsidy decreases, and the cost of school fees increases, with quintile 5 schools being the most well-resourced and highest 'fee-paying' out of all the quintiles (Department of Education 2004).

Quintile 5 schools were chosen for this study as they are fee-paying schools, and well-resourced. Although the education level of the parents/guardians was not measured, it was assumed that because their children were attending a school with high fees, they would be literate, and able to afford a variety of dairy products for their children to consume.

3.3 Design of study

3.3.1 Cross sectional study

Cross sectional studies are observational in nature, whereby the researcher intends to study a representative sample by drawing on a cross section of the population (Sedgwick 2014). In contrast to a longitudinal study where subjects are observed multiple times, a cross sectional

study gathers data only once, and therefore no trends can be observed. Specific, measurable variables are gathered, without any intervention taking place (Sedgwick 2014).

Cross sectional studies are ideal for studying the prevalence of a behaviour or disease, and many different variables can be studied at a single time, with different population groups observed together (Sedgwick 2014). They are generally quick and cost effective to conduct as they usually involve a questionnaire, and a large number of participants can therefore also be included. As subjects are seen only once, there are no concerns about losing a subject to follow-up (Sedgwick 2014).

One of the disadvantages of a cross sectional study includes a non-response bias where the subjects who consented to participate in the study are different to those who did not consent to participate. The situation may then arise whereby the study is no longer representative of a cross section of the population (Sedgwick 2014). Such a disadvantage was minimised in this study by ensuring an objective study title, and encouraging all parents/guardians to participate. Another disadvantage of this type of study is that as data are collected only once, no trends or causal relationships can be concluded from the study. As this study did not aim to investigate trends in the learners dietary intake, a cross sectional design was considered suitable.

3.4 Study population and sample selection

A resource-targeting list was obtained from the Department of Education (DOE), which indicated that there were ten quintile 5 schools within the Msunduzi municipality. Each of these ten schools were contacted telephonically to determine if they met the criteria for the study. Eight quintile 5 primary schools met the study criteria to participate in this study. The study criteria included:

- i) Grade 2 learners who were seven (7) turning eight (8) years old, or were already eight (8) years old at the time of data collection.
- ii) Grade 2 learners that were representative of the four main racial groups in South Africa, namely Black African, White, Indian and Coloured.
- iii) Grade 2 learners that were enrolled at quintile 5 schools that fell under the Msunduzi Municipality in Pietermaritzburg.

The reasons for selecting the age group 7 to 8 years old to study were as follows:

- i) Data from the NFCS (1999) showed that the 7 to 8 year old age group had the lowest calcium intake compared to the other age groups surveyed, namely 1 to 3 years and 4 to 6 years old.
- ii) There is an EAR for calcium for the age group 4 to 8 years old, and therefore it was possible to determine whether their calcium intake from their dairy consumption was close to meeting the requirements for half the healthy population in their age group, considering dairy is a major source of dietary calcium.
- iii) Adiposity rebound commonly occurs between the ages of 3 to 7 years old, and is characterised by a second rise in BMI (Cole 2004). During the first year of life, average BMI levels increase rapidly (by approximately 5 kg/m²). Between the ages of 4 to 8 years old BMI levels subsequently decrease, and reach the lowest point of approximately 15 kg/m². With subsequent increasing age, BMI levels begin to rise again, plateauing at roughly 20-25 kg/m² in adulthood (Freedman, Kettel Khan, Serdula, Srinivasan & Berenson 2001). It was hypothesised that the earlier the adiposity rebound occurred, the greater the risk of obesity later on in life. It was therefore proposed that by the age of 7 to 8 years old, the adiposity rebound would have occurred, and it would be possible to flag the number of children at increased risk for obesity in adulthood. This would allow the results to recommend important dietary interventions to reduce the risk of adult obesity amongst Grade 2 learners.
- iv) Parents/guardians would be required to complete the questionnaire. Children younger than ten (10) years old are unable to accurately recall their dietary intake (Magarey, Watson, Golley, Burrows, Sutherland, McNaughton, Denney-Wilson, Campbell & Collins 2011; Rockett Wolf & Colditz 1995). Because the children in this study were younger than ten, it was postulated that having an adult complete this questionnaire, rather than a young child, would increase the accuracy of the data collected. Therefore, learners in the Grade 2 age group were an appropriate sample to study.

All eight quintile 5 schools that met the criteria were invited to participate in the study. Seven of the eight schools that met the criteria responded positively to the researcher's invitation, following an appointment with the principal/head of department. The remaining school that met the criteria did not respond to the researcher's invitation to join the study. Following the initial appointment with the principal/head of department, three schools that met the criteria for study participation did not respond to the researcher's repeated attempts to contact them.

Ultimately, the principals/heads of departments from four out of the seven schools that responded gave informed consent for their school's participation (Appendix C, p137). Appointments were then set up with the relevant Grade 2 teachers to inform them of the study, obtain their informed consent (Appendix D, p140) and discuss the role they would play in the study.

According to the latest population census data from Stats SA (2011), there are 17281 (86.5%) Black Africans, 1474 (7.4%) Indians, 709 (3.6%) Whites and 506 (2.5%) Coloureds in the age category 7 to 8 years old residing in the Msunduzi municipality. This study was conducted in schools where all four of the main racial groups in South Africa were represented. Most of the participating schools had four Grade 2 classes, with a range of 12-33 learners in each class. This amounted to approximately 377 eligible participants. Non-probability sampling, which involved purposive sampling, was used in the study as specific subject criteria had to be met.

3.5 Measurement of dietary intake

Recording a child's dietary intake has its challenges with many factors to consider, such as the age of the child, their cognitive ability and literacy skills, and the respondent burden of the chosen method (Magarey *et al* 2011). No single dietary assessment tool can adequately recall an accurate dietary intake under all conditions (Magarey *et al* 2011; Huybrechts, De Bacquer, Matthys, De Backer & De Henauw 2006). Therefore, the final chosen methodology is usually a compromise between accurate data collection, respondent burden and available resources (Magarey *et al* 2011). Measuring the diets of school-going children can be imprecise due to the reliance on the child's, or parents' recall of dietary intake (McPherson, Hoelscher, Alexander, Scanlon & Serdula 2000). Children and adults may overestimate portion sizes, or, in the case of overweight individuals, the dietary intake may be underestimated (Magarey *et al* 2011).

The following methods are useful to determine dietary intake:

3.5.1 Weighted food record

The weighted food record is considered the most accurate method, whereby the participants are required to record the amount or weight of all food items and beverages consumed (Thompson, Subar, Loria, Reedy & Baranowski 2010). It does not rely on memory recall, and training of the participants can be done in a group session, thus reducing the time required for

training (Magarey *et al* 2011). Furthermore, errors in portion sizes are reduced by measuring food and beverage intake (Thompson *et al* 2010). However, the burden on the subjects is high as it is time consuming (Bertoli, Petroni, Paglaito, Mora, Weber, Chiumello & Testolin 2005), literacy and numeracy skills are required, and it is difficult to accurately report any food items eaten outside of the home (Magarey *et al* 2011).

3.5.2 24-hour recall

The 24-hour recall is an estimate of all foods and beverages consumed in the previous 24 hours. Interviewers need to be trained on using the tool in order to ensure the dietary recall is more accurate, and several days need to be reported on in order to obtain the usual intake of an individual (Magarey *et al* 2011). A detailed description of each item needs to be supplied, including brand names, portion sizes, and methods of preparation. Due to the detail required, an estimate of the total day's nutrient intake can be calculated (McPherson *et al* 2000). The advantages of the 24-hour recall method are that it is inexpensive, a large number of participants can be included if there are sufficient resources available, and the respondent burden on the subject is low (Johnson, Driscoll & Goran 1996). The participant does not require literacy or numeracy skills to recall their intake (Magarey *et al* 2011).

One of the disadvantages of the 24-hour recall method is that if only one day is considered, it may not be truly reflective of the regular intake, and multiple 24-hour recalls are necessary to gauge a more accurate dietary intake (Magarey *et al* 2011). If the study has time limitations and limited resources, it becomes difficult for both the interviewer and participant to arrange suitable times for multiple interviews, especially if a large number of participants is anticipated. Furthermore, a high variation may be reported between the different days recalled, and it also does not reflect seasonal variation in the diet (Nöthlings, Hoffmann, Bergmann & Boeing 2007). The sources of error in 24-hour recalls are often similar to those found in food frequency questionnaires (FFQ), such as reliance on memory, conceptualizing portion sizes from served items, and overestimation of reported diet (Cade *et al* 2002). Moore *et al* (2007) suggested the 24-hour recall may underestimate calcium intake, as they noted the energy intakes reported in the 24-hour recall were 10-35% less than the subject's requirements, when they compared calcium intake from a FFQ to calcium intake from a 24-hour recall.

3.5.3 Food frequency questionnaire

A FFQ asks subjects to indicate the frequency of consumption of particular food items, and in the case of a semi-quantitative FFQ, the portion size consumed. Parrish, Marshall, Krebs, Rewers & Norris (2003) reported that FFQs can be efficiently used in large epidemiological studies to determine usual habitual dietary intake spanning a duration of one month to one year. The usual dietary intake measured can then be used to rank an individual's food consumption according to usual intake (Magarey *et al* 2011), and is useful in predicting health outcomes (McPherson *et al* 2000).

The literature supporting the FFQ as an acceptable dietary recall tool will be discussed in the following section.

3.5.4 Literature supporting the semi-quantitative FFQ

There are many advantages to using a FFQ. As FFQ's are usually self-administered, a highly trained interviewer is not necessarily required, making them a cost effective tool (Thompson *et al* 2010). Studies involving a large number of subjects from a widespread geographical area have sent out FFQ via the post, with instruction on how to complete the FFQ (Lin *et al* 2012; Berkey 2005; Philips 2003). Labonté, Cyr, Baril-Gravel & Lamarche (2012) studied the validity of a web-FFQ, whereby the subjects were contacted electronically, and asked to complete a web-based FFQ, which was validated against an interviewer-administered FFQ and a 3 day record (Labonté *et al* 2012). The researchers concluded that the electronic tool showed good reproducibility and reasonable validity for assessing dietary intake. For self-administered questionnaires, it is recommended that questions be closed rather than open, to reduce coding time and transcription errors, and limit the number of questionnaires that need to be rejected due to inaccurate interpretation of the question (Cade *et al* 2002). If open questions are asked, it is preferable to make use of highly trained fieldworkers who can ensure the questions are answered effectively in one-on-one interviews (Cade *et al* 2002). As children experience difficulty in accurately recalling previous food intake, parental assistance is preferred if the recall is over a long period of time. Another advantage is that a minimal amount of time is required to complete the FFQ (Parrish *et al* 2003) and a larger number of participants can be included to increase the statistical significance. Anonymity of the subjects may enhance honest reporting. There is a lower workload entering the data (Huybrechts *et al* 2006), fewer expenses

are incurred (Nöthlings *et al* 2007), and it gives an adequate estimate of the subject's average consumption over a set period of time.

The disadvantages of using a FFQ to collect data on dietary intake include inaccurate recall, inability to probe further by asking the participant questions for clarification, literacy and numeracy skills are required if it is self-completed (Magarey *et al* 2011), and overestimation of portion size consumed (Parrish *et al* 2003). The risk of overestimating portion sizes is enhanced if adult portions are used to estimate children's intake (McPherson *et al* 2000). In a study by Jenner, Neylon, Croft, Beilin & Vandogen (1989), a comparison of the dietary recall efficiency between parents and their 11 to 12 year old children showed that children overestimated their consumption far greater than their parents did. Another disadvantage is the length of time taken by the researcher to develop and validate the FFQ, and then enter the data for analysis (Magarey *et al* 2011).

Taylor and Goulding (1998) assessed the validity of a short FFQ in children aged 3 to 6 years old. The calcium intake from a 4-day diet record was compared to the calcium intake recorded on a 35-item FFQ. The results showed that the FFQ tended to overestimate calcium intake and was not appropriate for determining individual calcium intakes. However, the predictive ability of the FFQ to identify children with calcium intakes less than 800 mg per day was good (79%). They concluded that the FFQ has merit in estimating calcium intake in relation to bone health in young children.

In a study by Huybrechts *et al* (2006), a semi-quantitative FFQ tended to underestimate calcium intakes in preschool children, but showed a reasonably good ability to classify the children into extremes of calcium intake (Huybrechts *et al* 2006). Bertoli *et al* (2005) showed a good correlation between a weighted 7-day food record and FFQ for 6 to 10 year old Italian children and 16 to 20 year old Italian adolescents. They reported the calcium intake measured in the FFQ to be 48% more than in the weighted food record, but suggested that respondents had included high calcium foods in the FFQ, and failed to eat them on the day the weighted food record was conducted. It was also noted that the long list of food items and food groups in the questionnaire may have caused overestimation of nutrient intake. Bertoli *et al* (2005) concluded that the correlation between the two dietary assessment methods was agreeable for calcium, but there was a risk that the calcium intake on the questionnaire may be 144 mg per day lower or 840 mg per day higher than the amount recorded in the food weighted record. Although the FFQ could not accurately estimate calcium intake in children and adolescents, it was a very

useful tool for classifying them into low, medium and high calcium intake categories (Bertoli *et al* 2005).

Moore, Braid, Falk & Klentrou (2007) compared the calcium intake obtained from a FFQ to the calcium values obtained from a 24-hour recall in male children and adolescents. Their results showed that the dietary calcium intake obtained from the FFQ was significantly higher than the calcium from the 24-hour recall. Male children consumed 1576 mg (\pm 1101 mg) calcium according to the FFQ, and 1003 mg (\pm 543 mg) according to the 24-hour recall, whilst male adolescents consumed 1873 mg (\pm 739 mg) calcium from the FFQ, versus 1159 mg (\pm 515 mg) calcium from the 24-hour recall. This is congruent with previous studies where FFQ was found to overestimate calcium intake. The researchers also suggested one of the possible reasons for FFQ overestimation is that the long list of food items presented to the subjects compelled them to choose items, even though they may not regularly consume them (Moore *et al* 2007). Zemel, Carey, Paulhamus, Stallings & Ittenbach (2010) conducted a study to determine the validity and reliability of the 41-food item “Calcium Counts FFQ” amongst 139 healthy 7 to 10 year old American children. The subjects’ calcium intake from the FFQ (1192 mg per day, SD 537) was compared to a 7-day weighed food record (885 mg per day, SD 347). The researchers found that although calcium intake from the FFQ was approximately 300 mg higher ($p < 0.01$) than the calcium intake from the 7-day weighed food records, the FFQ was found to successfully identify children with low calcium intakes, and they concluded the FFQ provided a valid and reliable estimation of calcium intake (Zemel *et al* 2010).

As it can be seen from the three methods that have been presented, all standard dietary assessment tools are subject to bias and error (Kristal, Andrilla, Koepsell, Diehr & Cheadle 1998), and the final decision on which tool to use must be determined by the situation, and study characteristics. The final chosen methodology is usually a compromise between accurate data collection, respondent burden and available resources (Magarey *et al* 2011). From the literature reviewed, the FFQ has proven to be a sound tool in estimating calcium intake. It can successfully rank individuals into low, medium and high calcium intakes, and can identify those children at risk of low calcium intakes. For the purpose of this study, a semi-quantitative FFQ was selected as the most appropriate method for determining calcium and dairy intake, due to low respondent burden, time constraints and cost limitations. The disadvantages of using a FFQ were considered, and the FFQ used in this study was designed bearing in mind the previously mentioned drawbacks. In the letter sent to them, the parents/guardians were

informed that the FFQ was anonymous. As the FFQ was to be self-administered, clear instructions on how to complete it were given, and closed questions were asked in order to reduce errors. The number of food items and related questions were limited to the absolute minimum in order to prevent respondent fatigue and the possibility of overestimation as discussed above.

In order to maintain the integrity of a larger sample size, it was decided not to make use of a 24-hour recall. An accurate and reliable 24-hour recall needs to be interviewer-administered, and the time and financial resources required to hire additional qualified fieldworkers to conduct multiple interviews on all the participants was not available. It was also a concern that if the participant was not able to remain 'anonymous', as they would have if a FFQ was used on its own, there was a risk that they may have adjusted their learners reported intake to meet their perceived perceptions of the study's requirements. This was particularly of concern in this study because the focus was specifically on dairy intake.

