ASSOCIATIONS BETWEEN DETERMINANTS OF WEIGHT STATUS IN CHILDREN, 13 – 15 YEARS IN BLOEMFONTEIN

by

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STATEMENT OF DECLARATION

I Ntsoaki Matumelo Lucia Meko (neé Motseki), certify that the thesis hereby submitted by me for the degree PhD (Dietetics) at the University of the Free State is my independent effort and has not previously been submitted for a degree at another university/faculty. I furthermore waive copyright of the thesis in favour of the University of the Free State.

___________________ **30 November 2009**

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LIST OF ABBREVIATIONS

AI	Adequate Intake
AIDS	Acquired Immune Deficiency Syndrome
AMP	Adenosine Monophosphate
AN	Acanthosis Nigricans
BLCD	Balanced Low-Calorie diet
BMI	Body Mass Index
BMR	Basal Metabolic Rate
CI	Confidence Interval
DRI	Dietary Reference Intakes
EAR	Estimated Average Requirement
EER	Estimated Energy Requirement
FFA	Free Fatty Acid
FFM	Free Fat Mass
HDL	High Density Lipoprotein
HIV	Human Immunodeficiency Virus
HSL	Hormone Sensitive Lipase
IL	Interleukin
LBM	Lean Body Mass
LDL	Low Density Lipoprotein
LPL	Lipoprotein lipase
MET	Metabolic Equivalent
MIT	Meal-induced thermogenesis
NASH	Non-alcoholic steatohepatitis

NIV	**Nutrient Intake Values**
PDPAR	**Previous Day Physical Activity Recall**
PSMF	**Protein-sparing modified fast**
REE	**Resting Energy Expenditure**
SDB	**Sleep-disordered breathing**
SES	**Socioeconomic Status**
TE	**Total Energy**
TEE	**Total Energy Expenditure**
TNF	**Tumour Necrosis Factor**
VLDL	**Very Low Density Lipoprotein**
WHO	**World Health Organisation**
YRBS	**Youth Risk Behaviour Survey**

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CHAPTER 1

INTRODUCTION

1.1 Problem statement

The World Health Organization (WHO) has declared obesity as the largest global chronic health problem. It is estimated that over 300 million people worldwide are obese, while more than one billion suffer from overweight (Frühbeck, 2005). The South African Demographic and Health Survey, undertaken in 1998, found high rates of overweight and obesity in adult South Africans with 29% of men and 56% of women found to be overweight or obese (Puoane *et al.,* 2002).

Childhood obesity has become a matter of major public health (Poskitt and Morgan, 2005: 293). This is due to the fact that children are heavier today than they were 20 years ago. One in five adolescents in the United States is overweight and although there are many putative causes, the actual cause of the increase in childhood obesity remains unknown (Sizer and Whitney, 2008: 479; Kimm and Obarzanek, 2002; Boyle and Morris, 1999: 434). The nationally representative South African Youth Risk Behaviour Assessment Survey 2002, conducted by the Medical Research Council, showed the prevalence of overweight and obesity among young people aged 13 – 19 years to be 21% overall, affecting more girls (30%) than boys (9%) (MRC, 2002). In other studies a quarter of South Africa's 12 to 18 year olds were classified as overweight or obese (Goedecke *et al.,* 2006; MRC, 2002).

Given that childhood obesity can lead to adult obesity, obesity among teenagers is cause for concern as it is associated with increased risk of adult morbidity and mortality (Pérez-Cueto *et al.*, 2005; Boyle and Morris, 1999: 434). The age of onset of obesity strongly influences this risk. The older the obese child, the more probable it is that he or she will become an obese adult (Wahlqvist *et al.,* 2005).

Although most of the medical side effects of obesity in children do not usually occur for decades approximately half of newly diagnosed type 2 diabetes cases are paediatric cases (Hannon *et al.,* 2005; Ebbeling *et al.,* 2002) and this is strongly associated with overweight and obesity (Hannon *et al.,* 2005). The social and emotional aspects of childhood obesity are of immediate consequence because of increased pressure and emphasis in the media on thinness. The overweight and obese child is therefore victimized on all fronts and many of these children may suffer from impaired social interaction and self-esteem (Wahlqvist *et al.*, 2005; Strauss, 1999).

The last two decades of the 20^{th} century have brought about shifts in dietary and physical activity patterns (Popkin and Gordon-Larsen, 2004; Kimm and Obarzanek, 2002). This nutritional transition taking place in developing countries such as South Africa has resulted in a different pattern of malnutrition in these countries (Gulliford *et al.,* 2001). The availability of abundant food has not only led to better overall nutrition and improved child health, but also to the current population's state of excess positive energy balance (Kimm and Obarzanek, 2002). The implications of this are that countries in nutritional transition are currently experiencing a double-burden of disease, with a high prevalence of undernutrition coupled by a steady increase in the frequency of overnutrition (Gulliford *et al.,* 2001).

During adolescence growth velocity increases and major biological, social, physiological, and cognitive changes take place. The average female experiences her most rapid growth spurt between the ages of 10 to 13 years, while the growth spurt of the average male occurs between the ages of 13 and 15 years. Adolescents have special nutritional needs due to rapid growth and maturational changes associated with the onset of puberty. In both developed and developing countries nutritional surveys show that many adolescents do not meet dietary recommendations for their age group whereas some adolescents have problems with dietary excesses and obesity (Mascarenhas *et al.*, 2001: 426; Heald and Gong, 1999: 845).

The majority of obese children have no recognisable underlying medical cause for their obesity. Presumably a genetic predisposition and an obesogenic environment combine in many children to produce obesity. Many other environmental, genetic and dietary factors (e.g. geographical region, ethnicity, parental education, etc.) have been shown to affect the development of obesity in children and adolescents (Poskitt and Morgan, 2005: 293; Wahlqvist *et al.,* 2005).

Several studies support the fact that obesity is an oligogenic disease. Its expression can be modulated by numerous polygenic modifier genes interacting with each other and with environmental factors. Feeding studies of identical twins highlight the importance of genetic background in determining obesity (Frühbeck, 2005; Wardlaw, 1999).

It is clear that eating patterns are influenced by environmental factors which also include the school environment (Vereecken *et al.*, 2005; Lobstein *et al.,* 2004). Many schools offer fast food concessions as an alternative to school lunch, meaning that apart from taking a lunch box to school, children will still spend money on preferred high-fat foods. The inter-personal processes and relationships with friends at school can also affect food habits through mechanisms such as modelling, reinforcement, social support and perceived norms (Vereecken *et al.*, 2005; Miller *et al.*, 2004).

The family and home environment also contribute substantially to the development of childhood obesity. The majority of families now have both parents or the single parent working, resulting in the need to find non-parental supervision after school. Fear of children playing outside without adult supervision has led many parents to admonish their children to stay inside after school. Children are thus spending more time watching television and playing computer games than exercising (Miller *et al.*, 2004).

The past few decades have brought marked lifestyle changes throughout the world, which have resulted in a decrease in physical activity and an increase in energy intake. Children use cars and other automated means of transportation, including elevators and escalators, rather than walking or climbing stairs to go from place to place. The amount of time that children spend playing outside has diminished over the past few decades, and physical education programmes in the schools have been reduced or eliminated (Miller *et al.*, 2004; Strauss, 1999). The relationship between obesity and sedentary activity is observed across age and gender. The belief that children are active and full of energy is largely a myth. Most high school boys and girls do not participate in gym on a regular basis (Miller *et al.*, 2004; Strauss, 1999).

Eating fast foods for meals and snacks is very popular with adolescents. Moreover, adolescents form positive associations with fast foods and negative associations with healthy foods. Fast foods include foods from vending machines, convenience groceries and franchised food restaurants. At the same time portion sizes in food outlets have more than doubled over the past two decades. Most fast food restaurants offer up to 20% larger portion sizes for minimal additional cost, adding hundreds of extra kilojoules. Fast foods tend to be low in most nutrients and vitamins, but they are also high in fat (Whitney and Rolfes, 2005; Miller *et al.*, 2004; Spear, 2004: 294). Studies show that children who prefer high-fat foods tend to be more overweight.

Data on the nutritional status and dietary intake patterns in African communities have shown that the more urbanized the African communities, the higher the rate of obesity and the less prudent their diets became (Kruger *et al.,* 2006; Popkin and Gordon-Larsen, 2004; Puoane *et al.*, 2002) . Data show an adult South-African population, with a malnutrition pattern of overnutrition rather than undernutrition. Factors that could explain the high obesity rates in adult South Africans include changes in nutritional patterns over time and the degree of urbanization that Africans are undergoing (Puoane *et al.*, 2002).

The relationship between childhood obesity and socioeconomic status remains unclear. About one third of studies show no relation, one third demonstrates increased obesity associated with low socioeconomic status, and one third demonstrates increased obesity, associated with high socioeconomic status (Strauss, 1999).

Most studies conducted in South Africa on childhood obesity (Armstrong, 2006; Goedecke *et al.,* 2006; MRC, 2002), mainly focused on determining the prevalence of obesity. Very few studies have investigated the factors that are associated with overweight and obesity in terms of determinants (Kruger *et al.,* 2006).

1.2 Objectives

The main objective of this study was thus to determine the associations between dietary intake, socio-economic status, physical activity levels, the school environment and overweight and obesity in children aged 13 – 15 years in Bloemfontein.

In order to achieve the study's objective, the following sub-objectives were set:

- To describe the usual daily dietary intake of the children;
- To describe the socio-economic status of the children;
- To describe the school environment of the children;
- To describe the physical activity levels of the children;
- To describe weight status in terms of the following anthropometric measurements: weight and height to determine body mass index (BMI)-for-age, as well as waist circumference measurements;
- To assess the association between daily dietary energy and fat intakes of the child and BMI-for-age;
- To assess the association between markers of socio-economic status of the child and BMI-for-age;
- To assess the association between the gender and BMI-for-age of the children;
- To assess the association between the levels of physical activity and BMI-for-age; and

- To assess the association between the levels of physical activity and daily dietary intake.

1.3 Scope of the thesis

Chapter 1 gives the motivation for the study as well as the description of the problem statement. The objectives as well as the outline of the study are also given.

Chapter 2 provides the literature overview in support of the study.

Chapter 3 describes the methods and techniques used in the collection of data. The operational definitions, choice and standardization of apparatus, measuring techniques, study population, study procedure and statistical analysis are discussed in this chapter.

The body of the thesis is contained in Chapter 4 - 6 in the form of three separate articles submitted for publication in peer-reviewed journals. In Chapter 4, the results of this study regarding school nutritional practices and the association between weight status and the socio-economic status of the children are documented.

Chapters 5 and 6 give the results of the associations between the weight status of the children and dietary intake and physical activity levels, respectively.

Finally, the conclusions and recommendations of the study are provided in Chapter 7.

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CHAPTER 2

LITERATURE REVIEW

2.1 INTRODUCTION

Obesity is considered to be the most significant chronic disease that emerged over the past two decades in the paediatric population. This disease overshadows all others in frequency in this population. As a result of this epidemic of childhood obesity, a multitude of chronic illnesses and risk factors for adult disease are now starting in childhood rather than in adulthood. More importantly and of great concern is the evidence for an accelerated rate of obesity in children that tracks into adulthood with a magnitude of serious health and emotional consequences (Sokol, 2000; Ellis *et al.,* 1999). Thus, there is growing interest in understanding better the reasons for weight gains in children that put them at risk of becoming and remaining overweight (O'Loughlin *et al.,* 2000).

2.2 THE BURDEN OF UNDERNUTRITION IN SOUTH AFRICA

Despite the findings on increasing overweight and obesity in the South African population, the problems of hunger and malnutrition continue to affect the lives of millions of children (Gericke and Labadarios, 2007). This can largely be ascribed to the fact that approximately 25.4% of South Africans live below the international poverty line (Human Development Report, 2009:online) and poverty is central to the problem of hunger and malnutrition (Smolin and Grosvenor, 2008: 722). Poverty with associated hunger consequently leads to decreased nutrient intake, absorption and utility (Manary and Solomons, 2004: 182).

The National Food Consumption Survey – Fortification Baseline (NFCS-FB) (Steyn *et al.,* 2005) of 2005 found the prevalence rates of stunting, underweight and wasting to be 18%, 9.3% and 4.5% respectively. In a sample of 10 – 15 year old children in the North West province the prevalence of stunting was 19% (Mukuddem-Petersen & Kruger, 2004), while mild stunting was found amongst 31% - 75% of primary school children aged 8 – 11 years in rural Kwazulu Natal (Jinabhai *et al.,* 2003).

The South African figures mentioned above are cause for concern as malnutrition has been associated with several negative consequences. Children with poor nutritional status are more likely to have greater rates of mortality from childhood diseases as well as more likely to contract diarrhoeal and respiratory infections. These children are also at risk of decreased cognitive development, decreased economic productivity and susceptibility to chronic diseases in later life (Manary and Solomons, 2004: 187).

2.3 EPIDEMIOLOGY OF OVERWEIGHT AND OBESITY

Childhood obesity appears to be worldwide and in many countries has reached sufficient proportions to be considered an epidemic. This phenomenon is not confined to industrialized countries only. High rates of overweight and obesity are already evident in some developing countries as well (Guillaume and Lissau, 2002; Ellis *et al.,* 1999). Recent trends in dietary patterns have provided confusing and sometimes contradictory statements about the state of nutrition throughout the world. On the one hand, undernutrition caused by energy and micronutrient deficiencies is still prevalent in developing countries. On the other hand, obesity caused by excess energy intake is increasing at alarming rates in most developed and some developing countries (Hoffman, 2004).

Using international definitions at least 10% of school age children worldwide are overweight or obese. To date there is little information on the extent of overweight among children in developing countries. Within the UN subregions the highest rate of overweight children was in North Africa (8.1%), followed by South Africa (6.5%) (Reilly, 2006; De Onis and Blössner, 2000). Armstrong and co-workers (2006) have also reported similar levels of overweight and obesity in their sample of South African children as compared to the international patterns in developed countries.

It has been suggested (Hoffman, 2004) that in South Africa, urbanization is associated with an increased risk of becoming overweight or obese. Dietary changes associated with urbanization tend to center around a shift from a high intake of fruits, vegetables and legumes and a low intake of processed foods and refined carbohydrates to a high intake of fats, processed foods and refined carbohydrates (Hoffman, 2004; Ebbeling *et al.,* 2002).

In many middle-income countries such as Brazil and China, non-communicable diseases account for the majority of deaths. A more long-standing concern for middle-income countries has been with undernutrition in children, rather than overnutrition. Of interest though is the fact that certain countries such as those in East Asia demonstrated high percentages of overweight at the same time as high frequencies of malnutrition (Deckelbaum and Williams, 2001; Gulliford *et al.,* 2001).

2.4 RISK FACTORS AND CAUSES OF CHILDHOOD OBESITY

Obesity is a disorder of energy metabolism. A positive energy balance over long periods of time often leads to storage of excess energy in the form of triglycerides in adipose tissue. The rise in both adult and childhood obesity indicates that fundamental changes are occurring in both energy intake and expenditure that adversely affect energy balance (O'Loughlin *et al.,* 2000; Caprio & Tamborlane, 1999;).

Researchers have identified potential modifiable risk factors such as television viewing and dietary habits that lead to obesity in childhood (Tanasescu *et al.,* 2000). Scientific evidence suggests that overweight and obesity result from the interaction of a variety of factors, including personal behaviours and biological issues related to weight regulation (Spear, 2006). Endocrine and genetic causes seem to be extremely rare. Other factors that may affect the development of overweight and obesity in children or adolescents include geographical region, population density (Wahlqvist *et al.,* 2005), ethnicity, socioeconomic status (Reilly, 2006), family size, gender, parental education, excessive dietary fat intake (Spear, 2006), physical activity levels (Sothern *et al.,* 2000), maternal age and maternal preference for a chubby baby (Wahlqvist *et al.,* 2005).

2.4.1 CRITICAL PERIODS OF GROWTH

Growth is defined as the acquisition of tissue coupled with an increase in body size. Development refers to changes in the body's capacity to function both physically and intellectually through increased tissue and organ complexity. Different individuals experience these processes at different rates. Nutritional needs change in response to the demands that these stages of growth place on the body (Wahlqvist *et al.,* 2005).

A critical period refers to a specific period of development when an insult has an enduring effect on the structure or function of organs, tissues and body systems. If not completely deterministic, these periods are often referred to as sensitive rather than critical. Several models have been advanced to explain which early factors are important in assessing later disease (Daniels *et al.,* 2005).

2.4.1.1 Infancy and childhood periods

Birthweight may be an important predictor of childhood obesity. Children with increased birth weight are consistently at increased risk for the development of later overweight (Dietz, 2003; Eriksson *et al.,* 2003). This may be due to both genetic factors and early programming by the intrauterine environment (Koletzko *et al.,* 2009). Other possible explanatory mechanisms include lasting changes in proportions of fat and lean body mass, central nervous system appetite control and pancreatic structure and function. The higher risk of obesity in children with high birthweight is present in early childhood and may be carried on into young adulthood (Daniels *et al.,* 2005; Tanasescu *et al.,* 2000).

In developing countries such as South Africa, the combination of foetal undernutrition followed by neonatal infant overnutrition seems likely to be associated with later obesity and metabolic or cardiovascular morbidity. Formula feeding in infancy also seems to predispose to obesity whereas breast feeding has been shown to provide modest protection against later obesity. Those infants that were breast fed for longer durations showed an even lower risk of childhood obesity (Reilly, 2006; Sothern, 2004).

Children who have an early adiposity rebound are at higher risk for obesity and persistent obesity (Rolland-Cachera *et al.,* 2006). Obesity or BMI rebound refers to a period usually between 4 and 7 years of age when BMI reaches nadir and begins to increase throughout the rest of childhood adolescence and young adulthood (Dietz, 2003). Fat mass at birth represents 12-15% of the total mass. It increases up to 4-6 months and remains around 21-23% until 1 year of age. Fat mass declines until 5-6 years of age then increases again to reach 11-17% in boys and 23-26% in girls by the end of the adolescent growth spurt. Thus the adiposity rebound which starts normally around 6 years of age corresponds to the second phase of increase in fat mass. This period of adiposity rebound is important but it is not the only important period for the development of obesity (Daniels *et al.,* 2005; Guillaume and Lissau, 2002).

2.4.1.2 Puberty

Adolescence is another critical period for the development of obesity or of behaviours predisposing to obesity, perhaps because of the significant psychosocial and behavioural changes which take place in this time. Predictors in early life of body size and fatness in adolescence include birth weight, anthropometric measures at 12, 50 and 80 months, weight and height velocities during the first year, the presence of a major illness, and parental socioeconomic status in early life (Wahlqvist *et al.,* 2005; Guillaume and Lissau, 2002). The risk that adolescent overweight will persist into adulthood is threefold greater in adolescent girls than boys (Dietz, 2003).

Changes that occur in body composition during adolescence have been well characterized and demonstrate sexual divergence. Specifically, in boys, fat-free mass tends to increase and body fat as a percentage of body weight decreases.

In girls, both fat and fat-free mass increase and fat-free mass as a percentage of body weight decreases. In addition to alterations in total and percentage of body fat during adolescence, patterns of fat distribution also change. Mediated in part by hormonal influences, patterns of fat distribution during this developmental period also demonstrate sexual differences. Pronounced centralization of fat stores with increases in subcutaneous fat and visceral fat in the abdominal region occurs in boys; this pattern is similar but less dramatic for girls. In addition fat tends to be deposited peripherally in the breasts, hips and buttocks in girls during this period (Daniels *et al.,* 2005).

During peak growth velocity, adolescents usually need to eat large amounts of food often. They are able to use foods with a high concentration of energy. However, they need to be careful to adjust the amounts they are eating and frequency when their growth slows. Habits of overeating adopted during adolescence are usually carried into adulthood (Spear, 2004).

2.4.2 ADIPOSE TISSUE DEVELOPMENT

The development of obesity, in a majority of cases, is a multifactorial event with a genetic predisposition affected by environmental factors, some of which are not fully understood. The storage of energy in white adipose tissue is physiologically important for survival during times of starvation, for fertility, for adequate function of the immune system and thus for overall well-being and health. Interestingly, recent investigations of the regulation of energy balance have shown that the amount of energy stored in adipose tissue is related to various biological functions, including regulation of growth, puberty, reproduction and the immune system (Wabitsch, 2002).

2.4.2.1 Regulation of body weight and energy stores

Regulatory systems such as neurochemicals, body fat stores, protein mass, hormones and postingestion factors all play a role in regulating intake and weight. Short-term controls are concerned primarily with factors governing hunger, appetite and satiety. Physical triggers for hunger are much stronger than those for satiety and it is easier to override the signals for satiety. In the short term, regulatory signals from the gastrointestinal tract and signals generated during the metabolism of food, inform the central nervous system about food intake and thus regulate actual hunger and satiety. There is evidence for long-term systems which also regulate bodily energy stores. Long term regulation seems to involve a feedback mechanism in which a signal from the adipose mass is released when “normal” body composition is disturbed as when weight loss occurs (Laquatra, 2004; Wabitsch, 2002).

2.4.2.2 Lipid storage and mobilization

Triglycerides serve the body primarily as a source of energy. The body’s fat stores have unlimited capacity because of adipose tissue. The fat cells of the adipose tissue readily take up and store fat. The energy required to convert food fats to body fat is very little. Dietary triglyceride is transported to the liver as a part of chylomicrons and is removed from the blood by lipoprotein lipase (LPL). Triglyceride synthesized in the liver from free fatty acids, travels as part of very-low-density lipoprotein (VLDL) and is removed from the blood in the periphery by LPL. LPL hydrolyzes triglycerides from lipoproteins and produces glycerol, free fatty acids and monoglycerides which then enter the liver and adipose cells. These are then reesterified into triglycerides in the adipose cells and fill the adipose cells, storing a large amount of energy in a small space. When cells demand energy hormone-sensitive lipase (HSL) the adipose cells responds by breaking the stored triglycerides down into fatty acids and glycerol and releases the latter directly into circulation (Whitney and Rolfes, 2005; Laquatra, 2004).

When energy intake exceeds expenditure the fat cells accumulate triglycerides and expand in size. When the cells enlarge they stimulate cell proliferation. Thus obesity develops when a person's fat cells increase in number, in size or in both number and size. LPL increases during periods of weight gain in both the obese and nonobese. After weight is lost, LPL returns to normal levels in nonobese persons, but in obese persons who have lost weight the LPL does not decrease but in fact increases. This increase is one of the factors contributing to the rapid weight regain that is so common (Whitney and Rolfes, 2005; Laquatra, 2004).

2.4.2.3 Hormonal factors

a. Leptin

Leptin is secreted from adipocytes and low concentrations are also synthesized and secreted from secondary sources including the hypothalamus, pituitary, skeletal muscle and bone. Leptin acts as a satiety signal regulating appetite and hunger. As the amount of fat stored in adipocytes rises, leptin is released into the blood and signals to the brain that the body has had enough to eat. Leptin also plays a major role in the control of body fat stores through coordinated regulation of feeding behaviour, fat metabolism, the autonomic nervous system, and body energy balance (Escott-Stump, 2008: 557; Körner *et al.,* 2007; Gat-Yablonski *et al.,* 2004). Serum leptin concentrations are highest between midnight and early morning. Its rhythm is influenced by several factors including meal timing, appetite suppression while sleeping and relative total body fat (Venner *et al.,* 2006).

Several experiments provide support for the hypothesis that a circulating signal generated in adipose tissue acts on hypothalamic centres to regulate energy intake and expenditure. The primary physiological role of leptin seems to be to send signals to the brain about the energy stores of the body and so to act as part of a feedback mechanism that can function as a 'lipostat' (Malecka-Tendera and Molnár, 2002; Caprio and Tamborlane, 1999). The ability to recover weight lost during periods of limited access to food is important for survival and hypothalamic interactions are key in this response. Human leptin mRNA and the protein are regulated by changes in body fat and food intake. Leptin has been found to have a positive correlation with BMI and fat mass, a negative correlation to fat-free mass and is usually higher in obese children relative to lean children. Any weight loss due to a decrease in adipose mass corresponds with a decrease in circulating leptin concentrations (Venner *et al.,* 2006).

It is theorized that the presence of chronically high leptin concentrations in overweight individuals is a result of resistance to the effects of leptin in these individuals. Children with high leptin levels are at an increased risk for gain in fat mass due to leptin resistance. The inherent leptin resistance in children may serve as a salient indicator of risk for greater adipose growth (Fleisch *et al.,* 2007).

Significantly higher leptin levels have been seen in obese adolescent girls when compared with obese adolescent boys. Subcutaneous fat synthesises more serum leptin than other fat depots. Females thus have greater amounts of subcutaneous fat; therefore they have higher leptin concentrations than boys. The gender differences in serum leptin concentrations may also be explained by a suppressive effect of testosterone on leptin production in boys and by the stimulatory effect of oestradiol on leptin concentrations in girls (Nishimura *et al.,* 2007; Venner *et al.,* 2006; Malecka-Tendera and Molnár, 2002).

b. Insulin

The hormone insulin is responsible for maintaining energy homeostasis through the coordination of the use of fat depots in adipose tissue, liver and muscles (Cañete *et al.,* 2007). During fasting, insulin levels fall and glycogen is mobilised. When blood glucose levels increase, insulin secretion increases and the rate of glucagon secretion decreases. This in turn decreases plasma glucose (Rolfes *et al.,* 2009: 113).

Insulin promotes fat storage and inhibits the breakdown of lipid stores. Fat storage is stimulated by insulin's contribution to adipocyte differentiation through its inhibition of lipolysis and its stimulation of lipogenesis. Inhibition of lipolysis occurs through the inhibition of the hormone-sensitive lipase translocation to the lipid droplet. Translocation of the lipase to the lipid droplet in the adipocyte is required for the liberation of free fatty acids (FFAs) from stored triglycerides by hormone-sensitive lipase. Insulin also promotes intracellular fatty acid transport by stimulating translocation of fatty acid binding proteins to the plasma membrane (Cañete *et al.,* 2007).

Increased levels of triglycerides are known to occur in children with insulin resistance. FFAs inhibit the degradation of hepatic glycogen, and stimulate gluconeogenesis. FFAs also inhibit LPL and therefore reduce plasma clearance of triglycerides and VLDL. Hyperinsulinaemia and insulin resistance in obese children display a significant direct correlation with FFA levels (Cañete *et al.,* 2007).

2.4.3 HEREDITABILITY

Genetic heritability estimates are based on adoption studies which compare pairs of identical and fraternal twins who are either raised together or apart (Bouchard, 2009). The genetic effect on BMI is fully expressed in childhood and children have BMIs closer to those of their biological parents than to those of the parents who raised them (Bouchard, 2009; Guillaume and Lissau, 2002). These twin and adoption studies show a genetic contribution for BMI of between 40 and 70% (Farooqi, 2005).

Cross-sectional observational studies also support the findings that there are family lines in which childhood obesity clusters (Demerath *et al.,* 2007; Dubois *et al.,* 2007). Individuals with parents and siblings with a high BMI are at an increased risk of being obese as compared with individuals who have only normal weight parents (Bouchard, 2009; Li *et al.,* 2007). A mother's BMI has particularly been shown to be a significant predictor of the obesity status of her child (Tanasescu *et al.,* 2000).

A number of inherited disorders in which childhood obesity is a clinical feature also exist. The majority of obese children do not have a specific syndrome linked to obesity, but these syndromes account for approximately 1 – 2% of total cases of childhood obesity. These syndromes may be associated with mental retardation, dysmorphic features and organ-specific developmental abnormalities (Lobstein *et al.,* 2004). Examples of inherited disorders linked to obesity include Down syndrome, Prader-Willi syndrome, Bardet-Biedl syndrome, Albright's hereditary osteodystrophy and Cohen syndrome (Farooqi, 2005; Lobstein *et al.,* 2004).

2.4.4 ETHNICITY

The effect of immigration on obesity has been most extensively studied in the USA (Bates *et al.,* 2008). These studies indicate that some races are more prone to become obese than others in societies where there is an abundance of food. For example, obesity is more common in blacks and Hispanics compared with whites in the United States (Ogden *et al.,* 2006). It is well known that obesity is highly hereditable (Farooqi and O'Rahilly, 2006) and it is likely that genetic factors contribute to the ethnic differences in obesity and its related comorbidities (Cossrow and Falkner, 2004).

Several studies have shown that black women in the US have higher rates of weight gain than do white women (Ogden *et al.,* 2006; McTique *et al.,* 2002). Freedman *et al.* (2005) reports that black and white girls had similar BMI levels when they were first examined for their study in the 1970s but the annual increases were larger among black girls throughout childhood and adulthood. This is also true for the South African population where it has been noted that as age increased, percentage overweight and obesity also increased in black girls in contrast to white girls (Armstrong *et al.*, 2006).

The racial difference in body image perception in South Africa stems from the fact that black women seem to have a larger ideal body size and are less likely to perceive themselves as overweight. In African culture it is often desired for girls to be overweight as it indicates wealth and happiness, whereas, white girls are more susceptible to be influenced by the Western beauty ideal. Coupled to this, obesity and overweight within the African culture may serve to show that a person does not have HIV/AIDS. This influence is important considering the current AIDS epidemic in sub-Saharan Africa (Armstrong *et al.,* 2006; Goedecke *et al.,* 2006).

2.4.5 NUTRITION

The role of energy or fat intake in the development of childhood and adult obesity remains inconclusive. This may be related to the large measurement errors associated with the assessment of energy intake in general and underreporting among obese children (Tanasescu *et al.,* 2000).

Recent observations in countries undergoing rapid economic development, such as South Africa, have reported that while undernutrition and infectious diseases continue to be highly prevalent, the prevalence of overweight and chronic metabolic diseases is increasing (Bourne *et al.,* 2006). This paradox is due to improved access to food, decreased physical activity and the consumption of "Western" diets. The combination of these factors create an environment that may predispose persons to becoming overweight and obese (Hoffman, 2004).

Adolescence is a period of growing independence including increased opportunities to make decisions about what and when to eat. Adolescents are maturing not only physically but also cognitively and psychosocially. They search for their identity, acceptance and are concerned about appearance. Adolescents spend time away from home as a result of social, school and work commitments, therefore irregular meals, snacking, eating away from home, and following alternative dietary patterns characterise the food habits of adolescents. These habits are further influenced by family, peers and the media (Spear, 2004; Videon and Manning, 2003).

2.4.5.1 Relationship between nutrition and obesity

In its simplest terms obesity is caused by a chronic positive energy balance, that is, an excess of energy input over output. The magnitude or rate of this energy imbalance can be surprisingly small, but must be sustained for a long period for a non-obese child to become obese (Reilly, 2006). Several longitudinal and cross-sectional studies have been conducted to investigate the relationship between nutrition and total adiposity. Some studies failed to find a relationship between total fat intake and obesity (Langevin *et al.,* 2007; Phillips *et al.,* 2004), whilst others have demonstrated a positive association (Li *et al.,* 2007; Gillis *et al.,* 2002).

Adolescent eating patterns are established through a process which involves internal and external factors. These factors include food preferences and availability, body weight perception and parental and peer influences. Poor eating patterns may result in nutritional problems that can impair growth and development. Eating habits formed in adolescence continue into adulthood and therefore have important implications for health and adulthood (Videon and Manning, 2003).

Dietary restraint, which involves voluntary restriction of food intake (involving denial of hunger cues and skipping meals); exercise for weight control purposes and the use of appetite suppressants or laxatives are common weight-reduction measures used by adolescents (Spear, 2006; Stice *et al.,* 2005). These practices predict the onset of obesity and normally result in weight gain rather than weight loss (Stice *et al.,* 2005).

Field *et al.,* (2003) refers to three possible mechanisms through which energy restriction could lead to the development of overweight. First, dieting may result in an increase in metabolic efficiency. This may lead to dieters requiring less energy to maintain weight. In many cases, weight gain occurs when dieters return to their normal eating habits, as often happens because restrictive diets are rarely maintained for extended periods of time. Second, dieting may lead to a cycle of energy restriction followed by binge eating. It is suggested that dieting results in an erratic delivery of nutrients for use by the body. This deregulates the normal appetite system and is thought to promote weight gain. Finally, dieters usually obtain a higher percentage of energy from carbohydrates. This physiologic response to oral glucose suggests a possible mechanism linking high carbohydrate intake to weight gain (Stice *et al.,* 1999).

2.4.5.2 Food intake distribution

Children who skip breakfast are at an increased risk of weight gain. The exact mechanism of this phenomenon is unclear. However, eating breakfast may be associated with decreased fat intake and decreased snacking later in the day. Eating breakfast may also be a marker of more organized family routines that indicate better health behaviour overall (Lobstein *et al.,* 2004).

In obese adults, extreme cases have been characterized by morning anorexia and massive eating in the late hours of the day or even during the night. The 'night eating syndrome' may be present in many obese children (Rolland-Cachera and Bellisle, 2002).

Night eating syndrome (NES) occurs when people eat inappropriately during arousals from nocturnal sleep (O'Reardon *et al.,* 2004; Winkleman, 2003). The syndrome is characterized by compulsive eating of high energy foods at night and morning anorexia. During episodes of NES the person is fully aware, compulsive eating occurs and it is difficult to suppress. NES patients do not have amnesia and sleep disorders are not common (Winkleman, 2003).

The circadian rhythms of eating and sleep are usually synchronized in such a way that food intake does not occur at night. In persons with NES, there is a possible dissociation between circadian patterns of eating and sleeping (O'Reardon *et al.,* 2004).

2.4.5.3 Daily number of meals

There is an increased tendency for well-defined eating occasions in both adults and young people (Lobstein *et al.,* 2004). Some researchers have failed to find clear, consistent evidence linking daily number of eating occasions with overweight and obesity (Bellisle, 2004; Nicklas *et al.,* 2004). However, Toschke *et al.,* (2005) found that an increased meal frequency was inversely related to prevalence of childhood overweight and obesity (Toschke *et al.,* 2005).

Obese adolescents tend to eat less in the morning than their lean counterparts and to eat more in the afternoon and evening (Berkey *et al.,* 2003; Bellisle, 2004). It is not known whether this daily distribution of eating is a cause or a consequence of the obese status (Bellisle, 2004).

Adolescents miss an increasing number of meals at home as they get older. Breakfast and lunch are often the meals most frequently missed. They identify time as the biggest barrier to eating properly. They perceive themselves as too busy to worry about food or eating well. At the same time eating outside the home has increased over time and food eaten away from home tends to be higher in fat and low in fibre than food prepared at home (Rennie *et al.,* 2005; Spear, 2004).

2.4.5.4 Snacking

Snacking is described as a secular trend in all age groups away from the traditional three-meals a day eating pattern towards more frequent and informal eating occasions (Rennie *et al.,* 2005). Snacks tend to be more energy-dense than meals. Large quantities of energy can thus be eaten outside mealtimes as snacks and as semi-automatic nibbling where the consumer is not fully aware of the amount of food ingested. Long hours in front of the television set are potentially free for semi-conscious stomach filling with ‘junk’ foods. This intake is unlikely to be reported accurately in dietary surveys because in some cases what constitutes a snack and what constitutes a meal may be somewhat blurred (McKinley *et al.,* 2005; Rolland-Cachera and Bellisle, 2002).

2.4.5.5 Binge eating

Persons with binge eating, experience a feeling of powerlessness over their eating. Emotional distress such as feelings of disgust, guilt and depression occur after a binge. Patients with binge eating have a higher prevalence of major depression, substance abuse and personality disorders (Schebendach, 2008).