3.6 Study method and data collection

The collection of data followed the procedure outlined below:

- i) Necessary ethical considerations were obtained, to be discussed in section 3.15.
- ii) The FFQ questionnaire (Appendix E, p143) was designed by the researcher, and the structure and wording of the FFQ was validated by a statistician. The nutritionally related content of the FFQ was validated by an international researcher (Abreu *et al* 2012).
- iii) The pilot study (to be discussed in section 3.9) was carried out.
- iv) Fieldworker training was conducted.
- v) All quintile 5 schools that met the study criteria were contacted and invited to participate in the main study.
- vi) Once informed consent had been obtained from the principal/head of department (Appendix C, p137) and Grade 2 teachers (Appendix D, p140), a letter was sent to all parents/guardians of Grade 2 learners informing them of the details of the study, and inviting them to participate (Appendix G, p161).
- vii) The informed consent forms signed by the parent/guardians were accepted as proof that the questionnaires were completed by the intended parent/guardian. By signing the informed consent form, the parent/guardian acknowledged that participation in the study

was completely voluntary, and they could withdraw at any time without any penalties incurred.

viii) The main study was conducted at the four schools that agreed to participate.

ix) The data from the FFQ were entered onto the SPSS Statistics Version 24 package. Once the data had been entered twice, and errors corrected, the data were analysed.

3.7 Measuring instruments used

3.7.1 Anthropometric measurements

All participating learners were initially asked for their assent before their weight and height was measured.

3.7.1.1 Procedure for measuring weight

A SECA digital scale was used to take the learner's weight, using the following method:

- The SECA digital scale was placed on a flat, even surface in a venue at the participating school.
- The scale was calibrated using a 5 kg weight.
- The learners were asked to remove any heavy clothing, such as jerseys and blazers, in addition to their school shoes and socks.
- The fieldworker switched the scale on and waited for it to read 0.00kg.
- The learner was asked to step on the scale and stand in the centre of it, with their weight evenly distributed over both feet, and arms resting at their sides.
- The learner was asked to remain still and the final reading, in kilograms to the nearest one decimal place, was recorded on the learner's questionnaire form (Gunther *et al* 2013; Phillips *et al* 2003; Carruth & Skinner 2001).
- The learner was asked to step off the scale, and the procedure was repeated a further two times. The three weight readings were averaged to obtain a final reading.

3.7.1.2 Procedure for measuring height

A SECA stadiometer with a sliding headpiece was used to measure the learner's height, using the following method:

- The SECA stadiometer was placed on a flat, even surface with the height stick in contact with a wall.
- The learner was asked to remove their school shoes and socks.
- If their hair was tied up on their head, they were asked to untie it so as not to obstruct measurements taken. If they were unable to untie their hair, a knitting needle was inserted through their hair, and used to measure their true height.
- The learner was asked to step onto the stadiometer, and turn around to face the fieldworker.
- The learner was asked to stand up straight, with arms resting at their sides, heels together, and head in the Frankfort horizontal plane.
- The fieldworker checked that the back of the learners' head, shoulders, bottom and heels were in contact with the measuring stick.
- The learner was asked to inhale deeply, and hold their breath whilst the measurement was taken.
- The headpiece was lowered so as to place firm pressure on the top of the learner's head.
- The height measure was read out aloud in centimetres to the nearest one decimal place (Gunther *et al* 2013; Phillips *et al* 2003; Carruth & Skinner 2001), and recorded on the learner's questionnaire.
- The learner was instructed to exhale, the headpiece was raised and the learner was asked to step off the stadiometer.
- The procedure was repeated a further two times, and the three height measurements were averaged to obtain a final measurement.

3.7.2 Semi-quantitative FFQ

The FFQ (Appendix E, p143) was divided into three separate sections: the first section (on page one of the questionnaire) recorded the learners' code, and their anthropometric measurements; namely weight, height and BMI. The second section enquired about the learners' age, gender, ethnic background, any medical conditions, level of physical activity and time spent being physically active, and hours spent in sedentary behaviour. The third section

focussed on the consumption of milk and dairy products, namely hot milk drinks (Tea, Coffee, Milo, Horlicks, Hot chocolate), flavoured milk drinks (Squillo's, Nesquick, Super M, Steri Stumpi), yoghurt, drinking yoghurt, maas, cheese, and dairy based desserts (icecream, custard, frozen yoghurt and other dairy-based dessert). Closed questions were asked, as per the literature recommendations, regarding the frequency of consumption of these products, and the amount consumed in a single sitting. There were nine response options which the parents/guardians could select: "less than once a week", "once a week", "twice a week", "three times a week", "four times a week", "five times a week", "six times a week", "everyday", and "more than once a day".

Closed questions were asked, as recommended by the literature for self-administered FFQ (Thompson *et al* 2010; Cade *et al* 2002). Portion sizes were stipulated so that absolute nutrient intake could be calculated (Cade *et al* 2002). Respondents were able to select from a variety of portion sizes, relevant to the packaging in which the dairy product was sold in. If none of the options were applicable, space was given for the respondent to indicate another portion size. The learners' dairy intake was then converted into standard servings of milk, flavoured milk, yoghurt, maas, cheese and dairy based desserts. This information was necessary to determine the average number of dairy servings per day, and total calcium intake from dairy. From this, it could be determined whether the learners were meeting their dairy and calcium requirements, and their dairy and calcium intake could be statistically extrapolated to their relevant BMI.

In order to assist the parent/guardian with the self-administration process, detailed instructions on how to complete the questionnaire as accurately and honestly as possible were provided on the questionnaire, and the parents/guardians were asked to recall the milk and dairy intake of their Grade 2 learner over the past 12 months. The researchers contact details were provided in the informed consent form, should any of the parents/guardians have further queries.

The FFQ was emailed to several international researchers who had conducted similar studies on school going children, to both validate the questionnaire and obtain any additional comments regarding the structure and content of the FFQ. Only one researcher responded (Abreu *et al* 2012) who, together with her research team, had conducted a study amongst Portuguese adolescents, published in 2012. The comments received were incorporated into the FFQ.

3.8 Fieldworker recruitment and training

Four field workers were recruited to assist with collecting anthropometric measurements. The field workers were current third year BSc Dietetic students (2016), who had some previous exposure and training in taking anthropometric measurements. The fieldworkers were contacted and attended a training session in the Dietetics department at UKZN, prior to collecting anthropometric data.

At the training session, the fieldworkers were informed of the purpose of the study. They were given an anthropometric training booklet to refer to, which included the aims and objectives of the anthropometric training session, and a step-by-step guide on taking correct weight and height measurements. Potential measurement errors to be avoided were also discussed.

SECA digital scales and portable height sticks were made available for the practical training session, where the researcher first demonstrated the correct technique for taking weights and heights, and then the fieldworkers were given the opportunity to practice under supervision. Once the researcher was satisfied that the fieldworkers had mastered the correct technique, they were theoretically tested on the correct technique, and errors to avoid when taking and recording anthropometric measurements.

3.9 Pilot study

A pilot study is a preliminary study conducted on a similar subject group to determine the feasibility of the study, and address any adverse events prior to commencing data collection. Prior to the pilot study commencing, permission was obtained from the DOE to perform the study (Appendix F, p160). This letter of permission was distributed to all schools that met the inclusion criteria when they were invited to participate in the study.

The pilot study was conducted in May/June 2016 at Athlone Primary School in Wembley, Pietermaritzburg as a means of detecting flaws in the questionnaire or anthropometric measurements. While Athlone Primary School met the criteria for inclusion in the study, it did not fall within the Msunduzi Municipality. There were three Grade 2 classes at Athlone Primary School, with approximately 28 learners in each class. Informed consent letters were sent to the parent/guardian of every Grade 2 learner. Of the potential 84 learners, 26 parents/guardians consented to participating in the pilot study, and were sent the FFQ with clear instructions on

how to complete it provided within the FFQ. The researcher's contact details were also provided in the informed consent letter to allow the parents/guardians to clarify any queries. Once the completed FFQ forms were returned to school, the researcher made an appointment with the school to visit with the fieldworkers and take the anthropometric measurements.

The following changes were made to the study method and design following the pilot study.

- 1) The duration of "physical activity (in minutes)" was expanded to include "per day".
- 2) The category "less than once a week" was introduced when indicating the frequency of product consumption. In the pilot study, the lowest frequency offered was "once a week".
- 3) A question on the intake, amount and frequency of plain milk consumption was added.

During the pilot study, the researcher noted that the response rate was very poor in that only 26 out of a potential 84 questionnaires were completed. It was then decided that an incentive should be offered to potentially increase participation in the main study. Galea & Tracy (2007) discussed concerns regarding the declining participation rates in clinical studies, with the researchers highlighting four main reasons for these declines: the emergence of an 'over-surveyed population' due to the increase in tele-marketing surveys; general decline in volunteerism of all kinds; a lack of willingness to participate in a study if the topic does not directly affect or interest the participants; and the demands made by the study on the participant's time ie. response burden. In an attempt to improve study participation it was observed that monetary incentives assist participation. Singer, Groves, Dillman, Eltinger & Little (2002) indicated that monetary incentives may encourage participants from lower household incomes and education levels, in addition to participants from higher income households, as they feel their time has been compensated for. Galea & Tracy (2007) report that creativity in study design may need to be employed to increase study participation. In a study conducted by van der Horst, Oenema, van de Looij-Jansen & Brug (2008), school children based in the Netherlands were offered a key holder as an incentive to participate in the ENDORSE study, which looked at environmental determinants of obesity related behaviours. Galea & Tracy (2007) further stated that extreme efforts at enrolling more participants may be unethical and lead to coercion.

Based on these findings a R500 mall voucher was offered as a lucky draw to all completed FFQ. The anonymous codes of the learners were put into a hat, and the winner of the voucher was randomly selected. The voucher was not awarded based on the type of information

recorded in the questionnaire, as the participants were advised that there were no right or wrong answers. As the parents/guardians were informed that participation was voluntary, and they may withdraw from the study at any time without any penalties being incurred, the researcher was confident that there was no coercion to participate in the study.

3.10 Data collection

An appointment was made with the Principal of the school to explain the study aims and objectives, and obtain consent (Appendix C, p137). Within the same week the researcher met with the Grade 2 teachers to explain the purpose of the study, obtain their consent (Appendix D, p140) and discuss the role the teachers would play in assisting with the distribution of the informed consent forms (Appendix G, p161), and the anonymous coded FFQ (Appendix E, p143) to the learner's parents/guardians.

Informed consent forms for the parents/guardians (Appendix G, p161) were given to the teachers to send home with the learners, and those parents/guardians that gave consent to participate in the study then received a coded FFQ to complete. The parents/guardians were asked to complete the information within a week of receiving it. Once all forms had been returned to the relevant Grade 2 teacher, the school contacted the researcher and an appointment was made for the researcher to take the anthropometric measurements.

A venue at the participating school was set aside for the anthropometric measurements, and each Grade 2 class arrived with their completed, coded FFQ. Their anthropometric measurements were taken, as per the method outlined in 3.7.1.1 and 3.7.1.2.

3.11 Data capturing and processing

Data from the FFQ were entered into SPSS Statistics Version 24 package twice, to ensure that no errors had occurred during data entry. The WHO Z-score, and IOTF BMI cut offs points for overweight and obesity were used to determine how many overweight and obese learners participated in the study. The WHO Z-score, and IOTF BMI cut off points for thinness were used to indicate how many wasted/thin and normal BMI learners participated in the study.

Milk and dairy products were classified into appropriate serving sizes (Table 3.1). Dairy intake, represented as servings per week, was determined and divided over seven days to determine the number of dairy servings per day.

Table 3.1: Serving sizes for milk and dairy products, calculated to provide 300 mg calcium (Milk SA 2016)

Dairy product	Single serving size
Milk	250 ml
Flavoured milk	250 ml
Yoghurt	200 ml
Drinking yoghurt	200 ml
Maas	200 ml
Custard	275 ml
Ice-cream	235 ml
Cheese, grated	1/3 cup or 40g
Cheese, sliced	40 g
Processed cheese	2-3 portions or 40 g
Cottage cheese	275 g

Daily calcium intake was determined by multiplying the total amount of each dairy item consumed per day, by its calcium content (per 100 g product) (Table 3.2).

Table 3.2: Calcium content of dairy products per 100 g/ml (Milk SA 2016; Danone Southern Africa 2017)

Dairy product	Calcium (mg)
Full cream milk, fresh	120 mg
Full cream UHT milk	117 mg
Full cream commercial milk, flavoured	112 mg
Low fat milk, fresh	122 mg
Low fat UHT milk	141 mg
Low fat commercial flavoured milk	115 mg
Skim milk, fresh	123 mg
Skim UHT milk	138 mg
Plain yoghurt, low fat	149 mg
Fruit yoghurt, low fat	145 mg
Fruit yoghurt, fat free	152 mg
Drinking yoghurt	142 mg
Maas	162 mg
Gouda cheese	806 mg
Cheddar cheese	788 mg
Mozarella cheese	505 mg
Feta cheese	386 mg
Full fat processed cheese	570 mg
Medium fat processed cheese	562 mg
Cream cheese	98 mg
Cottage cheese (full fat)	111 mg
Cottage cheese (fat free)	120 mg
Custard	102 mg
Ice-cream	124 mg
Ultramel Delight	105 mg

3.12 Statistical analysis of data

The following statistical tests were conducted:

- A Chi-square test of independence was carried out to determine if a significant association between gender and BMI, and race and BMI existed.
- A Kruskal Wallis test was conducted to determine if a significant association between age and BMI existed.
- A Mann Whitney test was conducted to determine if dairy and calcium intake differed amongst gender and race.
- A one-sample t-test was conducted to determine if the FFQ calcium was significantly less than the recommended EAR of 800 mg calcium per day.

- A Pearson correlation was employed to determine if a linear relationship existed between age and the corresponding calcium intake, and the EAR for calcium.
- The Independent Samples Test was conducted to determine if there was any significant difference between gender and calcium intake, when comparing dietary calcium intake to the EAR for calcium.
- ANOVA analysis was employed to determine if any particular race group had a greater calcium intake, and were more likely to meet the EAR for calcium.
- A one-sample t-test analysis was used to determine if the number of dairy servings of dairy was significantly lower than the recommended three servings per day.
- Regression analysis was utilized to compare the FFQ calcium intake with BMI.
- Regression analysis was employed to determine if a significant difference existed between the two genders' BMI and FFQ calcium.
- Regression analysis was also conducted to determine if there was a significant difference between the different race groups FFQ calcium and their BMI.
- Regression analysis was again used when total dairy intake and BMI was considered, according to the different genders and race groups.
- Pearson correlation was employed to determine if drinking either full cream milk, or low fat milk, had any significant impact on the learners' BMI.
- A Pearson correlation analysis was conducted to determine if a relationship between dairy intake and SSBs existed.
- A Likert scale, and a one-sample t-test was applied to determine which options significantly reduced the learners' ability to consume adequate amounts of calcium and dairy on a daily basis.

The objectives of the study, the variables required for analysis of the data, and the statistical tests carried out are presented in Table 3.3. A p value <0.05 was considered statistically significant.

Table 3.3: Analysis of data

Objectives	Variables required for the analysis	Statistical tests
To determine the BMI of Grade 2 learners in Pietermaritzburg	<ul style="list-style-type: none"> • Weight (in kg) • Height (in m²) 	<ul style="list-style-type: none"> • Descriptive statistics • Cross tabulation (gender and race) • Chi square test of independence (gender and race) • Kruskal Wallis test (age)
To determine the intake of dietary calcium from dairy, along with the total intake of dairy, in Grade 2 learners in Pietermaritzburg.	<ul style="list-style-type: none"> • FFQ calcium • Total dairy intake in grams or millilitres per day (obtained from the FFQ). 	<ul style="list-style-type: none"> • Descriptive statistics • Mann Whitney (gender and race) • Pearson correlation (age) • Paired samples t-test
To determine if the Grade 2 learners are meeting their dairy and calcium requirements.	<ul style="list-style-type: none"> • Calcium (mg per day) • Dairy intake (servings per day) • EAR for calcium 	<ul style="list-style-type: none"> • Descriptive statistics • One sample t-test • ANOVA • Pearson correlation • Independent Samples test
To determine whether there is a relationship between the dietary calcium (from dairy) and/or total dairy intake, and the BMI of Grade 2 learners in Pietermaritzburg.	<ul style="list-style-type: none"> • BMI • Calcium intake (mg per day) (FFQ) • Dairy intake (servings per day) 	<ul style="list-style-type: none"> • Regression analysis • ANOVA • Pearson correlation
To determine possible barriers to dairy intake in Grade 2 learners in Pietermaritzburg.	<ul style="list-style-type: none"> • Barriers to dairy consumption in questionnaire (Likert scale) 	<ul style="list-style-type: none"> • One sample t-test to test if the average agreement is <3 (disagreement) or > 3 (agreement) • Pearson correlation

3.13 Reliability and validity of data

In order to ensure the study results were accurate, it was necessary to ensure that the process of collecting data was reliable and valid. Reliability can be defined as the “degree to which an assessment tool produces stable and repeatable results” (Golafshani 2003), or its ability to replicate the same result on several occasions (Magarey *et al* 2011). The parents/guardians were contacted by a standardised letter informing them of the study, thus ensuring that everyone received the same information. As previously mentioned, the learners were attending quintile 5 schools, and so it was assumed the parents/guardians were adequately literate to understand the food frequency questions and record their learner’s intake. It was also assumed that the parents/guardians signing the informed consent, completed the FFQ. The FFQ was piloted to determine any errors in reliability. The appropriate changes were made prior to the main study (pilot study, section 3.9). The scales were calibrated at each school visit, thus ensuring accurate weight measurements.

Validity can be defined as “the degree to which the survey method can estimate the true dietary intake” (Johansson 2006), or “the accuracy of a measure, or how close to the truth it is” (Magarey *et al* 2011). To ensure the questionnaires were meeting the objectives of the measurements, the content of the FFQ was validated by an international researcher who had conducted a similar study (Abreu *et al* 2012), and the structure and wording of the FFQ was validated by a statistician. Each time the structure or wording of the FFQ changed, it was revalidated. The researcher trained the fieldworkers on the correct method for taking anthropometric measurements, ensuring that valid weights and heights were obtained.

3.14 Reduction of bias

During the course of research, bias can occur at many different stages during the methodology, data collection, analysis and reporting of results. Bias is introduced when the emotions, personal beliefs, and behavioural orientations of the researcher, fieldworkers and subjects are allowed to influence the course of research. In order to obtain accurate and objective results, it is essential that bias in all forms be minimised (Dovidio, Gaertner, Stewart, Esses, ten Vergert & Hodson 2004).

During the course of the study bias was introduced in that participation was voluntary, and parents/guardians interested in health and diet may have been more inclined to respond, than

those who were not health conscious. In an attempt to recruit a wide variety of participants, thus making the sample more representative, a mall voucher was offered as an incentive, in the form of a lucky draw.

In order to reduce any further bias, the following steps were taken:

- The FFQ was coded to ensure anonymity.
- Clear instructions that were simply worded were given in the FFQ, so as not to mislead or confuse the respondents.
- Closed questions were asked in the FFQ, so as not to lead the respondent.
- The researcher informed the parents/guardians in the Informed Consent letter (Appendix G, p161), that there were no “right” or “wrong” answers to the questions posed to them, therefore potentially minimizing bias and dishonesty.
- The questions in the FFQ were worded in a neutral manner, with no positive or negative wording employed (Schriesheim & Hill 1981).
- The lucky draw prize of a mall voucher was randomly selected, and not based on the answers given in the FFQ.
- The researcher trained all fieldworkers together, and they were tested on their knowledge and practical ability to correctly take anthropometric measurements prior to the study commencing.
- The fieldworkers were asked to remain objective throughout the anthropometric assessment, and the researcher recorded all data accurately.

3.15 Ethical considerations

The DOE was contacted for permission to conduct the study within the Msunduzi municipality of Pietermaritzburg, and permission was granted (Appendix F, p161). Ethics approval for the study was applied for, and granted by the Biomedical Research Ethics Committee, Ref BE: 275/16 (Appendix H, p164). An informed consent form was drawn up for all role players involved in the study- this included a separate informed consent form for the Principal of the participating school (Appendix C, p137), the Grade 2 teachers whose classes were involved in the study (Appendix D, p140), and the parents/guardians of the Grade 2 learners (Appendix G, p161). In the informed consent form it was made clear that the study was anonymous, and participation in the study was voluntary, with the participant able to withdraw at any time

without any negative consequences. The questionnaires were stored in a locked office, with only the researcher having access to the information.

3.16 Summary

This chapter outlined the reasons supporting the chosen methodology, including evidence from the literature. Background information to the sample population was given, and the process of data collection was explained. Efforts to reduce bias and ensure valid and reliable results were discussed. The following chapter will present the results of the statistical analyses of the data.

CHAPTER 4: RESULTS

This chapter will discuss the results of the study. A description of the study sample population will be provided, along with statistical analyses of the results in accordance with the study's objectives.

4.1 The demographic characteristics of the Grade 2 learners in Pietermaritzburg

Three out of the four schools that participated in the study had four Grade 2 classes, and one school had three Grade 2 classes. The number of learners in each class ranged from 12 to 33. There were potentially 377 subjects for the main study, but only 109 parents/guardians gave permission for their learner to participate in the study. From this amount, 18 had to be excluded, as they either did not complete all the information, or the learner was not between 7 to 8 years of age. In total, data for 91 learners was captured. This represents 24.1% of the study population.

More female learners (57.1%, n=52) participated in the study than males (42.9%, n= 39). Most of the respondents were Black African (40.7%, n=37), followed by White (27.5%, n=25), Indian (18.7%, n=17) and Coloured learners (13.2%, n=12). The gender and race of the learners is presented in Table 4.1. The learners' ages ranged from 7.67 to 8.83 years, with a mean of 8.3 years (SD 0.27539).

Table 4.1: Gender and race differentiation amongst the learners

		Gender		Total
		Male	Female	
Race	Black African	11	26	37
	White	17	8	25
	Indian	5	12	17
	Coloured	6	6	12
Total		39	52	91

4.2 The prevalence of overweight and obesity amongst Grade 2 learners in Pietermaritzburg, as measured by their BMI

The BMI measurements of the learners are presented as a distribution curve in Figure 4.1 with the two blue lines indicating the recommended range for normal BMI, according to WHO (2007) for that gender.

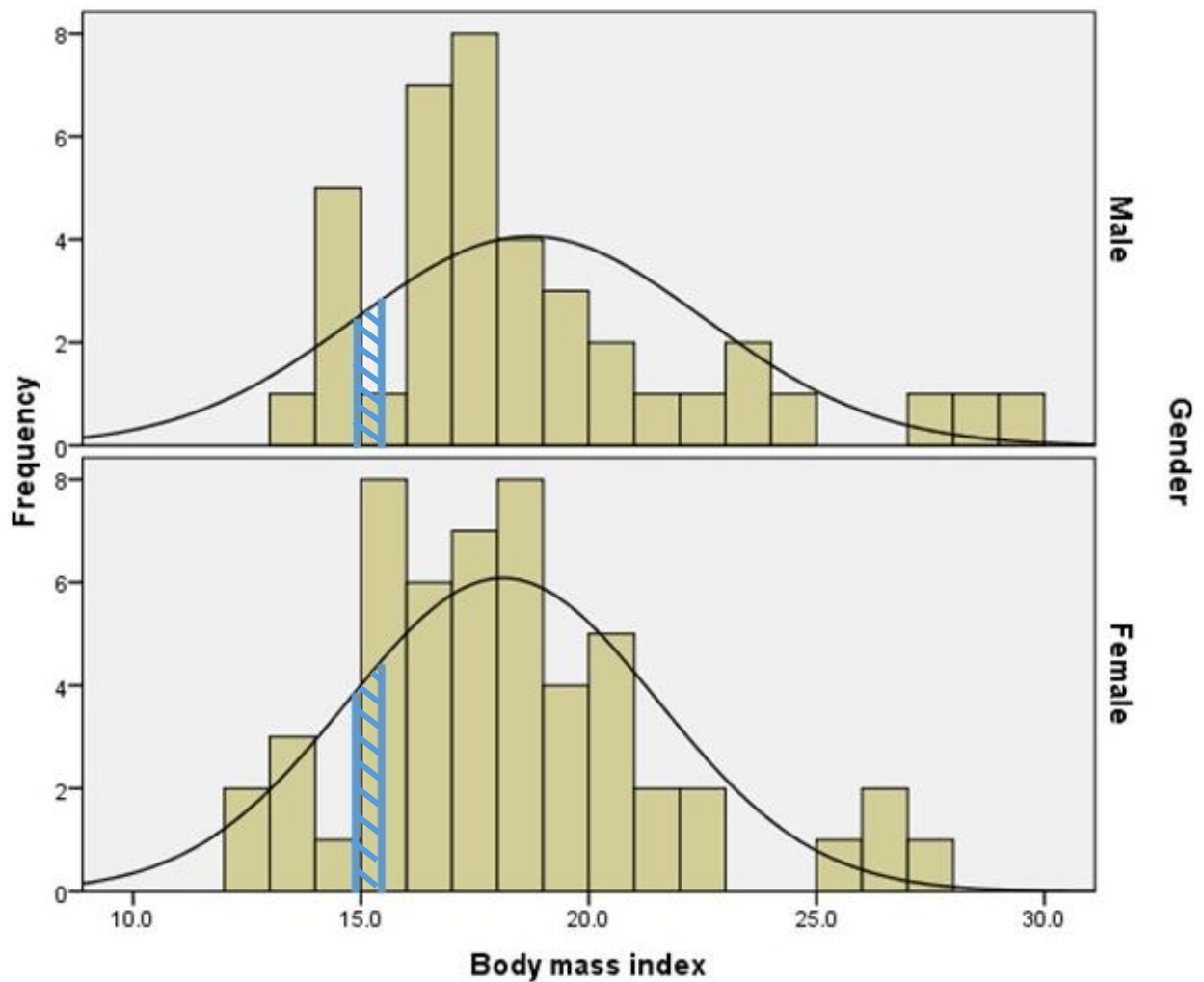


Figure 4.1: Normal distribution curve for BMI according to learners' gender

Figure 4.1 shows that the BMI values for both the male and the female learners were not distributed normally. The male learners had a mean BMI of 18.7 kg/m² (SD 3.83) (normal BMI-for-age for 7 to 8 years olds is 15-15.5 kg/m²) (WHO 2007). The female learners had a mean BMI of 18.1 kg/m² (SD 3.41) (normal BMI-for-age for 7 to 8 year olds is 14.9-15.4 kg/m²).

The classification of the learners' BMI is presented in Tables 4.2 and 4.3. The BMI values were compared to both the WHO and the IOTF classification for overweight and obesity. According to the IOTF classification, 24.2% (n=22) of the learners were overweight and 15.4% (n=14) were obese, compared to the WHO classification where 28.6% (n=26) of the learners were overweight and 19.8% (n=18) were obese. The minimum BMI measured was 12.4 kg/m², the maximum BMI measured was 29.1 kg/m², with a mean of 18.37 kg/m² (SD 3.59). The majority of learners were of a normal BMI (WHO: 50.5%, n=46, IOTF: 51.6%, n=47).

Table 4.2: The representation of the learners' BMI according to the WHO classification

Category	WHO	
	n	%
Wasted (< -2 to - 3 Z-score)	1	1.1
Normal (\leq -1 to + 1 Z-score)	46	50.5
Overweight (> + 1 to + 2 Z score)	26	28.6
Obese (> + 2 Z score)	18	19.8

Table 4.3: The representation of the learners' BMI according to the IOTF classification

Category	IOTF	
	n	%
Thinness (BMI <18.5 kg/m ² at 18 years old)	8	8.8
Normal (BMI \geq 18.5 kg/m ² and \leq 24.9 kg/m ² at 18 years old)	47	51.6
Overweight (BMI \geq 25 kg/m ² at 18 years old)	22	24.2
Obese (BMI \geq 30 kg/m ² at 18 years old)	14	15.4

A chi-square test of independence was conducted to determine if a significant association existed between the learners' gender and BMI. However, no significant relationship was found between the two variables. According to the WHO classification, more females were overweight (30.8%) compared to their male counterparts (25.6%), but more males were obese (23.1%) compared to females (17.3%) (Table 4.4). For the IOTF classification the same trend was shown, with females twice as likely to be overweight than males (30.8% versus 15.4%), but males were more likely to be obese than females (20.5% versus 11.5%) (Table 4.5).

A chi-square test of independence found no significant relationship between race and BMI (Tables 4.4 and 4.5).

Table 4.4: Gender, race and BMI interpretations according to the WHO classification

	Wasted (< -2 to -3 Z score)		Normal (≤ -1 to $+1$ Z score)		Overweight ($> +1$ to $+2$ Z score)		Obese ($> +2$ Z score)	
	n	%	n	%	n	%	n	%
Gender								
Male	0	0	20	51.3	10	25.6	9	23.1
Female	1	1.9	26	50	16	30.8	9	17.3
Race								
Black African	0	0.0	20	54.1	7	18.9	10	27.0
White	0	0.0	12	48.0	10	40.0	3	12.0
Indian	1	5.9	11	64.7	2	11.8	3	17.6
Coloured	0	0.0	3	25.0	7	58.3	2	16.7

Table 4.5: Gender, race and BMI interpretations according to the IOTF classification

	Thinness (BMI < 18.5 kg/m ² at 18 years old)		Normal (BMI ≥ 18.5 kg/m ² and ≤ 25 kg/m ² at 18 years old)		Overweight (BMI ≥ 25 kg/m ² at 18 years old)		Obese (BMI ≥ 30 kg/m ² at 18 years old)	
	n	%	n	%	n	%	n	%
Gender								
Male	2	5.1	23	59.0	6	15.4	8	20.5
Female	6	11.5	24	46.2	16	30.8	6	11.5
Race								
Black African	2	5.4	18	48.6	10	27.0	7	18.9
White	1	4.0	14	56.0	7	28.0	3	12.0
Indian	5	29.4	8	47.1	2	11.8	2	11.8
Coloured	0	0.0	7	58.3	3	25.0	2	16.7

According to the Kruskal Wallis test, no significant differences between age and BMI were found in learners of different gender and race.

4.3 The daily calcium and dairy intake of Grade 2 learners in Pietermaritzburg

The total dairy consumed per day was calculated using the dietary information obtained from the FFQ. The number of dairy servings per day was then determined from the total dairy intake, and a distinct range was observed. A minimum of 0.2 servings to a maximum of 7.6 servings of dairy was consumed per day, with a mean of 2.03 (SD 1.34). Two values for total daily calcium intake were obtained. Firstly, the FFQ gave the total amount of dairy consumed, and the calcium content was then calculated from the amount of each dairy product ingested. The total FFQ calcium consumed per day ranged from a minimum of 65 mg per day, to a maximum of 2298 mg per day, with a mean of 615.22 mg per day (SD 405.59) (Table 4.6).

Table 4.6: Summary of the calcium and dairy intake amongst the learners

	Recommended amount	Mean	SD	Minimum	Maximum
Calcium					
FFQ calcium (mg/day)	EAR: 800 mg/day	615.22	405.59	65	2298
Dairy					
Number of dairy servings per day	3	2.03	1.34	0.2	7.6

A Mann Whitney test showed no significant differences in calcium and dairy intake between the two genders (Table 4.7). The males' calcium intake from the FFQ was lower than that of the females' intake, which is in line with their lower dairy intake (mean 576.94 mg per day, SD 326.29 versus mean 643.94 mg per day, SD 457.17). Males consumed less dairy products per day, and therefore had fewer dairy servings per day than the females (mean 1.92 servings per day, SD 1.08 versus mean 2.11 servings per day, SD 1.52).

Table 4.7: Analysis of calcium and dairy intake according to gender

Calcium		n	%	Mean	SD	Minimum	Maximum
FFQ calcium (mg/day)	Male	39	42.9	576.94	326.29	65	1706
	Female	52	57.1	643.94	457.17	75	2298
	Combined	91	100	615.22	405.59	65	2298
Dairy							
Dairy servings per day	Male	39	42.9	1.921	1.08	0.2	5.7
	Female	52	57.1	2.113	1.52	0.3	7.6
	Combined	91	100	2.030	1.34	0.2	7.6

When race was introduced as the independent variable, a Kruskal Wallis test showed no significant differences in calcium and dairy intake between the four different race groups (Table 4.8)

Table 4.8: Analysis of calcium and dairy intake according to race

Calcium		n	%	Mean	SD	Minimum	Maximum
FFQ calcium (mg/day)	Black African	37	40.7	501.74	299.63	65	1213
	White	25	27.5	625.52	309.89	136	1583
	Indian	17	18.7	727.00	560.78	154	2095
	Coloured	12	13.2	785.33	539.18	155	2298
	Total	91	100	615.22	405.59	65	2298
Dairy							
Dairy servings per day	Black African	37	40.7	1.66	0.99	0.2	4.0
	White	25	27.5	2.10	1.04	0.5	5.2
	Indian	17	18.7	2.37	1.84	0.5	6.9
	Coloured	12	13.2	2.55	1.81	0.5	7.6
	Total	91	100	2.03	1.34	0.2	7.6

4.4 The Grade 2 learners' dietary calcium intake from dairy products, compared to the EAR for calcium

The calcium from the FFQ was compared to the EAR of 800 mg per day (Table 4.9).

Table 4.9: Calcium intake compared to the EAR

	FFQ calcium compared to the EAR	
	n	%
Below (< 800 mg/day)	69	75.8
Meets (800-899 mg/day)	4	4.4
Above (\geq 900 mg/day)	18	19.8

Table 4.9 reveals that most of the learners were not ingesting adequate amounts of dietary calcium to meet the EAR recommendations for calcium. When analysing the calcium intake from the FFQ, 75.8% of the learners consumed less than 800 mg calcium per day. Using a one-sample t-test, the FFQ calcium was found to be significantly less than the recommended EAR of 800 mg calcium per day, ($t(90)=-4.346$, $p<0.05$).

A Pearson correlation found no significant linear relationship between age and corresponding calcium intake, or the EAR for calcium. Furthermore, no significant difference between gender and calcium intake was noted by the Independent samples t-test, when comparing dietary calcium intake to the EAR for calcium ($p=0.06$).