Binge eating without purging is prevalent in obese individuals (Decaluwé *et al.,* 2003; Rolland-Cachera and Bellisle, 2002) and according to Tanofsky-Kraff *et al.,* (2006) and Stice *et al.,* (2005), self reported binge eating attempts are strong predictors of increases in body fat mass in children.

Obese children who are binge eaters tend to display more eating and weight-related disturbances than obese children without binge eating. These children tend to have more eating, weight and shape concerns. Obese binge eaters have low levels of self-reported physical appearance and self-worth than obese non-binge eaters (Decaluwé *et al.,* 2003).

2.4.5.6 Food preferences

Adolescents often show aversions to nutritious foods. Possible explanations for this inclination are found in literature (Sothern, 2004). Sothern (2004) states that parental influences are early determinants of food attitudes and practices in young children. Foods presented as rewards enhance preference for that food. Providing rewards for consuming nutritious foods initially enhances preference for that food but later produces a negative shift in preference for the nutritious food. McKinley *et al.* (2005) reported time, convenience, taste, mood, cost and appearance amongst others as factors identified by adolescents as barriers to healthy eating.

Fast foods as meals or snacks are especially popular with busy adolescents. Fast foods include foods from vending machines, restaurants and franchised food restaurants. These foods are perceived to be time-saving and more cost-effective than ‘healthy’ foods. Fast foods also ‘taste and look good’, and are therefore more acceptable to adolescents (Sokol, 2000). In fact fast foods are normally high in saturated and trans fats, low in fibre, high in glycaemic index, have a high energy density and tend to be low in iron, calcium, riboflavin and vitamin A as well as folic acid. The vitamin C content of fast foods is also low unless fruit or fruit juice is consumed (Spear, 2004). Table 2.1 shows the negative associations with healthy foods and the positive associations with “junk” foods that may be formed by adolescents (Spear, 2004; Ebbeling *et al.,* 2002).

Table 2.1 – Situations and feelings associated with eating junk foods and healthy foods (Spear, 2004)

Junk foods	Healthy foods
• Being with friends • Being away from home or parents • Being at the mall or store • Snacking • Enjoyment and pleasure • Not being in control, over-eating, guilt, disgust	• Being with parents • Staying home • Eating meals • Being concerned with weight and appearance • Self-control

2.4.5.7 Portion sizes

Most portions of marketplace food items are double that of the recommended sizes. Foods served in pre-packed units may be more likely to prompt over-consumption since the amount consumed is often influenced by this fixed serving size and the concept of leaving food is often ingrained as undesirable in many cultures (Rennie *et al.,* 2005; Sothern, 2004).

2.4.5.8 Other behavioural factors

Some obese subjects have a tendency to eat faster than their lean controls. They fail to respond to satiety sensations and in the clinical setting some obese subjects claim that they never experience satiety. These characteristics could be secondary to chronic dieting but could reflect fundamental metabolic and/or behavioural problems. It should always be remembered that, whilst some obese subjects have obvious behavioural problems such as nibbling, gorging and bingeing, many never show this sort of behaviour (Rolland-Cachera and Bellisle, 2002).

2.4.6 PSYCHOSOCIAL FACTORS

With obesity increasing in both adult and child populations, interest in the social context and psychological consequences of obesity has also risen (Hill and Lissau, 2002).

2.4.6.1 Socioeconomic status

The prevalence of obesity shows an interesting relationship with social development. Increasing economic development is associated with increases in the prevalence of paediatric obesity in developing countries (Reilly, 2005). In these developing countries, where life has been a little better than subsistence living, overweight and obesity in childhood are virtually confined to children from affluent urban families. In westernized societies obesity is usually more prevalent in areas of social deprivation and poverty (Reilly, 2006).

The reasons for the prevalence of obesity in deprived populations in western society are not clear. Research also does not find this relationship consistently. If it was better understood why obesity was so strongly associated with social deprivation under certain circumstances, it might be easier to design prevention and treatment programmes that could tackle the causes of obesity successfully (Guillaume and Lissau, 2002).

Low levels of education are associated with a higher prevalence of obesity (Wang and Beydoun, 2007) and adolescents whose parents are more educated and from higher-income families are more likely to have lower BMIs (Xie *et al.,* 2003). This can in part be explained by the fact that higher parental education is also associated with health consciousness in food choices (Patrick and Nicklas, 2005).

The impact of socio-economic status (SES) on the prevalence of obesity also seems to be mediated by gender, with adolescent girls from low SES having a higher prevalence of obesity than medium and high SES girls. High SES black adolescent girls were at increased risk compared to low-SES girls (Wang and Beydoun, 2007).

2.4.6.2 Children's self worth (self esteem)

Body image encompasses an individual's body-related self-perceptions and self-attitudes, and is linked to self-esteem, interpersonal confidence, eating and exercise behaviours, sexual experiences and emotional stability. Among adolescents body shape and body weight dissatisfaction have been associated with a number of psychological ills from eating disorders to major depression. There is a tendency for preadolescent and adolescent girls to express a preference for a slimmer figure and this has a marked effect of actual weight. Overweight children's desire to be thinner is almost always unanimous. These children also express the greatest dissatisfaction with their weight and figure. Overweight adolescents are at an increased risk for depression, poor body image, reduced self-esteem and reduced self-competence in the areas of physical appearance, close friendship and behavioural conduct. For adolescent boys, higher BMI was associated with reduced self-competence in physical appearance, athletic competence and romantic appeal (Huang *et al.,* 2007; Hill and Lissau, 2002).

2.4.6.3 Parental influences

Parents can influence their children's dietary practices, physical activity, sedentary habits and body satisfaction by controlling availability, accessibility of foods, meal structure, food socialization practices and food-related parenting style (Golan and Crow, 2004).

Parents may negatively influence their children's dietary intake and ability to self-regulate by either applying excessive external control or failing to offer healthful options. Controlling a child's intake can refocus the child away from responsiveness to internal cues of hunger and satiety. This means that the child's normal internal cues to self-regulate hunger and satiety may become unbalanced (Lindsay *et al.,* 2006; Ritchie *et al.,* 2005).

Limiting highly palatable foods that are in the home may actually promote the children's desire for such foods, causing dysregulatrion of energy intake, overeating and ultimately weight gain in children (Ritchie *et al.,* 2005). Imposing strict controls can also increase children's preferences for high-fat, energy-dense foods (Lindsay *et al.,* 2006). On the other hand using food as a reward increases a child's preference for that food, whereas pressuring or prompting a child to eat to obtain a reward tends to decrease a child's preference for the prompted food (Ritchie *et al.,* 2005).

The parent's eating behaviours may contribute to the development of overweight in their children. This could be a result of parents usually having foods that they like in the household (Lindsay *et al.,* 2006; Patrick and Nicklas, 2005). Therefore, if parents overeat, their children may overeat too. The types of food available and accessible in the home are also linked with weight status of children (Lindsay *et al.,* 2006).

2.4.6.4 Peer pressure

During adolescence, increasing amounts of time are spent with peers. Peer experiences represent an important social context for the development of body image among adolescents (Jones and Crawford, 2006; Jones *et al.,* 2004).

Heavier body weights and shapes are socially undesirable for both girls and boys, but they create a heavier burden for girls than boys. For overweight girls, being accepted by peers depends on them conforming more closely to the thin ideal (Jones and Crawford, 2006; Jones *et al.,* 2004).

Peers provide social pressure when they make suggestions for body change strategies. Adolescents who engage in frequent conversations about appearance with friends are more likely to have greater feelings of dissatisfactions with their bodies. This peer pressure for body change can have a lasting impact for adolescents and often leads to body dissatisfaction (Jones and Crawford, 2006; Jones *et al.,* 2004).

A relationship between teasing and obesity has been established and this usually leads to disturbed eating patterns. While social support generally acts as a buffer against the negative effects of life stress, teasing and bullying by peers can be very hurtful. Adolescents with eating disorders have a greater history of being teased about their appearance (Jones and Crawford, 2006; Young *et al.,* 2001).

2.4.6.5 The media

Television and magazines probably have a greater influence on adolescents' eating habits than any other form of mass media. Most of the advertisements on television feature food, most of which is high in fat, sugar and salt. There are very few, if any, advertisements that include fruit and vegetables (McKinley *et al.,* 2005; Golan and Crow, 2004). Viewing food advertisements while watching television often leads children to request such foods, and thus appears to influence children's dietary patterns (Anschutz *et al.,* 2009).

Adolescence is an age during which there is an increasing awareness of body shape and size together with a raised consciousness of the media, both of which influence eating patterns. Television viewing exposes the youth to thin images, which are frequently idealized by the immature individual who is preoccupied with identity issues such as adolescents are (McKinley *et al.,* 2005; Golan and Crow, 2004; Sothern, 2004).

The information they obtain from such magazines is not likely to be appropriate for this age group. Failing to use this medium as a channel for positive communications about nutrition may mean that this age group looks in other less suitable places for this information. Television advertisements and celebrities may be a source of positive (such as the association prompted between food, nutrition and sport) or negative influence (such as information about the latest fad diet the stars are following). Teenagers' discontent with their body shape and size is related to the frequency of reading magazines and the reading of magazines has also been associated with the amount of dieting to lose weight (Spear, 2006; McKinley *et al.,* 2005; Spear, 2004).

2.4.7 PHYSICAL ACTIVITY

Normal growth in children involves large fluctuations in both daily energy intake and expenditure and hence acute daily fluctuation in energy balance. In growing children, energy and substrate intakes must be chronically greater than energy expenditures and total substrate oxidation in order to accommodate normal growth. Thus obesity in children can be viewed as 'overgrowth' of the adipose tissue normally synthesized to achieve normal body composition (Schutz and Maffeis, 2002).

2.4.7.1 Components of energy expenditure

Basal metabolic rate (BMR) or resting energy expenditure (REE) is the largest component of total energy expenditure (TEE) in children, especially for those with sedentary and light activity behaviours. It reflects the energy needed for the work of vital functions. The most important determinant of BMR is body size and in particular the fat-free mass of the body (Frary and Johnson, 2008; Dulloo and Schutz, 2005). Greater REE in the obese can thus be explained by larger amounts of metabolically active tissue or fat free mass (FFM) (Bosy-Westphal *et al.,* 2004).

Thermic effect of food (TEF) represents the net rise in heat production when a food is ingested under standardized resting conditions, and is small in comparison with the REE component. Meal size, meal composition, the nature of the previous diet, insulin resistance, physical activity, and aging all influence TEF. The TEF is made up of an obligatory component related to the energy value of the food consumed and a facultative component that presumably responds to overeating by eliminating the excessive energy in the form of heat. There is support for the hypothesis of a defect in MIT in obese persons, but it is not clear whether this defect causes the obesity or results from obesity (Gee, 2008; Denzer and Young, 2003).

Quantitatively, physical activity is the most variable component of TEE since the energy spent on physical activity depends on the type and intensity of the activity and on the time spent in different activities. The energy expended in a physical activity depends largely upon body weight. The greater the body weight, the greater the energy cost of a specific activity. In terms of daily energy expenditure, physical activity can represent up to 70% of daily energy expenditure in an individual involved in heavy work. For most people, however, the contribution of physical activity to daily energy expenditure is relatively small (10 – 15%) (Frary and Johnson, 2008; Dulloo and Schutz, 2005).

2.4.7.2 Energy intake and energy expenditure

An increase in energy supply has made a major contribution to the obesity epidemic (Stubbs and Lee, 2004). Increasing energy consumption (especially from high-fat, energy-dense foods), decreasing energy expenditure, or a combination of both has led to a positive energy, which contributes to an increase in weight (Stein and Colditz, 2004; Raben *et al.,* 2003).

Obese children appear to have greater metabolic 'efficiency' and/or reduced levels of physical activity, when compared with nonobese children. Obese children and adolescents consume more food energy than their lean counterparts. Obese children often prefer diets rich in fat. Low fat diets cause a reduction in food intake, because they are bland and difficult to swallow and also because of their low energy density. In contrast the higher energy density of fatty foods, their low bulk which leads to diminished gastric distension and gastric emptying and their greater palatability compared with low-fat foods encourage high fat intakes. This small effect is a contributing factor to fat gain (Dulloo and Schutz, 2005; Schutz and Maffeis, 2002).

2.4.7.3 Reduced energy expenditure

Reduced physical activity due to a sedentary lifestyle is associated with low TEE. Several factors have contributed to the reduction of physical activity in children, including the reduced requirements for physical activity in schools; the increasing recreational use of video and computer games, the Internet and television. The amount of time that children spend playing outside has diminished over the past few decades. The reliance on the family car as the common means for parents to deliver their children to their various activities has also led to this reduction. (Schutz and Maffeis, 2002; Sokol, 2000; Strauss, 1999).

The level of activity required for work and daily living has changed. With advances in technology, there has been a reduction in the dependence on walking and cycling for transportation. Household physical activity has decreased due to labour-saving devices. Occupational energy requirements have also dropped as mechanized labour aids have become available. Jobs in general have become more sedentary (Stein and Colditz, 2004).

Slight increases in physical activity over a long duration may be more appropriate for fat gain since aerobic activity favours fat oxidation. Modest activity creates a smaller cardiac load than high-intensity activities of short duration and high-intensity activity may be compensated by increased placidity during the recovery period (Schutz and Maffeis, 2002).

2.4.7.4 Impact of television on physical activity

Time spent watching television and playing video games is positively associated with increased BMI in childhood (Lioret *et al.,* 2007) and it appears to be a better predictor of BMI than dietary intake or physical activity. With the increase in television channels and pay satellite television, viewing hours have increased. More homes have video or DVD players and this further increases television viewing time. Therefore, opportunities for ‘screen time’ are higher for children today (Hancox and Poulton, 2006). Another factor contributing to the increased ‘screen time’ is the fact that an increasing number of children have television sets in their bedrooms. These children in turn, watch more television than those without a set in their rooms (Christakis *et al.,* 2004).

Television viewing does not only influence BMI due to its sedentary nature, but may also impact on eating habits. This relationship between television viewing and increased energy intake could operate through a number of behavioural pathways, such as the greater opportunity to consume snacks whilst being inactive or through the influence of programme content or advertising of foods on food choice and dietary habits (Cooper *et al.,* 2006; Rennie and Jebb, 2003)

2.5 CONSEQUENCES OF CHILDHOOD OBESITY

Obesity and its associated metabolic consequences are major impediments to quality of life and are among the most important public health problems in many countries today. Once obesity is diagnosed, it is important to recognize the small proportion of obese children who have specific syndromes or pathology underlying their obesity. However, the vast majority of obese children remain those whose obesity does not seem associated with any underlying medical cause (Zwiauer *et al*., 2002; O’Loughlin *et al.,* 2000).

Nonpsychologic health consequences of overweight are less common in childhood and adolescence than in adulthood (Fowler-Brown and Tahwati, 2004).

2.5.1 PUBERTAL DEVELOPMENT

Overweight children develop a characteristic set of physical traits. On average obese girls have lower age at menarche compared with nonobese girls. The hypothesis that the timing of menarche depends on a critical mass of body fat is supported by this. Obese adolescents grow taller than their peers at first, but then stop growing at a shorter height. Advanced bone age and obesity are also associated with early sexual maturity and obese children develop greater bone and muscle mass in response to the demand of having to carry more weight – both fat and lean weight (Whitney and Rolfes, 2005: 564; Zwiauer *et al*., 2002).

The onset of puberty can be difficult to judge in obese girls since collections of subcutaneous fat in the mammary region in prepubertal, tall-for-age obese girls may be confused with true puberty. Early maturation shown by peak height velocity and age of menarche is also associated with increased fatness in adulthood and with increased abdominal obesity in women (Zwiauer *et al*., 2002).

2.5.2 COSMETIC PROBLEMS

A high proportion of children with acanthosis nigricans (AN) are obese (Guran *et al.,* 2008). AN is a rare skin condition occurring in association with a wide variety of clinical pathology. There is thickening and darkening of skin folds, particularly at the back of the neck, in axillae and groins and under the breasts (Jabbour, 2003). The darkening of the skin is apparently due to hyperkeratosis (Scheinfeld, 2004).

Biochemical mechanisms for developing acanthosis nigricans involve significant insulin resistance at the cellular level, with compensatory hyperinsulinaemia. Hyperinsulinaemia stimulates insulin-like growth factor receptors, with a subsequent induction of keratinocyte proliferation (Scheinfeld, 2004; Jabbour, 2003).

In both sexes gross obesity is very disfiguring. In obese girls, hirsutism and acne are often obvious. For obese boys the most troubling problems are often pseudo-gynaecomastia and pseudo-hypogenitalism. Apparent hypoplasia of the genetalia may accompany the gynaecomastia suggesting hormonal abnormalities. Usually the apparent hypoplasia is due to external genitalia being buried by lower abdominal fat and thus appearing disproportionately small considering the boys' overall size (Zwiauer *et al*., 2002).

2.5.3 HORMONAL PROBLEMS

In adolescent girls and young women, excess central or abdominal body fat is associated with high androgen levels. Hyperandrogenism in females presents with acne, hirsutism and menstrual disturbances (Speiser *et al.,* 2005; Scheinfeld, 2004).

There is a causal relationship between high androgen activity and hyperinsulinaemia in women and insulin resistance correlates strongly with the abdominal fat in obese adolescent girls. Insulin resistance stimulates ovarian as well as adrenal androgen and oestrogen production. These hormonal disturbances place the obese adolescent girl at a high risk of menstrual disorders and early onset polycystic ovarian syndrome (Speiser *et al.,* 2005).

2.5.4 CARDIOVASCULAR COMPLICATIONS

In South Africa, 4.8 million people (10% of the total population) presented with hypercholesterolemia, with 3.1 million people having raised low density lipoprotein (LDL) cholesterol levels (Goedecke *et al.,* 2006). Obese children and adolescents are at an increased risk of future cardiovascular disease. The children display a blood lipid profile indicative that atherosclerosis is beginning to develop, i.e. high levels of total cholesterol, triglycerides, and LDL cholesterol (Whitney and Rolfes, 2005: 564; Sothern *et al.,* 2000).

Cardiovascular disease involves atherosclerosis which develops when regions of an artery's walls become progressively thickened with plaque. The extent of the atherosclerotic lesions in childhood and adolescence is predicted by the number of cardiovascular risk factors present. If it progresses, atherosclerosis may eventually block the flow of blood to the heart and cause a heart attack or cut off blood flow to the brain and cause a stroke. Infants are born with healthy, smooth, clear arteries, but within the first decade of life, fatty streaks may begin to appear. During adolescence these fatty streaks may begin to accumulate fibrous connective tissue (Rolfes *et al.,* 2006: 547; Reilly *et al.,* 2003).

Endothelial dysfunction is one of the earliest signs of increased risk for cardiovascular disease and has been shown to be predictive of cardiovascular events. In obese children, endothelial dysfunction is related to the severity of obesity (Miller *et al.,* 2004). By early adulthood, the fibrous plaques may begin to calcify and become raised lesions, especially in boys and young men. As the lesions grow more numerous and enlarge, the heart disease rate begins to rise, most dramatically at about age 45 in men and 55 in women. From this point on, arterial damage and blockage progress rapidly, and heart attacks and strokes threaten life. Therefore, the consequences of atherosclerosis, which become only apparent in adulthood, have their beginnings in the first decades of life. The magnitude of this problem is likely to be much greater now than in the past following the rising epidemic of childhood obesity (Rolfes *et al.,* 2006: 547; Reilly *et al.,* 2003).

Overweight and hypertension are common conditions in the South African black adult population. Several factors have been suggested to be related to the blood pressure level in children and they include amongst others obesity, low physical activity, dietary factors as well as social influences (Monyeki *et al.*, 2005).

Overweight children tend to have high blood pressure. In fact, obesity is the leading cause of paediatric hypertension. High blood pressure may signal an underlying disease or early onset of hypertension and accelerates the development of atherosclerosis. Like atherosclerosis and high blood cholesterol, hypertension may develop in the first decades of life, especially among obese children. Hypertension occurs approximately nine times more frequently amongst obese than nonobese children with elevated systolic or diastolic blood pressures in 20 – 30% of obese children (weight > 120% of ideal body weight). Children can control their hypertension by participating in regular aerobic activity and by losing weight or maintaining their weight as they grow taller (Rolfes *et al.,* 2006: 549; Whitney and Rolfes, 2005: 564; Zwiauer *et al*., 2002).

2.5.5 ORTHOPAEDIC PROBLEMS

Overweight children are susceptible to developing bony deformities that can predispose them to other orthopaedic problems later in life. Excess weight may cause injury to the growth plate and result in slipped capital femoral epiphysis, tibia vara (Blount's disease), flat kneecap pressure/pain, flat foot, spondylolistheis (low back pain), scoliosis, and osteoarthritis (Speiser *et al.,* 2005).

Blount's disease generally occurs after 8 years of age. Blount's disease presents as visible bowing of the lower extremities. Slipped capital femoral epiphysis occurs between 9 and 16 years of age and affects boys more often than girls. These children have hip or knee pain and pain with walking (Barlow *et al.,* 2007).

Overweight children and adolescents report more fractures and musculoskeletal discomfort. The fractures are due to poorer balance in overweight children than in normal weight children. This poor balance increases their risk for falling during daily activities and impedes their ability to halt their forward progress once they begin to fall (Taylor *et al.,* 2006).

2.5.6 GASTROINTESTINAL COMPLICATIONS

Non-alcoholic fatty liver disease (NAFLD) represents fatty infiltration of the liver without excessive alcohol consumption (Weiss and Caprio, 2005). This condition is not confined to adults but is now the most common liver disease among obese adolescents in North America (Lavine and Schwimmer, 2004). NAFLD includes simple steatosis, steatohepatitis, fibrosis and cirrhosis (Barlow *et al.,* 2007).

NAFLD generally causes no symptoms, although some patients may have right upper quadrant abdominal pain or tenderness or mild hepatomegaly (Barlow *et* *al.,* 2007). Characteristic biochemical findings in NAFLD include elevations in hepatic transaminases and increased alkaline phosphatise and y-glutamyl transpeptidase levels (Speiser *et al.,* 2005).

NAFLD in children may progress to cirrhosis and related complications. NAFLD is common in obese young people and is associated with increased visceral fat deposition. The association between abdominal obesity and fatty liver may be partially explained by consistent exposure of the liver to elevated free fatty acids (FFAs) (Weiss and Caprio, 2005).

The proportion of cholesterol excreted into the bile is elevated in obesity in comparison with the excretion of bile acids and phospholipids, increasing the likelihood of gallstones. Obesity is associated with 8 – 50% of all gallstones diagnosed in children, but accounts for the majority of gallstones in children and adolescents without underlying diseases (Barlow *et al.,* 2007; Kaechele *et al.,* 2006).

2.5.7 RESPIRATORY AND SLEEP-RELATED PROBLEMS

Overweight has been associated with significantly more severe symptomatology in asthmatic subjects. Obesity appears to increase the risk of development of asthma and asthmatic children who are obese have been shown to have significantly lower peak expiratory flow rates than those with lower BMIs. At the same time, asthma may be a risk factor for low levels of physical activity in obese asthmatic children especially for those with exercise-induced bronchospasm. Pulmonary–function tests show a high incidence of mild obstructive lung disease in obese children and this may predispose to the obesity-hypoventilation syndrome in adulthood (Reilly, 2005; Reilly *et al.,* 2003; Schacter *et al.,* 2003).

Obstructive sleep-disordered breathing (SDB) in childhood is due to a combination of high upper airway resistance and increased pharyngeal collapsibility leading to intermittent partial or complete upper airway obstruction during sleep. Increased upper airway resistance has been attributed to restriction of the upper airway lumen by oversized tonsils and adenoids. Traditionally, the child with adenotonsillar hypertrophy and obstructive sleep apnoea is underweight. However, as a result of the epidemic proportions of childhood obesity, clinical characteristics of paediatric SDB are changing with obese children with snoring being referred for polysomnography at an increased frequency (Kaditis *et al.,* 2007; Kelly and Marcus, 2005).

2.5.8 METABOLIC COMPLICATIONS

Childhood obesity is associated with a variety of metabolic and endocrine alterations, which do not become apparent for a long time but can be demonstrated biochemically before they cause clinical symptoms. These metabolic and endocrine disturbances are perceived as precursors of conditions associated with increased morbidity and mortality in adult life (Zwiauer *et al*., 2002).

Metabolic syndrome is a cluster of traits that include hyperinsulinaemia, obesity, hypertension and hyperlipidaemia and it may be present in as many as 30% of obese adolescents (Daniels *et al.,* 2006; Cook *et al.,* 2003). It is believed to be triggered by a combination of genetic factors in combination with environmental factors such as excess energy intake and reduced levels of physical activity. The primary cause of the syndrome appears to be obesity leading to excess insulin production, which is associated with an increase in blood pressure and dyslipidaemia (Daniels *et al.,* 2006). The prevalence of the metabolic syndrome increases with the severity of obesity (Weiss and Caprio, 2005).

2.5.8.1 Hyperinsulinaemia and type 2 diabetes

Obesity is associated with high fasting glucose and fasting insulin levels (Young *et al.,* 2000). The relationship between obesity and insulin resistance was originally explained by lipotoxicity. The lipotoxicity theory states that accumulation of excess fat in the muscle cells and hepatocytes interferes with insulin signalling, leading to the development of hyperglycaemia and glucose intolerance. However, it is now known that adipose tissue secretes a number of bioactive molecules, known as adipokines. These include proteins and cytokines that are associated with insulin metabolism. Tumour necrosis factor (TNF)-α and interleukin (IL)-6 are proinflammatory adipokines that play a direct role in insulin resistance by inhibiting insulin action (Miller *et al.,* 2004)

Numerous authors (Rolfes *et al.,* 2006: 547; Daniels *et al.,* 2005) documented the multiple effects of increased insulin resistance in combination with obesity. These include increased hepatic synthesis of very-low-density lipoprotein (VLDL), resistance of the action of insulin on LPL in peripheral tissues, enhanced cholesterol synthesis, increased high-density lipoprotein (HDL) degradation, increased sympathetic activity, proliferation of vascular smooth muscle cells and increased formation and decreased reduction of plaque as well as high blood pressure.

Type 2 diabetes had been primarily a disease of adulthood; however, type 2 diabetes is being diagnosed at a much younger age. The increase in childhood obesity is associated with an escalation in the incidence of type 2 diabetes (DuToit and Van der Merwe, 2003). Most of the children diagnosed with type 2 diabetes are diagnosed during puberty, but as children become more obese and less active, the trend is shifting to younger children. Also, type 2 diabetes is most likely to occur in those who have a family history of diabetes. This is a serious concern in view of the increased duration of diabetes and the likelihood of microvascular and macrovascular complications appearing in young adulthood (Rolfes *et al.,* 2006: 547; Daniels *et al.,* 2005; Young *et al.,* 2000).

2.5.8.2 Dyslipidaemia

Studies have revealed that childhood obesity and the acquisition of obesity with time are important determinants of adverse lipoprotein levels later in life.

Childhood obesity is associated with increased levels of LDL-cholesterol and triglycerides and decreased levels of HDL-cholesterol. The risk of hypertriglyceridaemia and LDL-hypercholesterolaemia in overweight children is higher than in normal weight children (Li *et al.,* 2005; Sothern *et al.,* 2000).

In adults it is known that a high level of fitness, an active life-style and decreased body fat are associated with decreased cardiovascular risk. This is mediated through increased levels of HDL, low LDL and triglyceride levels, and decreased blood pressure (Sothern *et al.,* 2000).

The degree of obesity is consistently more strongly associated with high total cholesterol and abnormal lipoprotein profiles in male than in female adolescents. Recent data (Rolfes *et al.,* 2006: 548) suggest that visceral fat distribution is associated not only with hyperinsulinaemia, but also with an unfavourable lipid profile. Data also show that a predominantly abdominal fat distribution in adolescent girls is associated with an adverse risk factor profile. These relationships are apparent throughout childhood, and their magnitude increases with age. Children who are both overweight and have high blood cholesterol are likely to have parents who develop heart disease early. For this reason, selective screening is recommended for children and adolescents whose parents (or grandparents) have heart disease; those whose parents have elevated blood cholesterol; and whose family history is unavailable (Rolfes *et al.,* 2006: 548; Zwiauer *et al*., 2002).

Rolfes and co-workers (2006: 548) suggest that in addition to overweight, health care professionals should establish whether children smoke or consume a diet high in saturated fat. Children with the highest risks of developing heart disease are sedentary and obese, with high blood pressure and high blood cholesterol. In contrast children with the lowest risks of heart disease are physically active and of normal weight, with low blood pressure and favourable lipid profiles.

2.5.9 PSYCHOSOCIAL PROBLEMS

Childhood obesity brings a host of emotional and social problems. Because people frequently judge others on appearance more than on character, overweight children are often victims of prejudice. Many suffer discrimination by adults and rejection by their peers. They may have poor self-images, a sense of failure, and a passive approach to life. Television shows, which are a major influence in children's lives, often portray the fat person as the bumbling misfit. Overweight children themselves may come to accept this negative stereotype (Wardle and Cooke, 2005; Whitney and Rolfes, 2005: 564).

During adolescence, obese children have to face a society which perceives the obese as lazy and stupid (Latner and Stunkard, 2003). In peer-group ranking of friends, obese children are liked less even than children affected by very severe handicaps. Not surprisingly, it is at this stage in life that these children often seem to become more lonely and depressed. They have low self-esteem and difficulties in peer-group relationships and these children have fewer friends, as a result. In addition to having fewer friends, being teased about weight is another important mediator of psychosocial distress (Daniels *et al.,* 2005; Strauss, 2000). Consequently, obese children and particularly obese adolescents demonstrate high levels of depression, anxiety, and disturbed body image (Barlow *et al.,* 2007; Daniels *et al.,* 2005; Braet *et al.,* 2004). Those with decreasing levels of self-esteem demonstrate higher rates of sadness, loneliness, and nervousness and are more likely to engage in high-risk behaviours such as smoking or consuming alcohol. Teasing in overweight youth has been shown to be associated with an increase in both their suicidal ideation and number of suicide attempts (Daniels *et al.,* 2005; Eisenberg *et al.,* 2003).

2.6 PREVENTION

The experimental evidence for the effectiveness of preventive strategies in reducing the prevalence of overweight at the child and adolescent population level is marginal. No single approach to the treatment of childhood overweight has been demonstrated to be more effective than another (Fowler-Brown and Tahwati, 2004).

Obesity prevention includes evidence-based public health, population-oriented and individual-oriented approaches. Population-oriented approaches focus on environmental and policy change while evidence-based public health approaches ensure that recommended strategies and actions will have their intended effects (Daniels *et al.,* 2005; Koplan *et al.,* 2005).

Obesity prevention should be public health in action at its broadest and most inclusive level. Prevention efforts require all levels of government to commit adequate and sustained resources for surveillance, research, public health programmes, evaluation and dissemination of information (Koplan *et al.,* 2005). Settings for preventive interventions should include schools and other childcare settings as well as local clinics (Daniels *et al.,* 2005).

The thermodynamic basis for obesity is a positive energy balance. If energy consumed in the diet exceed energy expended through exercise, then surplus energy is stored as fat. Therefore the way to prevent obesity is (in theory) very simple, i.e. obtain a negative energy balance. This encourages the conversion of stored fat into energy with resulting loss in weight. Consequently, obesity should be preventable through increasing energy output through physical activity and by reducing energy intake in the diet (Lissau *et al.,* 2002).

When planning strategies or programmes for prevention of overweight and obesity, it is essential to identify modifiable risk factors that can guide the design and implementation of these programmes. It is important for health practitioners to recognise that many overweight children will not lose their overweight status through linear growth, and therefore, it is both justified and necessary to intervene at early ages (O'Loughlin *et al.,* 2000; Tanasescu *et al.,* 2000).

Prevention strategies should be designed with specific knowledge of the target audience and the best way to engage them in the process of change. The strategies should focus on understanding the nutritional and socio-psychological causes of obesity in children; examining the effects of the natural history and pathophysiology of obesity on common childhood developmental issues; characterising the medical, social, educational, and emotional consequences of obesity in childhood; and developing effective preventative strategies and treatments for the complications of obesity itself. Identifying these factors will increase the probability that the individual or group will pay attention to, participate in, and be motivated by the change process (Daniels *et al.,* 2005; Sokol, 2000).

During infancy and early childhood, preventive measures should focus on the promotion and protection of breastfeeding. Several reports suggest that this may be a powerful strategy for fighting the increasing levels of childhood obesity because breastfed infants seem to self-regulate their energy intake at a lower level than do formula-fed infants (De Onis and Blössner, 2000).

2.6.1 Increase energy expenditure

The first step towards increasing activity is to restrict sedentary activities in children. Making exercise readily accessible at all ages in schools and residential areas is another element for increasing activity levels. Schools should be encouraged to institute standards for physical activity by including 30 – 45 minutes of exercise two to three times per week (Speiser *et al.,* 2005).

Being physically active leads to improved body composition (i.e. increased lean muscle mass, reduced total body fat), improves physical fitness, lowers blood pressure, improves metabolic status (e.g. insulin sensitivity), and improves sense of well-being. It increases bone mineralization and also helps maintain the structure and functional strength of bone throughout life. Another benefit of increased physical activity is the reduction in total energy and fat intake. This is due to the fact that high-fat snack foods are usually consumed during periods of sedentary behaviour such as television watching and a decrease in opportunities to be sedentary decreases the opportunity to eat (Epstein *et al.,* 2005; Spear, 2004).

Interventions that concentrate on increasing physical activity levels must pay particular attention to the development of self-confidence in children and in their ability to increase their levels of physical activity (Tanasescu *et al.,* 2000). The following are recommendations for intervention strategies to promote physical activity in children and adolescents (Spear, 2004):

- Make physical activity enjoyable.
- Help adolescents succeed and increase their confidence in their ability to be physically active.
- Support adolescents' efforts to be physically active.
- Help adolescents learn about the benefits of physical activity, and help them develop positive attitude towards it.
- Help adolescents overcome barriers that keep them from being physically active.

Parental support is positively related to physical activity. Parents organising activities and providing transport encourage physical activity amongst older children and younger adolescents. Social influences such as physically active role models and role-model support for physical activity are important determinants of activity amongst young people. Some simple aims for the family to reduce inactivity are to (Lissau *et al.,* 2002):

- encourage physical activity in children;
- walk or cycle to school;
- exercise regularly as a family;
- involve children in home activities such as cooking, washing clothes, cleaning, gardening or dog walking; and
- encourage hobbies and interests which divert children from the pastime of watching television.

2.6.2 Reduce energy intake

Consumption of energy-dense food and sugar-sweetened drinks plays an important role in the development of overweight and obesity. Healthy eating involves not only attention to the quantity and quality of foods but also to the circumstances under which foods are eaten. Eating meals as a family should be an important part of family life and contribute to the development of sound dietary practices. Regular meals are important not only in terms of the quality and quantity of food provided, but also in the frequency of eating and the social ambience in which eating takes place (Ekelund *et al.,* 2005; Lissau *et al.,* 2002).

2.6.3 Reduce television watching

Television viewing exposes children to food marketing and thus affects children's food preferences and food selection (Batch and Baur, 2005). If there is one social practice which has paralleled the development of this epidemic, it must be the increase in time spent watching television. Children who watch more than 3 hours of television per day have been shown to be more overweight than those watching less television. Watching television encourages positive energy balance; physical activity is reduced and energy intake is boosted through snacking on high-energy foods and drinks (Reilly, 2006; Wareham *et al.,* 2005; Lissau *et al.,* 2002).

Parents have the main responsibility to restrict watching, both negatively (by rationing viewing time) and positively (by encouraging other interests and hobbies, which may or may not involve physical exercise). Television watching is not only sedentary. It actually leads to a fall in metabolic rate recorded as even below BMR. Children watching television excessively miss opportunities for developing social and cultural interests with friends and family. Metabolic rates do not fall quite as low with computer games as with television watching. Nevertheless, these games pose similar risks to television (Lissau *et al.,* 2002).

Parents need to be careful that television viewing does not become integrated into the daily routine of their children. Television may be used as a surrogate baby sitter when children are small and gradually, viewing becomes a habit with older children. Later on, when parents decide to provide children with their own televisions, they surrender any remaining control over their children's viewing. Children who have television sets in their bedrooms spend more time watching TV and are more likely to be overweight than children who do not have televisions in their rooms. These children are less likely to eat fruits and vegetables and often snack on the fattening foods that are advertised (Whitney and Rolfes, 2005: 564; Lissau *et al.,* 2002).

2.7 MANAGEMENT

Teenagers make many more choices for themselves than they did as children. They are not fed, they eat; they are not sent out to play, they choose to go. At the same time, social pressures thrust choices at them: whether to drink alcoholic beverages and whether to develop their bodies to meet extreme ideals of slimness or athletic prowess. Their interest in nutrition derives from personal, immediate experiences. They are concerned with how diet can improve their lives now. Therefore in planning interventions strategies these factors need to be considered (Whitney and Rolfes, 2005: 570).

Although weight loss is the most obvious outcome of successful obesity treatment, it is not the only desired outcome. Obesity is an important factor in the development of cardiovascular disease and other chronic noncommunicable disorders. Most of these are benefited by even relative small losses of excess fat (Caroli and Burniat, 2002).

In individual children and adolescents, the treatment goal should be weight maintenance or weight loss. Weight maintenance allows children to maintain current weight over time so that their BMI will gradually decrease as they grow taller. Weight loss is recommended for all overweight children (BMI in the 95th percentile or higher) who are older than seven years and those between two and seven years of age with medical complications; and for children at risk for being overweight (BMI in the 85th to 95th percentile) who are older than seven years with medical complications (Fowler-Brown and Tahwati, 2004).

Treatment should not focus solely on diet, and must aim to reduce sedentary behaviour and to increase physical activity. Treatment of those children and adolescents who are already obese is a form of secondary prevention, because successful treatment can prevent adult obesity and its comorbidities (Reilly, 2006).

2.7.1 LIFESTYLE MANAGEMENT

The return to, and maintenance of normal body fat percentage should be the goal of all treatment. The goal of all weight-control programmes should become reduction in excess body fat even it this does not result in normal nutrition. Evidence suggests that even modest reductions in excess body fat can reduce health risks. However, body fat reduction needs to be achieved through sustainable programmes compatible with normal social interaction. This is especially true with obese children and adolescents, where the development of healthy lifestyles which continue after contact with clinic and/or practitioner have ceased, should be the highest priority in management. Thus the underlying aim of treatment is sustainable lifestyle change through behavioural approaches such as goal-setting, self-monitoring, stimulus control and incentives (Reilly, 2006; Kirk *et al.,* 2005).

There have been suggestions that the more the obese are involved in formal slimming programmes, the less likely they are to be successful slimmers. Efforts to slim frequently begin without any professional involvement and some, perhaps even many of these 'self-help' slimmers succeed in their aims to lose weight – and seek no further advice. Thus, those seeking help could be predominantly those who have difficulty complying with well-known recommendations for weight reduction or those who have obesity which is for one reason or another, relatively unresponsive to simple slimming measures. If this is so, the obese subjects seeking help for weight reduction will then be those for whom success with treatment is least likely. Data on the prevalence of obesity and overweight in childhood support the view that many obese children do slim successfully; either spontaneously during the physiological changes in body composition which take place with growth, or as the result of family instituted measures (Poskitt, 2002).

Families of children who are significantly obese should be encouraged to seek nutritional help and advice. It is advisable to involve obese children in the slimming process and to develop their commitment to the programme of management as much as their age and maturity allow. This is very necessary with children of secondary school age whose lifestyles offer them plentiful access to food outside the home and who must therefore exercise dietary self-control. Parents will need to initiate changes in diets and lifestyles with young preschool children (Dietz, 2003; Postkitt, 2002). The obese adolescent, at the other end of the childhood spectrum, has plenty of opportunity, both at home and away from home to access food without parental involvement. In adolescence parental strictures on diet and lifestyle may be greeted with unhelpful antagonism and refusal to comply (Poskitt, 2002).

Adolescents will need to make their own decisions regarding diet and lifestyle changes. It is however important that parents have knowledge and understanding of obesity and its control, so that they can advice, support and encourage their adolescent children by whatever means appropriate. Family shopping must make low-energy-density foods available, so as to encourage moderated intakes by children helping themselves from cupboards and refrigerators (Poskitt, 2002).

Although lifestyle modification is the gold standard for achievement and maintenance of weight loss, dismal long-term success results in many obese individuals turning to fad diets, pharmacotherapy, or surgery to loose weight. Lifestyle interventions have not yet been shown to have a significant impact on the obesity epidemic, however, they are at the very least healthy goals to strive for and they are unlikely to cause any damage (Miller *et al.,* 2004; Du Toit and Van der Merwe, 2003).

2.7.1.1 Principles of modifying lifestyles

The basis of all slimming recommendations must be to alter the energy balance of obese individuals so that energy expenditure exceeds energy intake. Negative energy balance must continue for a significant period of time, in many cases for months or years, if it is to succeed in reducing obese individuals to acceptable body fat percentage (Poskitt, 2002).

Reaching a normal body fat percentage may be an almost impossible goal for the significantly obese individual. However, any reduction in fatness, if sustained, should improve health, fitness and longevity. Children grow and at certain stages in life they grow rapidly (e.g. the adolescent growth spurt). Fat loss can thus be compatible with no loss of weight or even slight weight gain. Many slimming recommendations for children do recognize this by aiming for no weight gain, rather than for weight loss (Poskitt, 2002).

Lifestyle or behaviour modification involves constant awareness of progress through contracting, self-monitoring, social reinforcement and modelling. Contracts reinforce adherence to the weight-loss programme. Self-monitoring involves careful daily observation of diet and activity while social reinforcement and modelling means teaching children and parents how to model diet and activity-related behaviours for other family members and friends (Dietz, 2003).

A degree of resistance to lifestyle changes must be expected even from patients who seem motivated to change their lifestyle. Making and sustaining lifestyle changes is extremely difficult and is usually without any short term benefit to children and their families (Reilly, 2006)

2.7.1.2 Lifestyle changes in feeding patterns

The development of a healthy lifestyle must include changes in both what is eaten and how it is eaten. Children should become more aware of what they eat and when they eat. If eating takes time and if it takes place in association with other 'satisfying' events, satiety may be achieved at lower energy intakes. Food should become something consumed in family meals and recognized snack periods rather than something used to combat boredom (Poskitt, 2002).

The following are lifestyle changes which may help fat reduction (Barlow *et al.,* 2007; Kirk *et al.,* 2005):

- Plan eating so that food is eaten to avoid hunger rather than as a time-filling event.
- Eat only at mealtimes and recognized snack periods.
- Eat smaller portions at meals and snacks.
- Eat as a family so there is social interaction and time is spent during the meal waiting for others to be served. This may contribute to satisfaction from a meal and psychophysiological satiety.

- Discourage eating in front of the television, or snacking when playing/working with the video or computer.
- Limit eating out at restaurants, particularly fast food restaurants.
- When eating out, select healthful options or split larger servings to share with other family members or peers.
- Select ‘whole foods’ or raw unprocessed foods whenever possible and prepare and cook meals at home.
- Raw ingredients, rather than foods bought already prepared, make it easier to see what is being consumed.
- It is more time consuming to eat whole foods, e.g. apples compared with apple juice. This helps satiety.
- Drink water rather than fruit juices or carbonated drinks.

2.7.1.3 Changing the family diet

There are a number of changes which can be made to the family diet without necessarily reducing the volume of food eaten and which may not make the reduced-energy nature of a diet very noticeable. It is important that children have the significance of dietary changes explained to them. Many will be prepared to try to cooperate, particularly if dietary changes are introduced gradually and in ways which make them attractive. Dietary changes are unlikely to be successful, particularly with older children, if they are imposed forcefully. They are also unlikely to be successful if they are regarded as something special for the obese child and not part of more general changes in the family diet. Children have difficulty understanding why they are denied certain foods which their obese parents eat unrestrainedly in front of them (Poskitt, 2002).

2.7.2 DIETARY MANAGEMENT

Good nutrition is not just about optimising a child's health. The nutrition children receive through their preschool and primary school period also has an effect on their long term health and the eating patterns established in childhood continue into adulthood. The main aims of dietary treatment are to provide adequate energy intake, achieve healthy body weight, and to develop and sustain healthful eating habits which enable maintenance of healthy body weight during growth and in adult life (Daniels *et al.,* 2005; McVeagh, 2000). In order to maintain healthy weight, dietary interventions should be aimed at reducing the intake of high-fat foods, refined sugars and sweetened beverages. Interventions should also strife to increase the intake of lower energy, high-fiber foods such as fruits, vegetables and whole grains (Singhal *et al.,* 2007).

Although concern has been expressed about the habit of snacking, teenagers may obtain substantial nourishment from snacks. Thus the choice of foods being eaten is more important than the time or place in which the food is eaten. For adolescents to improve their eating habits, counselling must centre on fitting proper nutrition into allowable time, making selection of healthy foods easier and making healthy foods appealing to teens and their peers. Thus in contrast to traditional weight-loss programs that focus on what to eat, behavioural programmes focus on how to eat. These techniques involve changing learned habits that lead a child to eat excessively (Whitney and Rolfes, 2005: 565; Spear, 2004).

Dietary recommendations also need to emphasize reducing the number of meals eaten outside the home, planning for healthy snacks, offering healthier, low-energy food choices and structuring eating times and places for family meals. Involving children in meal planning, shopping, gardening and preparation of food has been promoted in helping the child to adhere to recommended consumption patterns and healthier food choices (Barlow *et al.,* 2007; Daniels *et al.,* 2005).

Dietary modifications which range from straightforward nutritional counselling to very low energy diets remain the cornerstone in the management of obesity. Finding the best solution by comparing the reported results on different dietary regimens is not easy because of heterogeneity in dietary design and subject selection, lack of a common definition of obesity, lack of information on visit frequency, treatment duration, energy or nutrient intake and frequently, the absence of control groups or long-term follow-up. At the same time the long-term safety and efficacy of these diets have not been evaluated in children (Miller *et al.,* 2004; Caroli and Burniat, 2002).

Mild energy restriction is safe and can be effective when obese children and their families are motivated and encouraged to change longstanding feeding behaviours. Diets that are severely restricted in energy can facilitate more dramatic short-term weight loss. However, such diets cannot be sustained under free-living conditions. Severe energy restriction may also cause deficiencies of vitamins, minerals and micronutrients; they may limit bone mineralisation; reduce rates of linear growth; and disrupt menstrual cycles (Speiser *et al.,* 2005; St Jeor *et al.,* 2001).

2.7.2.1 Balanced energy diet

The balanced low-energy diet (BLEDs) is the most widely prescribed method of weight reduction. These diets are used over widely varying periods of time: from 12 weeks to more than 6 months. The diet is nutritionally adequate except for the energy which is reduced by about one third. The BLED should be relatively high in carbohydrates (50 – 55%) and should provide adequate protein (15 – 25%) to prevent conversion of dietary protein to energy. Fat content should not exceed 30%. The inclusion of extra fibre is recommended to reduce energy density, to promote satiety by delaying stomach-emptying time and to decrease intestinal absorption (Laquatra, 2004).

Regardless of the level of energy restriction, healthy eating should be taught and emphasized and recommendations for increasing physical activity should be included. One method of attaining this is through the use of the 'traffic-light diet'. This groups foods into categories according to structured eating patterns to meet age recommendations. Green colour means 'go' – these foods may be consumed in unlimited quantities. Yellow means 'caution' and red means 'stop' –

because of a high fat or simple carbohydrate content. This approach is close to the widely used food guide pyramid. However, many papers reviewing traffic-light diets concentrate on psychological parameters and outcomes and pay little attention to nutritional intakes or nutritional outcomes (Laquatra, 2004; Dietz, 2003).

2.7.2.2 Very low energy diet

Very low energy diets should be used with an emphasis on all members of the family moving to healthier eating patterns. The aim of these diets is to provide a programme that will aid the family and child in making changes in food choices and eating habits. Use of the low energy diet in the acute treatment phase for adolescent overweigh is effective for short-term improvement in weight status (Spear *et al.,* 2007*;* Batch and Baur, 2005).

Very low energy diets provide 3360kJ/day or fewer. They can be partially balanced with 25% protein, 30% fat, 45% carbohydrate or they may be unbalanced with 66% protein, 24% fat and 10% carbohydrates. This latter type of diet is described as a protein-sparing modified fast (PSMF) because it is supposed to spare lean body mass (LBM), while producing rapid loss of weight. The PSMF is the most widely used VLCD in the treatment of childhood obesity (Batch and Baur, 2005; Caroli and Burniat, 2002;).

The protein-sparing effect can be explained using the metabolic fuel cycle regulatory system. In physiological conditions, insulin decreases the release of FFAs from adipocytes by reducing cyclic AMP (adenosine monophosphate) – mediated activation as well as by increasing glycerol phosphate availability for FFA re-esterification. During starvation the reduction of insulin serum level is associated with a high release of FFA from adipocytes, which can be utilized as metabolic fuel by several organs and tissues. The absence of carbohydrate intake, together with the increased fat catabolism produces high levels of ketones which are utilized as metabolic fuel by the brain. Due to these modifications, the consumption of glucose by the brain is reduced and consequently the need for gluconeogenesis from amino acids also declines. Thus starvation ketosis is the main mechanism preserving body protein during fasting. An intake of additional protein will cause a very slight increase in serum insulin, which will not interfere with ketogenesis. A protein intake equal to requirements for age and sex will balance amino acid catabolism and reduce nitrogen losses (Caroli and Burniat, 2002).

The VLCD and in particular PSMF can be composed of normal, natural protein-rich foods such as lean meat, fish, fowl or eggs. Alternatively, they can be prepared as special formulas which incorporate powdered protein based on milk or egg protein. When PSMFs are prescribed, vitamin and mineral supplements are usually added although these diets do not seem to require the addition of all micronutrients. Serum electrolytes need to be monitored and supplemented when necessary (Laquatra, 2004).

Initially PSMFs were used for only 2 or 3 weeks and then in metabolic wards. Now use has been extended to periods of 2 – 3 months and to outpatient clinics with once-a-week or twice-a-week medical supervision and controls. Whilst VLCD cause dramatic weight loss, cardiac complications are cause for concern. VLCDs can lead to an increase of urinary ketones that interfere with the renal clearance of uric acid, resulting in increased serum uric acid levels, which then manifests as gout. Higher serum cholesterol levels resulting from mobilization of adipose stores also pose a threat (Laquatra, 2004; Caroli and Burniat, 2002).

2.7.2.3 Consequences of dieting

The most obvious result of treatment for obesity is reduced fat mass. It could be presumed that the lower the energy intake, the higher the weight loss should be. It is not known whether body fat distribution in obese children is also a significant risk factor for later morbidity. However, abdominal fat deposits in adolescents are associated with more frequent cardiovascular pathologies, hyperinsulinaemia and dyslipidaemia. Thus the young obese with central adiposity should particularly benefit from energy restriction and losing excess body fat. Moreover, it has been shown that adolescents with central adiposity, recognized by a high waist/hip ratio, lose more abdominal fat than subcutaneous deposits with dietary management. As a consequence they show significant metabolic improvements as well (Caroli and Burniat, 2002).

Falls in serum total cholesterol and TGL levels correlate with percentage weight loss. Researchers have stressed the dietary importance of lowering total cholesterol consumption and enhancing the polyunsaturated to saturated fatty acid ratio. Such diet design is well known as being effective in reducing total serum cholesterol, LDL-C and the TGL levels. Obese adolescents also show significant reductions in blood pressure when they change from high- to low-salt diets. Many studies have demonstrated that weight loss, even slight, improves blood pressure in the obese (Reinehr and Andler, 2004; Sung *et al.,* 2002).

Apolipoprotein B/A1 ratio is viewed as a marker of coronary artery disease. In children it has also been speculated that this ratio could detect those prone to a higher probability of developing atherosclerosis. Thus an important positive result of a dietary treatment in obese children and adolescents is a fall in apolipoprotein B/A1 (Caroli and Burniat, 2002).

2.7.3 PHYSICAL ACTIVITY

High levels of sedentary behaviour and low levels of habitual physical activity may be typical of modern children, and these behaviours may be established at an early age. Also, obese children and adolescents generally have limited exercise tolerance. These factors have to be taken into account when planning for treatment of overweight and obesity through physical activity (Singhal *et al.,* 2007; Reilly, 2006).

Diet modification alone is not sufficient to achieve weight loss. When energy intake decreases, metabolism slows, resulting in decreased energy use and difficulty achieving weight loss. Therefore, exercise is vital for weight loss (Miller *et al.,* 2004).

Physical activity is usually included in treatment programmes for obesity and can be considered a cornerstone in management. Too often physical activity is equated with formal exercise, since these two terms, physical activity and exercise, tend to be interchangeable although they refer to different constructs. According to Parizkova *et al.* (2002), physical activity can be defined as any bodily movement produced by skeletal muscles which results in increased energy expenditure. Exercise on the other hand is a subcategory of physical activity which is repetitive, structured and purposive in the sense that improved maintenance of physical fitness is an objective.

Skeletal muscle is the site of most fat oxidation in the body and physical activity affects total fat oxidation and fat balance through promotion of more favourable body composition. Moreover, increased fat oxidation rates help maintain glycogen stores, thus influencing the regulation of food intake and energy balance. Therefore, physical activity benefits obese children by (Daniels *et al.*, 2005; Parizkova *et al.,* 2002):

- Increasing lean body mass;
- Increasing energy expenditure;
- Improving the metabolic profile;

- Improving socialization through group participation; and
- Improving psychological well-being.

The addition of structured exercise may reduce the risk of multiple coronary heart disease risk profile of obese adolescents. Active children have a better lipid profile than physically inactive children. Both obesity and blood cholesterol also correlate with the inactive pastime of watching television (Sothern *et al.,* 2000; Rolfes *et al.,* 2006: 549).

Just as blood cholesterol and obesity track over the years, individuals who are inactive while young are likely to still be inactive years later. Similarly, those who are physically active now tend to remain so. Compared with inactive teens, those who are physically active weigh less, smoke less, eat a diet lower in saturated fats, and have better blood lipid profiles. Thus, physical activity offers numerous health benefits, and children who are active today are most likely to be active for years to come (Rolfes *et al.,* 2006: 549).

Programmes and policies that support the practice of regular physical activity should be encouraged. These might include both those targeted to the environment (i.e. increasing access to recreational facilities, and increasing the availability of community-based sports programmes) and those targeted to the individual and their family (i.e. daily physical education classes at school and programmes that promote active family lifestyles). The benefits of participating in organized sports outside school have been suggested. These types of activities should be investigated to assure that both overweight and normal-weight children benefit from them (O'Loughlin *et al.,* 2000).

2.7.3.1 Aims of physical activity programmes

Guidelines for physical activity recommend that children should accumulate at least 30 – 60 minutes of age-appropriate activity on most days of the week, preferably, everyday (Singhal *et al.,* 2007; Daniels *et al.,* 2005). Programmed aerobic exercise is less effective than lifestyle exercise. Lifestyle exercise increases movement through daily activities and encourages regular time for active play or more interactive, fun, structured exercise (Singhal *et al.,* 2007).

Lifestyle exercises that have been recommended by several authors include walking to school, walking the dog, playing hopscotch, riding bicycles, jumping rope with friends, dancing, climbing, weightlifting structured to improve endurance, gardening and using stairs rather than lifts and escalators in buildings amongst others. These activities increase energy output and however slightly help improve energy balance (Singhal *et al.,* 2007; Daniels *et al.,* 2005). A complementary approach would be to restrict sedentary free-time activities to less than 2 hours per day (Daniels *et al.,* 2005).

For many children, increasing physical activity may be adequate to prevent the onset of childhood obesity. Because humans are inherently active, young children will be active if given the opportunity. Plans for successful physical activity programmes have to incorporate factors that may influence the outcome of physical activity programmes. These programmes should address intensity, duration, type of activity, training level, fatigue induced by activity, extent of compensatory rest following activity, effect of activity on food intake and risk of injury or trauma from activity. Physical activity is the only discretionary component of total daily energy expenditure (TEE), so increased energy expenditure due to muscle work should increase TEE. Training improves children's individual energetic efficiency when performing exercise thus reducing the final energy costs of the exercise itself (Parizkova *et al.*, 2002).

Exercise intensity also has consequences on postexercise food intake and could influence children's overall compliance. Different types of exercise, performed at different intensities may have different impacts on glycogen depletion and variable effects on appetite. Moderate intensity aerobic exercise uses a high proportion of fatty acids as substrate and may affect appetite proportionally less than anaerobic exercise (i.e. heavy exercise) which uses glucose as the principal substrate and thereby depletes glycogen stores. The individual variation in ability to increase fat oxidation in response to exercise may also affect the rate of glycogen depletion, thereby determining the carbohydrate deficit and the postexercise carbohydrate and energy intake. Therefore, one of the goals of activity in obesity should be to favour activities which promote low carbohydrate/fat oxidation ratio, which is aerobic activities because relatively high fat oxidation stimulates appetite less than high carbohydrate oxidation (Parizkova *et al.*, 2002).

Children's food preferences, the availability of food and the composition of foods ingested can play important roles in compensating for the energy costs of exercise. It seems advisable to therefore limit the availability of energy-dense food after exercise (Parizkova *et al.*, 2002).

Weight loss during the treatment of obesity is usually due to loss of both fat and lean mass. Reduced LBM which is the metabolically active tissue, leads to reduced basal energy expenditure. Reduced basal metabolic rate (BMR) thus presents a risk factor for further weight gain if energy intakes are not balanced to the new energy requirements (Parizkova *et al.*, 2002).

The possible traumatic side effects of exercise have to be carefully considered when designing individual physical activity programmes. High-intensity exercises cause discomfort in obese children independent of their risk for injury. If obese individuals are to adhere to a physical activity programme, any proposed exercise should relate to their physical characteristics – and should be both safe and enjoyable. Thus an ideal physical activity programme should be designed to (Parizkova *et al.*, 2002):

- preserve LBM;
- avoid promotion of compensatory food intake;
- be tailored on the basis of the preferences of the child;
- be aerobic (walking, cycling, swimming, etc.);
- be realistic in intensity and duration;
- avoid psychological discomfort;

- develop a level of activity which can be maintained after the programme has ended.

2.7.3.2 Physical activity and exercise programmes

Obesity is characterized by great interindividual variability. Obese children and adolescents may have different levels of adiposity, fat distribution, and duration of obesity, complications and comorbidities. Previous levels of physical activity, fitness and functional capacity vary not only with age and gender, but also with other factors in the children's environments and previous health. Some overweight children are skilled in techniques involving small muscle groups, or have considerable muscular strength. It should be standard practice to individualize all components of movement therapy (Parizkova *et al.*, 2002).

Exercise programmes should be slowly progressive, preceded and followed by gradual warm-up and cool-down sessions. Symptoms of pain, fatigue, weakness and dizziness or the inability to sustain a conversation should halt the exercise. Fun, enthusiastic leadership, group activities and parental support and participation are strong motivating factors in children. If given the opportunity, young children will perform relatively large volumes of intermittent non-structured physical activity. Generous periods of free play are also highly recommended. Providing safe environments for young children to actively play outdoors is essential to increasing the physical activity patterns of overweight children and those at risk of obesity (Sothern, 2004; Parizkova *et al.*, 2002).

Video games and television programmes predominate as leisure-time activities for too many children and youths. The time spent with these programmes has been increasing during recent decades, helping to promote physically inactive behaviours. This creates serious problems as such programmes are likely to be more attractive than exercise. The only recipe for a healthy and active lifestyle is to encourage participation in interesting physical activities and adequate work loads as young as possible. Individual exercises and sports events must be chosen carefully so as to avoid obese children becoming disheartened over their difficulties and discomforts. It is unrealistic for children and families to dream of obese subjects growing into sustainable and acceptable adult body weight, body mass index and fatness, if they continue to refuse to change (Parizkova *et al.*, 2002).

It is impossible to prescribe specific exercise programmes to cover growing children of different ages, gender, degree and duration of obesity and from different environments and with different health histories. Many obese children have orthopaedic problems leading to characteristic silhouettes. These problems have to be taken into account when designing training programmes for obese children (Parizkova *et al.*, 2002).

It is necessary to develop obese children's interest in increased movement and exercise. The influence of environmental factors and the role of the family are very significant. The personality of the physical education instructor and the ambience of gym, sports hall or sport grounds need to be friendly and attractive.

The educator should be kind, patient and cheerful, drawing attention to errors sensitively and praising any success, however small. Attractive sports wear can also add to the pleasure of organized exercise (Parizkova *et al.*, 2002).

In older children, exercises aimed towards participation in team games such as soccer, rugby, basketball and so on, and seasonal individual sports (swimming, tennis, etc.) should be included in the programme (Parizkova *et al.*, 2002).

2.7.4 MULTIDISCIPLINARY MANAGEMENT

Treatment programs for childhood obesity requires a multidisciplinary approach and should include dietary changes, nutritional education, changes in physical activity patters, behavioural modification and parental involvement (Nemet *et al.,* 2005). This could then lead to an improvement in body composition, percentage of IBW and BMI. This type of intervention is effective in lowering total cholesterol and triglyceride levels in obese children (Sothern *et al.,* 2000).

2.8 CONCLUSION

Overweight and obesity is a complex condition whose causes are multifactorial. South Africa, like many developing countries, has a double burden of increased prevalence of under- and overnutrition. Factors such as birth-weight, feeding practices in the first year of life, hereditability and ethnicity are all factors that need intense consideration when looking at possible causes of overnutrition.

While consensus has not been reached on the role of nutrition in the development of overnutrition, substantial evidence does show that increased energy intakes do contribute to obesity.

The complexity of childhood obesity requires prevention and management strategies which are reasonably extensive. Such strategies should not only focus on the child but should also involve institutions such as government and schools as well as the child's family.

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CHAPTER 3

METHODOLOGY

3.1 Introduction

This chapter describes the apparatus, techniques, sample and procedures used for the study. Statistical analysis methods are also discussed. Furthermore the role of the researcher and that of the fieldworkers are discussed.

3.2 Study design

A cross-sectional analytical study was conducted to determine the factors associated with overweight/obesity and their implications on the weight status of the children.

3.3 Operational definitions

The variables determined to meet the objectives of this study were daily dietary intake, socio-economic status, the school environment, physical activity levels and weight status through the anthropometric measurements.

3.3.1 Usual dietary intake

Usual dietary intake indicates the types and quantity of foods consumed as well as the frequency of consumption per day, per week, or per month over a period of six months prior to the study (Hammond, 2004: 366). Usual dietary intake was determined using the Quantitative Food Frequency Questionnaire (QFFQ).

According to Murphy and Vorster (2007), Nutrient Intake Values (NIVs) have recently been recommended as the new standard for planning and assessing nutrient intakes of individuals and population groups. However, during the practical execution of this study from May 2006 the Dietary Reference Intakes (DRIs) were still in use and were therefore used in evaluating the dietary intake of the children in this study.

An intake of the nutrients that is ≤ estimated average requirement (EAR) was considered as inadequate (IOM, 1997 – 2000). An intake of energy of ≤ the estimated energy requirement (EER) was considered as inadequate (IOM, 2002).

3.3.2 Socio-economic status

Socio-economic status refers to the occupation and education levels of the main financial contributor of the household as well as the type of household, household density and the cooking facilities available. These were determined using an index count. Indexes are typical measures of variables and are constructed through the simple accumulation of scores assigned to individual attributes (Babbie, 1989: 391). For the purposes of this study these individual attributes include the occupation as well as the level of education of the main contributor of the household. The index was calculated using the following table.

Table 3.1: Socio-economic status index

Occupation		**Highest Educational Level**	
Specialist professionals	4	Post-matric	4
Graduate professionals	3	Matric	3
Skilled individuals	2	High school	2
Unskilled individuals	1	Primary school	1

For the purpose of this study a specialist professional refers to persons such as doctors, professors, directors, etc., while a graduate professional refers to persons working as teachers, nurses, managers and so on. Clerks, secretaries, retail workers, etc. are categorised as skilled individuals while cleaners, domestic workers, gardeners amongst others were categorised as unskilled individuals.

The sum of the combination of the occupation and highest education level of the main contributor to the household was used as an index of socio-economic status. The following index ranges have been calculated:

- 7 – 8: high socio-economic status
- 4 – 6 :medium socio-economic status
- 1 – 3: low socio-economic status

3.3.3 School environment

The school environment refers to the general environment created at schools with regards to the presence of regulations or policies that promote healthy food choices amongst school children as demonstrated by Vereecken *et al.* (2005). For the purposes of this study the presence of formal regulations or school nutrition programmes relating to foods sold or the promotion of healthy eating habits at the school was considered as a favourable environment.

3.3.4 Physical activity levels

Physical activity is defined as any form of muscular activity which results in the expenditure of energy (Powers and Howley, 2001: 294). Physical activity levels are therefore based on those activities structured around the household, activities during school and other leisure or extra-mural activities. Physical activity levels were determined using the Previous Day Physical Activity Recall (PDPAR). The intensity of the daily physical activity was characterised according to metabolic equivalents (METs). One MET is equal to the basal metabolic rate and is equal to 3.5 ml of oxygen per kilogram of body weight per minute. METs are a convenient and reliable measure of energy cost because their calculation considers the oxygen requirements of activities without having to calculate the amount of oxygen consumed separately (Frary and Johnson, 2008; Saris *et al.,* 2003).

A MET value was assigned based on the reported intensity of the activity. The children were classified according to the following categories (Pate *et al.*, 1997):

- Vigorously active if they reported two or more 30-minute blocks with physical activity at an intensity equal to or greater than 6 METs;
- moderately active if they reported two or more 30-minute time blocks with physical activity at an intensity more than 3 METs; and
- inactive if they report less than two 30-minute blocks with physical activity equal to or less than 3 METs.

3.3.5 Anthropometric status

Anthropometric status refers to the determination of body size and proportions using body mass index-for-age and the waist circumference.

3.3.5.1 Body mass index-for-age

Body mass index (BMI) is derived mathematically from the height and weight measures. BMI is calculated by dividing body weight (kg) by square of the adolescent's height (m^2) i.e. BMI = kg/ m^2. BMI values correlate significantly with body fatness and obesity, and also indicate weight status (Spear, 2004; Whitney *et al.*, 2002: 139). Cut-off points to be used in this study are such that a BMI-for-age (Cunningham, 2004; Sizer and Whitney, 2003):

- < 15th percentile indicates underweight,
- 15 - <85th percentile indicates normal weight,

- ≥ 85th percentile shows overweight and
- ≥ 95th percentile indicates obesity.

3.3.5.2 Waist circumference

Waist circumference is a highly sensitive and specific measure of upper body fat and is valuable in identifying overweight and obese children at risk of developing metabolic complications (Wang *et al.,* 2003). A waist circumference at the 75th and the 90th percentile indicates a high risk and a very high risk for comorbidities respectively (Fernandez *et al.*, 2004).

3.4 Measuring instruments and techniques

The following standardized measuring techniques were used to reach the objectives of this study.

3.4.1 Questionnaires

Four questionnaires were used to obtain information and they are discussed next.

3.4.1.1 Usual dietary intake

Dietary intake was determined using the Quantitative Food Frequency questionnaire (QFFQ) (Appendix A). This questionnaire has been validated in the THUSA study (MacIntyre *et al.,* 2000). Standardized food models as well as photographs of standardised food portions were used to estimate portion sizes as recommended by Lillegaard *et al.* (2005). The food frequency questionnaire was summarized and before analysis could continue the food was converted to gram weights using the Food Quantities Manual (Langenhoven *et al.*, 1991). Analysis was made using the Food Finder® Computer Program with the different food items being entered into the programme. The weight of food items consumed on a daily basis was entered as such. The weight of food items not consumed on a daily basis was calculated as food consumed on a monthly basis in grams divided by 30 days; and food consumed on a weekly basis in grams divided by 7 days (Joubert, 1999: 251).

3.4.1.2 Socio-economic background

The socio-economic background of the children was determined based on the occupation and education level of the person contributing most of the income in the household. The questionnaire on socio-economic background also includes information on the demographic background of the children as well as the type of dwelling, the household density and cooking facilities available in the household (Appendix B).

3.4.1.3 School environment

Headmasters/principals were asked to complete a questionnaire (Appendix C) which contains questions about the general environment and school policy provided by schools with regards to the availability of school nutrition programmes or regulations regarding foods sold on school premises and the surroundings. The presence of tuck shops and/or hawkers on the school premises, or any other shops in the school surroundings as well as vending machines and the types of foods sold on these facilities was investigated. The questions used have been adapted from a study by Vereecken *et al*. (2005).

3.4.1.4 Physical activity

Physical activity levels were determined in an interview with the children using the Previous Day Physical Activity Recall (PDPAR) (Appendix D) as used by Weston *et al*, (1997). Here the children were asked to list all of the activities they performed during the previous day as well as on one day during the weekend. The students were then asked to rate the intensity of the indicated activities using the following descriptors: very light (i.e. slow breathing and little or no movement), light (i.e. normal breathing and movement), medium (i.e. increased breathing and moderate movement), and hard (i.e. hard breathing and quick movement). From their answers a MET value was assigned to the activity based on the type of activity as well as its intensity (Ainsworth *et al.,* 1993).

3.4.2 Anthropometric measurements

The following standardised anthropometric measurements were measured as described by Lee and Nieman (2003: 225) and Sizer and Whitney (2003: 321): weight, height and waist circumference (Appendix E). These measurements were measured in triplicate to ensure reliability.

3.4.2.1 Weight

Weight was measured using a Seca beam balance scale (Vogel & Halke, Germany). The scale was placed on a flat, hard surface to ensure an accurate reading. Weight was then measured to the nearest 0.1kg with the children wearing minimal clothing and without shoes.

3.4.2.2 Height

A stadiometer (HS model, SA) was used to measure height. The children were required to be barefoot and to stand erect with weight equally distributed on both feet. Height was measured to the nearest 0.1cm.

3.4.2.3 Waist circumference

The waist circumference was measured using a non-stretching flexible tape measure with the measurement taken at the narrowest circumference on the waist above the iliac crest and below the lower rib (Sizer and Whitney, 2003: 321).

3.5 Target population and sampling

3.5.1 Sample/study participants

The Department of Education classifies schools as comprehensive, intermediate, combined, technical and ordinary secondary schools. The intermediate and combined schools were left out of the study and only the comprehensive, technical and ordinary secondary schools were included in the study so as to ensure that the participants are as similar as possible. A representative sample of school-going children was drawn proportionally from all of the secondary schools (Table 3.2).

After approval had been obtained from the Department of Education (Appendix I) and school headmasters (Appendix G), an alphabetical list of learners between the ages of 13 – 15 years in Grade 8 or higher in the school was obtained. From this list the children that would be taking part in the study were randomly selected.