4.5 The Grade 2 learners' dairy intake compared to the recommended dairy intake

A one-sample t-test analysis showed that the learners' average number of dairy servings per day (2.03) to be significantly lower than the recommended three servings per day ($t(90)=-6.889$, $p<0.05$). No significant differences in meeting the recommended dairy intake were noted by gender, race and categories of age.

4.6 The relationship between the Grade 2 learners' calcium and total dairy intake, and their BMI

Regression analysis was utilised when comparing the calcium intake obtained from the FFQ with the learners' BMI. No significant relationship between FFQ calcium and all learners' BMI was established ($p=0.772$). Further regression analysis of both gender and race with BMI revealed no significant relationship between the male learners' BMI and FFQ calcium ($p=1.28$), or the female learners FFQ calcium and BMI ($p=0.797$). No significant relationships were again noted amongst the different race groups for the FFQ calcium and BMI (Black African $p=0.79$; White $p=0.42$; Indian $p=0.70$ and Coloured $p=0.33$).

Regression analysis was conducted to determine the relationship between total dairy intake and BMI. No significant regression was noted between total dairy intake per day for all learners, and their BMI ($p=0.57$). When the data were analysed separately according to gender, no significant difference between the males' number of daily dairy servings and their BMI were noted ($p=0.13$), or for the females daily servings of dairy and their BMI ($p=0.69$). When analysed separately according to the different race groups, no significant relationship was noted between the daily number of dairy servings and the learners' BMI (Black African $p=0.77$; White $p=0.42$; Indian $p=0.61$ and Coloured $p=0.396$).

4.7 The dairy product most commonly consumed, and its effect on the Grade 2 learners' BMI

A significant number of learners consumed full cream milk and low fat milk ($\chi^2(9)=279.000$, $p<0.05$) compared to other dairy products available (Table 4.10). A Pearson correlation test showed no significant effect of the consumption of either full cream milk or low fat milk, on the learners' BMI (full cream milk $p=0.39$; low fat milk $p=0.21$).

Table 4.10: The most regularly consumed dairy product in the learners' diet

Product	n	%
Full cream milk	50	54.9
Low fat milk	29	31.9
Low fat yoghurt	4	4.4
Maas	2	2.2
Cheese	1	1.1
Skim milk	1	1.1
Drinking yoghurt	1	1.1
Dairy based dessert	1	1.1
Fortified supplement	1	1.1
Lactose free milk	1	1.1
Total	91	100

4.8 The dairy product that contributed the most calcium to the Grade 2 learners' diet, and its effect on the Grade 2 learners' BMI

Full cream milk and low fat milk were the most significant sources of the learners' calcium intake, compared to the other dairy products consumed ($\chi^2(9)=236.363$, $p<0.05$) (Table 4.11). A Pearson correlation showed that the calcium obtained from full cream milk and low fat milk did not have any relationship with the learners' BMI.

Table 4.11: The food item that contributed the most calcium in the learners' diet

Product	n	%
Full cream milk	49	53.8
Low fat milk	22	24.2
Cheese	8	8.8
Maas	4	4.4
Low fat yoghurt	3	3.3
Skim milk	1	1.1
Drinking yoghurt	1	1.1
Dairy based dessert	1	1.1
Fortified supplement	1	1.1
Lactose free milk	1	1.1
Total	91	100

4.9 Barriers that prevented the Grade 2 learners from consuming an adequate dairy intake

Parents/guardians were presented with a Likert scale to rate possible barriers that may have prevented the learners from consuming an adequate dairy intake (Table 4.12). From all the possible options presented in the FFQ, the results of the t-test showed no significant barriers that reduced the consumption of dairy. The most common barrier to dairy consumption was cited as the 'cost of dairy products', with 28 parents/guardians (30.8%) reporting to 'agree' and 'strongly agree' with this statement, followed by 20 parents/guardians (22%) indicating that the 'learner dislikes dairy' and 10 parents/guardians (11%) indicating 'learner follows a special diet'.

Table 4.12: Existing barriers that prevent the learners from consuming an adequate dairy (and calcium) intake

		Strongly disagree	Disagree	Neutral	Agree	Strongly agree	Total	Mean	SD
No fridge at home	n	52	10	2	4	5	73	1.63	1.21
	%	57.1	11	2.2	4.4	5.5	80.2		
Cost of dairy products	n	28	10	14	21	7	80	2.61	1.42
	%	30.8	11.0	15.4	23.1	7.7	87.9		
School does not allow dairy	n	49	15	4	3	3	74	1.59	1.05
	%	53.8	16.5	4.4	3.3	3.3	81.3		
Learner dislikes dairy	n	26	19	11	16	4	76	2.38	1.296
	%	28.6	20.9	12.1	17.6	4.4	83.5		
Carer dislikes dairy and therefore does not buy it/ encourage it	n	48	16	5	2	1	72	1.50	0.86
	%	52.7	17.6	5.5	2.2	1.1	79.1		
Learner has an intolerance/ allergy	n	45	15	4	7	2	73	1.71	1.11
	%	49.5	16.5	4.4	7.7	2.2	80.2		
Special diet followed	n	43	17	4	8	2	74	1.77	1.13
	%	47.3	18.7	4.4	8.8	2.2	81.3		
Cultural/religious reasons	n	49	15	3	2	3	72	1.54	1.01
	%	53.8	16.5	3.3	2.2	3.3	79.1		
Ethical reasons	n	47	17	5	1	2	72	1.53	0.90
	%	51.6	18.7	5.5	1.1	2.2	79.1		
Other reasons: Learner is overweight / Poor appetite	n	5	1	1	1	1	9	2.78	2.78
	%	5.5	1.1	1.1	1.1	1.1	9.9		

4.9.1 The relationship between dairy products and sugar sweetened beverages

Although not measured in the Likert scale, a possible barrier to dairy consumption is sugar sweetened beverages (SSBs). With the literature expressing concerns that reduced levels of dairy intake are associated with a greater increase in the consumption of SSBs, a Pearson correlation analysis was conducted to determine if such a relationship between dairy intake and SSBs existed. However, no significant correlation was found between dairy consumption and the following SSBs: fizzy soda drinks ($p=0.49$); diet soda drinks ($p=0.62$); 100% fruit juice ($p=0.77$); less than 100% fruit juice ($p=0.43$); squashes ($p=0.66$); and cordials ($p=0.19$). When all SSBs were analysed together, there was still no significant correlation between dairy intake and SSBs ($p=0.82$), thus showing that those learners who drank less dairy were not necessarily drinking more SSBs.

4.10 Summary of results

To summarise, data were collected from 91 out of a possible 377 Grade 2 learners, with a response rate of 24.1%. Slightly more females than males participated in the study (57.1%, $n=52$ females versus 42.9%, $n=39$ males), and the predominant racial group was Black African (40.7%, $n=37$), followed by White (27.5%, $n=25$), Indian (18.7%, $n=17$) and Coloured learners (13.2%, $n=12$). The mean age of the learners was 8.3 years old (SD 0.27539).

The first objective was to determine the BMI of the Grade 2 learners. The mean BMI for the male learners was 18.7 kg/m² (SD 3.83), and the mean BMI for the female learners was 18.1 kg/m² (SD 3.41). Although the WHO classified 50.5% of learners as having a normal BMI, and the IOTF classified 51.6% of learners as normal, almost half (48.6%) of the remaining learners were classified as either overweight (28.6%) or obese (19.8%) according to the WHO. Figures for the IOTF classification were slightly lower, with a total of 39.6% of learners classified as either overweight (24.2%) or obese (15.4%). Whilst more females were found to be overweight than males (WHO: 30.8% versus 25.6%; IOTF: 30.8% versus 15.4%), more males were obese compared to females (WHO: 23.1% versus 17.3%; IOTF: 20.5% versus 11.5%). No significant differences between gender and BMI, race and BMI, and age and BMI of the learners were observed.

The second objective was to determine the total calcium and dairy intake amongst the Grade 2 learners. The total amount of dairy consumed per day, as well as the number of dairy servings per day was determined from the FFQ. Dairy servings per day ranged from 0.2 to 7.6, with a

mean of 2.03 servings per day (SD 1.34). Male learners consumed less dairy than females, with the male learners recording a mean of 1.92 dairy servings per day, SD 1.08 versus the females' daily mean of 2.11 dairy servings per day, SD 1.52. The learners' average daily number of dairy servings was significantly lower than the recommended amount of three servings per day, but no significant differences were noted amongst gender, age or race in not meeting the recommended three servings of dairy per day. Dietary calcium was obtained from the FFQ, with a range of 65 mg per day to 2298 mg per day, mean 615.22 mg per day (SD 405.59) for all learners. According to the FFQ, males had a lower calcium intake than females, which is consistent with their reported lower dairy intake (mean 576.94 mg per day, SD 326.29 versus mean 643.94 mg per day, SD 457.17). No significant differences between gender or race, and the dairy and calcium intake were observed.

The third objective was to investigate the contribution of dairy products to meeting the Grade 2 learners' EAR requirements for calcium. The majority of learners significantly did not meet the recommended daily intake for calcium, with 75.8% of learners consuming <800 mg calcium per day from the FFQ. No significant differences between the learners' ages or genders were noted, when determining if their calcium intake met the EAR for calcium.

The fourth objective was to determine if any relationship existed between the Grade 2 learners calcium and dairy intake, and their BMI. No significant association was noted between FFQ calcium and all learners' BMI, nor were any significant differences observed between the calcium intake of different genders or races, and their corresponding BMI's. When analysing for total dairy intake and BMI, no significant association was noted between total dairy intake per day for all learners, and their BMI. Once again, no significant differences were noted when gender and race were considered.

With the majority of Grade 2 learners not meeting their calcium and dairy requirements, parents/guardians were asked about possible barriers that prevented the learners from obtaining sufficient calcium and dairy on a daily basis. Although there was significant disagreement that the proposed barriers prevented an adequate calcium and dairy intake, the most common barrier cited was the 'cost of dairy products', with 'learner dislikes dairy', and 'special diet followed' listed as the second and third most common barriers.

The next chapter will discuss the results from this study, in relation to similar studies conducted locally and internationally.

CHAPTER 5: DISCUSSION

The purpose of this study was to determine if there was a relationship between the calcium intake from dairy or total dairy intake, and the BMI of Grade 2 learners from quintile 5 schools in Pietermaritzburg. This chapter will discuss the results of each study objective, drawing on the findings from studies previously conducted, and comparing the results to the available literature.

5.1 The prevalence of overweight and obesity amongst Grade 2 learners in Pietermaritzburg, as measured by their BMI

According to the 2011 Census data (Stats SA 2016), Msunduzi is one of the most well populated municipalities within KZN, with 618 536 residents. The population of 7 to 8 year old children within the Msunduzi municipality consisted of 86.5% Black Africans, followed by 7.4% Indians, 3.6% Whites and 2.5% Coloureds (Stats SA 2011). The final sample of schools was not fully representative of the racial distribution of the learners in the Msunduzi municipality, as quintile 5 schools were surveyed and more White, Coloured and Indian learners responded, than were represented within the Msunduzi municipality population of 7 to 8 year olds (Stats SA 2016).

The BMI of the 91 learners was calculated and interpreted, according to both the WHO and the IOTF classifications for 'wasting' (WHO) or 'thinness' (IOTF), 'normal' BMI, 'overweight' and 'obese'. The results of this study showed lower levels of overweight and obesity when consulting the IOTF classification, compared to the WHO classification. The BMI of the male learners ranged from 13.9 kg/m² to 29.1 kg/m², with a mean BMI of 18.7 kg/m² (SD 3.83). The ideal range of BMI-for-age for 7 to 8 year old boys is 15 to 15.5 kg/m². According to the WHO classification, 51.3% of males had a normal BMI, 25.6% were overweight, and 23.1% were obese. When combining the overweight and obese figures, almost half of all the male learners studied (48.7%) were overweight or obese. According to the IOTF classification, 5.1% of males were thin, 59.0% were of normal BMI, 15.4% were overweight, and 20.5% were obese. This is a total of 35.9% of males who were overweight or obese, which is much lower than the WHO classification.

For the female learners, a BMI-for-age range of 12.6 kg/m² to 27.6 kg/m² was recorded, with a mean BMI-for-age of 18.1 kg/m² (SD 3.41). The normal BMI-for-age for 7 to 8 year old girls is 14.9 to 15.4 kg/m². When the female learners' BMI were compared to the WHO

classification, 1.9% were classified as wasted, 50.0% had a normal BMI-for-age, 30.8% were overweight, and 17.3% were obese. When combined, a total of 48.1% female learners were overweight or obese, slightly lower than for the male learners (48.7%). According to the IOTF classification, 11.5% of female learners were thin, 46.2% were of a normal BMI-for-age, 30.8% were overweight, and 11.5% were obese. This is a total of 42.3% overweight or obese females, which is less than the WHO classification. The WHO classification showed almost equal combined rates of overweight and obesity amongst the male and female learners, whereas the IOTF classification showed far more female learners to be overweight and obese than male learners.

As discussed in Chapter 3, the BMI interpretation according to the IOTF classification always shows lower rates of overweight and obesity compared to the WHO classification. This is because the cut-off values for overweight and obesity according to the IOTF criteria are higher than the WHO's criteria (for example, the SD equivalent for the IOTF overweight cut-off is 1.2-1.3, compared to the WHO's 1 SD). This implies that the IOTF may classify the WHO's same 'overweight' and 'obese' children as 'normal' or 'overweight' respectively. As a result, the IOTF results for overweight and obesity are considered more grave (Cole *et al* 2000). Whilst the WHO cut-offs have received international recognition, and been widely cited in many studies worldwide, the IOTF criteria, too, have been cited over 4250 times in many global studies (Cole & Lobstein 2012). When comparing the IOTF cut-offs with the WHO, the two standards follow a similar skewness in their curves, reflecting the fact they both include similar US data (Cole & Lobstein 2012). Limitations to both references have been recognised, namely the confusion that may arise at the age of five years old when the WHO cut off criteria for overweight and obesity changes, and the fact that the IOTF cut-offs are restricted to 2 to 18 years of age.

Although most of the South African studies on paediatric overweight and obesity did not specify the reason for their choice of either the WHO or IOTF for analysis of their results, Kemp *et al* (2011) indicated the IOTF was chosen because it refers to age-specific BMI cut off values, and the BMI of children changes constantly as they age. Armstrong *et al* (2006) stated that the IOTF cut-off's were consulted to ensure their results could be compared to other international data. These authors also suggested the IOTF cut-offs were superior to "using previous methods of arbitrarily defined percentile cut-offs". Monasta, Lobstein, Cole, Vigneronà & Cattaneo (2011) indicated the IOTF could be the method of choice in identifying

overweight and obese children at individual and population level as the cut-offs are “based on a crude association with ill health later in life, namely the definition of overweight and obesity at age 18 years”. Rolland-Cachera (2011) recommended that without international consensus on which classification to use, both the IOTF and WHO definitions for overweight and obesity should be used when assessing the prevalence of childhood overweight and obesity, and the Cole *et al* (2007) and WHO classifications for thinness.

When compared to South African studies on the prevalence of childhood overweight and obesity conducted from 1997 to 2013, the results of this study clearly depict an increasing trend in the rate of paediatric overweight and obesity. The most recent national study, SANHANES-1 (2013), showed paediatric overweight and obesity for 6 to 9 year olds (according to the IOTF classification) to be 4.5% and 2.7% for male children, and 12.3% and 4.1% for female children, with children from urban formal and urban informal areas having the highest BMI (Shisana *et al* 2013). More children were overweight and obese (8.4% and 3.4%) compared to the NFCS-FB study in 2005 (7.8% and 2.5% respectively). SANHANES-1 (2013) showed that South African males aged 2 to 14 years old hailing from KZN had the highest mean BMI of 17.3 kg/m², whilst the male learners in this study had a much higher average BMI (18.7 kg/m² versus 17.3 kg/m²). The KZN females in the SANHANES-1 study (2 to 14 years old) also had the highest mean BMI of 18.5 kg/m² out of all the other participating provinces (Shisana *et al* 2013), but the female learners in this study had a slightly lower mean BMI (18.1 kg/m² versus 18.5 kg/m²). The age range in the SANHANES-1 study was much larger than that of this study, and therefore may have had an impact on the overall final mean BMI.

In the SANHANES-1 study, 6 to 9 year old females were significantly more overweight or obese than the males. Although the IOTF classification figures in this study for overweight were not statistically significant between the two genders, twice the number of females were overweight compared to the males (30.8% versus 15.4%). Although also not statistically significant, the male learners in this study were more likely to be obese than the female learners (20.5% versus 11.5% respectively). This deviates from previous South African studies by Shisana *et al* (2013); Kemp *et al* (2011); Truter *et al* (2010); Armstrong *et al* (2006); Mukuddem-Petersen & Kruger (2004); Somers (2004); Jinabhai *et al* (2003); Monyeki *et al* (1999) and Cameron & Getz (1997) where females were usually more obese than males, and is a cause for possible concern.