The age group of 13 – 15 years was chosen due to the fact that most research on the prevalence of overweight and obesity published in South Africa focuses on children younger than 12 years of age. Children between the ages of 13 - 15 are known to be at a period in their lives that resembles the start of adolescence, which is frequently referred to as the period of maximum growth (Heald and Gong, 1999). Also due to the fact that recall questionnaires were used, younger children were excluded because it was expected that they would not be able to provide reliable information (Lee and Nieman, 2003: 166 – 167).

Table 3.2: List of secondary schools and sample size from each school

School	School size	Sample
Commtech	1723	30
Heatherdale	1111	26
Kagisho CS/S	1575	37
Navalsig CS/S	1475	35
Hodisa T/S	769	18
HTS Louis Botha	832	20
Atlehang S/S	873	21
Bloemfontein	704	17
Bfn South High	470	11
Brebner	1152	27
C & N H/Meisieskool Oranje	608	14
Dr Blok	910	21
Eunice	765	18
Fichardtpark	834	20
Grey Kollege	1143	27
Ikaelelo	1151	27
Jim Fouche	1318	31
Kaelang	1262	30
Lekhulong	912	21
Lereko	1078	25
Moemedi	1060	25
Petunia	1000	24
Sand du Plessis	749	18
Sehunelo	1236	29
Sentraal	975	23
St Bernards	450	11
Tsoseletso	1491	35
Total	**27 176**	**640**

3.5.2 Sample size

Sample size depends largely on the degree to which the sample population approximates the qualities and characteristics of the general population (Leedy, 1997: 210). A representative sample of 640 children was included in the study. Due to the resources available to the researcher (i.e. funds and human resources), this was an amount that was easy to manage by the researcher. At least eight children were interviewed per day during the data collection period.

3.5.3 Sample selection

The following inclusion and exclusion criteria were used for the selection of an appropriate sample.

3.5.3.1 Inclusion criteria

Children included in this study were to be:

- between the ages of 13 – 15 years;
- full-time students at their schools;
- in Grade 8 or higher and
- reportedly healthy

3.5.3.2 Exclusion criteria

Children included in this study could not be

- physically or mentally handicapped;
- reportedly ill and
- using chronic medication

Of the planned 640 children, 415 gave informed consent and participated in the study. The response rate was 64.8%.

3.5.4 Pilot study

A pilot study was undertaken to test the feasibility of the study, including the time it would take to carry out all of the interviews. Three children from each of the three schools (Navalsig, Tsoseletso and Bloemfontein High), that were seen to represent the schools around Bloemfontein were used for the pilot study. These children were not included as part of the main study. The researcher was responsible for collection of data during the pilot study and where questionnaire items were not clear to the participants, the questionnaires were adapted.

3.5.5 Ethical aspects

Permission was first obtained from the Department of Education of the Free State province before commencement of the study (Appendix I). The researcher wrote letters to individual schools' headmasters asking for permission to involve the children in their school as part of the research (Appendix G). Informed consent was obtained from the parents as well as from the children in the form of a letter (Appendix F) asking permission for the children to take part in the study. A signed consent letter, available in the preferred language, was obtained from the parents/guardian and the children before the children participated in the study. The interviews with the children were conducted in the children's language of preference by the researcher and trained fieldworkers.

Children that were found to be underweight, overweight or obese during the main study, were given a referral letter (Appendix H) that encouraged and enabled them to seek help from a dietician/physician so that they would be able to obtain suitable treatment.

Approval to conduct the study was obtained from the Ethics Committee of the Faculty of Health Sciences at the University of the Free State.

3.6 Study procedure

The process followed in carrying out the study is summarized in Figure 1, page 136.

Before commencement of the study, the protocol was submitted for approval by the Evaluation Committee at the Faculty of Health Sciences, University of the Free State (UFS). After the necessary adjustments had been made, the protocol was then submitted to the Ethics Committee at the Faculty of Health Sciences, UFS for approval.

Next permission was obtained from the Department of Education (Appendix I). Schools that were identified to participate in the study were notified by means of a letter (Appendix G) to the principal/headmaster. This letter explained the aim of the study as well as the procedures that would be used to collect information. An appointment was made by the researcher with the headmasters of these schools in order to explain the aim of the study and to answer possible questions that the headmasters may have had. At this point the time that would be allocated for the collection of the data (during school hours or after school) was confirmed with the headmasters. In some cases the researcher was introduced to the teachers who would arrange the children for the data collection in their particular school. A list of names of children falling into the specified age group was obtained from the principal and this was used to select the children that would take part in the study.

A pilot study was then carried out after which the necessary changes or adjustments that needed to be made to the questionnaires were made. The time it would take to obtain data from the children was established during the pilot study.

The children that participated in the study were randomly selected at each school as described in paragraph 3.5.1. Informed consent (Appendix F) letters were sent to the schools after identification of the children that would take part together with a list of these children. In certain schools the letters were given to all of the children falling in the particular age group identified for the study. The children who had been randomly selected to participate in the study were then asked to bring their consent forms along for the data collection. If it happened that the child had not received consent, the next child on the list who had written consent was then included in the study. In other schools consent forms were only given to those children who were selected to participate in the study and if their consent forms were not signed the next child on the list was given a consent form and once consent was obtained the child was included in the study.

A room was identified at each school that was used to conduct interviews and for anthropometric measurements. The field workers completed all of the questionnaires on one child. Fieldworkers collected data from one or two children at the same school with one child being asked after the other. On certain days, data collection was carried out at two schools, with one school being visited in the morning and the other in the afternoon.

The completed questionnaires were analysed statistically by the Department of Biostatistics. The results are documented by the researcher and a report summarising the results as well as the recommendations will be submitted to the Department of Education.

Table 3.3 gives an outline of the time schedule for the completion of the study.

Table 3.3: Time schedule for completion of study

Time period	Action
February – September 2005	Literature search and compilation of protocol.
October – November 2005	Evaluation committee approval Ethical committee approval Department of Education and Headmasters' approval
January 2006 – January 2007	Main study
February 2007 – November 2009	Analysis and documentation of data

3.6.1 Incentive

Each child participating in the study received a t-shirt with a health message, "Get up and get active" on it as an incentive. The t-shirts were sponsored by the South African Sugar Association.

3.6.2 The role of the researcher and of the fieldworkers

The roles of the researcher and the fourteen fieldworkers are summarized in Table 3.4.

Table 3.4: The role of the researcher and fieldworkers

The researcher was responsible for the following: ▪ Development of questionnaires; ▪ Writing of letters to the Department of Education, schools' headmasters and parents; ▪ Training of fieldworkers in carrying out interviews and standardization of anthropometric measurements; ▪ Data collection on a daily basis; ▪ Daily supervision of the fieldworkers during data collection and ▪ Coding of the questionnaires for statistical analysis as well as analysis of the food frequency questionnaire using the Foodfinder® computer programme.
The fieldworkers were responsible for: ▪ Collection of anthropometric measurements and ▪ Interviews to collect information on dietary intake, socio-economic status and physical activity levels.

Fourteen fieldworkers were used to assist the researcher with data collection for the study. The fieldworkers had to be competent in at least two of the following languages: English, Afrikaans and Sesotho. Therefore the fieldworkers were divided into two groups, with one group working in the predominantly Sotho, Setswana, Xhosa and English schools, while the other group was used in the predominantly Afrikaans and English schools. The fieldworkers were required to at least have Grade 12 as their highest level of education. Each fieldworker was trained thoroughly in the methods and techniques used for data collection. The fieldworkers were trained to conduct interviews for all of the questionnaires. They were also trained to take anthropometric measurements using standardized techniques (Lee and Nieman, 2003: 166 – 167).

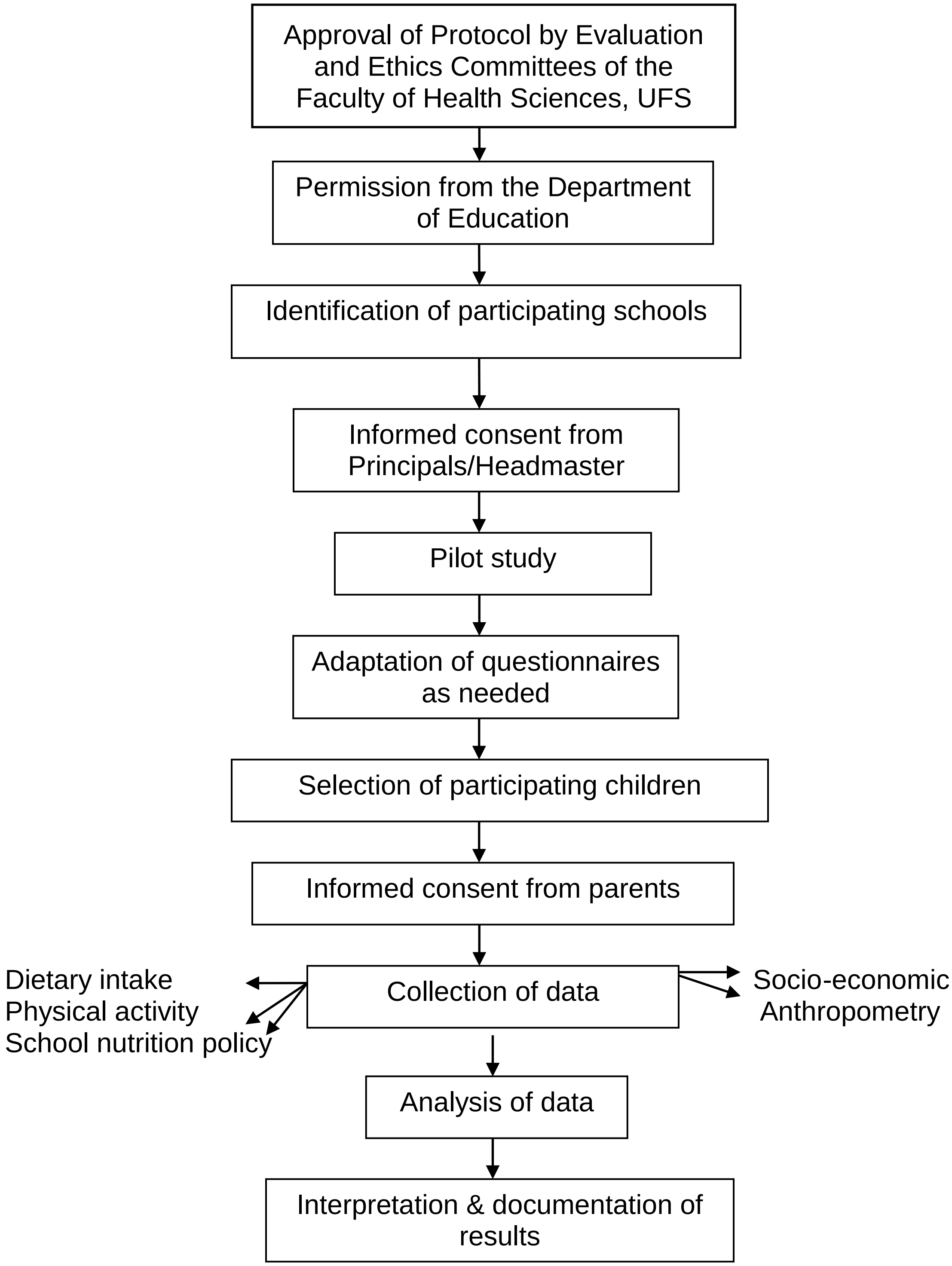

Figure 1: Study procedure to determine the determinants of overweight and obesity in children aged 13 – 15 years in Bloemfontein

3.7 Reliability

All of the information was collected during a personal interview with the children by the researcher and the fieldworkers, in the children's language of preference to ensure reliability. The fieldworkers were given thorough training on obtaining data using all of the questionnaires.

Ten percent of the completed questionnaires and measurements collected were re-collected by the researcher. The data from the questionnaires was collected within two weeks after the child had been interviewed. Anthropometric measurements were collected in triplicate on the same day to ensure reliability and accuracy. Where it was found that the answers to the questions differed by more than ten percent between the first and second interviews, the question was considered unreliable.

3.8 Validity

Validity of the food frequency questionnaire had already been determined in the THUSA Study (Potchefstroom) (MacIntrye *et al.,* 2000). The PDPAR form has also been validated by Weston *et al.* (1997). A pedometer was used to validate the results obtained from the PDPAR form on a sub-sample of the children. The pedometer was given to the children two days before the interview so that they could wear it a day before the interview was to be conducted and it was worn for one day only. The children were given clear instructions regarding the use of the pedometer before using it (i.e. its attachment and removal) and on the day of the interview, the values obtained from the pedometer were recorded (Tudor-Locke *et al.*, 2004).

The questions used in the school environment questionnaire have been adapted from a study by Vereeken *et al.* (2003). These questions were adjusted in order to suit the specific environment of the target sample population. In this way content validity of this questionnaire was ensured.

3.9 Statistical analysis

Descriptive statistics, namely medians and percentiles for continuous data and frequencies and percentages for categorical data, was calculated by group. Associations were described by means of contingency tables and chi-square or Fisher's exact test. The groups were compared by means of 95% confidence intervals (CI) for the difference in percentages and medians. The prevalence of overweight and obese children was calculated and described by means of 95% confidence intervals. Analysis was done by the Department of Biostatistics, University of the Free State.

Stepwise logistic regression analysis was performed and the odds ratios, 95% CI and P values were calculated for each risk factor in the final model. A P value of < 0.05 was considered statistically significant. Logistic regression was used to examine associations between BMI-for-age as the dependant variable and dietary energy and fat intake, socio-economic status, school environment variables and levels of physical activity as well as between dietary energy intake as the dependent variable and BMI-for-age, socio-economic status and levels of physical activity.

3.9.1 Reliability analysis

For each question, the answers obtained in the main study and the reliability survey were compared by means of k × k tables and where the percentages that give conflicting answers are more than 20%, the variables were considered as unreliable and ignored in further computations. For continuous variables, the difference between the two surveys was calculated and the number of non-zero differences was reported.

3.10 Summary

The aim of the study was to determine the factors associated with overweight/obesity and their implications on the weight status of the children. A sample of 640 children was randomly selected from the different schools in the Bloemfontein area.

Dietary intake of the children was determined by means of a standardized QFFQ which included all the different types of food. The data were analyzed to determine nutrient intake of the respondents.

Socio-economic status was determined using a questionnaire which included background details of the children. It also included information on cooking facilities, household density as well as the highest education level and occupation of the main contributor of the household.

The school environment was also determined using a questionnaire containing data on the presence or absence of nutrition education programmes and the availability of food vendors and tuck shops on or around the school premises.

A PDPAR form was used to investigate the physical activity levels of the children. Information regarding the types and intensity of the different activities carried out throughout the day was obtained and the questionnaire data were validated in 10% of the children using pedometers.

Anthropometric measurements included BMI and waist circumference.

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CHAPTER 4

School environment and the association between socio-economic status and weight status of children aged 13 – 15 years in Bloemfontein, in the Free State Province

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ABSTRACT

Introduction: Obesity is multifactorial in its causes and the school environment and socio-economic status are some of the factors that have been shown to play an important role in the development of obesity in children.

Objective: To determine nutritional practices at schools and the association between weight status and the socio-economic status of children aged 13 – 15 years in Bloemfontein, in the Free State Province.

Design: A cross-sectional analytical study.

Methodology: Six hundred and fourty children were randomly selected to participate in the study. Of the children that were selected, 415 children (175 boys and 240 girls) from schools around Bloemfontein participated in the study. Structured questionnaires were used to gather information on school nutritional practices and socio-economic status from school principals and children respectively. Anthropometric measurements included body mass index (BMI) and waist circumference. Children were classified as underweight if they had a BMI < 5^{th} percentile, overweight if BMI ≥ 85^{th} percentile and obese if BMI ≥ 95^{th} percentile of the Centers of Disease Control (CDC) percentiles. A waist circumference ≥ 75^{th} and ≥ 90^{th} percentile of the American percentiles indicated a high and very high risk for comorbidities respectively.

Results: Only 40% of the schools reported having nutrition education programmes. None of the schools had vending machines on the school premises and 18.7% schools reported the sale of milk and milk products in their school shops or by informal vendors. Biscuits (81.3%), chocolate bars (81.3%) and sweets (100%) were sold at most schools. The children's median age was 14.3 years and 87.5% were in grade 8. Most of the children had access to electricity (90.4%) and they mostly lived in brick houses. The father was indicated as the main household contributor by 46.3% of the children and 36.3% of the children indicated the mother as the main contributor. A high proportion of the parents (31.1%) only had primary school education. A total of 214 (51.6%) children in the study were underweight. A statistically significant association could not be found between BMI and race. No significant association could be found between BMI and socio-economic status. White children tended to be more overweight/obese (21.1%) than the black (15.3%) and coloured children (14.3%). Children from the high socio-economic status group were more obese than the children in the middle and low socio-economic status groups. This was not statistically significant however.

Conclusion: Results have shown that socio-economic status did not have any association with the weight status of the children in this study. Schools in the Free State seem to lack programmes on nutrition education. Nutrition education should receive urgent attention by all stakeholders as it plays an important role in the prevention of overweight and obesity.

INTRODUCTION

Obesity is a dynamic disease which is caused by a complex synergistic interaction of a variety of factors. These factors include personal behaviours, genetic predisposition, dietary intake, levels of physical activity as well as environmental factors (Spear, 2006; Frühbeck, 2005; Rennie *et al.,* 2005). Its prevalence and severity is increasing in children and adolescents worldwide. The known association of overweight and obesity with diseases such as diabetes and hypertension raises the level of importance for understanding overweight as a major public health concern for children and adolescents (Daniels *et al.,* 2005).

In first world countries such as the United States and Canada, childhood obesity prevalence is inversely associated with socio-economic status (SES), with the more disadvantaged groups being at greatest risk. In contrast, wealthier children in most developing countries are at a greater risk of obesity (Deckelbaum and Williams, 2001). This phenomenon is referred to as the 'social drift' phenomenon (Trauken and Bissel, 2007). The main socio-demographic factors known to be associated with body weight regulation in children include sex, age, race, parents' education levels and occupation, household size, residential density and geographical region (Frühbeck, 2005). Reasons for SES differences in childhood obesity risk are not clearly understood. One view is that SES differences are the results of factors which are largely or exclusively economic such as parents' education level and household income (Frühbeck, 2005; Reilly, 2005). The need to assess the prevalence of overweight and obesity among South African children of all ethnicities and social backgrounds and the effects of their environment on their weight status is important so that effective intervention programmes can be implemented at an early stage (Armstrong *et al.,* 2006).

While many parents are doing what they can to establish good eating habits in their children at home, children also begin to learn about food and nutrition in the classroom and from their peers (Whitney and Rolfes, 2005: 568). Schools remain one of the best avenues for disseminating nutrition education programmes as they have the greatest access to the children. Besides the characteristics of the school itself, the interpersonal processes and relationships with friends and educators at school can also affect food habits through mechanisms such as modelling, reinforcement, social support and perceived norms (Vereecken *et al.,* 2005).

More and more schools have school shops or tuck shops which offer a variety of foods purchased by the children themselves. Kruger and co-workers (2006) noted a phenomenon which is possibly unique to the South African environment where some schools do not have these shops on the school grounds. Children then have the option of purchasing foods at hawkers sitting outside the school gates, or of going to the different shops surrounding the school. Foods sold by these hawkers and surrounding shops are minimally regulated for nutritional adequacy and they are often low in nutritional value (Kruger *et al.,* 2006; Steyn, 2006). Probart and co-workers (2006) state that the availability of these high carbohydrate and fatty foods on school premises can foster food preferences that increase the intake of these foods by children and adolescents.

Only a few studies in South Africa have investigated the role of socio-economic status on overweight and obesity in children (Kruger *et al.,* 2006) and no such studies have been carried out in the Free State Province specifically. The aim of this study was to determine the BMI of children aged 13 – 15 years in Bloemfontein in the Free State Province and its association with socio-economic status. Furthermore, the existence of nutrition policies and nutrition practices in Free State schools has never been studied. Another aim of this present study was therefore to determine the conditions of the school environment with regards to nutrition policies and practices at schools in Bloemfontein.

METHODOLOGY

Sample

This was a population based, cross-sectional study that included 26 out of 28 secondary schools in Bloemfontein. Two schools' principals did not give permission to use their schools in the study. As part of the larger study carried out in 2006, daily dietary intake and physical activity levels were determined and are reported elsewhere (Meko *et al.,* 2010).

The Department of Education in the Free State province and schools' principals gave approval for the study to be carried out. Alphabetical lists of all learners between the ages of 13 – 15 years were then obtained from the schools' principals. A random sample of 640 children was selected from these lists. Parents or caregivers of all children were approached by means of letters, informing them about all aspects of the study, so that they could give permission for their children to participate in the study. Informed consent was then also obtained from all the children. Every child that gave consent received a t-shirt with the words "Get up and get active" as an incentive. The Ethics committee of the Faculty of Health Sciences, University of the Free State approved the study.

Anthropometry

Standardized methods and techniques were used by trained fieldworkers to take anthropometric measurements of weight, height and waist circumference of all children. Weight was measured to the nearest 0.1kg with the children wearing minimal clothing and no shoes. Height was measured using a stadiometer (Seca 214) to the nearest 0.5cm (Lee and Nieman, 2003: 164 – 168). Waist circumference was measured with a GWCC400 non-stretching measuring tape at the narrowest circumference on the waist (Sizer and Whitney, 2003: 321). The children were classified as underweight if they had a BMI < 5^{th} percentile; normal weight with a BMI between the 5^{th} – 84.9^{th} percentiles; overweight if they had a BMI between the ≥ 85^{th} – 94.9^{th} percentiles; and obese if they had a BMI ≥ 95^{th} percentile of the Centers for Disease Control (CDC) BMI-for-age percentile charts for boys and girls 2 to 20 years old (Cunningham, 2004; Sizer and Whitney, 2003). Ethnic-specific percentiles of waist circumference-for-age and gender were used to classify children according waist circumference associated risk. A waist circumference ≥75^{th} percentile indicated high risk for comorbidities and ≥90^{th} percentile gave an indication of a very high risk for comorbidities (Fernandez *et al.,* 2004).

School environment

School environment refers to the general environment created at schools with regards to the types of foods sold on school premises and the presence or absence of regulations or policies that promote healthy food choices amongst school children (Vereecken *et al.,* 2005).

The school environment questionnaire was based on a questionnaire used by Vereecken and co-workers (2005). It included questions about the presence or absence of nutrition policies and education campaigns at the schools, availability of tuck shops, vending machines and hawkers on the school premises as well as the types of foods sold. The questionnaire was distributed by the researcher to the principals whose schools were included in the study and they were asked to complete it. The principals were followed up telephonically and through visits and the questionnaires were collected once they indicated that they had completed them.

Socio-economic status

A structured questionnaire with close-ended questions was developed and used to collect information on socio-economic status (SES) during face-to-face interviews. Individual interviews were conducted by trained fieldworkers and every child was interviewed in his/her preferred language. Questions on SES included gender, language, household composition, type and size of dwelling as well as available cooking and storage facilities.

Information on the main contributor of the household (i.e. highest level of education and occupation) was also recorded. Parents were classified as specialist professionals (e.g. doctors, professors, directors, etc.), graduate professionals (e.g. teachers, nurses, managers, etc.), skilled individuals (clerks, secretaries, retail workers, etc) or unskilled individuals (cleaners, domestic workers, gardeners). The sum of the combination of the occupation and highest education level of the main contributor to the household was used as an index of socio-economic status to determine whether children were high, middle or low socio-economic status. Reliability was conducted during the main study on a random sample of ten percent of the children. The children were seen two weeks after the initial interview day and where the answers differed with more than ten percent, the question was considered unreliable. Validity of the questionnaire was determined during the pilot study conducted before the main study.

STATISTICAL ANALYSIS

Descriptive statistics, namely medians and percentiles for continuous data and frequencies and percentages for categorical data, were calculated per group. The groups were compared by means of 95% confidence intervals (CI). The prevalence of overweight and obese children was calculated and described by means of 95% CI. Stepwise logistic regression analysis was performed and the odds ratios, 95% CI and *P* values were calculated for each risk factor in the final model. A P value of < 0.05 was considered statistically significant. Analysis was done by the Department of Biostatistics, University of the Free State.

RESULTS

Socio-economic status

A total of 415 children (67.7%; including 175 boys and 240 girls) out of 640 children selected gave consent and participated in the study. Results of the socio-economic data are presented in Table 4.1. A high percentage of the children spoke Sesotho (41.2%), followed by Setswana (24.3%) and Afrikaans (15.4%). The children's median age was 14.3 years, and most were in grade 8 (87.5%).

Most children stayed in brick houses (89.7%), with a flush toilet (87.5%) and electricity (90.4%) was used as the main fuel for most households. Median room density was 1.33. Household appliances including a working stove (gas, coal or electricity; 93.0%) and a working refrigerator (88.7%) were available in most of the households. Almost all the households had a working radio and/or television (98.6%).

For almost half the children, the father was indicated as the one contributing most income to the household (46.3%) followed by the mother (36.3%). Most of the parents indicated as main contributors to the household were skilled workers (36.4%) (clerks, office assistants, sales persons), followed by unskilled workers (32.5%) (domestic workers, cleaners, gardeners and contract workers). Many of the contributors had a primary school education (31.1%) and only 11.3% of the children's parents who were contributors had post matric education. Half of the children (49.2%) were categorised as falling within the medium socio-economic status category based on the parent's highest level of education and occupation.

Table 4.1: Socio-economic data of the 13 – 15 year old children

	Boys n (%)	Girls n (%)	Total n (%)
School grade			
• Grade 8	160 (91.4)	203 (84.6)	363 (87.5)
• Grade 9	15 (18.6)	37 (15.4)	52 (12.5)
Race			
• Black	140 (80)	199 (82.9)	339 (81.7)
• Coloured	8 (4.6)	13 (5.4)	21 (5.1)
• Indian	-	1 (0.4)	1 (0.24)
• White	26 (14.9)	26 (10.8)	52 (12.5)
• Other (Chinese)	1 (0.6)	1 (0.4)	2 (0.48)
Home language			
• Afrikaans	33 (18.9)	31 (12.9)	64 (15.4)
• English	5 (2.9)	10 (4.2))	15 (3.6)
• Sesotho	72 (41.1)	99 (41.3)	171 (41.2)
• Setswana	38 (21.7)	63 (26.3)	101 (24.3)
• Xhosa	26 (14.9)	35 (14.6)	61 (14.7)
• Chinese	1 (0.6)	2 (0.8)	3 (0.72)
Type of dwelling			
• Brick or concrete	158 (90.3)	214 (89.2)	372 (89.7)
• Traditional mud	2 (1.1)	-	2 (0.48)
• Tin	13 (7.4)	19 (7.9)	32 (7.7)
• Apartment	2 (1.1)	6 (2.5)	8 (1.9)
• Wood	-	1 (0.4)	1 (0.24)

Type of toilet			
• Flush	154 (88)	209 (87.1)	363 (87.5)
• Pit	4 (2.3)	8 (3.3)	12 (2.9)
• Bucket	16 (9.1)	20 (8.3)	36 (8.7)
• VIP	1 (0.6)	3 (1.3)	4 (0.96)
Fuel used for cooking most of the time			
• Electric	158 (90.3)	217 (90.4)	375 (90.4)
• Gas	6 (3.4)	4 (1.7)	10 (2.4)
• Paraffin	9 (5.1)	19 (7.9)	28 (6.8)
• Wood, coal	2 (1.1)	-	2 (0.48)
Working refrigerator in household			
• Yes	159 (90.9)	209 (87.1)	368 (88.7)
• No	16 (9.1)	31 (12.9)	47 (11.3)
Working stove in household			
• Yes	164 (93.7)	222 (92.5)	386 (93.0)
• No	11 (6.3)	18 (7.5)	29 (6.99)
Working microwave oven in household			
• Yes	118 (67.4)	143 (59.6)	261 (62.9)
• No	57 (32.6)	97 (40.4)	154 (37.1)
Working radio and/or tv in household			
• Yes	173 (98.9)	236 (98.3)	409 (98.6)
• No	2 (1.1)	4 (1.7)	6 (1.4)

Main contributor to the household			
• Mother	66 (37.7)	86 (35.8)	152 (36.3)
• Father	82 (46.9)	110 (45.8)	192 (46.3)
• Sister/ Brother	9 (5.14)	12 (5.0)	21 (5.1)
• Grandparent	9 (5.14)	20 (8.3)	29 (6.99)
• Uncle/Aunt	9 (5.14)	12 (5.0)	21 (5.1)
Occupation of main contributor of income in household			
• Unskilled	48 (27.4)	87 (36.3)	135 (32.5)
• Skilled	69 (39.4)	82 (34.2)	151 (36.4)
• Graduate	48 (27.4)	63 (26.2)	111 (26.8)
• Specialist	10 (5.8)	8 (3.3)	18 (4.3)
Main contributor's highest level of education			
• Primary	12 (6.9)	35 (14.6)	129 (31.1)
• High school	48 (27.4)	7 (30.0)	119 (28.7)
• Matric	53 (30.3)	66 (27.5)	120 (28.9)
• Post matric	62 (35.4)	67 (27.9)	47 (11.3)
Socio-economic status categorisation			
• Low	32 (18.3)	74 (30.8)	106 (25.5)
• Medium	95 (54.3)	109 (45.4)	204 (49.2)
• High	48 (27.4)	57 (23.8)	105 (25.3)
Absence of food in the house			
• Never	140 (80.0)	186 (77.5)	326 (78.6)
• Sometimes	30 (17.1)	50 (20.8)	80 (12.3)
• Often	3 (1.71)	4 (1.7)	7 (1.7)
• Always	2 (1.14)	-	2 (0.48)

Weight status and socio-economic status

Median body mass index (BMI) was 18.4kg/m^2 for boys and 21.1kg/m^2 for girls (Table 4.2). Median waist circumferences for boys (68.5cm) did not differ much from that of the girls (69cm). Almost one third of the children (29.9%) had a waist circumference at the 25th percentile (Table 4.3). More girls (18.4%) than boys (12.6%) had a waist circumference above the 75th percentile of the US standards (Fernandez *et al.,* 2004).

Table 4.2: Anthropometric distribution of children aged 13 – 15 years

	Waist circumference (cm)			
	Boys	**Girls**	**Boys**	**Girls**
25th percentile	16.9	18.6	65.0	65.0
Median	18.4	21.1	68.5	69.0
75th percentile	20.3	23.3	73.0	75.3

Table 4.3: Waist circumference percentile distribution of boys and girls aged 13 – 15 years

Percentile	**Boys**		**Girls**		**Total**	
	N (175)	**%**	**N (240)**	**%**	**N (415)**	**%**
< 10	32	18.3	29	12.1	61	14.7
10 – 24.9	43	24.6	35	14.6	78	18.8
25 – 49.9	43	24.6	81	33.8	124	29.9
50 – 74.9	35	20.0	51	21.3	86	20.7
75 – 90	18	10.3	35	14.6	53	12.8
> 90	4	2.3	9	3.8	13	3.1

Percentiles based on American cut-off points (Fernandez *et al.,* 2004).

According to BMI cut-off points (Table 4.4) (Cunningham, 2004; Sizer and Whitney, 2003) a third of the children's weight was within the normal range (32.5%), with half of the children being underweight (51.6%). Only 10.4% of the children were overweight while 5.5% were obese. Almost a fifth (19.6%) of the girls and 10% of the boys had a BMI categorized as either overweight or obese.

Table 4.4: Weight classification according to BMI of boys and girls aged 13 – 15 years

CDC BMI Percentiles	Boys		Girls		Total	
	N (175)	%	N (240)	%	N (415)	%
< 15 (Underweight)	118	67.4	96	40	214	51.6
15–84.9 (Normal weight)	38	21.7	97	40.4	135	32.5
85 – 95 (Overweight)	11	6.3	32	13.3	43	10.4
> 95 Obese	8	4.6	15	6.3	23	5.5
Overweight/obese combined	19	10.9	47	19.6	66	15.9

No statistically significant association could be found between BMI and race (Table 4.5). However, there was a tendency for more white children to be overweight/obese (21.1%) than the black (15.3%) and coloured children (14.3%). For both the black and white children, half had a low BMI (53.1% and 50% respectively) compared with the coloured children of whom only 33.3% were underweight.

Table 4.5: BMI comparisons according to race of the children 13 – 15 years, n (%)

Race	≤ 15 (Under-weight)	15.1 – 84.9 (Normal weight range)	85 – 95 (Over-weight)	> 95 (Obese)	≥ 85 (Overweight/ obese)
Black	180 (53.1)	107 (31.6)	32 (9.4)	20 (5.9)	52 (15.3)
Coloured	7 (33.3)	11 (52.4)	3 (14.3)	0	3 (14.3)
Indian	0	1 (100)	0	0	0
White	26 (50.0)	15 (28.9)	8 (15.4)	3 (5.8)	11 (21.2)
Other (Chinese)	1 (50)	1 (50)	0	0	0

The prevalence of overweight/obesity was higher in the group of children with a high socio-economic status (SES) (21.9%) with the prevalence being the lowest in the medium SES group (12.7%) (Table 4.6). No statistically significant association could be found between weight status and SES groups.

Table 4.6: BMI comparisons according to SES of the children aged 13 – 15 years, n (%)

	≤ 15 (Under-weight)	15.1 – 84.9 (Normal weight range)	85 – 95 (Over-weight)	> 95 (Obese)	≥ 85 (Overweight/ obese)
Low SES	52 (49.1)	37 (34.9)	9 (8.5)	8 (7.5)	17 (16)
Medium SES	116 (56.9)	62 (30.4)	18 (8.8)	8 (3.9)	26 (12.7)
High SES	46 (43.8)	36 (34.3)	16 (15.2)	7 (6.7)	23 (21.9)

Median room density was 1.3 and the obese group of children had a slightly higher room density of 1.5 as compared with the other groups (Table 4. 7 and

4.8). No statistically significant differences could be established between room density of boys and girls as well as between room density of the different BMI categories.

Table 4.7: Room density in the houses of the children aged 13 – 15 years

	Boys	Girls	Total
25th percentile	0.80	0.86	0.8
Median	1.2	1.3	1.33
75th percentile	1.67	2.0	1.75

Table 4.8: Room density comparisons according to BMI distribution of the children aged 13 – 15 years

Percentile	25th percentile	Med	75th percentile
<15 (Underweight)	0.88	1.33	2.0
15–84.9 (Normal weight)	0.80	1.25	1.67
85–95 (Overweight)	0.71	1.0	1.67
> 95 Obese	1.0	1.50	1.75

Table 4.9 shows the prevalence of overweight/obesity according to the parents' occupation. The highest prevalence (22.6%) of overweight or obesity occurred among children whose parents had a graduate occupation. Only two children whose parents fell under the specialist category were found to be overweight or obese. A statistically significant difference could however only be found between the skilled and graduate parents' children, with statistically significantly more children whose parents had graduate occupations (22.6%) being overweight or

obese than those whose parents were skilled workers (12%) (95% CI for the difference: -20.2%; -1.5%).