Wiles *et al* (2013) conducted a study within Pietermaritzburg, regarding the tuck shop purchasing practices of 311 Grade 4 learners in the same schools that the current study was conducted in. The mean age of their learners was 9.85 (± 0.5) years. Their results found that the males had an average BMI of 19.8 (± 4.9) kg/m², and the females had an average BMI of 20.3 (± 4.6) kg/m². These figures are higher than the figures from the current study. In Wiles *et al*'s (2013) study the incidence of overweight and obesity (according to the WHO classification) for males was 29% and 24.6 % respectively (a total of 53.6%). The results for the females showed 24.9% of females were overweight and 29.5% were obese (a total of 54.4%). It must be noted that the male learners were more overweight than the females, but had not yet surpassed them in rates of obesity.

While the current study shows a slight decrease in the overall incidence of overweight and obesity in the past few years within Pietermaritzburg schools, these results should be interpreted with caution considering the sample size of this study was much smaller than Wiles *et al*'s (2013) study. More attention must be focussed on efforts to further reduce overweight and obesity within these schools, especially in light of the number of obese male learners now exceeding the number of obese female learners.

5.2 The daily calcium and dairy intake of Grade 2 learners in Pietermaritzburg

The average calcium intake of Grade 2 learners obtained from the FFQ was 615.22 mg calcium per day. When considering gender and race, the female learners reported a higher calcium intake from the FFQ than the male learners did (643.94 mg per day versus 576.94 mg per day).

Regarding the different races, the FFQ calcium intake was highest for the Coloured learners (mean 785.33 mg per day), followed by the Indian learners (mean 727 mg per day), the White learners (mean 625.52 mg per day), and the Black African learners (mean 501.74 mg per day). These results are consistent with other studies, which have shown low calcium intakes amongst the South African population, especially the Black Africans (Vorster *et al* 1997; Van Rensburg, Benade, Rose & Du Plessis 1983).

The dairy intake of the Grade 2 learners was also obtained from the FFQ. Although the learners' dairy intake varied widely, ranging from 0.2 to 7.6 servings per day, the average number of dairy servings per day was 2.03 (± 1.34). This amount was significantly lower than the recommended three servings of dairy per day, which would provide 900 mg calcium per day

(Milk SA 2016). The most commonly consumed dairy product of the learners was full cream milk (54.9%, n=50), followed by low fat milk (31.9%, n=29). As is consistent with the FFQ calcium, the Coloured learners reported more dairy servings per day (mean 2.55 servings per day) compared to the Indian learners (mean 2.37 servings per day), and the White learners (mean 2.1 servings per day), with the Black African learners consuming the least amount of dairy (mean 1.66 servings per day).

Whilst the importance of assessing children's dietary intake is extremely relevant with today's current obesity epidemic, the many limitations and obstacles in obtaining an accurate dietary report have been recognised (Magarey *et al* 2011). It is recommended in studies where children are under the age of 10 years old that parents or caregivers report on their dietary intake, due to the subjects' limited memory recall and conceptualization of portion sizes and frequency of eating (Magarey *et al* 2011). However, this is no guarantee that the recorded dietary intake will be more accurate, as children are not always in the presence of their parents/guardians when eating. The weight status of the reporting individual has also shown to influence reporting accuracy, with increased body fatness associated with underreporting of food intake (Magarey *et al* 2011).

A self-administered FFQ was chosen as the most practical means of gathering information on the calcium and dairy intake of the Grade 2 learners, due to time and financial constraints. The advantages and disadvantages of the FFQ were previously discussed in Chapter 3, where it was shown to accurately rank individuals according to levels of intake of a particular nutrient; however it could not always precisely determine the true intake of a particular nutrient. It must be noted that because the FFQ was retrospectively done over a 12 month period, the results should be interpreted with caution.

International studies have shown variance in the accuracy of measuring calcium intake when using FFQ's. In a study conducted on 162 Canadian male children and adolescents from 9 to 16 years of age, the calcium intake from a FFQ and 24-hour recall were compared, with the results showing a significant, yet moderate, difference in the calcium intake between the two methods. The authors concluded that the FFQ overestimated the dietary intake of calcium (Moore *et al* 2007). Likewise, Zemel *et al* (2010) showed the calcium intake from a FFQ to be higher than a 7-day weighted food record, but concluded that the FFQ was a valid tool in identifying children with a low calcium intake. Conversely, Huybrechts *et al* (2006) found that

the FFQ (completed by proxy) underestimated preschool children's (aged 2.5 to 6.5 years old) calcium intake, when compared to a 3-day estimated diet record.

Concern has been raised about the widespread low calcium intakes amongst children and adolescents. A national survey in Canada showed that amongst 10 to 16 year olds, 61% of males and 83% of females did not meet the prescribed three servings of dairy per day (Statistics Canada 2007). In America, where 2 cups (480 ml) of dairy products per day is recommended for 4 to 8 year olds, 42.2% of 4 to 8 year olds consumed dairy products below the recommended minimum amount (Krebs-Smith, Guenther, Subar, Kirkpatrick & Dodd 2010).

There are few studies available on the calcium and dairy intake of the paediatric population in South Africa. Pettifor, Ross, Moodley & Shuenyane (1979) estimated that urban Black African primary school children consumed 337 mg calcium per day, compared to a rural group of Black African primary school children who consumed only 125 mg calcium per day. When analysing the diets of South African children based on the Health Systems Trust data (1975-1996), Vorster *et al* (1997) showed low calcium intakes at all ages, except for children aged 0 to 1.9 years old and White, Coloured and Indian children 2 to 5.9 years old. As part of the Birth-to-Ten Study (BTT), MacKeown *et al* (2003) showed that the majority of children (70-90%) consumed less than their age group's requirements for calcium. The NFCS (1999) established dietary intake using a 24-hour recall and quantitative FFQ. Results showed that consumption of milk and dairy products was positively correlated with height-for-age ($p < 0.05$) in five provinces and weight-for-age ($p < 0.05$) in seven provinces. In almost all provinces except the Western Cape, the calcium intake was less than half of the requirements for 95% of all children (Labadarios *et al* 2005). The 24-hour recall indicated that 42% of children consumed full cream milk, and the FFQ showed that 61% consumed full cream milk (Labadarios *et al* 2005). Steyn, Labadarios, Maunder, Nel & Lombard (2005) conducted a secondary analysis of data from the NFCS of 1999, to ascertain whether food variety and dietary diversity scores were accurate indicators of dietary adequacy amongst South African children. They showed that the age group 7 to 8 years old had the lowest mean adequacy ratio (MAR), indicating the lowest micronutrient-adequate diet, due to limited variety. The Nutrient Adequacy ratio (NAR), whereby the intake of a specific nutrient is divided by the WHO/FAO recommended intake for that nutrient was lowest for calcium in the 7 to 8 year age group, with an NAR for calcium of 46.1% (Steyn *et al* 2005).

The NFCS-FB (2005) and SANHANES-1 (2013) did not investigate the dairy and calcium intake of the South African paediatric population as they were focused on the serum results of micronutrients Vitamin A, iron (Shishana *et al* 2013; Labadarios *et al* 2005), iodine, zinc and folate (Labadarios *et al* 2005) instead. Therefore no results regarding calcium intake of children are available from either of these surveys to compare with the results of this study.

As part of the NutriGo study, Theron *et al* (2007) measured the calcium intake of 12 to 24 month old children from poor socioeconomic backgrounds in Gauteng and Limpopo. These children consumed calcium well below the recommended intake for their age group of 500 mg per day, with the urban group consuming an average of 286 mg per day (SD 245) and the rural group consuming even less calcium: 205 mg per day (SD 207). The calcium intake increased by approximately 100 mg per day in both groups when breastmilk was included in the analysis. Whole, fresh milk (full cream milk) was the fourth most commonly consumed item in the urban subjects' diets, following maize meal, tea and carbonated drinks. The other dairy products commonly consumed by these young children were mahewu (seventh), icecream (eleventh) and skimmed milk (twenty eighth). In the rural subjects, whole fresh milk was the fifth most commonly consumed item, following maize meal, tea, potato and mahewu. Skim fresh milk was the nineteenth most commonly consumed item in their diet (Theron *et al* 2007).

In 2003, Smuts, Faber, Schoeman, Laubscher, Oelofse, Benadé & Dhansay (2008) looked at the nutritional status of 0 to 71 month old children and their caregivers across two provinces, KZN and the Eastern Cape. Most of the subjects came from a poor socioeconomic setting with limited access to basic services. When looking at dietary intake, the variety of food consumed was limited, with more people 'seldom or never' consuming products of animal origin, and 51-64% of households interviewed claiming to 'seldom or never' drink milk (Smuts *et al* 2008).

The literature shows calcium and dairy intake amongst the paediatric population of South Africa to be well below the requirements for their specific age group. Whilst the results from this study are consistent with national results that show a low calcium intake in South African children' diets, the data from this study must be interpreted with caution. Written guidelines on accurately and honestly completing the FFQ were given to the parents/guardians, but because completion of the FFQ was not explained in person to the parents/guardians, an element of bias and recall error may have resulted. It must also be noted that other nutrients in the diet that interfere with the absorption of calcium, such as tannins in tea, phytates in cereals,

and oxalates in spinach were not measured, and therefore the bioavailability of the recorded calcium intake cannot be confirmed.

Due to the current cost of dairy products and their need for refrigeration, it can be assumed that learners from quintile 1-4 schools may have even less access to dairy products and therefore a much lower dairy and calcium intake than the learners in this study. With the rapid skeletal growth that occurs in the adolescent stage fast approaching, it is the last opportunity for learners to lay down calcium stores for optimum bone accretion. It is therefore essential that primary school children are encouraged to increase their dairy intake, and subsequent calcium intake, to maximise on this window of opportunity.

5.3 Grade 2 learners' dietary calcium intake from dairy products, compared to the EAR

The majority of learners in this study did not consume adequate amounts of dietary calcium to meet the EAR for calcium for 4 to 8 year olds. The FFQ showed calcium intakes to be significantly less than the EAR, with 75.8% of learners consuming less than 800 mg calcium per day. However, no significant differences were noted between age and dairy intake, or gender and dairy intake. This implies that the prevalence of inadequate calcium intake amongst the population group studied is high. However, as previously mentioned, these results need to be interpreted cautiously, due to the researcher not having met the parents/guardians in person to explain the dietary assessment tool. The intake of dietary supplements was not measured, as the literature showed they have little anti-obesity effect (Zemel 2000), and were therefore not considered necessary to the outcome of the study. However, some of the learners may have taken dietary supplements containing calcium, and therefore have a higher calcium intake than that measured.

Dairy is the richest source of dietary calcium, in addition to many other important nutrients such as potassium, magnesium, the B vitamins, and bioactive peptides. One serving of dairy provides approximately 300 mg calcium, and by consuming three servings of dairy per day, approximately 900 mg calcium will be provided, thus ensuing the EAR for calcium is met.

5.4 The Grade 2 learners' dairy intake compared to the recommended dairy intake

The average number of dairy servings per day amongst the learners was 2.03 (SD 1.34). This was significantly lower than the recommended three servings of dairy per day, but this result

needs to be interpreted with caution. Dairy, specifically milk and yoghurt, can be used as a good indicator of the quality of a diet, due to the nutritional density of these foods (Weaver 2014). In diets where dairy consumption was low, the nutritional profile of the diet was found to be lacking in several vital nutrients; few people are able to meet all of their nutritional requirements on a low dairy, or a dairy-free diet (Weaver 2014).

Considering the known benefits of calcium, and that there is often inadequate intake of calcium, increasing the intake of dairy in the diet will contribute significantly towards improving the growth potential and overall health of the South African paediatric population.

5.5 The relationship between the Grade 2 learners' calcium and total dairy intake, and their BMI

No significant associations were found between the calcium intake from the FFQ and BMI of learners ($p=0.772$), irrespective of the learners' gender or race. When analysing the effect of dairy intake on the learners' BMI, no significant relationship was detected for gender (males $p=0.13$; females $p=0.69$), or race (Black African $p=0.77$; White $p=0.42$; Indian $p=0.61$ and Coloured $p=0.396$). Therefore, the hypothesis that the intake of dietary calcium, and /or total dairy intake is inversely related to the BMI of Grade 2 learners in Pietermaritzburg is rejected. However, the rejection of this hypothesis must be done with caution due to the risk of recall error in the self-administered FFQ.

Despite Zemel *et al* (2000) demonstrating an inverse relationship between dietary calcium and adiposity in adult adipocytes, as yet, no such study has been conducted on children at cellular level. As children express a different metabolic and physiological profile to adults, it has been queried whether this same response would be noted in children (Dror 2014). Many international studies have been conducted to determine the relationship between calcium or dairy products on weight and body fat in children.

Some studies have shown a positive relationship between dietary calcium or dairy, and weight loss (Eriksson & Strandvik 2010; Kelishadi *et al* 2009; LaRowe *et al* 2007; Johnson *et al* 2007; Moore *et al* 2006; Barba *et al* 2005; Dixon *et al* 2005; Carruth & Skinner 2001; Tanasescu *et al* 2000), whilst other studies have shown calcium or dairy to have no impact at all on weight status (Fayet *et al* 2013; Lin *et al* 2012; Danyliw *et al* 2012; Bradlee *et al* 2010; Wiley 2010; Moore *et al* 2008; Murphy *et al* 2008; Fiorito *et al* 2006; Tam *et al* 2006; Berkey *et al* 2005; Phillips *et al* 2003). Gunther *et al* (2013) showed dairy to have a positive, inverse relationship

to weight in underweight and normal weight children only, with no effect on overweight or obese children. Three studies showed calcium and milk products to have an inverse association with BMI in girls only (Abreu *et al* 2012; Moreira *et al* 2005; Forshee & Storey 2003). Many of the studies differed in terms of their subject demographics, study design, methodology, type of dairy products and serving sizes thereof, follow up duration and anthropometric measurement outcomes, and so it is impossible to compare them. With such mixed results, it is difficult to draw an obvious conclusion on the matter.

The theory that a potential threshold effect of calcium exists at intakes equal or greater than 963 mg per day, with no benefit observed in obese children (Dixon *et al* 2005), cannot be proven as the calcium intake was so low amongst the majority of learners studied. It can be argued that the learners' calcium and dairy intakes were too low to notice any association with their BMI. Furthermore, the majority of studies indicated that full cream milk may be more beneficial than low fat milk (Louie *et al* 2011), but most of the learners favoured full cream milk (54.9%) compared to all other types of milk and dairy products, and no association was observed with their weight.

5.6 Barriers affecting dairy intake

With the majority of learners' not meeting the EAR for calcium, in addition to the recommended three servings of dairy per day, it was important to determine what barriers restricted them from consuming sufficient dairy, and therefore calcium. These questions were posed in the form of a Likert scale in the FFQ, with 10 possible barriers presented to the parents/guardians. However, the parents/guardians indicated that none of the potential barriers listed significantly reduced the opportunity for their learners to consume dairy.

“Cost of dairy products” was the most commonly cited obstacle to the learners' dairy intake, with 23.1% agreeing and 7.7% strongly agreeing that cost played a large role in consuming an adequate dairy intake. Cost is a major influence on purchasing practices in developing countries, as observed by Le Roux *et al* (2016). The study population were specifically chosen from quintile 5 schools, as it was expected that these families would be able to afford dairy products. It may therefore be assumed that learners from quintile 1-4 schools are even less likely to consume dairy products than the quintile 5 sample studied, and therefore have an even lower dairy intake than the learners in this study.

The second most commonly cited reason for reduced dairy intake was taste preference, with 17.6% (n=16) agreeing and 4.4% (n=4) strongly agreeing that the “learner dislikes dairy”. Taste does play an important role in food choices, with culturally determined food preferences developed early on in life (Mennella, Forestell, Morgan & Beauchamp 2009). Closely connected to taste preferences is parental influence, where the home setting plays a huge role in the development of food tastes and preferences (Lissau & Poulsen 2005). A small number of parents/guardians acknowledged “carer dislikes dairy, and therefore does not buy it/encourage it”, with 2.2% agreeing and 1.1% strongly agreeing to this statement.

“Special diet followed” was the third most common reason for reduced dairy intake, with 8.8% agreeing and 2.2% strongly agreeing to this statement. Few parents/guardians indicated that cultural/religious or ethical reasons posed a barrier to their learner consuming dairy, with 2.2% agreeing and 3.3% strongly agreeing that dairy was avoided for cultural/religious reasons, and 1.1% agreeing and 2.2% strongly agreeing that their learner did not consume dairy for ethical reasons.

Quite a few parents/guardians agreed (7.7%) and strongly agreed (2.2%) that their “learner has an intolerance/allergy”, yet only one learner reported drinking lactose free milk. Studies have shown that individuals suffering from lactose intolerance may still comfortably consume at least one cup (240 ml) of milk per day (Savaiano *et al* 2006), and that symptoms are better managed by consuming dairy as part of a meal, or by consuming fermented products, such as yoghurt, or cheese (Saviano *et al* 2006). To ensure an adequate calcium intake in these individuals with a diagnosed/perceived lactose intolerance it is important that the learners and their parents/guardians are informed of the alternative products available, and that they are encouraged to increase their calcium intake via dairy products with a lower lactose content.

Another potential barrier was “no fridge at home”, with 4.4% (n=4) agreeing and 5.5% (n=5) strongly agreeing that this posed a barrier to their learner’s dairy intake. With South Africans coming from a wide range of socioeconomic classes, it is possible some learners from quintile 5 schools may lack basic services like refrigeration at home. As most dairy products require storage at cool temperatures, it is unlikely they will be consumed regularly in homes that lack refrigeration. Racey *et al* (2017) mentioned how Canadian male subjects reported transporting dairy to school as a barrier to dairy consumption, by stating it “was too much work” (Racey *et al* 2017).

An equal number of parents/guardians agreed (3.3%, n=3) and strongly agreed (3.3%, n=3) that the “school does not allow dairy”, which inhibited their learners’ dairy intake. It is not clear why only six out of 91 respondents felt the school did not allow dairy products, as the numbers are not enough to imply this was a school rule. Perhaps this perception had been verbally conveyed or implied in passing, due to a lack of sufficient refrigeration facilities at the school. As children spend a large portion of their day at school, the school environment becomes a major influence on the development of their attitudes and beliefs towards food (Story 2009). It is therefore essential that the school environment encourages and promotes healthy food options, in addition to making these food options available.

Wiles, Green & Veldman (2011) conducted a study on tuck shop practices in the same schools as the current study. Their results showed that children bought from tuck shops on a regular basis (at least three times a week). Only 18.2% (n=2) of tuck shops stocked flavoured milk (the most nutritious beverage available for sale), and they were the least sold items of all the beverages available (1.5 units per day) (Wiles *et al* 2011). The reasons given for such low sales of flavoured milks were lack of visibility, and that they were unpopular amongst the school children and as a result often expired. The school tuck shops were often supplied with fridges by Amalgamated Beverage Industries Ltd, who supply Coca-Cola products (Wiles *et al* 2011). As part of this arrangement, only Coca-Cola products were allowed to be displayed in these fridges, with other, non Coca-Cola products such as flavoured milk, being stored in fridges at the back of the tuck shop, possibly due to a shortage of space near the front of the tuck shop (Wiles *et al* 2011).

Under ‘other reasons’, 1.1% (n=1) of the learners had a poor appetite, which hindered dairy intake, and 1.1% (n=1) of the learners avoided dairy because the learner was overweight. Negative misconceptions that dairy is fattening do exist (Henry, Whiting, Phillips, Finch, Zello & Vatanparast 2015; James 2004), and this is regarded by many as a barrier to dairy consumption. With the rich nutritional content of dairy products, it is essential that children and adolescents be educated on the many health benefits of dairy, so as to avoid such misconceptions and encourage a greater intake of dairy.

The literature has suggested a link between the observed decrease in the intake of milk and dairy products, and the increased consumption of SSBs (Nielsen & Popkin 2004; French *et al* 2003; Cavadini *et al* 2000), and therefore it can be assumed that the consumption of SSBs may be a barrier to ensuring an adequate dairy intake. The learners consumption of SSBs was

recorded as part of the FFQ, but no direct association between SSB consumption and dairy intake was detected in this study ($p=0.82$). This implies that the learners who drank less dairy were not drinking more SSBs, and so this barrier to dairy consumption may be ruled out.

5.7 Summary

The male learners in this study had a mean BMI of 18.7 kg/m^2 , which was much greater than the ideal range of $15-15.5 \text{ kg/m}^2$ for 7 to 8 year old boys. According to the WHO classification, almost half of all the male learners studied (48.7%) were overweight or obese. However, overweight and obesity figures were much lower when compared to the IOTF classification, with a total of 35.9% of males overweight or obese. The female learners had a mean BMI-for-age of 18.1 kg/m^2 , which exceeded the ideal range for 7 to 8 year old girls of $14.9-15.4 \text{ kg/m}^2$. The combined incidence of overweight and obesity was slightly lower when compared to the male learners, with a total of 48.1% female learners overweight or obese according to the WHO classification, and a total of 42.3% overweight or obese compared to the IOTF classification. Although the females were more overweight than the males (WHO: 30.8% versus 25.6% and IOTF: 30.8% versus 15.4%), the male learners were more obese than the females (WHO: 23.1% versus 17.3% and IOTF: 20.5% versus 11.5%).

These results for childhood overweight and obesity far exceed the measurements for 6 to 9 year old males and females reported in the SANHANES-1 study (7.2% overweight and obese boys, and 16.7% overweight and obese girls according to IOTF classification) (Shishana *et al* 2013). Whilst previous national studies have shown a steady increase in the rates of paediatric overweight and obesity (with females consistently heavier than males), this study demonstrates the male obesity figures to have surpassed the rates of female obesity.

International studies have previously highlighted low calcium intakes amongst the paediatric population (Krebs-Smith *et al* 2010; Statistics Canada 2007) with local studies showing similar results. Although the SANHANES-1 (2013) and NFCS-FB (2005) did not specifically measure calcium intake, other large studies in South Africa have shown calcium intakes to be well below the recommended intake for the particular age group studied (Theron *et al* 2007; Labadarios *et al* 2005; Steyn *et al* 2005; MacKeown *et al* 2003; Vorster *et al* 1997; Pettifor *et al* 1979). This study showed a similar trend of low calcium intake, with the majority of learners not meeting the EAR for calcium for 4 to 8 year olds. The FFQ showed an average calcium intake of 615.22 mg per day, with calcium intakes significantly less than the EAR (75.8% of learners consuming

less than 800 mg per day). The average number of dairy servings per day was 2.03 (± 1.34), which was significantly lower than the recommended three servings of dairy per day for this age group (Milk SA 2016).

Many challenges have been identified in accurately obtaining a true reflection of dietary intake, especially in the paediatric population. International studies have shown discrepancies using different dietary recall methods to record the dietary calcium intake (Zemel *et al* 2010; Moore *et al* 2007; Huybrechts *et al* 2006; McPherson *et al* 2000). Several factors need to be considered when deciding which calcium value is a better indication of true calcium intake, for example reporting bias of the parents/guardians, and poor memory recall. Due to the potential errors in respondent bias that may have occurred in using the FFQ, the results obtained from this study need to be carefully interpreted.

With Zemel *et al* (2000) demonstrating a link between calcium intake and adiposity in adults, several international studies have been conducted on the association between milk and/or dairy intake and BMI amongst children, with mixed results. Although no association was identified in this study between calcium intake or dairy intake and the learners' BMI, the learners' calcium intakes were so low, with few meeting the EAR for calcium for their age group, that this should be an incentive for encouraging increased calcium intake. Dairy is the most abundant source of dietary calcium (in addition to many other important nutrients), and with the presence of dairy (particularly milk and yoghurt) considered a good indicator of diet quality, an increased intake across all population groups in South Africa must be encouraged by government and various other stakeholders.

Parents/guardians were asked to identify barriers that existed to their learners' dairy intake. Although there was no significant agreement that all the barriers listed were obstructing dairy intake, the cost of dairy products was identified as the most common barrier, supported by Le Roux *et al* (2016). With Grade 2 learners from well-resourced quintile 5 schools not managing to meet their calcium requirements, it is highly unlikely that children from poorer socioeconomic backgrounds who lack basic services such as refrigeration, and knowledge of healthy foods will be able to meet their calcium requirements. Other barriers to dairy intake included taste preference, parental influence, special diet followed, cultural/religious or ethical reasons, milk intolerance/ allergy, school does not allow dairy, misconceptions that dairy is fattening, and poor appetite.

CHAPTER 6: CONCLUSION AND RECOMMENDATIONS

This chapter concludes the findings of the study in relation to the set objectives. Limitations of the study are discussed, and appropriate recommendations for further research are made.

6.1 Conclusion of study findings

6.1.1 Objective 1: To determine the incidence of overweight and obesity amongst Grade 2 learners in Pietermaritzburg, as measured by their BMI

The number of people who are overweight and obese is increasing at a rapid rate, both globally and at a national level. In several studies conducted over the last two decades on the South African paediatric population, increasing levels of overweight and obesity have been observed, with females often more overweight and obese than males. Compared to the most recent national rates for a similar age group, the current study recorded even higher rates of overweight and obesity amongst Grade 2 learners in Pietermaritzburg quintile 5 schools, with the number of obese boys exceeding the number of obese girls. According to the IOTF classification, 24.2% of the learners were overweight, and 15.4% were obese, with twice the number of females overweight compared to the male learners (30.8% versus 15.4%). However, more males were obese than females (20.5% versus 11.5% females). The WHO classification showed higher rates of overweight and obesity, with 28.6% of learners overweight and 19.8% of learners obese. More female learners were overweight compared to male learners (30.8% versus 25.6%), however, 23.1% of male learners were obese, compared to 17.3% of female learners.

6.1.2 Objective 2: To determine the calcium intake from dairy and the total dairy intake in Grade 2 learners in Pietermaritzburg

The South African FBDG were implemented by the government in order to encourage a healthy diet for all South Africans from different race groups and socioeconomic backgrounds. One of these guidelines encourages the daily consumption of milk and dairy products, due to the established low intake of dairy amongst the South African population, and the recognized health benefits of this food group. The current study observed low calcium and dairy intakes well below the recommended amount for the age group 4 to 8 years old, with Black African learners having the lowest calcium intake of the four race groups studied. This is consistent with previous studies that recorded low calcium and dairy intake amongst children from different geographical areas across South Africa.

6.1.3 Objective 3: To determine the contribution that dairy products make towards meeting the calcium requirements of Grade 2 learners

Dairy products have the potential to be the richest and most readily available source of calcium in the diet. Therefore, it was expected that by meeting the dairy requirements of three servings per day, the Grade 2 learners would undoubtedly meet their daily calcium requirements. The current study showed the majority of learners were unable to meet the EAR for calcium for their age group, as they were unable to meet the recommended number of three dairy servings per day. The learners consumed two servings of dairy per day on average, with full cream milk being the most commonly consumed dairy product.

6.1.4 Objective 4: To determine the relationship between the dietary calcium (from dairy) and/or total dairy intake, and the BMI of Grade 2 learners in Pietermaritzburg

Several international studies have shown an inverse relationship between calcium or milk intake and the BMI of paediatric subjects, whilst other international studies have shown no relationship at all between the two variables. In light of the obesity epidemic currently facing South Africa, and that a study of this nature had not previously been conducted, the need arose to investigate such an association.

No correlation between calcium or dairy intake, and the BMI of the Grade 2 learners could be established in this study, leading to the conclusion that no relationship existed between calcium and/or dairy intake, and the BMI of the Grade 2 learners.

6.1.5 Objective 5: To determine possible barriers to dairy intake in Grade 2 learners in Pietermaritzburg

No significant barriers to ensuring the Grade 2 learners consumed adequate amounts of dairy were identified. It can therefore be assumed that the learners' low consumption of dairy products may be as a result of poor knowledge regarding the recommended amount that should be consumed for their age group.

6.2 Limitations

Time constraints restricted this study to only include Grade 2 learners (7 to 8 years old) from quintile 5 schools in Pietermaritzburg thus limiting the sample size. Children from a wider area should be included in further studies to increase the reliability of the results. In addition, learners from quintile 1-4 schools were not included in the study, as it was assumed they would not have adequate access to dairy products, due to financial constraints. However, further research should include these learners to investigate this assumption. This will allow the results to be more representative of all South African learners.

Time constraints prevented the researcher from being able to individually meet with each participating family. Despite the scientifically endorsed methodology, the accuracy of the FFQ has been queried due to the risk of recall error. Overestimation or underestimation of dairy product intake may have occurred, with the parents/guardians unable to accurately recall their learner's dairy intake over the past 12 months, relying more on the learners' most recent dairy intake. As the study was conducted over the winter months the learners may have temporarily reduced their dairy intake (by replacing breakfast cereals with porridge or toast, and avoiding "cold" foods such as yoghurt), and this may have influenced what the parents/guardians recorded in the FFQ.

The FFQ was chosen due to limited time and financial constraints, and the low respondent burden it placed on the parents/guardians. The researcher made contact with the parents/guardians via written correspondence, providing clear instructions on how to complete the FFQ, and only physically met with the Grade 2 learners when the anthropometric measurements were taken. Although no parents/guardians made use of the opportunity to contact the researcher should they have had any queries, it cannot be assumed that they were fully confident to complete the self-administered FFQ. It would be useful to include more detailed dietary recall methods such as the weighted food method or 24-hour recall, in addition to the FFQ, to provide more quantitative data. However, the weighted food method may be tedious and result in fewer complete records from the respondents. The 24-hour recall was originally included as an alternative dietary assessment tool, but due to limited time and available financial resources, the parents/guardians were asked to complete it over two non-consecutive days. As it was not interviewer-administered, concern was raised regarding the reliability and validity of the data, and so it was decided not to include the data collected from the 24-hour recall.

Future research using dietary recalls should also perhaps not emphasise that a particular food group is under investigation, to provide a more accurate reflection of usual dietary intake.

Participation in the study was voluntary and as a result, the sample size was limited. For this reason, and because the researcher did not physically meet with the parents/guardians to discuss the study, the results of this study should be interpreted with caution. Future research should focus on using more than one dietary assessment measure, and increasing study participation.

BMI was the only anthropometric calculation in this study. Although the BMI's ability to accurately determine overweight and obesity has been recognised, it is not endorsed to measure body fat. This is not a direct limitation of the study, as it is common practice by researchers to measure weight and height alone. However, it would be interesting to investigate the learners' body fat in conjunction with their BMI, particularly because the learners were consuming high fat and energy dense dairy products, such as milkshakes. These products may have contributed to an increased BMI and body fat composition. Future research could isolate learners into those who consume "low fat" versus "high fat", and "low sugar" versus "high sugar" dairy products to provide a more accurate reflection as to whether the energy value of the dairy products consumed affects the learners' BMI.

6.3 Recommendations

6.3.1 Recommendations for dietetic practice

With the results of this study showing that the majority of learners aged 7 to 8 years old did not meet their EAR for calcium, it is recommended that ADSA (Association of Dietetics in South Africa) take greater steps to educate the public on the importance of meeting their dairy requirements. The marketing of dairy products should focus on promoting an increased intake of age-appropriate, culturally-acceptable milk and low fat dairy products in order to ensure that different population groups meet their prescribed calcium requirements. Milk is a nutrient-rich dietary source with a great potential for improving the nutritional status of a country's population. The price of milk is quite acceptable compared to other beverages available, particularly in terms of nutritional value. As all dairy products are derived from milk, by promoting the daily consumption of three dairy servings per day, it is highly probable that children's calcium requirements will be met, and the quality of their diets may greatly improve. These small changes will contribute towards the improvement of the child's cognitive ability,

sense of wellbeing and overall improved health that follows from the consumption of a nutritious diet.

6.3.2 Recommendations for the government

The low consumption of dairy amongst the Grade 2 learners in Pietermaritzburg has demonstrated that national nutritional messages and the South African FBDG are not necessarily reaching an important segment of the population, and exerting a positive impact on them. The school environment is considered one of the most influential areas of a child's life, therefore it is recommended that the DOE place greater emphasis on ensuring that a healthy food environment is promoted at all schools.

Schools should be encouraged to monitor the type of foods and beverages offered on their premises, whether it be food brought from home, or sold by the tuck shop. Whilst most learners only consume one out of the main meals of the day at school, by ensuring that one serving of dairy is consumed at school will aid in improving the learners overall dairy and subsequent calcium intake. In addition, schools that offer meals to their learners, whether in the form of a food programme or at a boarding school, should ensure that adequate milk/dairy products are provided on the set menu. Registered dietitians should be invited to educate teachers, parents and school going children on the fundamental basics of a healthy, balanced diet, with emphasis on appropriate portion sizes provided. Dietitians should also be given the opportunity to clear any misconceptions regarding dietary beliefs. The government could consider subsidizing dairy farmers, or milk and dairy products to make them more affordable to the general public, and improve marketing strategies so as to make dairy consumption more appealing.

6.3.3 Recommendations for future research

Future research on this topic should include a controlled intervention diet over an appropriate length of time where causality between milk and/or dairy intake and BMI can be more accurately assessed. A greater number of subjects would be useful for the results to be more representative of the population, and children from other age groups where different rates of growth are experienced should be included. Further studies could also focus on a narrower spectrum of dairy products, such as milk, maas and yoghurt only, to reduce the length of the FFQ and respondent fatigue. These products are also lower in energy, and thus less likely to counteract any weight-loss promoting properties, compared to other, high-energy dairy

products. It would be preferable to interview each subject rather than use self-recall, in order to obtain an accurate portrayal of the subjects' dietary intake. It would also be advisable to measure other anthropometric variables, such as subscapular skinfold thickness, to determine if dairy products have any impact on body fat. Future research should be conducted during the warmer months of the year, as cold dairy products such as fresh milk, maas and yoghurt may be avoided in Winter.