Table 4.9: BMI distribution according to parent's occupation category, n (%)

Occupation	**≤ 15 (Under-weight)**	**15.1 – 84.9 (Normal weight range)**	**85 – 95 (Over-weight)**	**> 95 (Obese)**	**≥ 85 (Over-weight/ Obese combined)***
Unskilled	71 (52.6)	43 (31.9)	11 (8.2)	10 (7.4)	21 (15.6)[a,b]
Skilled	89 (59)	44 (29.1)	12 (8)	6 (4)	18 (12)[a]
Graduate	44 (39.6)	42 (37.8)	18 (16.2)	7 (6.3)	25 (22.6)[b]
Specialist	10 (55.6)	6 (33.3)	2 (11.1)	0	2 (11.1)[a,b]

***** Percentage overweight or obese is statistically significantly different between occupation categories with different superscripts (95% CI for the difference: -20.2%; 1.5%).

Logistic regression

Reporting the results of multiple regression analysis involves providing details about the strategy adopted (such as backward or forward stepwise regression) as well as all the variables which were included in the analysis (Altman, 1991). For the purpose of this study a backward stepwise regression was adopted. The results of the logistic regression analysis are indicated in Tables 4.10 and 4.11. The odds ratios, 95%CI and *P*-values were calculated for the risk factors in each of the final models. The following variables were included in each model: socio-economic status, gender, carbohydrate-, fiber-, protein-, calcium- and vitamin D intake. A *P*-value of <0.05 was considered statistically significant and a variable was then included in the model.

Table 4.10: Logistic regression predicting overweight and obesity in children aged 13 – 15 years

Variable	Odds ratio	95% CI	*P*-value
Girls	2.364	1.188 – 5.048	0.0161

On logistic regression analysis with BMI as the dependent variable, only gender was selected in the final model. The regression showed girls to be more likely than boys to be overweight.

Table 4.11: Logistic regression predicting low socio-economic status in children aged 13 – 15 years

Variable	Odds ratio	95% CI	*P*-value
Protein	1.49	1.191 - 1.866	0.0004

On logistic regression analysis with socio-economic status as the dependent variable, protein intake was selected in the final model. The regression showed children from a low socioeconomic status were more likely to have a low protein intake than children from a higher socioeconomic status.

School environment

Of the 26 schools with children participating in the study, ten (38.5%) school principals completed the school environment questionnaire. The rest of the principals could not submit the form due to reportedly not having time to complete it. Table 4.12 shows results obtained from these forms. Only 40% of the schools reported having any nutrition education programmes or campaigns and in the majority of these schools, the programmes were run only once a year (75%) mostly by the educators (75%).

Table 4.12: School environment of the 13 – 15 year old children

	N (10)	% of total
Presence of nutrition education programmes in the school		
• Yes	4	40
• No	6	60
Frequency of the programmes		
• Once a year	3	75
• Twice a year	0	0
• More than twice a year	1	25
People running the programmes		
• Educators	3	75
• Learners	0	0
• Other (invited health workers)	1	25
Presence of vending machines on school premises		
• Yes	0	0
• No	10	100
Presence of tuck shop and/or hawkers on or surrounding the school premises		
• Yes	10	100
• No	0	0

None of the schools had vending machines on the school premises, but all schools reported having a 'tuckshop' and/or hawkers on/or around the school premises. Table 4.13 gives a representation of foods sold either on or around the school premises (other shops and hawkers). Very few schools reported the sale of dairy products such as yoghurt (20.0%) and milk (20.0%). Crisps, sweets and carbonated drinks were sold at most schools. Wholewheat bread was sold in only two schools and fresh fruits were sold in 60.0% of the schools.

Table 4.13: Foods sold in tuckshops and/or by hawkers at schools of children aged 13 – 15 years in Bloemfontein

Food item	Yes		No	
	N	%	N	%
Biscuits	8	80.0	2	20.0
Chocolate bars	8	80.0	2	20.0
Sweets	10	100	0	0
Chips	10	100	0	0
White bread	6	60.0	4	40.0
Wholewheat bread	1	10.0	9	90.0
Fast foods such as pies, vetkoek, “slap” chips	10	100	0	0
Fruit	6	60.0	4	40.0
Yoghurt	2	20.0	8	80.0
Full cream milk	2	20.0	8	80.0
2% or low fat milk	0	0	10	100
Fruit juices	9	90.0	1	10.0
Carbonated drinks	9	90.0	1	10.0
Diet carbonated drinks	6	60.0	4	40.0
Coffee, tea, instant soup	5	50	5	50

DISCUSSION

Weight status

The objectives of this study were to examine the influence of socio-economic status on overweight and obesity in adolescents. However, a significant finding was that only about a third of the children in this study were at their normal BMI-for-age and more than 50% of the children were underweight.

The National Food Consumption Survey – Fortification Baseline (NFCS-FB) of 2005 found the prevalence rates of stunting, underweight and wasting to be 18%, 9.3% and 4.5% respectively (Steyn *et al.,* 2005). In comparison to the national statistics, mild stunting was observed in 31% to 75% of primary school children aged 8 – 11 years in Kwazulu Natal (Jinabhai *et al.,* 2003).

The high underweight figures emphasize the fact that even though there is an observed increase in the prevalence of overweight and obesity, the problem of malnutrition continues to affect millions of South African children (Gericke and Labadarios, 2007). One can speculate whether the high prevalence of underweight in this study is a result of peer pressure, participating in unhealthy dieting practices or poverty. Taking into account that only 16% of the children in this study reported being on slimming diets (Meko *et al.,* 2010), it becomes clear that the high prevalence of underweight in this study population rather reflects the high levels of food poverty (Rose and Charlton, 2002) and underdevelopment which are typical of the Free State province (MRC, 2002; Kruger *et al.,* 2006).

The results of the present study show the prevalence of overweight and obesity amongst children aged 13 – 15 years in Bloemfontein to be comparable to the prevalence in Russia which was found to be 16% (Wang, 2001). The prevalence of overweight/obesity in this study also corresponds with that of the South African Youth Risk Behaviour Survey (YRBS) (21.2%) conducted in South Africa (MRC, 2002), but it is a little higher than the THUSA BANA group (7.9%) (Kruger *et al.,* 2006).

Similar to other South African studies (Mamabolo *et al.,* 2007; Kruger *et al.,* 2006; MRC, 2002), the prevalence of overweight and obesity in our study was higher among girls than boys. Other countries such as Bolivia and Canada also found a higher prevalence of overweight and obesity in girls than boys (Perez-Cuerto *et al.*, 2005; Young *et al.,* 2000). When logistic regression analysis was performed for this study, the odds of being obese were higher in girls than in boys. This is similar to the findings of other studies (Mamabolo *et al.,* 2007; Perez-Cuerto *et al.,* 2005). The higher prevalence in girls than boys can be ascribed to earlier sexual maturation. Sexual maturation influences body fatness where fat gain occurs in boys and girls in adolescence but then ceases in boys and continues in girls throughout adolescence. This then means that girls accumulate more fat than boys (Lobstein *et al.,* 2004).

The association between waist circumference and BMI in this study was statistically significant. Only a small percentage of the children in this study had waist circumference above the 75th percentile compared to 27.9% of the children in Mexico in a study by Halley-Castillo and co-workers (2007). In those children where waist circumference was above the suggested cut-off point, the risk of metabolic complications is increased. Adolescents with a waist circumference above the 90th percentile have been shown to have higher concentrations of low density lipoprotein cholesterol, triglycerides and insulin and lower concentrations of high density lipoprotein (Fernandez *et al.,* 2004; McCarthy *et al.,* 2003) increasing their risk of developing chronic diseases of lifestyle in later years.

Weight status and socio-economic status

The children in this study lived in an urban area of the Free State. Bloemfontein consists largely of built up areas as well as informal settlements. Most of the children lived in brick houses and they mostly had access to water and sanitation facilities. This differs from the THUSA BANA study (Kruger *et al.,* 2006) and the study by Mamabolo *et al.* (2007) with samples including children from both urban and rural areas. McVeigh *et al.,* (2004) obtained similar results on their sample of children living in Johannesburg, South Africa. In their study 88% of the children lived in brick houses and 95% and 94% of these households had a television set and refrigerator, respectively, while only 39% owned a microwave. The fact that this study was based in an urban area also meant that a high percentage of the children had storage and cooking facilities such as fridges, stoves and microwave ovens available in their homes.

The number of children from low and high SES groups was equal. SES has been established as a predictor of overweight and obesity in several studies (Perez-Cuerto *et al.,* 2005; Deckelbaum and Williams, 2001; Wang, 2001). In developed countries lower SES has been found to be a strong predictor of the increased prevalence of obesity (Deckelbaum and Williams, 2001), while a high SES status in developing countries has been associated with the development of overweight and obesity (Perez-Cuerto *et al.*, 2005; Poskitt, 2005).

The current study failed to find any statistically significant linear association between the prevalence of obesity and SES. The reason for this could be due to the fact that even though the prevalence of overweight/obese in this study's population was higher among the high SES group, the odds of being obese were higher in children with a low SES. The higher prevalence of overweight in the higher SES group of children in this study corresponds to the findings of Perez-Cuerto *et al.,* (2005) who found that the odds of being obese were higher among the wealthier adolescents in their study ($P = 0.044$). This study of Perez-Cuerto was also done in a developing country (Bolivia). The results of the present study therefore confirm the results of other studies in developing countries of a higher prevalence of overweight and obesity among the higher SES groups (Perez-Cuerto *et al.,* 2005).

The current study showed that children whose parents had graduate occupations were significantly more overweight/obese than those children whose parents were skilled labourers. The THUSA BANA study conducted in the North West Province, South Africa (Kruger *et al.,* 2006) also compared the children's weight status with their parents' occupation. They found that children whose parents were employed as domestic or contract workers (unskilled) were less overweight/obese than the children whose parents had professional or business occupations (graduate and specialists). This could mainly be attributed to more money being available to spend on food in these households than there is money in the domestic or contract workers' households. In contrast to this current study Ekelund and co-workers (2005) established an inverse association between the parents' education level and BMI in the girls in their study in Stockholm.

Family size has also been associated with the prevalence of overweight and obesity with children from smaller households having a higher prevalence (Kruger *et al.,* 2006; Gulliford *et al.* 2001). There was no statistically significant difference between median room density across the different BMI groups in this study.

No association could be found between overweight/obesity and race in this study. However, the prevalence of overweight/obesity was higher among the white children compared to the black and coloured children. This is consistent with the findings of the THUSA BANA study where the prevalence of obesity was twice as high in the white children compared to the other racial groups in their study (Kruger *et al.*, 2006). Mamabolo *et al.* (2007) also found that white primary school children were heavier than their black counterparts. Nationally, Indian children (25.3%) were more overweight than the white (23.4%) and black children (16.6%) (MRC, 2002). It is important to note however, that in all these studies, a limited number of white children were included and the data may not be representative of the total population. With adult populations however, the picture is different with the prevalence of obesity being higher among black women (31.8%) than white women (22.7%). Also a higher percentage of white men (18.2%) than black men (6.0%) are currently overweight (Puoane *et al.,* 2002).

Possible reasons for the higher prevalence of obesity among white children may include an environment that leads to the development of obesity. Whilst this was not determined in the current study, white children are likely to live closer to fast-foods establishments. They are therefore likely to be consuming more energy-dense foods. Also, unlike most black children who have to walk long distances to school and still do house chores such as cleaning and laundry, white children are more likely to have more sedentary lifestyles. Commuting to school is done with the aid of the family car and house chores are left to the household's domestic worker in most cases (Kruger *et al.,* 2006; Perez-Cuerto *et al.,* 2005). Differences that exist in SES among the different ethnicities, as is sometimes apparent in many South African communities, are among the factors that may explain the difference in obesity prevalence (Wang, 2001).

School environment

The school environment provides access to a large number of adolescents thus providing a suitable environment for health promotion (Jihabhai *et al.*, 2007). Innovative and effective strategies that focus at schools are needed to help promote healthy food choices among teenagers (Hamdan *et al.,* 2005).

Of the schools surveyed in this study, most did not have any nutrition education programmes in place, similar to the Belgian-Flanders study (Vereecken *et al.,* 2005). The focus by most schools in South Africa is mainly on academic performance meaning that programmes such as health promotion are not first on the priority list of most schools.

Where schools had programmes in place, most were run once a year and they were led by educators and not by the learners themselves. Hamdan *et al.,* (2005), reports that student led nutrition and health promotion programmes are more effective in changing students' food choices. They state that youth prefer delivering health education themselves as well as receiving it from their peers. No studies have been carried out in South Africa where the presence or absence of nutrition education programmes has been investigated. It would be interesting to determine the prevalence of such programmes as well as their effectiveness.

Compared to Belgium where most of the schools have vending machines (Vereecken *et al.,* 2005), none of the schools in this study had vending machines on the school premises. In Belgian-Flanders, 80% of the secondary schools had vending machines. Only a few (27%) of their secondary schools had school stores compared to all of the schools in this study who had a shop and/or informal vendors selling food on the school premises (Vereecken *et al.,*2005).

In both the formal and informal food market sector, shop owners will always mainly focus on their target market in order to maintain or improve sales (Herbold and Taylor, 2008: 82). Pupil's food preferences influence the types of foods sold at school shops and by other vendors. Health and nutrition are not a priority for adolescents (Probart *et al.,* 2006), therefore items such as milk, will not be stocked easily by all vendors. Very few schools sold any dairy products in their shops. A little under two thirds of the schools had fruits sold on their premises. The perishability of fruits makes it less attractive and convenient for selling by the school shops or informal vendors. Similar to the Belgian-Flanders study, soft drinks, biscuits, sweets and fast foods were sold on the school premises in the majority of the schools in this study (Vereecken *et al.,* 2005).

Only a small number of white, Indian, coloured and Chinese children participated in this study and therefore the data does not necessarily represent the total population. Regarding the school environment questionnaire, not all school principals completed the questionnaire. Data from only ten schools could be analysed, meaning that data from the other twenty six schools is not included in the results. Therefore the results cannot be viewed as representative of the whole population.

CONCLUSION AND RECOMMENDATIONS

The prevalence of underweight was high despite the prevalence of overweight and obesity in this study population. The effect of socioeconomic status on the prevalence of overweight and obesity remains important if effective intervention programmes are to be planned. From this study it seems as if the parents' occupation played a major role in determining the prevalence of overweight and obesity in children. Of concern is the limited literature on socioeconomic status and obesity prevalence in South African children specifically. More focus should therefore be given to this area considering the diversity of this country.

Since schools have most access to children, they should be the area of focus in implementing intervention programmes aimed at preventing overweight and obesity. Furthermore, extensive research is needed to investigate school nutrition practices with attention being given to popular junk foods sold in and around schools.

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CHAPTER 5

The association between daily dietary intake and weight status of children aged 13 – 15 years in Bloemfontein, in the Free State Province

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Abstract

Introduction: There has been a progressive increase in the prevalence of childhood obesity in South Africa. The role of dietary intake in the development of overweight and obesity remains inconclusive. Although it is well accepted that maintaining a negative energy balance may aid in the prevention of overweight and obesity, the role of dietary intake in the development of overweight and obesity remains inconclusive.

Objective: To determine the association between dietary intake and weight status of children aged 13 – 15 years in Bloemfontein, Free State Province.

Design: A cross-sectional analytical study.

Methodology: A total of 640 children were randomly selected for the study. Four hundred and fifteen children (including 175 boys and 240 girls) met the inclusion criteria and participated in the study. Weight, height and waist circumference were measured and children were classified as underweight, overweight, or obese according to BMI <5th, ≥85th and ≥95th percentiles respectively, of the Centers of Disease Control (CDC). Waist circumferences ≥ 75thand ≥ 90th of the United States' percentiles indicated high and very high risks for comorbidities respectively. Dietary intake was determined using the Quantitative Food Frequency questionnaire. Portion sizes were estimated using standardized food models and food packaging. Data was analyzed using the Food Finder® computer programme.

Results: Median BMI of all children was 19.5 kg/m^2 with 15.9% of the children being overweight/obese. More girls (18.4%) than boys (15.6%) had waist circumferences above the 75th percentile. The prevalence of overweight/obesity was lower in the boys (10.9%) than girls (19.6%). A total of 214 (51.6%) children in the study were underweight. Macro- and micronutrient intakes of the children were within the normal ranges, except for fibre, calcium, phosphorus, magnesium, selenium, vitamin D and folate. Most of the children (40.8%) reported eating at least three meals per day. The boys' nutrient intakes were mostly statistically significantly higher than that of the girls. Half (51.1%) of all children had energy intakes equivalent to the estimated energy requirements

(EER). Dietary fat intake as percentage of total energy was high (>35%) in 48.0% of the children. No association between total energy intake and overweight/obesity was found.

Conclusion: The macronutrient intakes of the children in this study were adequate. Dietary fibre intake as well as the intake of phosphorus, magnesium, selenium and vitamin D were below recommendations. Results of this study show that there are probably factors apart from dietary intakes that are closely associated with weight status of these children, as no statistically significant association could be made between dietary intake and weight status.

INTRODUCTION

The prevalence of childhood obesity is increasing rapidly worldwide and it has become a global epidemic with an estimated 1.3 billion people who are overweight and obese. In the United States the prevalence of childhood obesity has tripled in the last decade with the prevalence rate of 15% currently. Increases in childhood overweight and obesity have also been observed in countries such as Canada, the United Kingdom and China amongst others (Daniels *et al.,* 2005; Kelly and Marcus, 2005).

Observations in countries undergoing rapid economic development such as Brazil, China and South Africa have shown that while undernutrition, food insecurity and infectious diseases continue to be prevalent, the prevalence of overweight and obesity is increasing (Hoffman, 2004; Cole *et al.,* 2000). In South Africa particularly, the increase in the prevalence of childhood obesity has been progressive for several decades (Puoane *et al.,* 2002), and an increasing prevalence of 25% has been reported, particularly among girls (MRC, 2002).

South Africa has a complex mix of developed areas in terms of its population and economy. The gap in income distribution between the poor majority and wealthy minority is huge. This unequal distribution is evidenced by the high prevalence of stunting in black children, especially in rural areas, accompanied by a high prevalence of overweight and obesity in all ethnic groups residing in urban areas (Steyn, 2006).

Childhood obesity is associated with several risk factors for later heart disease and other chronic diseases including hyperlipidaemia, hyperinsulinaemia, hypertension and early arthrosclerosis (Goedecke *et al.,* 2006; Cole *et al.,* 2000). Recent research in Soweto (a South African township) (Dalby and White, 2008; Sliwa *et al.,* 2008) has shown that an increasing number of black African people, a group among which chronic diseases of lifestyle were previously less common, now seek medical care for heart disease. A large number of these people, particularly women, were obese (Sliwa *et al.,* 2008). Because of their public health importance, the trends in child obesity need to be closely monitored.

The multifaceted causes of obesity make it difficult to fully determine the origin of an individual's obesity. Both environmental and genetic factors are involved in a complex interaction of variables leading to childhood obesity. These include psychological and cultural influences as well as physiological regulatory mechanisms. Over the years many hypotheses have evolved to explain why some people become fat whereas others remain thin and no single theory, which is consistently applicable to all persons has been able to explain reasons for this disease (Venner *et al.,* 2006; Laquatra, 2004).

Excess energy intake in children can result from consuming large portion sizes or eating large amounts of energy-dense foods. Nutrition transition, which is eminent in developing countries, exacerbates the problem by increasing exposure to "Western diets" as well as fast foods which are usually energy-dense and nutrient-poor (Farooqi, 2005; Hoffman, 2004; Laquatra, 2004).

It is evident that a passive approach towards the obesity epidemic can no longer be tolerated as it has failed to produce any results. Interventions aimed at reducing childhood overweight and obesity need to be introduced. This can only be done effectively once the causal factors are well understood (Du Toit, 2003).

The aim of this study was to determine usual dietary intake and its association with weight status in the children aged 13 – 15 years in Bloemfontein, Free State Province.

METHODOLOGY

A cross-sectional population-based study was undertaken between January and November 2006 amongst children aged 13 – 15 years. The aim of the study was to determine associations between dietary intake and body weight status of the children. As part of the larger study carried out in 2006, socio-economic status, school nutritional practices and physical activity levels were determined and are reported elsewhere (Meko *et al.,* 2010).

Sample

The Ethics committee of the Faculty of Health Sciences at the University of the Free State approved the study. A total of 26 secondary schools out of 28 in Bloemfontein in the Free State Province that were identified, participated in the study. The headmasters of the two schools that did not participate declined to give permission for the study to be carried out at their schools. Approval was obtained from the Department of Education in the Free State Province as well as from the schools' principals. Alphabetical lists of learners between the ages of 13 – 15 years were obtained from the principals of these schools. A representative sample of 640 children was randomly selected from these lists. Parents or caregivers of all children were given letters informing them about all aspects of the study. Informed consent was obtained from all parents or caregivers as well as all the children. Every child that gave consent was awarded a t-shirt with the words "Get up and get active" as an incentive.

Anthropometric measurements

Anthropometric measurements were done by fieldworkers who were trained in standardized methods and techniques (Lee and Nieman, 2003: 166). Body weight was measured to the nearest 0.1kg using a Seca beam balance scale with the children wearing minimal clothing and without shoes. A Seca 214 portable stadiometer was used to measure height to the nearest 0.5cm (Lee and Nieman, 2003: 225 – 229). Waist circumference was measured at the narrowest circumference on the waist above the iliac crest and beneath the lower rib using a flexible non-stretch tape measure (GWCC400) (McCarthy *et al.,* 2003).

The Centers for Disease Control (CDC) percentiles for BMI-for-age and gender were used to classify the children according to weight status. BMI was classified using < 15^{th} percentile for underweight, 15 – 84.9^{th} percentiles for normal weight, ≥ 85^{th} – 94.9^{th} percentiles for overweight and ≥95^{th} percentile was used for obesity (Cunningham, 2004; Sizer and Whitney, 2008). Ethnic specific percentiles of waist circumference-for-age and gender were used to classify the children according to WC associated risk. A waist circumference ≥ 75^{th} percentile (based on ethnicity and gender) indicated high risk and ≥ 90^{th} percentile a very high risk of comorbidities (Fernandez *et al.,* 2004).

Dietary intake

Dietary intake was determined using the Quantitative Food Frequency Questionnaire (FFQ). The validity of the questionnaire had already been determined in the THUSA study (MacIntyre *et al.,* 2000). The interviews with the children were conducted in the children's language of preference by the researcher and trained field workers. Frequency of food intake during the previous six months was recorded. Portion sizes were estimated using standardized food models and examples of food packaging materials. The FFQ was first summarized and the weights of individual food items were determined using the Food Quantities Manual (Langenhoven *et al.,* 1991). Data from the questionnaire was computerized and analyzed using the Food Finder® computer program.

Recently Nutrient Intake Values (NIVs) have been recommended as the new standard for planning and assessing nutrient intakes of individuals and population groups (Murphy and Vorster, 2007). However, during the practical execution of this study from May 2006, the Dietary Reference Intakes (DRIs) were still in use and are therefore used in evaluating the dietary intake of the children in this study. Energy intakes were compared to Estimated Energy Requirements (EER) while nutrient intakes were compared to Recommended Dietary Allowances (RDAs), Estimated Average Requirements (EARs) or Adequate Intakes (AI) in order to evaluate for adequacy of energy and nutrient intakes.

STATISTICAL ANALYSIS

Statistical analysis was done by the Department of Biostatistics, University of the Free State. Descriptive statistics, namely medians and percentiles for continuous data and frequencies and percentages for categorical data, were calculated per group. The groups were compared by means of 95% confidence intervals (CI). The prevalence of overweight and obese children was calculated and described by means of 95% CI. Stepwise logistic regression analysis was performed and the odds ratios, 95% CI and *P* values were calculated for each risk factor in the final model. A *P* value of < 0.05 was considered statistically significant.

RESULTS

A total of 415 children (175 boys and 240 girls) out of 640 children selected gave consent and participated in the study with a response rate of 67.7%.

Table 5.1 shows the anthropometric distributions of the children while Table 5.2 gives the gender differences of BMI according to percentiles.

Table 5.1: Anthropometric distributions of boys and girls aged 13 – 15 years

	BMI (kg/m^2)		Waist circumference (cm)	
	Boys	**Girls**	**Boys**	**Girls**
25th percentile	16.9	18.6	65.0	65.0
Median	18.4	21.1	68.5	69.0
75th percentile	20.3	23.3	73.0	75.3

Table 5.2: Weight classification according to BMI of boys and girls aged 13 – 15 years

CDC BMI Percentiles	Boys		Girls		Total	
	N (175)	**%**	**N (240)**	**%**	**N (415)**	**%**
≤ 15 (Underweight)	118	67.4	96	40	214	51.6
15–85 (Normal weight)	38	21.7	97	40.4	135	32.5
85 – 95 (Overweight)	11	6.3	32	13.3	43	10.4
≥ 95 Obese	8	4.6	15	6.3	23	5.5
Overweight/obese combined	19	10.9	47	19.6	66	15.9

A third of the children's weight was within the normal range (32.5%), with half of the children being underweight (51.6%). Obesity occurred in only 5.5% of the children while 10.4% were overweight. The prevalence of overweight/obesity was higher in girls (19.6%) than boys (10.9%).

Median waist circumference for all the children was 69cm and was similar in boys and girls. Table 5.3 shows the waist circumferences of the children according to percentiles based on the American children's ethnic specific references (Fernandez *et al.,* 2004).

Table 5.3: Waist circumference percentile distribution of boys and girls aged 13 – 15 years

Percentile	Boys		Girls		Total	
	N (175)	%	N (240)	%	N (415)	%
< 10	32	18.3	29	12.1	61	14.7
10 – 24.9	43	24.6	35	14.6	78	18.8
25 – 49.9	43	24.6	81	33.8	124	29.9
50 – 74.9	35	20.0	51	21.3	86	20.7
75 – 90	18	10.3	35	14.6	53	12.8
> 90	4	2.3	9	3.8	13	3.1

Percentiles based on American cut-off points (Fernandez *et al.,* 2004).

Most of the boys (69.2%) and most of the girls (69.7%) had a waist circumference within the normal range of between the 10^{th} and the 74.9^{th} percentiles. Children with a waist circumference above the 75^{th} percentile made up 15.9% of the total study population. With regards to the gender distribution, more girls (18.4%) had a waist circumference above the 75^{th} percentile of the US standards than boys (12.6%) (Fernandez *et al.,* 2004). The association between waist circumference and BMI was statistically significant (95% CI for the difference: -86.3%; -53.6%).

Table 5.4 shows data on the dietary habits and eating patterns of the children.

Table 5.4: Dietary habits and eating patterns of children aged 13 – 15 years

	N	% of total
Lunch box taken to school		
• Yes	133	32.1
• No	281	67.9
Special diet		
• Yes	23	5.6
• No	391	94.4
Type of diet		
• Diabetic	1	4.6
• Slimming	16	72.7
• Allergy	3	13.6
• Vegetarian	2	9.1
Use of added salt at the table		
• Yes	376	90.8
• No	38	9.2
Use of dietary supplements		
• Yes	38	9.2
• No	376	90.8
Type of supplements		
• Vitamins	30	78.9
• Minerals	2	5.4
• Protein	3	8.1
• Energy	3	8.1
Number of meals eaten per day		
• More than three plus snacks	106	25.6
• Three plus snacks	169	40.8
• Three meals only	54	13.0
• Two plus snacks	47	11.4
• Two meals only	8	1.9

• One plus snacks	22	5.3
• One meal only	6	1.5
• Nibble the whole day	2	0.48
Coffee/tea consumption with meals		
• Yes	356	86
• No	58	14
Daily intake of meat, fish or poultry		
• None	4	0.97
• Once	226	54.9
• Twice	145	35.2
• Three times	29	7.0
• Four times	6	1.5
• Five times	2	0.49

Only one third of the children (32.1%) reported taking lunch boxes to school. Most of the children (94.4%) reported that they were not on any special diet; similarly most of the children did not use any dietary supplements (90.8%). The majority of those children using supplements were using vitamin supplements (78.4%). Most of the children ate at least three meals per day (40.8%), followed by those who ate three meals plus a snack during the day (25.6%). Over half of the children in this study (54.9%) reported eating meat, fish or poultry only once per day with another 35.2% of the children eating meat at least twice a day. Tea and coffee with meals was a popular habit amongst these children with 86% of the children reporting drinking tea or coffee with their meals. Whilst only a few children reported being on a special diet (5.6%), the majority of those on special diets (72.7%) reported being on a slimming diet.

The energy intakes of the children according to estimated energy requirements are shown in Table 5.5.

Table 5.5: Energy intake according to estimated energy requirements of boys and girls aged 13 – 15 years

Estimated energy requirements (EER)	**Boys n (%)**	**Girls n (%)**	**Total n (%)**
< EER	53 (30.3)	98 (40.8)	151 (36.4)
= EER	92 (52.6)	120 (50.0)	212 (51.1)
> EER	30 (17.1)	22 (9.17)	52 (12.5)

The energy intakes of most of the children (51.1%) were equal to the estimated energy requirements (EER). More boys (17.1%) than girls (9.17%) had an energy consumption above the EER. The energy intake of the boys was not statistically significantly different from that of the girls.

Table 5.6: Fat intake as percentage of total energy of boys and girls aged 13 – 15 years

Total fat as percentage of total energy (TE)	**Boys n (%)**	**Girls n (%)**	**Total n (%)**
< 30% of TE	26 (14.9)	20 (8.3)	46 (11.1)
30 – 35% of TE	82 (46.9)	88 (36.7)	170 (41.0)
> 35% of TE	67 (38.3)	132 (55.0)	199 (48.0)

Most of the children (48.0%) had a dietary fat intake above 35% of total energy, while 41.0% of the children had a dietary fat intake between 30 – 35% of total energy. More girls (55.0%) than boys (38.3%) had a dietary fat intake of above 35% of total energy.

The range and median macro- and micronutrient intakes of the children are shown in Table 5.7. Due to the higher energy intake of boys compared to girls, median intakes of most nutrients were statistically significantly higher in boys than in girls.

Table 5.7: Macro- and micronutrient median intakes of boys and girls aged 13 – 15 years

Nutrients	Boys		Girls		95% CI of median difference
	Median	Range	Median	Range	
Macronutrients					
Energy (kJ)	8431.0	3123.6 - 17896.3	7774.3	2274.0 - 17168.9	328.25;1400.66 *
Carbohydrates (g)	250.07	94.8 - 553.3	222.9	51.7 - 477.0	14.58;46.86*
Fibre (g)	17.6	6.0 - 41.6	15.3	4.2 -34.8	1.20;3.78*
Protein (g)	64.3	19.6 - 149.0	59.4	20.6 - 124.5	1.79;10.04*
Micronutrients					
Calcium (mg)	539.3	111.9 - 1606.7	484.5	132.3 - 1144.9	10.14;90.71*
Phosphorus (mg)	975.8	274.7 - 2241.4	872.9	248.4 - 1828.4	49.74;173.18*
Magnesium (mg)	251.9	81.0 - 523.1	213.4	50.9 - 473.4	16.92;48.71*
Iron (mg)	9.66	2.7 - 21.8	8.59	3.2 - 31.7	0.10;1.44*
Zinc (mg)	7.91	2.6 - 16.3	7.1	3.0 - 14.9	0.34;1.31*
Iodine (mcg)	34.04	6.2 - 75.4	31.3	4.8 - 92.4	0.44;5.52*
Selenium (mcg)	33.7	8.4 - 96.0	34.3	6.1 - 116.2	
Chloride (mcg)	1458.90	240.0 - 4010.6	1408.1	301.6 - 4151.6	
Potassium (mcg)	2150.6	635.4 - 4630.7	1922.5	575.1 - 4491.0	58.93;335.92*
Sodium (mcg)	1828.8	584.9 - 3861.9	1674.0	298.7 - 4234.1	
Vitamin A (RE)	517.2	32.8 - 2577.7	458.5	45.8 - 3218.4	
Vitamin D (mcg)	4.3	0.12 - 12.2	3.6	0.5 - 10.9	0.15;0.95*
Vitamin E (mg)	11.1	2.2 - 33.1	10.2	2.1 - 35.5	0.04;2.13*
Vitamin K (mcg)	77.0	3.9 - 560.5	86.1	5.1 - 654.8	
Thiamin (mg)	1.1	0.29 - 2.6	0.97	0.28 - 2.2	0.04;0.18*
Riboflavin (mg)	1.4	0.27 - 4.36	1.5	0.24 - 10.8	
Niacin (mg)	16.8	5.3 - 39.5	14.9	5.3 - 37.5	0.31;2.59*
Vitamin B6 (mg)	1.3	0.24 - 3.4	1.2	0.35 - 3.0	
Folate (mcg)	193.0	35.4 - 423.8	166.6	35.0 - 407.9	10.87;38.78*
Vitamin B12 (mcg)	4.3	0.69 - 14.9	3.7	0.95 - 29.6	
Vitamin C (mg)	63.8	8.9 - 312.8	57.8	8.2 - 224.3	

Table 5.8: Macro- and micronutrient intakes of boys and girls aged 13 – 15 years according to the estimated average requirements (EAR), recommended dietary allowance (RDA) or adequate intake (AI)

Nutrients	Boys		Girls		Total	
	<RDA/ AI	≥RDA/ AI	<RDA/ AI	≥RDA/ AI	<RDA/ AI	≥RDA/ AI
	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)
	Macronutrients					
Carbohydrates (g)	2 (1.1)	173 (98.9)	3 (1.3)	237 (98.7)	5 (1.2)	98.8 (410)
Fibre (g)	168 (96.0)	7 (4.0)	227 (94.6)	13 (5.4)	395 (95.2)	20 (4.8)
Protein (g)	-	175 (100)	-	240 (100)	-	415 (100)
	Micronutrients					
	<EAR / AI	**≥ EAR / AI**	**<EAR / AI**	**≥ EAR / AI**	**<EAR / AI**	**≥ EAR / AI**
Calcium (mg)	174 (99.4)	1 (0.57)	249 (100)	-	414 (99.8)	1 (0.2)
Phosphorus (mg)	100 (57.1)	75 (2.9)	170 (70.8)	70 (29.2)	270 (65.1)	145 (34.9)
Magnesium (mg)	114 (65.1)	61 (34.9)	168 (70.4)	71 (29.6)	283 (68.2)	132 (31.8)
Iron (mg)	43 (24.6)	132 (75.4)	77 (32.1)	163 (67.9)	120 (28.9)	295 (71.1)
Zinc (mg)	92 (52.6)	83 (47.4)	136 (56.7)	104 (43.3)	228 (54.9)	187 (45.1)
Iodine (mcg)	175 (100)	-	239 (99.6)	1 (0.42)	414 (99.8)	1 (0.2)
Selenium (mcg)	115 (65.7)	60 (34.3)	144 (60.0)	96 (40.0)	259 (62.4)	156 (37.6)
Vitamin A (RE)	101 (57.7)	74 (42.3)	121 (50.4)	119 (49.6)	222 (53.5)	193 (46.5)
Vitamin D (mcg)	114 (65.1)	61 (34.9)	173 (72.1)	67 (27.9)	287 (69.2)	128 (30.8)
Vitamin E (mg)	94 (53.7)	81 (46.3)	130 (54.2)	110 (45.8)	224 (54.0)	191 (46.0)
Vitamin K (mcg)	82 (46.9)	93 (53.1)	105 (43.8)	135 (56.2)	187 (45.1)	228 (54.9)
Thiamin (mg)	56 (32.0)	119 (68.0)	78 (32.5)	162 (67.5)	134 (32.3)	281 (67.7)
Riboflavin (mg)	39 (22.3)	136 (77.7)	44 (18.3)	196 (81.7)	83 (20.0)	332 (80.0)
Niacin (mg)	33 (18.9)	142 (81.1)	35 (14.6)	205 (85.4)	68 (16.4)	347 (83.6)
Vitamin B_6 (mg)	49 (28.0)	126 (72.0)	63 (26.3)	177 (73.7)	112 (27.0)	303 (73.0)
Folate (mcg)	150 (85.7)	25 (14.3)	224 (93.3)	16 (6.67)	374 (90.1)	41 (9.9)
Vitamin B_{12} (mcg)	9 (5.1)	166 (94.9)	19 (7.9)	221 (92.1)	28 (6.8)	387 (93.2)
Vitamin C (mg)	69 (39.4)	106 (60.6)	101 (42.1)	139 (57.9)	170 (40.1)	245 (59.0)

Table 5.8 shows the macro-and micronutrient intakes of the children according to EARs, RDAs or AIs. The protein and carbohydrate intakes of the children were adequate based on their respective RDAs. The fibre intake however, was below the recommendations for most of the children (95.2%). Despite the adequate energy intakes, most of the children had intakes below the EAR for phosphorus, magnesium, selenium, chloride, vitamin D and folate. All but one child had calcium and iodine intakes below the EAR for those nutrients. The association between macro- and micronutrient intakes and BMI was not statistically significant.