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APPENDIX A: International cut off points for BMI for overweight and obesity by gender between 2 and 18 years, defined to pass through BMI of 25 and 30 kg/m² at 18 years of age (Cole *et al* 2000)

Age (in years)	BMI 25 kg/m ² (overweight)		BMI 30 kg/m ² (obese)	
	Male	Female	Male	Female
2	18.4	18.0	20.1	20.1
2.5	18.1	17.8	19.8	19.5
3	17.9	17.6	19.6	19.4
3.5	17.7	17.4	19.4	19.2
4	17.6	17.3	19.3	19.1
4.5	17.5	17.2	19.3	19.1
5	17.4	17.1	19.3	19.2
5.5	17.5	17.2	19.5	19.3
6	17.6	17.3	19.8	19.7
6.5	17.7	17.5	20.2	20.1
7	17.9	17.8	20.6	20.5
7.5	18.2	18.0	21.1	21.0
8	18.4	18.3	21.6	21.6
8.5	18.8	18.7	22.2	22.2
9	19.1	19.1	22.8	22.8
9.5	19.5	19.5	23.4	23.5
10	19.8	19.9	24.0	24.1
10.5	20.2	20.3	24.6	24.8
11	20.6	20.7	25.1	25.4
11.5	20.9	21.2	25.6	26.1
12	21.2	21.7	26.0	26.7
12.5	21.6	22.1	26.4	27.2
13	21.9	22.6	26.8	27.8
13.5	22.3	23.0	27.2	28.2
14	22.6	23.3	27.6	28.6
14.5	23.0	23.7	28.0	28.9
15	23.3	23.9	28.3	29.1
15.5	23.6	24.2	28.6	29.3

16	23.9	24.4	28.9	29.4
16.5	24.2	24.5	29.1	29.6
17	24.5	24.7	29.4	29.7
17.5	24.7	24.8	29.7	29.8
18	25	25	30	30

APPENDIX B: International cut off points for BMI for grades 1, 2, and 3 thinness by gender between 2 and 18 years, defined to pass through BMI of 16, 17 and 18.5 kg/m² at 18 years of age (Cole, Flegal, Nicholls & Jackson 2007)

Age (years)	Boys			Girls		
	16 kg/m ² (thinness grade 3)	17 kg/m ² (thinness grade 2)	18.5 kg/m ² (thinness grade 1)	16 kg/m ² (thinness grade 3)	17 kg/m ² (thinness grade 2)	18.5 kg/m ² (thinness grade 1)
2.0	13.37	14.12	15.14	13.24	13.90	14.83
2.5	13.22	13.94	14.92	13.10	13.74	14.63
3.0	13.09	13.79	14.74	12.98	13.60	14.47
3.5	12.97	13.64	14.57	12.86	13.47	14.32
4.0	12.86	13.52	14.43	12.73	13.34	14.19
4.5	12.76	13.41	14.31	12.61	13.21	14.06
5.0	12.66	13.31	14.21	12.50	13.09	13.94
5.5	12.58	13.22	14.13	12.40	12.99	13.86
6.0	12.50	13.15	14.07	12.32	12.93	13.82
6.5	12.45	13.10	14.04	12.28	12.90	13.82
7.0	12.42	13.08	14.04	12.26	12.91	13.86
7.5	12.41	13.09	14.08	12.27	12.95	13.93
8.0	12.42	13.11	14.15	12.31	13.00	14.02
8.5	12.45	13.17	14.24	12.37	13.08	14.14
9.0	12.50	13.24	14.35	12.44	13.18	14.28
9.5	12.57	13.34	14.49	12.53	13.29	14.43
10.0	12.66	13.45	14.64	12.64	13.43	14.61
10.5	12.77	13.58	14.80	12.78	13.59	14.81
11.0	12.89	13.72	14.97	12.95	13.79	15.05
11.5	13.03	13.87	15.16	13.15	14.01	15.32
12.0	13.18	14.05	15.35	13.39	14.28	15.62
12.5	13.37	14.25	15.58	13.65	14.56	15.93
13.0	13.59	14.48	15.84	13.92	14.85	16.26
13.5	13.83	14.74	16.12	14.20	15.14	16.57
14.0	14.09	15.01	16.41	14.48	15.43	16.88
14.5	14.35	15.28	16.69	14.75	15.72	17.18
15.0	14.60	15.55	16.98	15.01	15.98	17.45

15.5	14.86	15.82	17.26	15.25	16.22	17.69
16.0	15.12	16.08	17.54	15.46	16.44	17.91
16.5	15.36	16.34	17.80	15.63	16.62	18.09
17.0	15.60	16.58	18.05	15.78	16.77	18.25
17.5	15.81	16.80	18.28	15.90	16.89	18.38
18.0	16.00	17.00	18.50	16.00	17.00	18.50

APPENDIX C: Informed consent form for Principal

11 April 2016

Dear Sir/Madam,

My name is Joanne Galliers and I am currently employed in the Discipline of Dietetics & Human Nutrition at the University of KwaZulu-Natal.

Your school is invited to consider participating in my MSc Dietetics study which will look at the impact of dietary calcium from dairy, and total dairy intake on the Body Mass Index (BMI) of grade 2 learners in Pietermaritzburg.

The aims and purpose of my research are:

- To determine the Body Mass Index of Grade 2 learners in Pietermaritzburg.
- To determine the intake of dietary calcium from dairy, along with the total intake of dairy, in Grade 2 learners in Pietermaritzburg.
- To determine the contribution of dairy product intake to meeting the calcium requirements of Grade 2 learners.
- To determine whether there is a relationship between the dietary calcium (from dairy), and/or total dairy intake, and the Body Mass Index of Grade 2 learners in Pietermaritzburg.
- To determine possible barriers to dairy intake in Grade 2 learners in Pietermaritzburg

The study is expected to enrol Grade 2 learners of all race groups from quintile 5 schools in Pietermaritzburg.

The procedure for the study is as follows:

- 1) If you give consent for your Grade 2 teachers and learners to participate in the study, I will visit your school to meet with yourself and the Grade 2 teachers to explain how the study will proceed. As the study is anonymous, I will require the teachers to allocate each consenting learner with a code against their name on the register.
- 2) The questionnaires will be delivered to your school, and the teachers will send one home with each consenting learner. The questionnaire will consist of approximately 38 questions related to the dairy intake of the Grade 2 learners' diet. The parents/guardians will be asked to answer each question as accurately and truthfully as possible. There are no right or wrong answers.

I will request that the parents/ guardians complete the questionnaire as soon as possible, and return it to your school.

- 3) Once the questionnaires have been completed and returned to your school, I will visit the school to measure the weights and heights of the Grade 2 learners, so as to calculate their Body Mass Index. These measurements will involve them standing on a portable scale and height stick. These are not invasive procedures, and no pain or discomfort will be experienced.

Please note this study will not provide any direct benefit or harm to the study participants. It is hoped that the study will shed light on the actual consumption of dairy products in Grade 2 learners, and whether there is a link between dairy intake and Body Mass Index.

The study will be anonymous and voluntary. Each Grade 2 learner will be allocated a code, and his/her name will not be required on the questionnaire form. Your school may withdraw from the study at any point, should you wish to do so, with no penalties incurred.

Data collected from the study will be stored, securely locked away. After a 5 year period the data will be shredded and destroyed.

This study has been ethically reviewed and approved by the UKZN Biomedical Research Ethics Committee (BE275/16).

In the event of any problems or concerns/questions you may contact the researcher at:

	Mrs Joanne Galliers	galliersj@ukzn.ac.za	(033) 2605820
Supervisors:	Dr Nicky Wiles	wilesn@ukzn.ac.za	(033) 260 5430
	Dr Nicky Tyler	tyler@ukzn.ac.za	(033) 260 5475

OR

BIOMEDICAL RESEARCH ETHICS ADMINISTRATION

Research Office, Westville Campus
 Govan Mbeki Building
 University of KwaZulu-Natal
 Private Bag X 54001, Durban, 4000
 KwaZulu-Natal, SOUTH AFRICA
 Tel: 27 31 2602486 - Fax: 27 31 2604609
 Email: BREC@ukzn.ac.za

Reference number: BE275/16

CONSENT

I (Name) _____ have been informed about the study entitled: "To determine the impact of dietary calcium from dairy, and/or total dairy intake on the Body Mass Index (BMI) of Grade 2 learners in Pietermaritzburg" by Joanne Galliers.

I understand the purpose and procedures of the study.

I declare that the staff, parents/carers and learner's participation in this study is entirely voluntary and that they may withdraw at any time.

If I have any further questions/concerns or queries related to the study I understand that I may contact the researcher on email at galliersj@ukzn.ac.za or telephonically at (033) 260 5820.

If I have any questions or concerns about my school's rights as a study participant, or if I am concerned about an aspect of the study or the researchers then I may contact:

BIOMEDICAL RESEARCH ETHICS ADMINISTRATION

Research Office, Westville Campus
Govan Mbeki Building
University of KwaZulu-Natal
Private Bag X 54001, Durban, 4000
KwaZulu-Natal, SOUTH AFRICA
Tel: 27 31 2602486 - Fax: 27 31 2604609
Email: BREC@ukzn.ac.za

Reference number: BE275/16

(Signature of Principal)

Date

APPENDIX D: Informed consent form for Grade 2 teacher

18 July 2016

Dear Grade 2 teachers,

My name is Joanne Galliers and I am currently employed in the Discipline of Dietetics & Human Nutrition at the University of KwaZulu-Natal.

Your school has been invited to consider participating in my MSc Dietetics study which will look at the impact of dietary calcium from dairy and/or total dairy intake on the Body Mass Index (BMI) of Grade 2 learners in Pietermaritzburg.

The aims and purpose of my research are:

- To determine the Body Mass Index of Grade 2 learners in Pietermaritzburg.
- To determine the intake of dietary calcium from dairy, along with the total intake of dairy, in Grade 2 learners in Pietermaritzburg.
- To determine the contribution of dairy product intake to meeting the calcium requirements of Grade 2 learners.
- To determine whether there is a relationship between the dietary calcium (from dairy), and/or total dairy intake, and the Body Mass Index of Grade 2 learners in Pietermaritzburg.
- To determine possible barriers to dairy intake in Grade 2 learners in Pietermaritzburg

The study is expected to enrol Grade 2 learners of all race groups from quintile 5 schools in Pietermaritzburg.

The procedure for the study is as follows:

- 4) If you give consent for your participation in the study, I will visit your school to meet with the principal and yourself to explain how the study will proceed. As the study is anonymous, I will request you allocate each consenting learner with a code against their name on the register.
- 5) The questionnaires will be delivered to your school, and I will request you send a questionnaire home with each consenting learner. The questionnaire will consist of approximately 43 questions related to the dairy intake of the Grade 2 learners' diet, and a 24 hour dietary recall. The parents/guardians will be asked to answer each question as accurately and truthfully as possible. There are no right or wrong answers.
I will request that the parents/ guardians complete the questionnaire as soon as possible, and return it to your school.

- 6) Once the questionnaires have been completed and returned to you, please keep them safely stored away until I visit the school to measure the weights and heights of the Grade 2 learners, so as to calculate their Body Mass Index. Prior to the learners having their measurements taken, please can you hand their questionnaires back to them (using the codes on the questionnaire against their names on the register). The weight and height measurements to be taken will involve them standing on a portable scale and height stick. These are not invasive procedures, and no pain or discomfort will be experienced. I will then record their measurements on the front page of their questionnaire.

Please note this study will not provide any direct benefit or harm to the study participants. It is hoped that the study will shed light on the actual consumption of dairy products in Grade 2 learners, and whether there is a link between dairy intake and Body Mass Index.

All accurately completed questionnaires and 24 hour recalls will be entered into a lucky draw prize, with a R500 Liberty Midlands Mall voucher offered to the winner. This will be delivered to the school.

The study will be anonymous and voluntary. Each Grade 2 learner will be allocated a code, and his/her name will not be required on the questionnaire form. Your school may withdraw from the study at any point, should you wish to do so, with no penalties incurred.

Data collected from the study will be stored, securely locked away. After a 5 year period the data will be shredded and destroyed.

This study has been ethically reviewed and approved by the UKZN Biomedical Research Ethics Committee (BE275/16).

In the event of any problems or concerns/questions you may contact the researcher at:

	Mrs Joanne Galliers	galliersj@ukzn.ac.za	(033) 2605820
Supervisors:	Dr Nicky Wiles	wilesn@ukzn.ac.za	(033) 260 5430
	Dr Nicky Tyler	tyler@ukzn.ac.za	(033) 260 5475

OR

BIOMEDICAL RESEARCH ETHICS ADMINISTRATION

Research Office, Westville Campus
 Govan Mbeki Building
 University of KwaZulu-Natal
 Private Bag X 54001, Durban, 4000
 KwaZulu-Natal, SOUTH AFRICA
 Tel: 27 31 2602486 - Fax: 27 31 2604609
 Email: BREC@ukzn.ac.za

Reference number: BE275/16

CONSENT

I (Name) _____ have been informed about the study entitled: "To determine the impact of dietary calcium from dairy and/or total dairy intake on the Body Mass Index (BMI) of Grade 2 learners in Pietermaritzburg" by Joanne Galliers.

I understand the purpose and procedures of the study.

I declare that my participation in this study is entirely voluntary and that I may withdraw at any time.

If I have any further questions/concerns or queries related to the study I understand that I may contact the researcher on email at galliersj@ukzn.ac.za or telephonically at (033) 260 5820.

If I have any questions or concerns about my school's rights as a study participant, or if I am concerned about an aspect of the study or the researchers then I may contact:

BIOMEDICAL RESEARCH ETHICS ADMINISTRATION

Research Office, Westville Campus
Govan Mbeki Building
University of KwaZulu-Natal
Private Bag X 54001, Durban, 4000
KwaZulu-Natal, SOUTH AFRICA
Tel: 27 31 2602486 - Fax: 27 31 2604609
Email: BREC@ukzn.ac.za

Reference number: BE 275/16

(Signature of Grade 2 teacher)

Date

APPENDIX E: Food Frequency Questionnaire

UNIVERSITY OF[™]
KWAZULU-NATAL
 INYUVESI
YAKWAZULU-NATALI

CODE:

Questionnaire to determine the relationship of dietary calcium from dairy and/or total dairy intake to the Body Mass Index (BMI) of Grade 2 learners in Pietermaritzburg.

Thank you for taking the time to complete this questionnaire. It should not take you more than 20 minutes to complete. Please note the instructions below.

Instructions.

- Please read all questions carefully, and mark your answer with an “X”.
- Please answer each question as truthfully and accurately as possible. There are no right or wrong answers.
- Please do not leave any questions blank. Estimate if you are not sure.
- If you decide to change your answer, please clearly cross out the incorrect answer, and mark the correct answer with an “X”.

Please proceed to Section A: Information of Learner (overleaf)

TO BE COMPLETED BY RESEARCHER ONCE QUESTIONNAIRE IS RETURNED TO SCHOOL

Weight: _____ kg _____ kg _____ kg

Average weight: _____ kg

Height: _____ m _____ m _____ m

Average height: _____ m

Body Mass Index: _____ kg/m²

SECTION A: INFORMATION ABOUT YOUR GRADE 2 LEARNER

1. Date of birth: _____

2. Gender:

Male	
Female	

3. Race:

Black	
White	
Indian	
Coloured	
Other: please specify _____	

4. Does your grade 2 learner have any of the following medical conditions?

	YES	NO
4.1 Lactose intolerance		
4.2 Insulin dependent Diabetes		
4.3 Non-insulin dependent Diabetes		
4.4 Allergies - Please specify: _____		
4.5 Other condition - Please specify: _____		

5. Does your grade 2 learner partake in any physical activity?

YES	NO

Activity	Once a week	Twice a week	Three times a week	Four times a week	Five times a week	Six times a week	Every day	More than once a day Please specify how many times:
7.6 Football								
7.7 Cricket								
7.8 Dancing								
7.9 Other: please specify								

8. How many hours a day does your grade 2 learner spend watching television and/or playing on a computer device? (eg. computer games, cell phone, iPad/tablet)

	In the week (Monday – Friday)	Over the weekend	In the holidays
8.1 Watching TV			
8.2 Playing computer games			
8.3 Using a cell phone			
8.4 Using an iPad/tablet			

SECTION B: MILK CONSUMPTION

9. Does your grade 2 learner drink plain milk?

YES	NO

If you answered “no” to question 9, please proceed to question 13

If you answered “yes” to question 9:

10. What type of milk does he/she consume most of the time?
(Select ONE option only)

Full cream	2% Low fat	1% Low fat	Skim milk

11. Indicate approximately how much milk he/she drinks in one sitting.
(Select ONE option only)

¼cup	
⅓cup	
½cup	
1 cup	
Other: please specify _____	

12. Over the past 12 months, how often did he/she drink plain milk?
(Select ONE option only)

Less than once a week	
Once a week	
Twice a week	
Three times a week	
Four times a week	
Five days a week	
Six days a week	
Every day	
More than once a day	How many times a day? _____

13. Does he/she consume milk in hot drinks eg. tea, coffee, hot chocolate, Milo, Horlicks?

YES	NO

If you answered “no” to question 13, please proceed to question 16

14. **If you answered “yes” to question 13**, indicate approximately how much milk is added each time (Select ONE option only).