Table 5.9 shows the association between energy intakes and categories of weight status of the children who participated in this study.

Table 5.9: BMI distribution and energy intake levels of children aged 13 – 15 years

Body mass index (BMI)	**< EER** **n (%)**	**= EER** **n (%)**	**> EER** **n (%)**
≤ 15 (Underweight)	80 (37.4)	101 (47.2)	33 (15.4)
15–84.9 (Normal weight)	48 (35.6)	73 (54.1)	14 (10.4)
85 – 95 (Overweight)	14 (32.6)	26 (60.5)	3 (6.9)
> 95 Obese	9 (39.1)	12 (52.2)	2 (8.7)

In all the BMI categories, most children had energy intakes that were equal to the EER. Very few children in the overweight (6.9%) and obese (8.7%) groups had energy intakes above the EER. No statistically significant association could be found between total energy intake and weight status in the children in this study.

Table 5.10 gives a comparison of the children's dietary fat intake as a percentage of total energy intakes according to their BMI distribution.

Table 5.10: Dietary fat intake as a percentage of total energy intake according to categories of weight status of children aged 13 – 15 years, n (%)

	< 30% TE	30 – 35% TE	> 35% TE
≤ 15 (Underweight)	25 (11.7)	91 (42.5)	98 (45.8)
15–84.9 (Normal weight)	17 (12.6)	50 (37.0)	68 (50.4)
85 – 95 (Overweight)	3 (7.0)	17 (39.5)	23 (53.5)
> 95 Obese	1 (4.3)	12 (52.2)	10 (43.5)

Most of the children in the different BMI groups, except for the obese group, had dietary fat intakes of more than 35% of total energy. Most children in the obese group (52.2%) had a dietary fat intake of between 30 – 35% of total energy. More children in the overweight group (53.5%) compared to the other BMI groups had a dietary fat intake above 35% of total energy. No statistically significant association could be made between dietary fat intake and weight status.

Logistic regression

Reporting the results of multiple regression analysis involves providing details about the strategy adopted (such as backward or forward stepwise regression) as well as all the variables which were included in the analysis (Altman, 1991). For the purpose of this study a backward stepwise regression was adopted. The results of the logistic regression analysis are indicated in Table 5.11 and 5.12.

The odds ratios, 95%CI and *P*-values were calculated for the risk factors in each of the final models. The following variables were included in each model: socio-economic status, gender, carbohydrate-, fiber-, protein-, calcium- and vitamin D intake. A *P*-value of <0.05 was considered statistically significant and a variable was then included in the model.

Table 5.11: Logistic regression predicting overweight and obesity in children aged 13 – 15 years

Variable	**Odds ratio**	**95% CI**	***P*-value**
Girls	2.364	1.188 – 5.048	0.0161

On logistic regression analysis with BMI as the dependent variable, only gender was selected in the final model. The regression showed girls to be more likely than boys to be overweight.

Table 5.12: Logistic regression predicting low socio-economic status in children aged 13 – 15 years

Variable	**Odds ratio**	**95% CI**	***P*-value**
Protein	1.49	1.191 - 1.866	0.0004

On logistic regression analysis with socio-economic status as the dependent variable, protein intake was selected in the final model. The regression showed children from a low socioeconomic status were more likely to have a low protein intake than children from a higher socioeconomic status.

DISCUSSION

The objectives of this study were to examine the influence of dietary intake on overweight and obesity in adolescents. However, a significant finding was that only about a third of the children in this study were at their normal BMI-for-age and more than 50% of the children were underweight.

The National Food Consumption Survey – Fortification Baseline (NFCS-FB) of 2005 found the prevalence rates of stunting, underweight and wasting to be 18%, 9.3% and 4.5% respectively (Steyn *et al.,* 2005). In comparison to the national statistics, mild stunting was observed in 31% to 75% of primary school children aged 8 – 11 years in Kwazulu Natal (Jinabhai *et al.,* 2003).

The high underweight figures emphasize the fact that even though there is an observed increase in the prevalence of overweight and obesity, the problem of malnutrition continues to affect millions of South African children (Gericke and Labadarios, 2007). One can speculate whether the high prevalence of underweight in this study is a result of peer pressure, or participating in unhealthy dieting practices or the result of poverty. Taking into account that only 16% of the children in this study reported being on slimming diets, it becomes clear that the high prevalence of underweight in this study population rather reflects the high levels of food poverty (Rose and Charlton, 2002) and underdevelopment which are typical of the Free State province (MRC, 2002; Kruger *et al.,* 2006).

Almost one fifth of the children in this study were either overweight or obese. This finding corresponds with that of the South African Youth Risk Behaviour Survey (YRBS) (21.2%) (MRC, 2002), but is higher than that of the children aged 9 – 15 years in the THUSA BANA group (7.9%) (Kruger *et al.,* 2006). The coexistence of undernutrition and overweight is a recognized burden of countries in nutritional transition (Prentice, 2006; Deckelbaum and Williams, 2001).

Similar to other South African studies (Mamabolo *et al.,* 2007; Kruger *et al.,* 2006; MRC, 2002), the prevalence of overweight and obesity was higher among girls than boys. According to logistic regression analysis, the odds of being obese were higher in girls than in boys, further confirming the results stated above. Countries such as Bolivia and Canada also found a higher prevalence of overweight and obesity in girls than boys (Perez-Cuerto *et al.*, 2005; Young *et al.,* 2000). The higher prevalence of overweight/obesity amongst the girls in this study could possibly be due to the fact that the girls were less active than the boys (Meko *et al.,* 2010), even though the boys reported a higher energy intake than the girls. Similar results of higher activity levels amongst boys than girls were also reported by Mamabolo and co-workers (2007) in black South African adolescents as well as by Vilhjalmsson and Kristjansdottir (2003) in Icelandic teenagers. Another recognised explanation for the higher prevalence of overweight and obesity in girls compared to boys is that early sexual maturity is strongly related to an increased risk of developing overweight (Adair and Gordon-Larsen, 2001). It is well known that girls tend to mature earlier than boys sexually (Wang, 2002), and this could possibly be another reason why the girls of this study were more overweight than the boys.

The risk for metabolic complications including higher concentrations of low density lipoprotein cholesterol, triglycerides and insulin and lower concentrations of high density lipoprotein is increased in adolescents with a waist circumference above the 90^{th} percentile (McCarthy *et al.,* 2003). Only 15.9% of the children in this study had waist circumference above the 75^{th} percentile compared to 27.9% of the children in Mexico in a study by Halley-Castillo and co-workers (2007). There was a significant association between waist circumference and BMI. Concern for future development of metabolic complications still remains for those children who had a waist circumference above the 90^{th} percentile of the American standard in this study.

Dietary causes of obesity are complex and poorly understood (Nicklas *et al.,* 2003). Associations between weight status and total energy- and fat intake have been established in some studies (Li *et al.,* 2007; Gillis *et al.,* 2002), while other studies have failed to identify this association (Langevin *et al.,* 2007; Phillips *et al.,* 2004). South African studies have also not been able to establish the association between energy intake and the prevalence of overweight and obesity (Kruger *et al.,* 2006; Kruger *et al.,* 2005). The majority of the children in this study had a total energy intake that was equal to the EER. However, when comparing energy intake level to weight status of the children in this particular study, no statistically significant association could be found.

A study on Canadian children and adolescents found a positive association between the energy and fat intakes and obesity. Obese children consumed significantly more total energy and total fat than their non-obese counterparts (Gillis *et al*., 2002). In the current study no association could be found between obesity and dietary fat intake as percentage of total energy similar to the findings of Langevin and co-workers (2007). While the prevalence of underweight was high in these children, the relatively high fat intake is of great concern. Most of the children in this study had a dietary fat intake of more than 35% of total energy. This is despite the fact that 36% of these children had energy intakes below the EER. The increased dietary fat intake can possibly be attributed to the fact that a substantial number of these children reported consuming snacks in between their meals. These snacks which include foods such as crisps, biscuits, 'vetkoek', etc. are typically low in nutrients and high in fat and possibly contributed to the children's high fat intake.

Globalisation has led to increased exposure to the global market economy which in turn has led to a shift from home-grown traditional foods which were low in fat and rich in fibre (Golan and Crow, 2004). People are now consuming increased amounts of meat and other foods high in saturated fats and low in fibre (Rennie *et al.,* 2005). These trends are also observed in South Africa. Contributing factors to excess energy intake in school children, as observed by Kruger and co-workers (2005), may be the availability of a wide variety of low-cost, high-energy foods at community shops, school shops and street vendors. Furthermore, the consumption of fast foods is also on the increase amongst most age groups with a concurrent increase in the intake of trans fatty acids (Stender *et al.,* 2007; Pereira *et al.,* 2005). Checks on McDonald's fast food outlets revealed trans fatty acid levels of 14 – 15% of total energy content of food items in South Africa, compared to 14 – 16% in US outlets (Stender *et al.,* 2007). KFC is another popular fast food chain in South Africa and its trans fatty acid content ranged from 11 – 30% (Stender *et al.,* 2006).

Although the boys' fibre intake in the present study was statistically significantly higher than that of the girls, low fibre intakes were reported by all children. The low fibre intake may be ascribed to a low consumption of fresh fruits and vegetables as well as a high consumption of refined carbohydrates such as white bread, maize meal, rice and macaroni. The risk for metabolic syndrome is increased with a low fibre intake. Ventura and co-workers (2008) found that adolescents who did not present with metabolic syndrome, tended to eat more grams of total fibre compared to those adolescents in their study who presented with metabolic syndrome. Steffen and co-workers (2003) showed that increased dietary fibre was associated with lower body mass and greater insulin sensitivity among adolescents.

There is growing interest in the role of carbohydrates in determining energy intake since the form of carbohydrate may be important in determining satiety (Warren *et al.,* 2003, Brand-Miller *et al.,* 2002). Warren and co-workers (2003) found that adolescents who consumed diets high in carbohydrates (especially those with many foods with a high glycaemic index) and low in fat had a high

BMI. The Bogalusa study also showed a positive association between the consumption of sweet beverages and obesity (Nicklas *et al.,* 2003). Whilst no association between carbohydrate intake and weight status could be determined in this study, it would be wise to educate adolescents and parents alike about the benefits of choosing low glycaemic index foods. Low glycaemic index foods aid in the prevention and treatment of obesity, insulin resistance and type 2 diabetes and cardiovascular diseases (Pereira *et al.,* 2004; Ebbeling *et al.,* 2003; Brand-Miller *et al.,* 2002).

Vitamins and minerals have roles beyond those functions normally given to them in prevention of symptoms of deficiency diseases and subclinical deficiencies have important impacts on the development of chronic disease (Gallagher, 2008: 69). The micronutrient intakes of the children were above the estimated average requirements for most of the children, except for calcium, phosphorus, magnesium, selenium, vitamin D and folate. The low levels of these nutrients are indicative of low intakes of foods such as milk and milk products, seafoods and green leafy vegetables by the children in this study. The increased consumption of sweetened soft drinks and fruit juices as was the case in the children of this study, often leads to the displacement of the consumption of dairy products (Bowman *et al.,* 2004; Skinner *et al.,* 2003). These sugar-sweetened drinks may increase energy intake and replace nutrient-dense foods in the diet (Ebbeling *et al.,* 2003).

Similar to this study Langevin and co-workers (2007) found that the intake of calcium was low in 93% of the children aged 7 to 13 years in their study in the United States. In the case of a deficiency in calcium, stores that can be used to support bone mineralization are not available and adolescents' requirements should be met entirely from dietary sources (Treuth and Griffin, 2003). Low calcium intakes have shown an inverse association with obesity in several studies (Skinner *et al.,* 2003; Davies *et al.,* 2000). In the current study, however, the association between calcium intake and weight status was not statistically significant.

The results of this study clearly show a need for concern regarding dietary behaviour of children and adolescents. Problems with children's eating patterns are based on the children's established habits while they are still toddlers and also at weaning. Modern weaning practices do not encourage children to learn to deal with foods which require substantial chewing before swallowing. This in turn leads to children avoiding foods which require a lot of chewing such as fruit and vegetables, as was the case with this study's participants (Poskitt, 2005; Ogden *et al.,* 2002).

Adolescence is a period of autonomy where teenagers use their pocket money to purchase food of their choice (Bowman *et al.,* 2004). This is a time in particular when eating habits lead to the consumption of energy-dense, high fat foods. These changes in food habits, lifestyles and social behaviour are responsible for the significant increase in adult-onset diseases in adolescence and acquiring insight into adiposity and energy balance regulation during this period of development is of the utmost importance (Jinabhai *et al.,* 2007; Venner *et al.,* 2006; Templeton *et al.,* 2005).

While the results of this study indicated an inadequate intake of most nutrients and adequate intake of some, consideration should be made for the possibility of under- and overreporting by the children. Black and Cole (2001) state that biased over- or underreporting is characteristic of some persons and extreme intakes may reflect under- and overreporting rather than true low or high intakes as was the case with this study. According to Gibson (2005) overreporting of intakes usually occurs as a result of a tendency for participants to respond in such a way as to avoid criticism and to seek praise.

Additionally measurement of energy and nutrient intakes in adolescents is challenging because adolescents usually become bored or irritated by food intake assessment methods, which then results in underreporting. In adolescents, additional demands on recording imposed by increased energy requirements, unstructured eating patterns, out-of-home eating, concerns with self-image and rebellion against authority are additional contributors to poor compliance in dietary reporting (Livingstone *et al.,* 2004).

CONCLUSION AND RECOMMENDATIONS

Few studies are in agreement about the effects of dietary intake on the progression of overweight and obesity in children. This study in particular, failed to find an association between dietary intake and the prevalence of overweight and obesity. In South Africa there is a lack of studies that investigate the link between dietary intake and weight status, particularly amongst children. If successful intervention programmes are to be planned, further studies are needed that will determine the effects of dietary habits on weight status. It remains difficult to obtain accurate data about the dietary intakes of children and innovative methods will be necessary to assess the dietary intakes of adolescents.

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CHAPTER 6

The association between physical activity and weight status of children aged 13 – 15 years in Bloemfontein, in the Free State Province

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ABSTRACT

Introduction: The relationship between physical activity and weight status in children is not well established

Objective: To determine the association between physical activity and weight status of children aged 13 – 15 years in Bloemfontein in the Free State Province.

Design: A cross-sectional analytical study.

Methodology: A total of 640 children from all the secondary schools around Bloemfontein were randomly selected. Four hundred and fifteen children (175

boys and 240 girls) met the inclusion criteria and participated in the study. Weight, height and waist circumferences of all children were measured. Children were classified as underweight if they had a BMI < 5^{th} percentile, overweight if ≥ 85^{th} percentile and obese if > 95^{th} percentile. A waist circumference ≥ 75^{th} and ≥ 90^{th} percentiles of the American reference indicated a high and very high risk for comorbidities respectively. Physical activity was measured using the Previous Day Physical Activity Recall (PDPAR) questionnaire. The children were asked to recall activities which they performed during the previous week day and weekend day. The intensity of these activities was then recorded as very light, light, medium or hard. Activity levels were then categorised as inactive, moderately active or vigorously active based on the metabolic equivalent (MET) values assigned to the reported activities.

Results: Median BMI of the children was 19.5 kg/m^2 with 15.9% of the children being overweight/obese. More girls (12.6%) than boys (18.4%) had a waist circumference above the 75^{th} percentile of the American reference. The prevalence of overweight/obesity was lower in the boys (10.9%) than girls (19.6%). A total of 214 (51.6%) children in the study were underweight. Most of the children were moderately and vigorously active both during the week and weekend. Activity levels declined during the weekend and the number of hours spent watching television increased to median of 3.5 hours during the weekend compared to median of 2.0 hours during the week. More girls (75.3%) than boys (24.7%) were inactive during the weekend. The boys were also more active than the girls during the week. There were statistically significantly more vigorously active boys (59.5%) than there were moderately active (28%) and inactive (25.6%) boys. As BMI increased total MET values and activity levels decreased. In the active category, statistically significantly more children were underweight (94.4%) compared to overweight children (90.7%) (95% CI for the difference: 0.7%; 31.7%) and normal weight children (85.9%) (95% CI for the difference: 2.2%; 15.7%). No statistically significant association could be found between BMI and total number of television hours.

Conclusion: The results of this study suggest that physical activity has an important effect on weight status in children. Physical activity should therefore be promoted as a measure of preventing and treating childhood obesity, particularly amongst teenage girls.

INTRODUCTION

The worldwide epidemic of childhood obesity is progressing and in South Africa an astounding 21.2% of school-going children in urban areas have been reported to be overweight (MRC, 2002). A number of chronic illnesses and risk factors for adult diseases are now starting in childhood rather than in adulthood as a result of this epidemic. Overweight children are twice as likely to have elevated blood pressure and they are also at an increased risk of having increased insulin levels and type 2 diabetes as well as increased triglyceride levels. Childhood obesity is also associated with orthopaedic complications, sleep apnoea, gall bladder disease and non-alcoholic steatohepatitis (Fleet, 2006; Sokol, 2000).

Maintaining a constant body weight is orchestrated by a complex system of neural, hormonal and chemical mechanisms that keeps the balance between energy intake and energy expenditure within limits. Normal growth in children involves fluctuations in both daily energy intake and energy expenditure. This then causes acute daily fluctuations in energy balance. Abnormalities of the mechanisms that regulate body weight may result in weight fluctuations such as obesity (Laquatra, 2004; Schutz and Maffeis, 2002).

Physical activity is defined as any bodily movement produced by the contraction of skeletal muscles resulting in energy expenditure (Aadahl and Jørgensen, 2003). Regular participation in physical activity is recognized as essential to normal development in children. Promotion of physical activity in children and adolescents has become a recognized goal of public health authorities. To maximise the effectiveness of intervention programmes it is important to understand the demographic, psychosocial and environmental factors that influence physical activity behaviour in children (Pate *et al.,* 1997).

Urbanisation has been associated with an increased risk of becoming overweight or obese in South Africa (Armstrong *et al.,* 2006). In industrialised countries rapid technological developments have contributed to sedentary behaviours in adults and children (Schutz and Maffeis, 2002). Coupled to this is the deemphasized requirement for physical activity in schools and the reliance on the family car and public transportation as a means of getting from one point to another. These are some of the reasons that lead to increased sedentary living which in turn leads to increased prevalence of overweight in children (Tudor-Locke *et al.,* 2003).

Television viewing and the use of video and computer games are markers of sedentary behaviour and inactivity amongst children and adolescents. Television viewing specifically has been repeatedly identified as a risk factor due to its suppressive effect on physical activity (Schutz and Maffeis, 2002). Of concern is the increasing number of families who choose to put television sets in their children's bedrooms. A television in the bedroom is strongly associated to increased risk of developing obesity (O' Brien *et al.,* 2004).

In developing countries such as South Africa the need to address decreasing levels of physical activity and the risks associated with modern society is a matter of urgency (Armstrong *et al.,* 2006; Tudor-Locke *et al.,* 2003). Very few studies that look at physical activity levels of children and its effects on weight status have been conducted in South Africa. The aim of the current study was thus to determine levels of physical activity as well as the association between levels of physical activity and weight status.

METHODOLOGY

A cross-sectional study was undertaken to determine factors that are associated with the development of overweight and obesity in children aged 13 – 15 years in Bloemfontein in the Free State Province. As part of the larger study carried out in 2006, socio-economic status, school nutritional practices and daily dietary intake were determined and are reported elsewhere (Meko *et al.,* 2010).

The population studied included 26 out of 28 secondary schools in Bloemfontein in the Free State Province. Approval for the study to be carried out was obtained from the Free State Department of Education as well as from the schools' principals. Two of the schools' principals declined to give approval for the study in their schools. An alphabetical list of names of children falling within the required age group was obtained from all schools. A random sample of 640 children was selected from the different schools. Informed consent was obtained from the children as well as from the children's caregivers/parents after receiving a letter explaining the aims of the study to them. Every child that gave consent received a t-shirt as an incentive with the words "Get up and get active" written on it. The Ethics committee of the Faculty of Health Sciences at the University of the Free State gave approval for the study to be conducted.

Anthropometry

Anthropometric measurements were carried out by trained fieldworkers using standardized methods and techniques (Lee and Nieman, 2003: 166 – 167). Body weight was measured to the nearest 0.1kg with the children wearing minimal clothing and without shoes. Height was measured using a portable stadiometer (Seca 214) to the nearest 0.1cm. The children were measured without shoes, in an upright position with the head in a Frankfurt plane. Waist circumference was measured using a non-stretch measuring tape (GWCC400) to the nearest 0.5cm. Waist circumference was measured at the narrowest circumference on the waist above the iliac crest and below the lower rib (Sizer and Whitney, 2008: 329; Lee and Nieman, 2003: 166 – 167).

The children were classified as underweight if they had a BMI < 5^{th} percentile; normal weight with a BMI between the 5^{th} – 84.9^{th} percentiles; overweight if they had a BMI between the ≥ 85^{th} – 94.9^{th} percentiles; and obese if they had a BMI ≥ 95^{th} percentile of the Centers for Disease Control (CDC) BMI-for-age percentile charts for boys and girls 2 to 20 years old (Sizer and Whitney, 2008; Cunningham, 2004). Ethnic specific percentiles of waist circumference-for-age and gender were used to classify the children according to waist circumference (WC) associated risk. A waist circumference ≥ 75^{th} percentile indicated high risk and ≥ 90^{th} percentile a very high risk of comorbidities (Fernandez *et al.,* 2004).

Physical activity levels

Physical activity levels were determined using the Previous Day Physical Activity Recall (PDPAR) questionnaire (Weston *et al.,* 1997). The children were asked to list all of the activities they performed during the previous day as well as on the previous weekend day. The intensity of the listed activities was indicated using the following descriptors: very light (i.e. slow breathing and little or no movement), light (i.e. normal breathing and movement), medium (i.e. increased breathing and moderate movement), and hard (i.e. hard breathing and quick movement) (Ainsworth *et al.,* 1993).

The intensity of the daily physical activity was characterised according to metabolic equivalents (METs). One MET is equal to the basal metabolic rate and is equal to 3.5ml of oxygen per kilogram of body weight per minute. METs are a convenient and reliable measure of energy cost because their calculation considers the oxygen requirements of activities without having to calculate the amount of oxygen consumed separately (Saris *et al.,* 2003; Trombly, 1983: 412). A MET value was assigned to the activities based on the type and intensity of each activity (Ainsworth *et al.,* 1993).

The children's activity levels were categorised as vigorously active if they reported two or more 30-minute blocks with physical activity at an intensity equal to or greater than 6 METs; moderately active if they reported two or more 30-minute time blocks with physical activity at an intensity more than 3 METs; and inactive if they reported less than two 30-minute blocks with physical activity equal to or less than 3 METs (Pate *et al.,* 1997). A pedometer was used to validate the results obtained from the PDPAR form on a subsample of the children.

STATISTICAL ANALYSIS

Statistical analysis was done by the Department of Biostatistics, University of the Free State. Descriptive statistics, namely medians and percentiles for continuous data and frequencies and percentages for categorical data, were calculated per group. The groups were compared by means of 95% confidence intervals (CI). The prevalence of overweight and obese children was calculated and described by means of 95% CI. Stepwise logistic regression analysis was performed and the odds ratios, 95% CI and *P* values were calculated for each risk factor in the final model. A *P* value of < 0.05 was considered statistically significant.

RESULTS

A total of 415 children (175 boys and 240 girls) out of 640 children selected gave consent and participated in the study giving a response rate of 67.7%.

Weight status

Table 6.1 shows the BMI and waist circumference values of the children. Median body mass index (BMI) for the boys was $18.4 kg/m^2$ and $21.1 kg/m^2$ for the girls. The waist circumference according to gender results are presented in Table 6.2. More girls (18.4%) than boys (12.6%) had a waist circumference above the 75^{th} percentile of the US standards (Fernandez *et al.,* 2004). The association between waist circumference and BMI was statistically significant (95% CI for the difference: -86.3%; -53.6%).

Table 6.1: Body mass index (BMI) and waist circumference medians and percentiles of children aged 13 – 15 years

	BMI (kg/m^2)		Waist circumference (cm)	
	Boys	**Girls**	**Boys**	**Girls**
25th percentile	16.9	18.6	65.0	65.0
Median	18.4	21.1	68.5	69.0
75th percentile	20.3	23.3	73.0	75.3

Table 6.2: Waist circumference percentile distribution of boys and girls aged 13 – 15 years

Percentile	Boys		Girls		Total	
	n (175)	**%**	**n (240)**	**%**	**n (415)**	**%**
< 10	32	18.3	29	12.1	61	14.7
10 – 24.9	43	24.6	35	14.6	78	18.8
25 – 49.9	43	24.6	81	33.8	124	29.9
50 – 74.9	35	20.0	51	21.3	86	20.7
75 – 89.9	18	10.3	35	14.6	53	12.8
≥ 90	4	2.3	9	3.8	13	3.1

Percentiles based on American cut-off points (Fernandez *et al.,* 2004).

The children's weight status according to gender is shown in Table 6.3.

Table 6.3: Weight classification according to BMI of boys and girls aged 13 – 15 years

CDC BMI Percentiles	Boys		Girls		Total	
	n (175)	%	n (240)	%	n (415)	%
< 15 (Underweight)	118	67.4	96	40	214	51.6
15–84.9 (Normal weight)	38	21.7	97	40.4	135	32.5
85 – 95 (Overweight)	11	6.3	32	13.3	43	10.4
> 95 Obese	8	4.6	15	6.3	23	5.5
Overweight/obese combined	19	10.9	47	19.6	66	15.9

A third of the children's weight was within the normal range (32.5%), with half of the children being underweight (51.6%). Only 15.9% of the children were overweight/obese. Almost one fifth of the girls were overweight/obese (19.6%) while only 10.9% of the boys were overweight/obese.

Physical activity

Table 6.4 shows the distribution of television hours and METs according to medians and percentiles.

Table 6.4: Total metabolic equivalents (METs) and time spent watching television of children aged 13 – 15 years according to medians and percentiles

	Total TV hours			Total METs		
	25th percentile	Median	75th percentile	25th percentile	Median	75th percentile
Weekday	1.0	2.0	3.5	63.3	71.7	85.5
Weekend day	2.0	3.5	5.0	55.8	66.3	84.1

Median television hours during the week were 2.0 hours per day and this increased to 3.5 hours daily during the weekend. The maximum number of hours spent watching television during the week was 3.5 hours/day and this increased to 5.0 hours/day during the weekend. Almost half of the children in this study were moderately active both during the week (45.5%) and the weekend (46.5%) and 45.1% were vigorously active during the weekend, but only 34.0% were vigorously active during the weekend as shown in Table 6.5.

Table 6.5: Frequencies of physical activity level as measured by the PDPAR of children aged 13 – 15 years

	Weekday		Weekend day	
	n	% of total	n	% of total
Inactive	39	9.4	81	19.5
Moderately active	189	45.5	193	46.5
Vigorously active	187	45.1	141	34

The children's physical activity levels according to gender are presented in Table 6.6.

Table 6.6: Physical activity levels of boys and girls aged 13 – 15 years

Activity level	Week day n (%)		Weekend day n (%)	
	Boys	Girls	Boys	Girls
Inactive	10 (25.6)	29 (74.4)	20 (24.7)	61 (75.3)
Moderately active	53 (28)	136 (72)	65 (33.7)	128 (66.3)
Vigorously active	112 (59.9)*	75 (40.1)	90 (63.8)*	51 (36.2)

Comparing the boys and girls for the different activity levels, the inactive group consisted of more girls than boys during the week as well as during the weekend. There were statistically significantly more vigorously active boys during the week (59.9%) and on the weekend (63.8%) than there were inactive boys during the week (25.6%) (95% CI for the difference: -47.2%; -17.2%) and weekend (24.7%) (95% CI for the difference: -50.2%; -29.5%). Similarly, statistically significantly more of the boys were vigorously active than they were moderately active during the week (28%) (95% CI for the difference: -40.8%; -22.0%) and the weekend (33.7%) (95% CI for the difference: -39.9%; -19.4%).

Dietary energy and fat intakes and physical activity

Table 6.7 gives the results of total dietary energy intake in relation to physical activity, while Table 6.8 shows fat intake as percentage of total energy and physical activity levels comparisons. No statistically significant association could be found between energy intake and physical activity levels. Most children had adequate to high dietary fat intakes both during the week and weekend. However, no statistically significant association could be made between total fat intake and physical activity levels.

Table 6.7: Total dietary energy intake and physical activity levels comparison of boys and girls aged 13 – 15 years

Activity level	Weekday n (%)			Weekend day n (%)		
	< EER	**= EER**	**> EER**	**< EER**	**= EER**	**> EER**
Inactive	16 (41.0)	20 (51.3)	3 (7.7)	25 (30.9)	48 (59.3)	8 (9.9)
Moderately active	63 (33.3)	100 (52.9)	26 (13.8)	68 (35.2)	100 (51.8)	25 (12.9)
Vigorously active	72 (38.5)	92 (49.2)	23 (12.3)	58 (41.1)	64 (45.4)	19 (13.5)

Table 6.8: Fat intake as percentage of total energy intake and physical activity levels comparison of boys and girls aged 13 – 15 years

Activity level	Weekday n (%)			Weekend day n (%)		
	< 30% TE	**30 - 35% TE**	**> 35% TE**	**< 30% TE**	**30 - 35% TE**	**> 35% TE**
Inactive	5 (12.8)	16 (41.0)	18 (46.2)	12 (14.8)	26 (32.1)	43 (53.1)
Moderately active	21 (11.1)	74 (39.2)	94 (49.7)	20 (10.4)	81 (42.0)	92 (47.6)
Vigorously active	20 (10.7)	80 (42.8)	87 (46.5)	14 (9.9)	63 (44.7)	64 (45.4)

Physical activity and weight status

The association between weight status and time spent watching television as well as with METs is shown in Table 6.9. During the week, the total MET values decreased as BMI increased. The weekend's activity pattern was the same with regards to the METs except for the obese group's METs which was 67.2METs. The underweight group had a statistically significant higher MET value (75.3METs) than the normal weight (69.7METs) (95% CI for the difference: 1.2%; 8.2%) and overweight groups (69.4METs) (95% CI for the difference: 2.1%; 11.8%) during the week. During the weekend the underweight group had a statistically significant higher MET value (70.4METs) than the normal weight (63.0METs) (95% CI for the difference: 0.9%; 88%) and overweight groups (60.3METs) (95% CI for the difference: 0.8%; 12.4%). No statistically significant association could be found with the obese group possibly due to the small sample of this group.

Table 6.9: Total METs and TV hours comparisons according to BMI of boys and girls aged 13 – 15 years

BMI percentiles	n	Week day		Weekend day	
		Total METs	Total TV hours	Total METs	Total TV hours
< 15 (Underweight)	118	75.3*	2.0	70.4*	3.5
15–84.9 (Normal weight)	38	69.7	2.0	63.0	3.5
85 – 95 (Overweight)	11	69.4	2.0	60.3	2.5
> 95 Obese	8	68.8	3.5	67.2	3.0

The number of television hours in the obese group (3.5 hrs) was higher than that of the other groups during the week although no statistically significant difference could be found for the total television hours amongst the groups.

Table 6.10 and 6.11 presents the associations between weight status and physical activity levels of the children during the week and weekend respectively. The children's activity levels decreased as BMI increased during the week. More children in the normal weight group (44.4%) and overweight group (55.8%) were moderately active, while more of the children in the obese group (47.8%) were vigorously active during the week. In the active category (moderate and vigorously active), statistically significantly more children were underweight (94.4%) compared to overweight children (90.7%) (95% CI for the difference: 0.7%; 31.7%) and normal weight children (85.9%) (95% CI for the difference: 2.2%; 15.7%) during the week.

Table 6.10: Physical activity level comparisons according to BMI of children aged 13 – 15 years during the week, n (%)

BMI percentiles	Activity levels			
	Inactive	Moderately active	Vigorously active	Moderately/ Vigorously active
< 15 (Underweight)	12 (5.6)	97 (45.3)	105 (49.1)	202 (94.4)*
15–84.9 (Normal weight)	19 (14.1)	60 (44.4)	56 (41.5)	116 (85.9)
85–95 (Overweight)	4 (9.3)	24 (55.8)	15 (34.9)	39 (90.7)
> 95 Obese	4 (17.4)	8 (34.8)	11 (47.8)	19 (82.6)

During the weekend there was no clear significant association between physical activity levels and BMI groups (Table 6.9). Almost half of the children in the underweight (43.5%), normal weight (45.2%), overweight (62.8%) and obese (52.2%) groups were moderately active during the weekend.

Table 6.11: Physical activity level comparisons according to BMI of children aged 13 – 15 years during the weekend, n (%)

BMI percentiles	Activity levels		
	Inactive	Moderately active	Vigorously active
< 15 (Underweight)	37 (17.3)	93 (43.5)	84 (39.2)
15–84.9 (Normal weight)	32 (23.7)	61 (45.2)	42 (31.1)
85 – 95 (Overweight)	8 (18.6)	27 (62.8)	8 (18.6)
> 95 Obese	4 (17.4)	12 (52.2)	7 (30.4)

Logistic regression

Reporting the results of multiple regression analysis involves providing details about the strategy adopted (such as backward or forward stepwise regression) as well as all the variables which were included in the analysis (Altman, 1991). For the purpose of this study a backward stepwise regression was adopted. The results of the logistic regression analysis are indicated in Table 6.12. The odds ratios, 95%CI and *P*-values were calculated for the risk factors in each of the final models. The following variables were included in each model: socio-economic status, gender, carbohydrate-, fiber-, protein-, calcium- and vitamin D intake. The results on socio-economic status and dietary variables are reported elsewhere (Meko *et al.,* 2010). A *P*-value of <0.05 was considered statistically significant and a variable was then included in the model.

Table 6.12: Logistic regression predicting overweight and obesity in children aged 13 – 15 years

Variable	Odds ratio	95% CI	*P*-value
Girls	2.364	1.188 – 5.048	0.0161

On logistic regression analysis with BMI as the dependent variable, only gender was selected in the final model. The regression showed girls to be more likely than boys to be overweight.

DISCUSSION

Weight status

The present study is the first of its kind to be carried out in the Free State Province where factors associated with the prevalence of overweight in preadolescent children were investigated specifically. The prevalence of overweight/obesity corresponds with that of the South African Youth Risk Behaviour Survey (YRBS) (21.2%) (MRC, 2002), but it is higher than the THUSA BANA group (7.9%) (Kruger *et al.,* 2006).

While the prevalence of overweight and obesity was established in this study, the fact that only about a third of the children in this study were at their normal BMI-for-age and more than 50% of the children were underweight is of great concern. The coexistence of undernutrition and overweight is a recognized burden of countries in nutritional transition such as India and the Philippines (Prentice, 2006; Deckelbaum and Williams, 2001).

The National Food Consumption Survey – Fortification Baseline (NFCS-FB) of 2005 found the prevalence rates of stunting, underweight and wasting to be 18%, 9.3% and 4.5% respectively (Steyn *et al.,* 2005). In comparison to the national statistics, mild stunting was observed in 31% to 75% of primary school children aged 8 – 11 years in Kwazulu Natal (Jinabhai *et al.,* 2003).

The high underweight figures emphasize the fact that even though there is an observed increase in the prevalence of overweight and obesity, the problem of malnutrition continues to affect millions of South African children (Gericke and Labadarios, 2007). One can speculate whether the high prevalence of underweight in this study is a result of peer pressure, or participating in unhealthy dieting practices or the result of poverty. Taking into account that only 16% of the children in this study reported being on slimming diets (Meko *et al.,* 2010), one can it becomes clear that the high prevalence of underweight in this study population rather reflects the high levels of food poverty (Rose and Charlton, 2002) and underdevelopment which are typical of the Free State province (MRC, 2002; Kruger *et al.,* 2006).

Similar to other South African studies (Mamabolo *et al.,* 2007; Kruger *et al.,* 2006; MRC, 2002), the prevalence of overweight and obesity was higher among girls than boys. These results were also confirmed by the logistic regression where the odds of being obese were higher in girls. Other countries such as Bolivia and Canada also found a higher prevalence of overweight and obesity in girls than boys (Perez-Cuerto *et al.*, 2005; Young *et al.,* 2000).

Waist circumference measures in this study were low or normal in most children based on the ethnic specific waist circumference percentiles of the American children (Fernandez *et al.,* 2004). In those children where waist circumference was high, the risk of metabolic complications may be increased. Adolescents with a waist circumference above the 90th percentile have been shown to have higher concentrations of low density lipoprotein cholesterol, triglycerides and insulin and lower concentrations of high density lipoprotein (McCarthy *et al.,* 2003). A statistically significant association was found between waist circumference and BMI in this study.

Physical activity

Physical activity levels are decreasing largely due to increased convenience as a result of improvements associated with modernization. Factors such as the car being a preferred form of transportation, the use of elevators instead of stairs, as well as reduced availability and lack of access to recreational facilities are some factors associated with a reduction in activity levels (Golan and Crow, 2004).

Physical education in some schools in South Africa has been de-emphasized and included as a subsection of the life skills segment of the school curriculum.

With the schools surveyed in this particular study, none had a physical education period included as part of the time table. This lack of opportunities to take part in physical activities during school time coupled with increased convenience leads to increased sedentary living among adolescents (Armstrong *et al.,* 2006).

Although assessment methods differed, physical activity levels of the children in the current study are comparable to those of the South African Youth Risk Behaviour Survey (YRBS) where 44.6% of the children in that study were found to be vigorously active and 33.5% were moderately active (MRC, 2002). The present study showed that more of the children were moderately and vigorously active during the week than over weekends. Interestingly the YRBS (MRC, 2002) found that the Free State Province had the highest prevalence of learners who participated in vigorous physical activity compared to other provinces.

The children's activity levels decreased during the weekend, contrary to the THUSA BANA study carried out in the North West Province where the children were more active on weekends than they were during the week (Kruger *et al.,* 2006). The fact that most of the children in the current study walked long distances to school and participated in school sporting activities are possible reasons for higher activity levels during the week than on weekends. The THUSA BANA children on the other hand had limited involvement in school activities and sports during the week (Kruger *et al.,* 2006).

The girls in this study were less active than the boys during the week and on the weekend and this corresponds with the findings of other South African researchers (Mamabolo *et al.,* 2007; Kruger *et al.,* 2006). There were significantly more boys who were vigorously active than there were boys who were inactive or moderately active in this study. This could possibly be attributed to the fact that the boys in this study reported participating in after-school sporting activities such as soccer, cricket, etc. more than the girls.

The children's activity levels decreased as BMI increased with the underweight group being significantly more active than the normal weight and overweight children during the week. These findings are the same as those found by Ekelund and co-workers (2005) where the boys who were more physically active had a lower BMI compared to those who were inactive. Therefore, while an association could not be established between weight status and dietary intake (Meko *et al.,* 2010), it seems as if physical activity does play a more important role in determining weight status in adolescents.

In a study undertaken in 2002 (MRC, 2002) in South Africa it was found that 25.2% of the children spent three hours or more per day watching television. In the present study the children's number of hours watching television ranged from one to five hours per day during the week and the number of hours increased during the weekend. Tudor-Locke and co-workers (2003) found that most of the Filipino youth they studied watched television for more than two hours per day. No significant association could be found between the number of television hours and weight status in the present study. McVeigh and co-workers (2004) also found a strong relationship between fatness and activity levels than between fatness and television hours in their study on South African children in the Birth to Twenty birth cohort. However, children who watched more than 4 hours of television have been found to have an increased BMI compared to those children who watched less TV in the United States (Tudor-Locke *et al.,* 2003).

South Africa is a country undergoing a nutritional transition. While the children in this study were relatively active, progression of modernisation means that primary sources of physical activity such as walking and doing household chores will eventually decrease (Tudor-Locke *et al.,* 2003). The decreased activity levels during weekends of these children clearly demonstrates the effect that urbanisation is having on children's activity levels. Children are not playing outside as much as they used to; instead they are spending more time engaging in sedentary activities such as watching television (Kruger *et al.,* 2006; Berkey *et al.,* 2000). Activities such as playing computer and video games are increasingly becoming popular with the economic transition that is currently taking place in most communities and these activities contribute to a sedentary lifestyle (Kumanyika *et al.,* 2002).

Lack of physical activity leads to sedentary living and this increase in sedentary living can also be explained by the increasing number of flats and small houses will little or no garden space. Coupled to this is the shortage of recreational areas and sport grounds, leaving the children with very limited opportunities to engage in any form of physical activity (Poskitt, 2005). The availability and use of recreational centres as well as participation in community sports leads to increased levels of physical activity in adolescents (Gordon-Larsen *et al.,* 2000).

Physical activity like obesity is affected by various factors such as culture and socio-economic status (SES). Very little research has been conducted where the effects of SES and culture on physical activity levels in South African children were determined (McVeigh *et al.,* 2004). Gordon-Larsen *et al.* (2000), for example, report that children from households with high family incomes had an increased likelihood of being physically active than those with low family incomes. The link between low levels of physical activity and the increase in the risk of being obese emphasizes the need for more research in this field and it also emphasizes the need to address inactivity in childhood.

CONCLUSION AND RECOMMENDATIONS

Physical activity has an important role to play in the prevention of overweight and obesity as evidenced by our results where the prevalence of obesity was low in the group of children who were shown to be vigorously active. The re-introduction of physical education as part of the school curriculum should be emphasized. This will help ensure that activity levels, especially of those children who are not engaging in any form of physical activity are increased, thus assisting in helping to reduce the risk of overweight and obesity in children. Promotion of physical activity should also be more aggressive amongst girls due to their increased risk of being sedentary as well as their increased risk of developing overweight and obesity as compared to boys.

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CHAPTER 7

CONCLUSIONS AND RECOMMENDATIONS

7.1 Introduction

Obesity in children has reached epidemic proportions in industrialised countries (Janssen *et al.,* 2005). Developing countries such as South Africa are still dealing with the high prevalence of undernutrition and stunting. The increasing prevalence of overweight and obesity in such countries is producing a double burden (Hoffman, 2004). To further complicate matters, there is no clear explanation of the causes of overweight and obesity in children and adolescents (Laquatra, 2004; Janssen *et al.,* 2005). A determination of factors leading to obesity as well as a clear understanding of how these contribute to obesity may aid in the development of preventative measures for overweight and obesity in children.

The main aim of this study was to determine the associations between the determinants of overweight and obesity in children aged 13 – 15 years in Bloemfontein. Data on socioeconomic status, daily dietary intake and levels of physical activity were obtained from 415 children. Data on the children's school environment was also obtained from the children's school principals. The results of this study can be considered to be valid and reliable due to the fact that standardized techniques and calibrated apparatus were used by the researcher and fieldworkers during the execution of the study.

The main objectives of this study were met and the conclusions and recommendations based on the findings are discussed below.

7.2 Limitations of the study

Although the results of this study provide very valuable information regarding the prevalence and possible causes of overweight and obesity in children aged 13 – 15 years in Bloemfontein, limitations of the study should be acknowledged.

- Initially a sample size of 640 children was anticipated, however only 415 children participated in the study. Due to the small sample size it is difficult to say that the results of this study are generally representative of children residing in Bloemfontein. The small sample size could further limit the power of the study in general.
- The random sampling of the children in this study resulted in very small groups of white, coloured, Indian and Chinese children and a large group of black children. The lack of proportion in numbers made it difficult to compare the prevalence of overweight and obesity based on race and this could possibly be the reason why race did not emerge as a determinant of BMI. The random sampling could also be the reason for the failure of this study to show a relationship between socio-economic status and BMI.

- The results of the school environment are also not representative of the schools in Bloemfontein due to the fact that only 10 out of 26 schools' principals completed the School environment questionnaire. The data from the other 16 schools is not included in the final analysis.
- Finally the fact that the USA percentiles for BMI-for-age were used in this study to categorise children as underweight, normal, overweight and obese should not be overlooked. The International Obesity Task Force (IOTF) recommended classifications are currently being used to classify children's weight status. To identify risk of overweight and obesity the IOTF cut-offs are defined to pass through BMI of 25 and 30kg/m^2 at age 18 years (Cole *et al.,* 2000).

7.3 Conclusions

The following conclusions could be made from this study:

7.3.1 Socioeconomic status

- Most children in this study lived in brick houses, had household appliances such as a working stove, refrigerator, radio and television present in their homes.

- The main contributor in most households was the father and most of the contributors were skilled professionals (i.e. clerks, retail workers) followed by unskilled workers (i.e. domestic workers, cleaners, gardeners).

- With regards to overall socioeconomic status classification, most of the children in this study were classified as having a medium socioeconomic status.

7.3.2 Anthropometry

- Typical to developing countries, almost half of the children in this study were underweight while only about a third were at their normal BMI-for-age and only a few were overweight/obese.

- Most of the children had a waist circumference falling a little under normal. The association between body mass index (BMI) and waist circumference was statistically significant.

- The prevalence of overweight/obesity was higher amongst girls than boys.

7.3.3 Daily dietary intake

- Most of the children in this study reported eating at least three meals per day as well as having a meat product at least once per day. This explains the protein intake which was within recommendations with all the children.

- The macro- and micronutrient intakes of the children were mostly within the normal ranges. However, fibre intake was low in most of the children indicating a low intake of unrefined carbohydrates as well as a low intake of fruits and vegetables.

- Daily calcium intake was also low in most of the children and even though no significant association could be determined, the low intake places these children at an increased risk of developing overweight and obesity.

- Total energy intake was high in most of the children and most had a normal to high fat intake. The children's risk of developing obesity is further increased by the increased energy and fat intakes.

7.3.4 Physical activity levels

- The children in this study were mostly moderately and vigorously active both during the week and weekend. This is due to the fact that most of the children in this study still walked long distances to school and during the weekend most participated in informal sporting activities.

- The girls were less active than the boys.

7.3.5 School environment

- Most schools surveyed did not have any nutrition programmes in place. Where schools had nutrition education programmes in place, these were run mostly by the educators and not the learners themselves. This may render these nutrition programmes inefficient.
- All of the schools reported having a tuck shop and/or informal sellers in or around the school premises.

- Energy-dense, nutrient poor foods were sold in most of the schools and very few healthy options were available at the school shops and informal sellers.

7.3.6 Weight status and socioeconomic status

- No significant association could be made between BMI and race. However, white children tended to be more overweight/obese than black and coloured children.

- The association between BMI and socioeconomic status was not significant in this study.

7.3.7 Weight status and daily dietary intake

- The macro- and micronutrient intakes of the children in this study did not show a significant association with BMI.

- Energy intakes were high in all the BMI groups with the underweight children having the highest energy intake. No significant association could be determined between BMI and total energy intake.
- No significant association could be determined between BMI and dietary fat intake.

7.3.8 Weight status and physical activity

- The association between BMI and the number of hours spent watching television was not significant.

- The children who were underweight in this study had significantly higher MET values than the normal weight and overweight children both during the week and weekend. This gives an indication that the underweight children's energy expenditure was higher than that of the normal and overweight children.

- Similarly, significantly more underweight than normal weight and overweight children were moderately and vigorously active during the week.

- There was no significant association between physical activity levels and BMI during the weekend in these children.

7.4 Recommendations

In order for prevention and management strategies to be effective they need to take into account the child's physical environment which includes areas such as schools, churches, food outlets, type of neighbourhood and recreational facilities in the neighbourhood. Furthermore, macro environmental factors such as government policies, food production, marketing and distribution, urban and rural development as well as transport systems also need to be considered as they have an influence on physical activity and food intake (Reilly, 2006; Batch and Baur, 2005).

7.4.1 The role of the school in prevention

- Schools have an important role to play in health promotion as children spend most of their time here. Including obesity prevention strategies such as healthy food choices and physical education in the classroom curricula can have a large impact in promoting healthy lifestyles in children.

- Nutrition education programmes should be encouraged in all schools in all grades in South Africa with focus being placed on providing learners with relevant food skills eventually leading to the development of healthy eating habits. The programmes should be designed in such a way that they also impact on the foods being sold on the school premises or in the school shops.

- Programmes on preventing obesity should not only focus on eating right and improving activity levels, but should also equip learners with the ability to be critical of advertising and media influences. Learners should be taught how to withstand commercial pressures within their societies.

- These nutrition education programmes should preferably be peer-driven, by the learners themselves so as to ensure maximum results.

7.4.2 Improving dietary habits

- Before effective prevention strategies can be planned, it is important that the underlying factors influencing children's and adolescents' eating patterns be understood . South Africa is a country which is unique and diverse in terms of culture and religion. Extensive research needs to be conducted further focusing on the influence that culture, religion and socioeconomic status have on eating patterns and activity levels.

- Improvement of dietary habits should start during infancy and should continue as the child grows. Tools such as the Paediatric Food-Based Dietary Guidelines developed for the South African population (Bourne, 2007) should be used to educate mothers about proper feeding methods of their infants and toddlers.

- Adolescents should be encouraged to eat breakfast and education programmes should endeavour to explain the benefits attached to eating breakfast to adolescents and children.

- In an age of single-parent families and both parents working, the culture of families eating together is fast fading away. Meals as a family, where time is taken to eat and satiety comes from a pleasant experience rather than overeating, should be encouraged.

- Teaching children to cook at home encourages an interest in food, which then leads to knowledge of food ingredients and provides skills which may facilitate healthy eating in later life.

- Because snacking forms a large part of an adolescent's eating pattern, healthy snack choices such as whole fruits, carrot sticks and similar food items should be encouraged.

7.4.3 Increasing levels of physical activity

- Participation in physical activity is well known to have a positive association with reducing overweight and obesity. Therefore children should be encouraged to at least 60 minutes of moderate to vigorous physical activity per day (Reilly *et al.,* 2004) in order prevent the development of obesity.

- It is well known that lack of safety and increasing levels of crime are some of the factors that hamper physical activity in children. Provision of safe and accessible places for exercising, especially in the South African setting, will go a long way to increasing children's activity levels.

- Promotion of indigenous games, formation of exercise clubs, informal sporting activities after school and during the weekend should be investigated as alternatives for increasing activity levels in children, particularly among girls who are consistently being found to be inactive.

- Government programs introduced to increase activity levels in children, such as the "Sports for all" initiative (Goslin, 2002), should be marketed and promoted more intensely so that they can be implemented in communities.

7.4.4 The role of health care professionals

- In dealing with this condition, the role of the dietician as the primary source of nutrition information should be recognized and utilised optimally. Paediatricians and general practitioners should be encouraged to refer children who they find to be overweight or obese to a dietician. Additionally, biokineticists should be included in the health care team caring for the overweight or obese child in order to assist by prescribing safe and appropriate physical activity programmes.

- Health professionals should also lobby for the introduction of legislation regarding the sale and marketing of energy-dense, high fat foods to children and adolescents (Du Toit and Van der Merwe, 2003).

7.4.5 The role of media and industry

- Marketing and advertising guidelines should be developed and regulated that minimise the risk of obesity in children and youth in South Africa. Alternately the Sydney guiding principles for the protection of children against commercial promotion of foods and beverages can be implemented (Swinburn *et al.,* 2008).

- Dieticians should also be encouraged to make more use of the media (television, local radio stations, newspapers, etc.) as a means of promoting healthy eating habits. Events such as the National Nutrition Week should be utilised in such a way that the message of healthy eating reaches more people in the community.

- Use of already established media projects such as the loveLife and Soul City programmes in prevention of overweight and obesity should be considered. These programmes have already proven to be effective in HIV/AIDS awareness programmes and they specifically target the youth between the ages of 12 and 24 years. An added benefit of these programmes is that through their use of different forms of media (newspapers, television, radio, etc.) they are able to reach a wider population (Pelzer and Promtussananon, 2003; Stadler and Hlongwa, 2002).

7.5 References

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Appendix A

Quantitative Food Frequency Questionnaire

a. Subject number _______ 1 [| |] 3

b. Interviewer _________________

c. Date ______/______/______ 4 [| | | | | | |] 11

Please think about the food and drinks that you have consumed during the past 6 months. I will now go through a list of foods and drinks with you and I would like you to tell me:

- If you eat these particular foods
- How the food is prepared
- How much of the food you eat at a time, and
- How many times a day you eat it and if you do not eat it everyday, how many times a week or a month it is eaten?

To help you to describe the amount of a food, I will show you pictures or models of different amounts of the food. Please say which picture or model is the closest to the amount eaten, or if it is smaller, between sizes or bigger than the picture or models. Amounts can also be reported as cups, tablespoons or teaspoons.

- **THERE ARE NO RIGHT OR WRONG ANSWERS**
- **EVERYTHING YOU TELL ME IS CONFIDENTIAL**
- **Is there anything that you want to ask me now?**
- **Are you willing to go on with the questions?**

a. Do you take a lunch box to school? [ ] 12

1 Yes

2 No

b. Do you follow a special diet? [ ] 13

1 Yes

2 No

c. If yes, please specify [ ] 14

1 Diabetic diet

2 Slimming diet

3 Allergies

4 Other, (specify) _____________

d. Do you use salt in your food ☐ 15

1 Yes

2 No

e. Are other flavoured salts e.g. Aromat, used in your food? ☐ 16

1 Yes

2 No

3 Don't know

Please specify ________________________

f. Do you use beef/chicken stock in your food? ☐ 17

1 Yes

2 No

3 Don't know

g. Do you use any dietary supplements? ☐ 18

1 Yes

2 No

h. If yes, please specify: ☐ 19

1 Vitamins: ______________________

2 Minerals: ______________________

3 Protein: ______________________

4 Energy: ______________________

5 Other: ______________________

i. How many meals do you eat per day including between meals ☐ 20

Please indicate which of the following best describes the eating pattern you usually follow (Mark only one).

1 More than three meals with eating between meals

2 Three meals with eating between meals

3 Three meals with no eating between meals

4 Two meals with eating between meals

5 Two meals with no eating between meals

6 One meal with eating between meals

7 One meal with no eating between meals

8 Nibble the whole day, no specific meals

j. Do you eat breakfast: ☐ 21

1 Regularly (≥ 4 times a week)

2 Sometimes

3 Never

k. How often do you eat away from home? ☐ 22

1 Never

2 > Once /week

3 Weekly

4 Monthly

5 > Once a month

l. Where would you mostly eat, if it is away from home? ☐ 23

1 Family

2 Friends

3 Café

4 Restaurant, Fast food

5 Other, specify _______________

m. Do you drink coffee and tea (except Rooibos) with your meals? ☐ 24

1 Yes

2 No

n. If yes, at which meals? ☐ 25

Breakfast	1 Yes	2 No
Lunch	1 Yes	2 No
Supper	1 Yes	2 No

o. With how many meals per day do you eat meat, fish or poultry? ☐ 26

p. Do you eat fresh fruit and vegetables with the following meals? ☐ 27

SUMMARY OF FOOD FREQUENCY QUESTIONNAIRE

FOOD	CALCULATIONS	CODE AMOUNT PER DAY (g)								
										(1-8)
										(9-16)
										(17-24)
										(25-32)
										(33-40)
										(41-48)
										(49-56)
										(57-64)
										(65-72)
										(73-80)
										(1-8)
										(9-16)
										(17-24)
										(25-32)
										(33-40)
										(41-48)
										(49-56)
										(57-64)
										(65-72)
										(73-80)
										(1-8)
										(9-16)
										(17-24)
										(25-32)
										(33-40)
										(41-48)
										(49-56)
										(57-64)
										(65-72)
										(73-80)
										(1-8)
										(9-16)
										(17-24)
										(25-32)
										(33-40)
										(41-48)
										(49-56)
										(57-64)
										(65-72)
										(73-80)
										(1-8)
										(9-16)
										(17-24)
										(25-32)
										(33-40)
										(41-48)
										(49-56)
										(57-64)
										(65-72)
										(73-80)

FOOD	DESCRIPTION	AMOUNT USUALLY EATEN	TIMES EATEN				CODE	AMOUNT/ DAY
			Per day	Per week	Per month	Seldom/ Never		
Maize-meal porridge	Stiff (pap)						**3400**	
Maize-meal porridge	Soft (slappap)						**3399**	
Maize-meal porridge	Crumbly (phutu)						**3401**	
Sour porridge	Specify ratio Mabella/Maize						**3399**	
Mabella porridge	Stiff, coarse, fine						**3437**	
Mabella porridge	Soft, coarse, fine						**3437**	
Oats porridge	Brand name:						**3239**	
Breakfast cereals	Puffed Wheat, plain						**3325**	
	Corn Flakes, plain						**3243**	
	Weet Bix						**3244**	
	Puffed Rice, sweet						**3372**	
	Specify types usually eaten ____________________ ____________________ Brand names of cereals available at home now:____________________							
Milk on porridge or cereal: Circle type usually used	None							
	Whole/fresh						**2718**	
	Sour						**2787**	
	2% fat						**2772**	
	Fat free/skimmed						**2775**	
	Milk blend						**2771**	
	Soy milk						**2737**	
	Condensed (whole,sweet)						**2714**	
	Condensed (skim, sweet)						**2744**	
	Evaporated whole						**2715**	
	Evaporated low fat						**2827**	
	Non-dairy creamer						**2751**	
Is sugar added to porridge or cereal? (Tick box)	None □ White □ Brown □ Syrup □ Honey □ Sweetener: type____________						 **3989** **4005** **3988** **3984**	
Is fat added to porridge or cereal? (Tick box)	None □ Animal fat (butter) □ Hard margarine □ Soft margarine □ Oil □ Peanut Butter □						 **3479** **3484** **3496** **3507** **3485**	
Samp/Maize rice **Samp and beans** **Samp and peanuts**	Bought Self ground Specify ratio (1:1) Specify ratio						**3250** **3725** **3402**	

Rice: specify brands names:	White Brown Sorghum rice						**3247** **3315** **3437**	
Stamped wheat							**3249**	
Pastas	Macaroni Spaghetti Spaghetti in tomato sauce Other:						**3262** **3262** **3258**	

HOW MANY TIMES A WEEK DO YOU EAT PORRIDGE OR BREAKFAST CEREAL AT ANY TIME OF THE DAY (NOT ONLY BREAKFAST)?_____________

FOOD	**DESCRIPTION**	**AMOUNT USUALLY EATEN**	**TIMES EATEN**				**CODE**	**AMOUNT/ DAY**
			Per day	**Per week**	**Per month**	**Seldom/ Never**		
Bread/Bread rolls	White						**3210**	
Bread slices: thin	Brown						**3211**	
Medium, thick	Whole wheat						**3212**	
Other breads	Specify types e.g. Raisin Maize meal Sweetcorn Rye Other						 **3214** **3278** **3379** **3213**	
Pizza (specify toppings) **Hot Dogs(specify sausage)** **Hamburgers (specify meat)**	Cheese, tomato & onion ____________________ ______________________ ______________________ ______________________ ______________						**3353**	
Are any the following spreads used on bread? **Fat spreads (Tick box)**	Butter ☐ Butro ☐ Animal fat (beef tallow) ☐ Lard ☐ Hard margarine (brick) ☐ Soft margarine (light) ☐ Cooking Fat ☐						**3479** **3523** **3494** **3495** **3484** **3496** **3516**	
Peanut butter							**3485**	
Sweet spreads	Jam Syrup Honey						**3985** **3988** **3984**	
Marmite/ **OXO/** **Bovril**							**4030** **4029** **4029**	
Fish paste **Meat paste**							**3109** **2917**	
Cheese	Specify types: Cottage low-fat cheese Cream cheese Gouda Cheddar Other:_______________						 **2760** **2725** **2723** **2722**	

Cheese spreads	Low fat Full fat Specify types						**4310** **2730**	
Atchar							**3117**	
Other spreads: (Specify tipes)	______________________							

Dumpling							**3210**	
Vetkoek							**3257**	
Provita **Crackers (refined)** **Crackers (whole wheat)**							**3235** **3331** **3391**	
Rusks *Home-made:*	Bran Buttermilk White Boerebeskuit, white All-bran Raisins Buttermilk, white Buttermilk, whole wheat Other						**3330** **3329** **3364** **3364** **3380** **3380** **3215** **3255**	
Scones							**3237**	
Muffins	Plain Bran						**3408** **3407**	

HOW MANY TIMES A DAY DO YOU EAT BREAD? _________

	DESCRIPTION	AMOUNT USUALLY EATEN	TIMES EATEN				CODE	AMOUNT/ DAY
			Per day	**Per week**	**Per month**	**Seldom/ Never**		
Chicken	Boiled: with skin Without skin						**2926** **2963**	
Do you eat the chicken with the skin?	Fried: in batter/crumbs Fried, but not coated						**3018** **2925**	
Yes □ **No** □	Roasted/grilled with skin without skin						**2925** **2950**	
Chicken bones stew							**A003**	
Chicken heads, raw							**2999**	
Chicken stew, with veg. & skin							**3005**	
Chicken feet, raw							**2997**	
Chicken offal	Giblets						**2998**	
Chicken pie	Commercial Home-made						**2954** **2954**	
Red meat: Beef	Fried/grilled: with fat without fat						**2908** **2959**	
	Stewed/boiled: with fat without fat						**3006** **2909**	
	Mince with tomato and						**2987**	

	onion							
Red meat: Mutton	Fried/grilled: with fat without fat						**2927** **2934**	
	Stewed/boiled: with fat without fat						**3040** **2916**	
Red meat: Pork	Fried/grilled: with fat without fat						**2930** **2977**	
	Stewed/boiled: with fat without fat						**3046** **3045**	

Red meat: Goat	Fried/grilled: with fat without fat						**4281**	
	Stewed/boiled: plain with veg						**4281** **4282**	
Offal: Specify type:	Intestines: boiled, nothing added						**3003**	
	"Vetderm" fried						**3003**	
	Stewed with vegetables							
	Liver						**2955**	
	Kidney						**2956**	
	Tripe "pens" trotters, head						**3003**	
	Pluck (lungs, heart, gullet)						**3019**	
Specify vegetables used in meat stews (only if not mentioned elsewhere)								
Wors / sausage	Fried						**2931**	
Bacon							**2906**	
Cold meats	Polony						**2919**	
	Ham						**2967**	
	Vienna's canned						**2936**	
	Russian						**2948**	
	Frankfutter						**2937**	
	Other (specify)							
Canned meat	Bully beef						**2940**	
	Other (specify)							
Meat pie	Bought						**2939**	

FOOD	**DESCRIPTION**	**AMOUNT USUALLY EATEN**	**TIMES EATEN**				**CODE**	**AMOUNT/ DAY**
			Per day	**Per week**	**Per month**	**Seldom/ Never**		
Legumes: specify dried beans/peas/ Lentils	Stews & curries (specify) Soups Salad						 **3157** **3174**	
Baked beans							**3176**	
Soya products e.g. Toppers/ Imana	Brands at home now Don't know_______________ **Show examples**						**3196**	

							code	
Fried fish (fresh or frozen fried in sun oil)	With batter/crumbs Without batter/crumbs						**3072** **3060**	
Fresh water fish **Specify type**	**Specify cooking method** Medium fat, batter, fried						**3094**	
Canned fish:								
Pilchards	In brine						**3055**	
	In tomato sauce						**3102**	
	Mashed with fried onion						**A005**	
Sardines	In oil In tomato sauce						**3087** **3087**	
Tuna	In oil In brine						**3093** **3054**	
Mackerel							**3113**	
Salmon							**3101**	
Pickled fish/curried							**3076**	
Do you remove fish bones before eating canned fish	YES □ NO □							
Fish cakes Specify canned or other	Fried: oil/butter/margarine, commercial						**3080**	
Salted dried fish							**3077**	
Eggs	Boiled/poached Scrambled in: oil butter margarine Fried in: oil butter margarine bacon fat Curried						**2867** **2889** **2886** **2887** **2869** **2868** **2877** **2870** **2902**	

HOW MANY TIMES A WEEK DO YOU EAT MEAT __________,

BEANS __________,

CHICKEN __________,

FISH __________ **AND**

EGGS _________**?**

FOOD	DESCRIPTION	AMOUNT USUALLY EATEN	TIMES EATEN				CODE	AMOUNT/ DAY
			Per day	Per week	Per month	Seldom/ Never		
Cabbage	Boiled, nothing added						**3756**	
	Boiled with potato and onion and fat						**3813**	
	Fried, in margarine (nothing added)						**3810**	
	Fried, in oil (nothing added)						**3912**	
	Boiled, then fried with potato, onion						**A006**	
	Other:							
Spinach/ morogo/ imfino/other green leafy vegetables: List names	Boiled, nothing added						**3913**	
	Boiled fat added (margarine)						**3898**	
	Boiled with onion/tomato and fat						**A011**	
	-onion &potato (margarine)						**3901**	
	- onion, tomato & potato							
	- with peanuts							
	Other:							
Tomato and onion 'gravy'/relish /chow	Home made-with fat without fat						**3910** **3925**	
	Canned						**4129**	
Pumpkin Specify type:	Cooked in fat & sugar						**A010**	
	Boiled, little sugar and fat						**A010**	
	Boiled						**4164**	
____________	Other:							
Carrots	Boiled, sugar & fat						**3819**	
	Boiled, nothing added						**3757**	
	Boiled, potato, onion, no fat						**3934**	
	Boiled, potato, onion, margarine						**3822**	
	Boiled, with sugar						**3818**	
	With potato/onion						**3934**	
	Raw, salad (orange juice)						**3711**	
	Chakalaka							
	Other:							
Mealies/ Sweet corn	On cob						**3725**	
	Off cob -creamed sweet corn Off cob whole kernel						**3726** **3942**	
Beetroot	Cooked Salad (bought or home-made)						**3698** **3699**	

FOOD	DESCRIPTION	AMOUNT USUALLY EATEN	TIMES EATEN				CODE	AMOUNT/ DAY
			Per day	Per week	Per month	Seldom/ Never		
Potatoes	Boiled with skin						**4155**	
	without skin						**3737**	
	Baked in skin(flesh and skin) - in skin (flesh only)						**3736** **3970**	
	Mashed - skim milk, margarine						**3875**	
	Mashed - whole milk, margarine						**3876**	
	Roasted in beef fat						**3878**	
	French fries/potato chips (oil)						**3740**	
	Salad (mayonnaise and egg)						**3928**	
	Other:							
Sweet potatoes	Boiled - with skin						**3748**	
	- without skin						**3903**	
	Baked - with skin						**3748**	
	- without skin						**3903**	
	Mashed						**3903**	
	Other:							
Peas	Green, frozen Green, frozen with sugar With sugar and butter Tinned peas						**4146** **3720** **3859** **4149**	
Green peppers	Raw Cooked (stew with oil)						**3733** **3865**	
Brinjal/egg plant	Cooked Fried in oil Stew (oil, onions, tomato)						**3700** **3802** **3798**	
Mushrooms	Raw Sautéed in brick margarine Sautéed in oil						**3842** **3839** **3841**	
Onions	Sauteed in sun oil Sauteed in margarine						**3730** **3844**	
Salad vegetables	Raw tomato						**3750**	
	Lettuce						**3723**	
	Cucumber						**3718**	
	Avocado's						**3656**	
Green Beans	Boiled, nothing added						**3696**	
	Cooked, potato, onion, margarine						**3792**	
	Cooked, potato, onion, no fat						**3933**	
Cauliflower							**3716**	
Other vegetables; specify	____________________							

If you fry veg or add fat specify type of fat usually used	Butter ☐ Butro ☐ Animal fat (beef tallow) ☐ Lard ☐ Hard margarine (brick) ☐ Soft margarine (tub) ☐ Soft margarine (light) ☐ Sunflower oil ☐						**3479** **3523** **3494** **3495** **3484** **3496** **3524** **3507**	

HOW MANY TIMES A WEEK DO YOU EAT VEGETABLES? _______________

FOOD	**DESCRIPTION**	**AMOUNT USUALLY EATEN**	**TIMES EATEN**				**CODE**	**AMOUNT/ DAY**
			Per day	**Per week**	**Per month**	**Seldom/ Never**		
Mayonnaise/ salad dressing	Mayonnaise: bought home-made Cooked salad dressing Salad dressing low-oil Salad dressing French Oil: Olive Sunflower Canola						**3488** **3506** **3503** **3505** **3487** **3509** **3507** **4280**	
Apples	Fresh Canned, unsweetened						**3532** **4216**	
Pears	Fresh Canned, in syrup						**3582** **3583**	
Bananas							**3540**	
Oranges **Naartjie**							**3560** **3558**	
Grapes							**3550**	
Peaches	Fresh Canned, in syrup						**3565** **3567**	
Apricots	Fresh Canned, in syrup						**3534** **3535**	
Mangoes	Fresh						**3556**	
Pawpaw	Raw						**3563**	
Pineapple	Raw Canned (syrup)						**3581** **3648**	
Guavas	Fresh Canned (syrup)						**3551** **3553**	
Watermelon							**3576**	
Spanspek	Orange flesh Green flesh						**3541** **3575**	
Wild fruit/berries (Specify types)	________________ ________________ ________________ ________________ ________________							
Dried fruit (also as snacks)	Raisins Prunes (raw) Prunes (cooked with sugar) Peaches (raw) Peach (cooked with sugar) Apples (raw) Dried fruit sweets Other						**3552** **3596** **3564** **3568** **3569** **3600** **3995**	

	______ ______ ______							
Other fruit	______ ______ ______ ______ ______ ______ ______ ______	______	______	______	______	______		______