A few drops of milk	
1 teaspoon	
1 tablespoon	
$\frac{1}{4}$ cup	
$\frac{1}{3}$ cup	
$\frac{1}{2}$ cup	
Other: please specify _____	

15. Over the past 12 months, how often did he/she drink hot drinks eg. tea, coffee, hot chocolate, Milo, Horlicks?

Less than once a week	
Once a week	
Twice a week	
Three times a week	
Four times a week	
Five times a week	
Six times a week	
Every day	
More than once a day	How many times a day? _____

16. Does your grade 2 learner consume milk in cereal or porridge?

YES	NO

If you answered “no” to question 16, please proceed to question 19.

17. **If you answered “yes” to question 16**, how much milk is added to the cereal? (Select ONE option only)

$\frac{1}{4}$ cup	
$\frac{1}{3}$ cup	
$\frac{1}{2}$ cup	
1 cup	
Other: please specify _____	

18. Over the past 12 months, how often did he/she eat cereal or porridge?
(Select ONE option only)

Less than once a week	
Once a week	
Twice a week	
Three times a week	
Four times a week	
Five times a week	
Six times a week	
Every day	
More than once a day	How many times a day? _____

19. Does your grade 2 learner drink flavoured milk at home eg. Milo, Squillos or Nesquik?

YES	NO

If you answered "no" to question 19, please proceed to question 22

20. **If you answered "yes" to question 19**, indicate approximately how much flavoured milk he/she drinks in one sitting. (Select ONE option only)

$\frac{1}{4}$ cup	
$\frac{1}{3}$ cup	
$\frac{1}{2}$ cup	
1 cup	
Other: please specify _____	

21. Over the past 12 months, how often did he/she drink flavoured milk at home? (Select ONE option only)

Less than once a week	
Once a week	
Twice a week	
Three times a week	
Four times a week	
Five times a week	
Six times a week	
Every day	
More than once a day	How many times a day? _____

22. Does your grade 2 learner consume flavoured milk purchased at a shop eg. Super M, Steri Stumpi?

YES	NO

If you answered “no” to question 22, please proceed to Section C: Yoghurt consumption

23. **If you answered “yes” to question 22**, indicate approximately how much store- bought flavoured milk he/she drinks in one sitting. (Select ONE option only)

100ml	
200ml	
250ml	
300ml	
350ml	
Other: please specify _____	

24. Over the past 12 months, how often did he/she consume store- bought flavoured milk? (Select ONE option only)

Less than once a week	
Once a week	
Twice a week	
Three times a week	
Four times a week	
Five times a week	
Six times a week	
Every day	
More than once a day	How many times a day? _____

SECTION C: YOGHURT CONSUMPTION

25. Does your grade 2 learner consume yoghurt in a tub?

YES	NO

If you answered “no” to question 25, please proceed to question 29

26. **If you answered “yes” to question 25**, what type of yoghurt does he/she consume most of the time? (Select ONE option only)

Double cream	Full cream	Low fat	Fat free

27. How much yoghurt does he/she eat in one sitting?
(Select ONE option only)

100g	
175g	
200g	
250g	
Other: please specify	

28. Over the past 12 months, how often did he/she eat yoghurt?
(Select ONE option only)

Less than once a week	
Once a week	
Twice a week	
Three times a week	
Four times a week	
Five times a week	
Six times a week	
Every day	
More than once a day	How many times a day? _____

29. Does your grade 2 learner drink drinking yoghurt?

YES	NO

If you answered “no” to question 29, please proceed to Section D: Maas consumption

30. **If you answered “yes” to question 29**, how much drinking yoghurt is consumed at one sitting? (Select ONE option only)

100ml	
200ml	
300ml	
400ml	
500ml	
Other	How much? _____

31. Over the past 12 months, how often did he/she consume drinking yoghurt? (Select ONE option only)

Less than once a week	
Once a week	
Twice a week	
Three times a week	
Four times a week	
Five times a week	
Six times a week	
Every day	
More than once a day	How many times a day? _____

SECTION D: MAAS CONSUMPTION

32. Does your grade 2 learner consume plain maas or add it to food?

YES	NO

If you answered “no” to question 32, please proceed to Section E: Cheese consumption

33. **If you answered “yes” to question 32**, how much maas does he/she consume in one sitting? (Select ONE option only)

100ml	
200ml	
300ml	
400ml	
Other	How much? _____

34. Over the past 12 months how often did he/she consume maas? (Select ONE option only)

Less than once a week	
Once a week	
Twice a week	
Three times a week	
Four times a week	
Five times a week	
Six times a week	
Every day	
More than once a day	How many times a day? _____

SECTION G: OTHER BEVERAGE CONSUMPTION

40. Does your grade 2 learner consume any of the beverages listed below?

Beverage	Yes	No
40.1 Fizzy soda drinks eg. Coke, Sprite, Fanta		
40.2 Diet soda drinks eg. Coke Zero, Coke light, Tab, Sprite Zero, Fanta Zero		
40.3 100% fruit juice eg. Ceres, Liqui Fruit		
40.4 Less than 100% fruit juice eg. Fruit Nectar, Clover		
40.5 Squashes eg. Oros, Lecol, Halls		
40.6 Cordials eg. Roses		
40.7 Other. Please specify _____		

If you answered “no” to question 39, please proceed to Section H: Barriers to Dairy Consumption

41. **If you answered “yes” to question 40,** how much does he/she consume in one sitting?

	100ml	200ml	300ml	400ml	500ml	Other: Please specify amount
41.1 Fizzy soda drinks						
41.2 Diet soda drinks						
41.3 100% fruit juice						
41.4 Less than 100% fruit juice						
41.5 Squashes						
41.6 Cordials						
41.7 Other. Please specify _____						

42. Over the past 12 months how often did he/she consume these beverages?

	Never	Less than once a week	Once a week	Twice a week	Three times a week	Four times a week	Five times a week	Six times a week	Every day	More than once a day. Please specify how many times
42.1 Fizzy soda drinks										
42.2 Diet soda drinks										
42.3 100% fruit juice										
42.4 Less than 100% fruit juice										
42.5 Squashes										
42.6 Cordials										
42.7 Other. Please specify:										

SECTION H: BARRIERS TO DAIRY CONSUMPTION

43. Indicate your agreement that the following factors limit your grade 2 learners' intake of dairy.

Factors limiting dairy intake	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
43.1 No refrigeration at home					
43.2 Cost of dairy products					
43.3 School does not allow dairy products					
43.4 Learner does not like dairy products					
43.5 Carer does not like dairy products and therefore does not buy them					
43.6 Learner has an allergy/intolerance to dairy					
43.7 Special diet followed					
43.8 Cultural and religious reasons					
43.9 Ethical reasons					
43.10 Other: please specify					

Thank you for taking the time to complete this questionnaire, it is much appreciated. Feedback on the study will be sent to all participating schools.

APPENDIX F: Permission to conduct research from the KZN DOE

education

Department:
Education
PROVINCE OF KWAZULU-NATAL

Enquiries: Nomangisi Ngubane

Tel: 033 392 1004

Ref.:2/4/8/728

Mrs J L Galliers
PO Box 4277
Willowton Hub
Pietermaritzburg
3200

Dear Mrs Galliers

PERMISSION TO CONDUCT RESEARCH IN THE KZN DoE INSTITUTIONS

Your application to conduct research entitled: **“TO DETERMINE THE IMPACT OF DIETARY CALCIUM AND/OR DAIRY INTAKE ON THE BODY MASS INDEX (BMI) OF GRADE 2 LEARNERS IN PIETERMARITZBURG”**, in the KwaZulu-Natal Department of Education Institutions has been approved. The conditions of the approval are as follows:

1. The researcher will make all the arrangements concerning the research and interviews.
2. The researcher must ensure that Educator and learning programmes are not interrupted.
3. Interviews are not conducted during the time of writing examinations in schools.
4. Learners, Educators, Schools and Institutions are not identifiable in any way from the results of the research.
5. A copy of this letter is submitted to District Managers, Principals and Heads of Institutions where the intended research and interviews are to be conducted.
6. The period of investigation is limited to the period from 23 February 2016 to 30 June 2017.
7. Your research and interviews will be limited to the schools you have proposed and approved by the Head of Department. Please note that Principals, Educators, Departmental Officials and Learners are under no obligation to participate or assist you in your investigation.
8. Should you wish to extend the period of your survey at the school(s), please contact Miss Connie Kehologile at the contact numbers below.
9. Upon completion of the research, a brief summary of the findings, recommendations or a full report / dissertation / thesis must be submitted to the research office of the Department. Please address it to The Office of the HOD, Private Bag X9137, Pietermaritzburg, 3200.
10. Please note that your research and interviews will be limited to schools and institutions in KwaZulu-Natal Department of Education.

UMgungundlovu District

Nkósinathi S.P. Sishi, PhD
Head of Department: Education
Date: 23 February 2016
KWAZULU-NATAL DEPARTMENT OF EDUCATION

POSTAL: Private Bag X 9137, Pietermaritzburg, 3200, KwaZulu-Natal, Republic of South Africa ...dedicated to service and performance
PHYSICAL: 247 Burger Street, Anton Lembede House, Pietermaritzburg, 3201. Tel. 033 392 1004 **beyond the call of duty**
EMAIL ADDRESS: kehologile.connie@kzndoe.gov.za / Nomangisi.Ngubane@kzndoe.gov.za
CALL CENTRE: 0860 596 363; Fax: 033 392 1203 WEBSITE: WWW.kzneducation.gov.za

APPENDIX G: Informed consent form for parents/guardians



25 July 2016

Dear Parent/Guardian,

My name is Joanne Galliers and I am currently employed in the Discipline of Dietetics & Human Nutrition at the University of KwaZulu-Natal.

If your daughter or son is already eight years old, or turning eight years old this year, you are invited to consider participating in my MSc Dietetics study which will look at the impact of dietary calcium from dairy, and dairy intake on the Body Mass Index (BMI) of Grade 2 learners in Pietermaritzburg.

The aims and purpose of my research are:

- To determine the Body Mass Index of Grade 2 learners in Pietermaritzburg.
- To determine the intake of dietary calcium from dairy, along with the total intake of dairy, in Grade 2 learners in Pietermaritzburg.
- To determine the contribution of dairy product intake to meeting the calcium requirements of Grade 2 learners.
- To determine whether there is a relationship between the dietary calcium (from dairy), and/or total dairy intake, and the Body Mass Index of Grade 2 learners in Pietermaritzburg.
- To determine possible barriers to dairy intake in Grade 2 learners in Pietermaritzburg.

The study is expected to enrol Grade 2 learners of all race groups from quintile 5 schools in Pietermaritzburg.

The procedure for the study is as follows:

- 7) If you give your consent for participation in the study, a questionnaire will be sent home with your Grade 2 learner. The questionnaire will consist of approximately 40 questions related to the dairy intake of your Grade 2 learners' diet, and a two day 24 hour recall. Please answer these questions as accurately and truthfully as possible. There are no right or wrong answers.
Please can you complete the questionnaire and two day 24 hour recall as soon as possible, and return them to your class teacher.

- 8) Once the questionnaire and 24 hour recalls have been completed and returned to school, I will visit the school to measure the weights and heights of the Grade 2 learners, so as to calculate their Body Mass Index. These measurements will involve them standing on a portable scale and height stick. These are not invasive procedures, and no pain or discomfort will be experienced.

Please note this study will not provide any direct benefit or harm to the study participants.

All accurately completed questionnaires and 24 hour recalls will be entered into a lucky draw prize, with a R500 Liberty Midlands Mall voucher offered to the winner. This will be delivered to the school.

The study will be anonymous and voluntary. Each Grade 2 learner will be allocated a code, and his/her name will not be required on the questionnaire form. You may withdraw from the study at any point, should you wish to do so, with no penalties incurred.

Data collected from the study will be stored, securely locked away. After a 5 year period the data will be shredded and destroyed.

This study has been ethically reviewed and approved by the UKZN Biomedical Research Ethics Committee (BE275/16).

In the event of any problems or concerns/questions you may contact the researcher at:

	Mrs Joanne Galliers	galliersj@ukzn.ac.za	(033) 2605820
Supervisors:	Dr Nicky Wiles	wilesn@ukzn.ac.za	(033) 260 5430
	Dr Nicky Tyler	tyler@ukzn.ac.za	(033) 260 5475

OR

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 University of KwaZulu-Natal
 Private Bag X 54001, Durban, 4000
 KwaZulu-Natal, SOUTH AFRICA
 Tel: 27 31 2602486 - Fax: 27 31 2604609
 Email: BREC@ukzn.ac.za

Reference number: BE275/16

CONSENT

I/We (Name) _____ have been informed about the study entitled: "To determine the impact of dietary calcium from dairy and/or total dairy intake on the Body Mass Index (BMI) of Grade 2 learners in Pietermaritzburg" by Joanne Galliers, and would like to/ would not like to participate.

I understand the purpose and procedures of the study.

I declare that my participation in this study is entirely voluntary and that I may withdraw at any time.

If I have any further questions/concerns or queries related to the study I understand that I may contact the researcher on email at galliersj@ukzn.ac.za or telephonically at (033) 260 5820.

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

BIOMEDICAL RESEARCH ETHICS ADMINISTRATION

Research Office, Westville Campus

Govan Mbeki Building

University of KwaZulu-Natal

Private Bag X 54001, Durban, 4000

KwaZulu-Natal, SOUTH AFRICA

Tel: 27 31 2602486 - Fax: 27 31 2604609

Email: BREC@ukzn.ac.za

Reference: BE 275/16

(Signature of parent/guardian)

Date

APPENDIX H: Ethics approval from BREC



16 May 2016

Mrs J Galliers (962079942)
 Discipline of Dietetics and Human Nutrition
 School Agriculture, Engineering Sciences
galliers@ukzn.ac.za

Dear Mrs Galliers

Protocol: To determine the impact of dietary calcium from dairy and / or total dairy intake on the body mass index of grade 2 learners in Pietermaritzburg.

Degree: MSc

BREC reference number: BE275/16

The Biomedical Research Ethics Committee has considered and noted your application received on 25 April 2016.

The study was provisionally approved pending appropriate responses to queries raised. Your response received by BREC on 11 May 2016 to queries raised on 11 May 2016 have been noted and approved by a sub-committee of the Biomedical Research Ethics Committee. The conditions have now been met and the study is given **full ethics approval**.

This approval is valid for one year from **16 May 2016**. To ensure uninterrupted approval of this study beyond the approval expiry date, an application for recertification must be submitted to BREC on the appropriate BREC form 2-3 months before the expiry date.

Any amendments to this study, unless urgently required to ensure safety of participants, must be approved by BREC prior to implementation.

Your acceptance of this approval denotes your compliance with South African National Research Ethics Guidelines (2015), South African National Good Clinical Practice Guidelines (2006) (if applicable) and with UKZN BREC ethics requirements as contained in the UKZN BREC Terms of Reference and Standard Operating Procedures, all available at <http://research.ukzn.ac.za/Research-Ethics/Biomedical-Research-Ethics.aspx>.

BREC is registered with the South African National Health Research Ethics Council (REC-290408-009). BREC has US Office for Human Research Protections (OHRP) Federal-wide Assurance (FWA 678).

The sub-committee's decision will be **RATIFIED** by a full Committee at its meeting taking place on **14 June 2016**.

We wish you well with this study. We would appreciate receiving copies of all publications arising out of this study.

Yours sincerely

Professor V Rambiritch
 Deputy Chair: Biomedical Research Ethics Committee

cc supervisor: wiles@ukzn.ac.za

cc postgraduate officer: higherdegrees2@ukzn.ac.za

Biomedical Research Ethics Committee

Professor J Tsoka-Gwegweni (Chair)

Westville Campus, Govan Mbeki Building

Postal Address: Private Bag X54001, Durban 4000

Telephone: +27 (0) 31 260 2488 Facsimile: +27 (0) 31 260 4609 Email: brec@ukzn.ac.za

Website: <http://research.ukzn.ac.za/Research-Ethics/Biomedical-Research-Ethics.aspx>

1910 - 2010
 100 YEARS OF ACADEMIC EXCELLENCE

Founding Campuses: Edgewood Howard College Medical School Pietermaritzburg Westville