HOW MANY TIMES A WEEK DO YOU EAT FRUITS? ______________

WE NOW WILL ASK YOU QUESTIONS ABOUT WHAT YOU USUALLY DRINK

BEVERAGES	**DESCRIPTION**	**AMOUNT USUALLY TAKEN**	**TIMES TAKEN**				**CODE**	
			Per day	**Per week**	**Per month**	**Seldom/ Never**		
Water							**4042**	
Tea	Ceylon Rooibos						**4038** **4054**	
Coffee							**4037**	
Sugar per cup of tea or coffee	White Brown						**3989** **4005**	
Milk per cup of tea or coffee	Fresh/long life whole						**2718**	
What type of milk do you put in tea and/or coffee?	Fresh/long life 2% Goat						**2772** **2738**	
	Fresh/long life/fat free (skimmed)						**2775**	
	Whole milk powder, reconstituted Specify brand: ______						**2831**	
	Skimmed milk powder, reconstituted Specify brand: ______						**2719**	
	Milk blend, reconstituted Specify brand: ______						**2771**	
	Whitener/non-dairy creamer Specify brand: ______						**2751**	
	Condensed milk (whole)						**2714**	
	Condensed milk (skim)						**2744**	

	Evaporated milk (whole)						**2715**	
	Evaporated milk (low-fat)						**2827**	
	None							
Milk as such: What type of milk do you drink as such?	Fresh/long life/whole Fresh/long life/2% Fresh/longlife/fat free (skimmed) Goat						**2718** **2772** **2775** **2738**	
	Sour / Maas						**2787**	
	Buttermilk						**2713**	

BEVERAGES	**DESCRIPTION**	**AMOUNT USUALLY TAKEN**	**TIMES TAKEN**				**CODE**	**AMOUNT/ DAY**
			Per day	**Per week**	**Per month**	**Seldom/ Never**		
Milk drinks Specify brands, Including milk supplements and type of milk used	Nestle Nesquik___________ Milo____________________ Flavoured milk___________ Other						**4287** **2735** **2774**	
Yoghurt	Drinking yoghurt Thick yoghurt, plain, fruit						**2756** **2732**	
Squash	SixO Oros Lecol with sugar -artificial sweetener Kool Aid Other__________________ ________________________						**3990** **3982** **3982** **3990** **3982**	
Fruit juice	Fresh/Liquifruit/Ceres/						**2866**	
	"Tropica"/ mixtures with milk						**2791**	
Fruit syrups	Average Guava syrup						**2865** **2864**	
Fizzy drinks Coke, Fanta	Sweetened Diet						**3981** **3990**	
Mageu/ Motogo							**4056**	
Alcoholic beverages such as Sorghum beer	Sorghum beer Specify:						**4039**	
Other , specify:	Beer average Wine Cider ________________________ ________________________ ________________________ ________________________ ________________________ ________________________						**4031** **4033** **4057**	

PLEASE INDICATE WHAT TYPES AND AMOUNTS OF SNACKS, PUDDINGS AND SWEETS YOU EAT:

FOODS	DESCRIPTION	AMOUNT USUALLY EATEN	TIMES EATEN				CODE	AMOUNT/ DAY
			Per day	Per week	Per month	Seldom/ Never		
Potato crisps/chips							**3417**	
Peanuts	Roasted, unsalted Roasted, salted						**3452** **3458**	
Cheese curls: Niknaks etc.	Average Savoury						**3267** **3418**	
Popcorn	Plain (no salt and butter) Plain (salt and butter added) Sugar coated						**3332** **3359**	
Raisins (seeds)							**4231**	
Chocolates	Milk Kit Kat Peppermint crisp Specify types and names _________________________						**3987** **4024** **3997**	
Candies	Sugus, gums, hard sweets (specify) Peppermint						**3986** **4004**	
Sweets	Toffees Hard boiled Fudge, caramels (specify)						**3991** **3986** **3991**	
Biscuits/ cookies	Specify type Home made plain Shortbread, butter Commercial, plain Commercial with filling						 **3233** **3296** **3216** **3217**	
Cakes & tarts	Chocolate, plain						**3419**	
Pancakes/ crumpets							**3344**	
Koeksisters							**3231**	
Savouries	Sausage rolls Samoosas - vegetable Samoosa - mutton Biscuits e.g. bacon kips Other:						**2939** **3414** **3355** **3331**	
Pudding: jelly							**3983**	
Baked pudding	Plain batter						**3429**	
Instant pudding	Skim milk Whole milk						**3314** **3266**	

Ice cream	Commercial regular Commercial rich Soft serve Sorbet Ice lollies Chocolate coated individual ice creams (e.g. Magnum)						**3483** **3519** **3518** **3491** **3982**	
Custard	Home made, whole milk Ultramel						**2716** **2716**	
Cream	Fresh						**3520/ 3480**	
Other puddings (Specify):	____________________							

HOW MANY TIMES A WEEK DO YOU EAT SNACK FOODS? _______________

SAUCES / GRAVIES / CONDIMENTS

FOODS	**DESCRIPTION**	**AMOUNT USUALLY EATEN**	**TIMES EATEN**				**CODE**	**AMOUNT/ DAY**
			Per day	**Per week**	**Per month**	**Seldom/ Never**		
Tomato Sauce **Worcester sauce**							**3139** **4309**	
Chutney	Fruit						**3168**	
	Tomato						**3114**	
Pickles							**3866**	
Packet soups							**3158**	
Beef/ chickenstock							**4029**	
Others:								

WILD BIRDS, ANIMALS, INSECTS OR FRUITS AND BERRIES (hunted or collected in rural areas or on farms: (specify)

- **PLEASE MENTION ANY OTHER FOODS YOU EAT MORE THAN ONCE EVERY TWO WEEKS WHICH WE HAVE NOT TALKED ABOUT AND OR FOODS EATEN IN OTHER HOMES OR PLACES DURING THE PAST WEEK**

FOOD	**DESCRIPTION**	**AMOUNT USUALLY EATEN**	**TIMES EATEN**				**CODE**	**AMOUNT/ DAY**
			Per day	**Per week**	**Per month**	**Seldom/ Never**		

- **ARE THERE ANY FOODS THAT YOU EAT WHICH WE HAVEN'T TALKED ABOUT? PLEASE LIST THEM.**

FOODS	DESCRIPTION	AMOUNT USUALLY EATEN	TIMES EATEN				CODE	AMOUNT/ DAY
			Per day	Per week	Per month	Seldom/ Never		

THANK YOU FOR YOUR CO-OPERATION AND PATIENCE.
GOOD BYE!

ADAPTED FROM THE QUESTIONNAIRES OF THE THUSA STUDY (WITH ACKNOWLEDGEMENT TO THE RESEARCH GROUP OF PUCHO) AND THE NATIONAL FOOD CONSUMPTION SURVEY

Appendix B

SOCIO-ECONOMIC QUESTIONNAIRE

---

a. Subject number ___________ 1 [ ][ ][ ] 3

b. Date _____/______/_______ 4 [ ][ ][ ][ ][ ][ ][ ][ ] 11

c. Interviewer _________________________

d. Date of Birth _____/______/______ 12 [ ][ ][ ][ ][ ][ ][ ][ ] 19

e. Do you presently suffer from any disease? [ ] 20

 1 Yes

 2 No

f. Are you presently using any medication (including chronic medication)? [ ] 21

 1 Yes

 2 No

g. Name of school _________________________

h. What grade are you in? [ ] 22

 1 Grade 8

 2 Grade 9

 3 Grade 10

 4 Grade 11

 5 Grade 12

i. Race [ ] 23

 1 Black

 2 Coloured

 3 Indian

 4 White

 5 Other

j. Home language [ ] 24

 1 Afrikaans

 2 English

 3 Sesotho

 4 Setswana

 5 Xhosa

 6 Other (Specify) _____________

k. Gender 25

1 Male

2 Female

l. What type of house do you live in? 26

1 Brick, concrete

2 Traditional mud

3 Tin

4 Flat

5 Other (Specify) _________________

m. How many rooms excluding the toilet/kitchen does your house have? 27 28

n. How many people live at your house for more than 4 days a week? 29 30

m. What type of toilet does your household have? 31

1 Flush

2 Pit

3 Bucket

4 VIP

5 Other (specify) ____________

o. What fuel is used for cooking most of the time? 32

1 Electric

2 Gas

3 Paraffin

4 Wood, coal

5 Sun

6 Open fire

p. Does your home have a working refrigerator? 33

1 Yes

2 No

q. Does your home have a working stove (gas, coal or electric) or Hot plate? 34

1 Yes

2 No

r. Does your home have a working primus or paraffin stove? ☐ 35

1 Yes

2 No

s. Does your home have a working microwave? ☐ 36

1 Yes

2 No

t. Does your home have a working radio and/or television? ☐ 37

1 Yes

2 No

With regards to the person who contributes the most income in the household please specify:

u. Relation to the person ☐ 38

1 Mother

2 Father

3 Sister/Brother

4 Grandparent

5 Other (Specify) ________________

v. His/her occupation ________________________ ☐ 39

w. Highest education level achieved ☐ 40

1 Post matric

2 Matric

3 High School

4 Primary School

x. Are there times when there isn't enough food in the house? ☐ 41

1 Never

2 Sometimes

3 Often

4 Always

Appendix C

SCHOOL ENVIRONMENT QUESTIONNAIRE

To the Headmaster/Principal

In an effort to address the problem of overweight and obesity in children, this study aims to investigate all of the possible causes of infertility in adolescents. I am therefore asking you to complete this form as a means of providing information on the possible effects the school environment may have on the development of obesity in adolescents. Please be advised that the information collected here will be treated confidentially.

PLEASE CHOOSE THE APPROPRIATE ANSWER BY MAKING CIRCLING THE ADJACENT NUMBER!

a. Are there any nutrition education programs organized by your school? ☐ 1

1 Yes

2 No

b. How often are these programmes run? ☐ 2

3 Once a year

2 Twice a year

3 > Twice a year

c. By whom are these programmes run (i.e. planned)? ☐ 3

1 Educators

2 Learners

3 Parents

4 Other(s), please specify

d. Is there a vending machine on the school premises? ☐ 4

1 Yes

2 No

e. Is /are there a tuck shop/ hawkers on the school premises or surrounding areas? ☐ 5

1 Yes

2 No

f. Please state whether these foods are available from the shop (s), hawkers or vending machine?

1 / 2

Biscuits	Yes/No	6
Chocolate bars	Yes/No	7
Sweets	Yes/No	8
Chips	Yes/No	9
Sandwiches/ rolls:		
White	Yes/No	10
Wholewheat	Yes/No	11
Fast foods such as pies, vetkoek, slap chips, etc.	Yes/No	12
Fruit	Yes/No	13
Yoghurt	Yes/No	14
Beverages:		
Full cream milk	Yes/No	15
2% or low fat milk	Yes/No	16
Fruit juices	Yes/No	17
Soft drinks	Yes/No	18
Diet soft drinks	Yes/No	19
Coffee, tea, instant soup	Yes/No	20

Appendix D

Physical activity questionnaire: previous week day

a. Subject number _______ 1 [| |]

b. Interviewer ________________

c. Date _____/_____/_____ 4 [| | | | | | |] 11

d. Age _________

e. Day of the week for which the form was filled in [ ] 12

1 Monday 2 Tuesday 3 Wednesday 4 Thursday

5 Friday 6 Saturday 7 Sunday

Think back to yesterday. For each of the 30 minutes periods, select a primary activity that you performed and specify the type of activity.

Time	Activity	Very light	Light	Medium	Hard	METS			
7:00								.	
7:30								.	
8:00								.	
8:30								.	
9:00								.	
9:30								.	
10:00								.	
10:30								.	
11:00								.	
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17:00								.	
17:30								.	
18:00								.	
18:30								.	
19:00								.	
19:30								.	
20:00								.	
20:30								.	
21:00								.	
21:30								.	
22:00								.	

f. Pedometer reading: _______________ 13 [| | | |] 17

Physical activity questionnaire: previous weekend day

a. Subject number _______ 1 3

b. Interviewer ________________ 4 11

c. Date _____/_____/_____

d. Age _________

e. Weekend day for which the form was filled in 12

1 Saturday 2 Sunday

Think back to the weekend. For each of the 30 minutes periods, select a primary activity that you performed and specify the type of activity.

Time	Activity	Very light	Light	Medium	Hard	METS			
7:00								.	
7:30								.	
8:00								.	
8:30								.	
9:00								.	
9:30								.	
10:00								.	
10:30								.	
11:00								.	
11:30								.	
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17:00								.	
17:30								.	
18:00								.	
18:30								.	
19:00								.	
19:30								.	
20:00								.	
20:30								.	
21:00								.	
21:30								.	
22:00								.	

Appendix E

Anthropometry data form

a. Subject number ________ 1 | | | | 3

b. Interviewer ____________________

c. Date _____/_____/_____ 4 | | | | | | | | | 11

d. Weight ________ kg 12 | | | | | | 16

________ kg

________ kg

e. Height ________ kg 17 | | | | | | 21

________ kg

________ kg

f. Waist circumference _________ cm 22 | | | | | 25

_________cm

_________cm

_________cm

Appendix F

CONSENT LETTER FOR PARENTS AND GUARDIANS

ASSOCIATIONS BETWEEN THE DETERMINANTS OF OVERWEIGHT AND OBESITY IN CHILDREN AGED 13 – 15 YEARS IN BLOEMFONTEIN, IN THE FREE STATE PROVINCE.

Dear Parent/ Guardian

The Department of Human Nutrition at the University of the Free State, will be conducting research on children aged 13 -15 years and we would like to invite your child to participate in the study. The purpose of the research is to determine the factors that are related to overweight and obesity in adolescent children living in Bloemfontein. The information collected will be collected from approximately 640 children from different schools in Bloemfontein.

The following information will be obtained from your child:

- Information regarding personal background and socio-economic status;
- Measurements of weight, height and waist circumference;
- Information regarding the usual food intake;
- Questions concerning the physical activity levels of the child as well as the type of activities the child performs throughout the day.

Should your child be found to be underweight, overweight or obese this information will be communicated to you as a parent/guardian. The child will be given a referral letter to enable you to seek further consultation from a dietician or a medical doctor.

Participation in this study will not cost your child anything, except time after school to gather all of the necessary information. As a way of showing appreciation for your child's taking part in the study, he/she will receive a t-shirt as an incentive. All information will be kept confidential. The findings will be reported as part of a PhD study, but individual results will remain anonymous.

Your child cannot be forced to participate in the study and you can also not be compelled to consent on behalf of your child. Your child can withdraw from the study at any time and this will not be held against either of you.

Should you have any questions, please feel free to contact the researcher at the following numbers: (051) 401 3317.

Thank you for your consent.

Yours sincerely

____

Ntsoaki Lucia Motseki (M Sc Dietetics)

Parent/guardian

I, the undersigned ______________________ , the legal guardian of _____________________ fully understand the purpose of the survey and that my child may withdraw at any time. I therefore agree that he/she can take part in the study and provide all of the necessary information.

Signature: _________________

Signed at ___________________on ____________200__

Learner

I, _________________________ fully understand the purpose of the survey and that I may withdraw at any time. I therefore agree to take part in the study and provide all of the necessary information.

Signature: _________________

Signed at ___________________on ____________200__

LENGOLO LA TUMELLO YA BATSWADI KAPA BALEBEDI

ASSOCIATIONS BETWEEN THE DETERMINANTS OF OVERWEIGHT AND OBESITY IN CHILDREN AGED 13 – 15 YEARS IN BLOEMFONTEIN, IN THE FREE STATE PROVINCE.

Motswadi/ Molebedi

Lefapha la Phepo ya Batho Yunivesithing ya Foreisitata le etsa dipatlisiso ho bana ba dilemo tse 13 ho isa ho tse 15 mme re rata ho mema ngwana wa hao ho nka karolo. Sepheo sa dipatlisiso tsena ke ho lekola dintho tse amanang le monono kapa botenya ho bana ba seng ba hodile ba dulang Bloemfontein. Tlhahiso leseding e tla bokellwang e tla fumanyw ho tswa ho bana ba ka bang 300 ka palo ho tswa dikolong tse fapaneng tsa Bloemfontein.

Tlhahiso leseding e tla fumanwa ho ngwana wa hao e kentse:

- Tlhahiso leseding mabapi le personal background le socio-economic status;
- Ho methwa ha boima, botelele le bophara ba letheka;
- Tlhahiso leseding mabapi le dijo tse jewang;
- Dipotso ka mesebetsi/boikwetliso ba ngwana hammoho le mefuta ya mesebetsi/ boikwetliso eo ngwana a e etsang ka letsatsi.

Ha ho ka fumanwa hore boima ba mmele wa ngwana bo tlase haholo kapa ha ngwana a fumanwa a nonne kapa a le motenya haholo o tla tsebiswa jwaloka motswadi ka maemo ana. Ngwana o tla fuwa lengolo le tla le thusa ho batla thuso ngakeng kapa ho dietician.

Ngwana wa hao a ke ke a lefa letho ha a nka karolo dipatlisisong tsena, feela re tla hloka nako ka mora sekolo ho fumana tlhahiso leseding. Ho leboha ho nka karolo ha ngwana wa hao dipatlisisong tsena, ngwana o tla fuwa sekipa e le mokgwa wa teboho. Tlhahiso leseding yohle e tla ba lekunutu. Dintlha tsa dipatlisiso tsena di tla ngolwa e le karolo ya dithuto tsa PhD, feela mabitso a bana e tla dula e le lekunutu.

Ngwana wa hao a ke ke a qobellwa ho nka karolo dipatlisisong tsena le wena o ke ke wa qobellwa ho fana ka tumello boemong ba ngwana wa hao. Ngwana wa hao a ka tlohella ho nka karolo dipatlisisong nako enngwe le e nngwe mme le ke ke la nkuwa hampe.

Ha e be le na le dipotso, le ka letsetsa mobatlisisi dinomorong tsena tse latelang: (051) 401 3317.

Ke lebohela tumello ya lona.

Wa lona

____

Ntsoaki Lucia Motseki (M Sc Dietetics)

Motswadi/ molebeledi

Nna, ya ngotsweng ______________________ , ke le molebeledi wa molao wa _____________________ ke utlwisisa hantle sepheo sa dipatlisiso tsena le hore ngwana wa ka a ka tlohella ho nka karolo nako e nngwe le e nngwe. Ka hoo ke dumela hore ngwana a ka nka karolo dipatlisisong le ho fana ka tlhahiso leseding yohle e hlokahalang.

Signature: _________________

E saenuwe ___________________ka ____________200__

Moithuti

Nna, _________________________ ke utlwisisa hantle sepheo sa dipatlisiso tsena le hore nka tlohella ho nka karolo nako e nngwe le e nngwe. Ka hoo ke dumela ho nka karolo dipatlisisong le ho fana ka tlhahiso leseding yohle e hlokahalang.

Signature: _________________

E saenuwe ___________________ka ____________200__

TOESTEMMINGSBRIEF AAN OUERS EN VOOGDE

ASSOCIATIONS BETWEEN THE DETERMINANTS OF OVERWEIGHT AND OBESITY IN CHILDREN AGED 13 – 15 YEARS IN BLOEMFONTEIN, IN THE FREE STATE PROVINCE.

Geagte Ouer/ Voog

Die Departement Menslike Voeding by die Universiteit van die Vrystaat, beoog om navorsing te doen op kinders tussen 13 – 15 jaar oud. Graag nooi ons u kind om aan die studie deel te neem. Die doel van die navorsing is om die faktore te bepaal wat verwant is aan oorgewig en obesiteit in adolesente wat in Bloemfontein woonagtig is. Die inligting sal van ongeveer 640 kinders van verskillende skole in Bloemfontein ingesamel word.

Die volgende inligting sal van u kind verkry word:

- Inligting aangaande persoonlike agtergrond en sosio-ekonomiese status.
- Meting van gewig, lengte en omtrek van die middellyf.
- Inligting aangaande die gewone voedsel inname
- Vrae rakende die fisiese aktiwiteitsvlakke van die kind sowel as die tipe aktiwiteite wat die kind uitvoer gedurende die verloop van die dag.

Indien daar bevind word dat u kind ondergewig, oorgewig of vetsugtig is, sal die inligting aan u as ouer/voog oorgedra word. Die kind sal 'n verwysingsbrief ontvang wat u dan in staat sal stel om verdere konsultasie by 'n dieetkundige of dokter te kry.

Daar is geen koste verbonde vir u kind indien hy/sy sou deelneem aan die studie nie, behalwe ekstra tyd na skool om die nodige inligting in te samel nie. Om dankie te sê sal u kind 'n t-hemp ontvang omdat hy/sy in die studie deelgeneem het. Alle inligting sal streng privaat gehou word. Die bevindinge sal as deel van 'n PhD studie bekend gemaak word, maar individuele resultate sal annoniem bly.

U kind sal op ‘n vrywillige basis aan die studie deelneem en u is ook nie gedwing om, namens u kind toestemming te gee nie. U kind kan ten enige tyd aan die studie omtrek en sal nie gepenaliseer word nie.

Dit staan u vry om die navorser te skakel indien u enige navrae het. U kan haar skakel by die volgende nommer: (051) 401 3317.

Dankie byvoorbaat vir u toestemming.

Die uwe

____

Ntsoaki Lucia Motseki (M Sc Dietetics)

Ouer/ voog

Ek, die ondertekende ________________________ , die wettige voog van ______________________ verstaan ten volle die doel van die navorsing en dat my kind ter enige tyd mag ontrek. Ek gee my toestemming dat hy/ sy mag deelneem aan die studie en die nodige inligting mag verskaf.

Handtekening: __________________

Geteken ____________________op ____________200__

Leerder

Ek ______________________ verstaan ten volle die doel van die navorsing en ek ter enige tyd mag ontrek. Ek gee my toestemming om deel te neem aan die studie en die nodige inligting te verskaf.

Handtekening: __________________

Geteken ____________________op ____________200__

Appendix G

LETTER TO THE HEADMASTER/ PRINCIPAL

ASSOCIATIONS BETWEEN THE DETERMINANTS OF OVERWEIGHT AND OBESITY IN CHILDREN AGED 13 – 15 YEARS IN BLOEMFONTEIN, IN THE FREE STATE PROVINCE.

Dear Sir / Madam

The Department of Human Nutrition will be conducting research on children aged 13 -15 years and we would like to invite your school to participate in the study. The purpose of the research is to determine the factors that are related to overweight and obesity in adolescent children living in Bloemfontein. The information collected will be collected from approximately 640 children from different schools in Bloemfontein.

The following information will be obtained from the children:

- Information regarding personal background and socio-economic status;
- Measurements of weight, height and waist circumference;
- Information regarding the usual food intake;
- Questions concerning the physical activity levels of the child as well as the type of activities the child performs throughout the day.

Should any of the children be found to be underweight, overweight or obese this information will be communicated to the parents/guardians of the child. The child will be given a referral letter to enable him/her to seek further consultation from a dietician or a medical doctor.

Participation in this study will not cost the children anything, except time after school to gather all of the necessary information. As a way of showing appreciation for the children taking part in the study, each child will receive a t-shirt as an incentive. We will also need a room to conduct interviews and take all the necessary measurements.

All information will be kept confidential, the name of the school as well as those of the children will not be mentioned anywhere. The findings will be reported as part of a PhD study, but individual results will remain anonymous.

The children cannot be forced to participate in the study and the children may withdraw from the study at any time and this will not be held against them.

Should you have any questions, please feel free to contact the researcher at the following numbers: (051) 401 3317.

Thank you for your co-operation.

Yours sincerely

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Ntsoaki Lucia Motseki (M Sc Dietetics)

BRIEF AAN DIE SKOOLHOOF/ PRINSIPAAL

ASSOCIATIONS BETWEEN THE DETERMINANTS OF OVERWEIGHT AND OBESITY IN CHILDREN AGED 13 – 15 YEARS IN BLOEMFONTEIN, IN THE FREE STATE PROVINCE.

Geagte Dame/ Meneer

Die Departement van Menslike Voeding beoog om navorsing te doen op kinders tussen 13 – 15 jaar oud. Graag nooi ons u skool om aan die studie deel te neem. Die doel van die studie is om die faktore te bepaal wat verband het met oorgewig en obesiteit in adolesente in die Bloemfontein omgewing. Die inligting sal van ongeveer 300 kinders van verskillende skole in Bloemfontein verkry word.

Die volgende inligting sal van die kinders ingesamel word:

- Inligting aangaande die persoonlike agtergrond en sosio-ekonomiese status
- Meting van lengte, gewig en die omtrek van die middellyf
- Inligting aangaande die gewone voedsel inname
- Vrae rakende die fisiese aktiwiteitsvlakke van die kind sowel as die tipe aktiwiteite wat die kind uitvoer gedurende die verloop van die dag.

Indien daar bevind word dat enige van die kinders ondergewig, oorgewig of vetsugtig is, sal die inligting oorgedra word aan die ouer/voog van die kind. Die kind sal ‘n verwysingsbrief ontvang wat die ouer/voog in staat sal stel om verder konsultasie by ‘n dieetkundige of ‘n dokter te kry.

Daar sal geen koste verbonde wees met deelname aan die studie nie. Daar sal egter van die kind verwag word om tyd na skool af te staan om die nodige inligting in te samel. Om dankie te sê sal elke kind wat deelneem ‘n t-hemp ontvang. Ons sal ook ‘n area benodig waar ons onderhoude kan waarneem en die nodige metings kan uitvoer.

Alle inligting sal streng privaat gehou word. Die naam van die skool sowel as die van die kinders sal nie genoem word nie. Die bevindinge sal as deel van ‘n PhD studie bekend gestel word, maar individuele resultate sal anoniem bly.

Die studie deelname is vrywillig en die kinders mag ter enige tyd onttrek aan die studie en sal nie gepenaliseer word nie.

Indien u enige navrae het, staan dit u vry om die navorser te skakel by die volgende nommer: (051) 401 3317.

Dankie vir u samewerking.

Die uwe

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Ntsoaki Lucia Motseki (M Sc Dietetics)

APPENDIX H

UNIVERSITY OF THE FREE STATE:
DEPARTMENT OF HUMAN NUTRITION

REQUEST FOR SPECIAL SERVICE

To: ………………………………………………..

Service required: ………………………………

Diagnosis:

……………………………. **……………………………**

Date/ Datum **NML Motseki RD (SA)**

APPENDIX I

APPLICATION FOR PERMISSION FROM THE DEPARTMENT OF EDUCATION

FREE STATE PROVINCE

Enquiries : Ms. Gaborone MMA
Reference no. : 16/4/1/1-2006

Tel :(051) 404 8658
Fax :(051) 447 7318

2006-01-12

Ms. N.M.L. Motseki
P.O. Box 23081
Kagisanong
9301

Dear Ms. Motseki

REGISTRATION OF RESEARCH PROJECT

1. This letter is in reply to your application for the registration of your research project.

2. **Research topic**: **Associations between the determinants of overweight and obesity in children aged 13-15 years in Bloemfontein, in the Free State Province.**

3. Your research project has been registered with the Free State Education Department and you may conduct research in the Free State Department of Education under the following conditions:

   3.1 Educators and learners, participate voluntarily in the project.
   3.2 The names of all schools, educators, and learners involved remain confidential.
   3.3 The questionnaires are completed and the interviews are conducted outside normal tuition time.
   3.4 This letter is shown to all participating persons.

4. You are requested to donate a report on this study to the Free State Department of Education. It will be placed in the Education Library, Bloemfontein. It will be appreciated if you would also bring a summary of the report on a computer disc, so that it may be placed on the website of the Department.

5. Once your project is complete, you may be invited to present your findings to the relevant persons in the FS Department of Education. This will increase the possibility of implementing your findings wherever possible.

6. **You are requested to confirm acceptance of the above conditions in writing to:**

   The Head: Education, for attention:
   DIRECTOR : QUALITY ASSURANCE
   Room 401, Syfrets Building
   Private Bag X20565, BLOEMFONTEIN, 9301

We wish you every success with your research.

Yours sincerely

FR SELLO
DIRECTOR : QUALITY ASSURANCE

SUMMARY

Introduction

Childhood obesity has become a major public health issue with children being heavier today than they were 20 years ago. This phenomenon is presently observed in both developed and developing countries. As a result of this childhood obesity epidemic, a number of chronic illnesses and risk factors for adult diseases are now beginning in childhood.

Most studies conducted in South Africa only determined the prevalence of overweight and obesity, however few addressed the determinants of overweight and obesity in children.

Objective

The main objective of this study was to determine the school environment as well as associations between dietary intake, socio-economic status, physical activity levels and weight status of children aged 13 – 15 years in Bloemfontein.

Methodology

A representative sample of 415 children of different ethnic and socio-economic backgrounds participated in the study.

Questionnaires were used to collect socio-economic, dietary intake, physical activity, and school environment data. Body mass index was calculated using weight and height measurements and waist circumference was measured. The quantitative food frequency questionnaire was used to determine dietary intake, and nutrient intake was analysed.

Results

Weight status

Only a small percentage of the children were overweight and obese, with the girls being more overweight and obese than the boys. A statistically significant association was made between BMI and waist circumference.

Socio-economic status

The association between socio-economic status and overweight and obesity was not significant, but the prevalence of overweight and obesity was higher in children with a high socio-economic status and lowest in children with a medium socio-economic status. No statistically significant association could be found between BMI and race. However, white children tended to be more overweight and obese than black and coloured children.

School environment

Only a few schools reported having nutrition education programmes or campaigns. In most of these schools, the programmes were run only once a year and mostly by educators and not the learners themselves. None of the schools had vending machines on the school premises, but all schools reported having a tuckshop and/or hawkers on or around the school premises. The sale of healthier options of foods such as yoghurt, milk and whole-wheat bread was reported by few schools, while most schools reported selling less healthy options, including crisps, sweets and carbonated drinks.

Dietary intake

Macro- and micronutrient intakes of the children were mostly within the adequate range. Fibre intake was below the requirements in most children and the intakes of calcium, folate and potassium were also below requirements. Most of the children had energy intakes equal to or above the estimated energy requirements. Slightly more boys than girls had energy intakes above the estimated energy requirements. No statistically significant association could be made between energy intake and dietary fat intake and BMI.

Physical activity levels

Physical activity levels of the children were mostly moderate to vigorous. During the weekend the number of inactive children increased, and that of the vigorously active children decreased. The inactive group of children consisted of more girls than boys. Underweight children had a significantly higher metabolic equivalent value than the normal and overweight groups. No statistically significant association could be made between total number of television hours and BMI. In the category of children who were classified as moderately and vigorously active, statistically significantly more children were underweight compared to the overweight and the normal weight children during the week.

Conclusion

Decreased energy intake and promotion of physical activity levels should form integral parts of any prevention program that focuses on childhood obesity. Childhood obesity prevention programmes require a joint multidisciplinary, multi-sectoral collaboration in order for them to be successful.

Key words: Overweight, obesity, socio-economic status, energy intake, fat intake, physical activity, school environment, waist circumference, body mass index

OPSOMMING

Inleiding

Pediatriese vetsug het 'n belangrike openbare gesondheidsprobleem geword met kinders wat vandag swaarder weeg as 20 jaar gelede. Hierdie verskynsel kom huidiglik in beide ontwikkelde en ontwikkelende lande voor. 'n Direkte gevolg van hierdie vetsug ontwikkelende epidemie is dat verskeie chroniese siektes en risikofaktore vir volwasse siektes nou reeds in die kinderjare begin voorkom.

Die meeste studies wat in Suid-Afrika uitgevoer is het slegs op die voorkoms van oormassa en vetsug gekonsentreer, terwyl slegs enkeles ook die bepalende faktore wat oormassa en vetsug in kinders veroorsaak, ondersoek het.

Doelwit van die studie

Die hoofdoelwit van hierdie studie was om die skoolomgewing te ondersoek en verbande tussen dieetinnames, sosio-ekonomiese status, fisiese aktiwiteitsvlakke en massastatus van kinders tussen 13 – 15 jaar in Bloemfontein te bepaal.

Metodologie

'n Verteenwoordigende steekproef bestaande uit 415 kinders van verskillende etniese en sosio-ekonomiese agtergronde, het aan die studie deelgeneem.

Vraelyste is gebruik om data met betrekking tot sosio-ekonomiese status, voedselinname, fisiese aktiwiteitsvlakke en die skoolomgewing in te samel.

Liggaamsmassa-indeks (LMI) is met behulp van massa en lengtemate bereken en die middellyfomtrek is gemeet. Die kwantitatiewe voedselfrekwensievraelys is gebruik om voedselinname te bepaal, en die voedingswaarde-inname is daarvolgens geanaliseer.

Resultate

Massastatus

'n Relatief klein persentasie van die kinders was oormassa en vetsugtig, met meer meisies wat oormassa en vetsugtig was, as seuns. 'n Statisties betekenisvolle verband is tussen LMI en middellyfomtrek gevind.

Sosio-ekonomiese status

Sosio-ekonomiese status was nie betekenisvol met oormassa en vetsug geassosieer nie, maar die voorkoms van oormassa en vetsug was wel hoër in kinders met 'n hoë sosio-ekonomiese status en die laagste in kinders met 'n medium sosio-ekonomiese status. Geen statisties betekenisvolle verband is tussen LMI en ras gevind nie, maar meer wit kinders was oormassa en vetsugtig as swart- en kleurlingkinders.

Skoolomgewing

Slegs 'n paar skole het 'n voedingsopleidingsprogram of –veldtog geraporteer. In die meeste van hierdie skole is die program slegs een maal per jaar aangebied en meestal deur opvoeders en nie deur die leerders self nie. Geen van die skole het outomatiese verkoopsmasjiene op die skoolgronde gehad nie, maar al die skole het 'n snoepwinkel en/of smouse op, of rondom die skoolgronde gerapporteer. Die verkoop van gesonder voedselopsies, soos jogurt, melk en volgraanbrood, is deur 'n paar skole gerapporteer, terwyl die meeste skole gerapporteer het dat minder gesonde opsies, insluitende skyfies, lekkergoed en gaskoeldrank, verkoop word.

Dieetinname

Makro- en mikrovoedingstofinnames van die kinders was meestal binne die aanbevole parameters van toereikendheid. Veselinname van die meeste kinders was laer as die aanbevelings, terwyl die inname van kalsium, folaat en kalium ook laer as toereikend was. Ietwat meer seuns as meisies het energie-innames bo die aanbevole geskatte energievereistes gehad. Geen statisties betekenisvolle verband kon tussen energie-innames en dieetvetinnames of LMI getrek word nie.

Fisiese aktiwiteit

Fisiese aktiwiteit van die kinders was meestal matig tot hoog. Meer kinders was oor naweke onaktief as gedurende die week. Die onaktiewe groep kinders het uit meer meisies as seuns bestaan. Dié kinders wat ondermassa was, het ‘n betekenisvol hoër metabolies ekwivalente waarde getoon as dié normale en oormassagroepe. Geen statisties betekenisvolle verband kon tussen die totale aantal ure wat die kinders televisie gekyk het en hul LMI getrek word nie. In die kategorie van kinders wat as matig tot hoogs aktief gedurende die week geklassifiseer is, was statisties betekenisvol meer kinders ondermassa, vergeleke met kinder swat oormassa en normale massa was.

Gevolgtrekking

Verminderde energie-inname en bevordering van fisiese aktiwiteitsvlakke behoort integrale dele van enige voorkomingsprogram wat op pediatriese vetsug fokus, te wees. Ten einde suksesvol te wees, sal sodanige programme gesamentlike multidissiplinêre, multisektorale samewerking vereis.

Sleutelwoorde: Oorgewig, vetsugtigheid, sosio-ekonomiese status, energie-inname, vetinname, fisiese aktiwiteit, skoolomgewing, middellyfomtrek, liggaamsmassa-indeks.