Prevalence and determinants of obesity among adolescents in Vhembe district Municipality, Limpopo Province

By

Baloyi Brenda

Student Number

11561999

Bachelor of Science in Nutrition (University of Venda)

This dissertation is submitted in partial fulfilment of the requirements for the degree of Masters of Science in Public Nutrition in the Department of Nutrition in School of Health Science, University of Venda, South Africa.

Supervisors: Dr LF Mushaphi
Department of Nutrition, School of Health Sciences
University of Venda
Co-supervisor: Mr NS Mabapa
Department of Nutrition, School of Health Sciences
University of Venda

2020

DECLARATION

I, **Baloyi Brenda** here declare that the dissertation for the **Masters of Science in Public Nutrition** degree at the University of Venda, hereby submitted by me, has not been submitted previously for a degree at this or any other university, that it is my own work in design and in execution, and that all reference material contained therein has been duly acknowledged.

Signature: 

(Baloyi Brenda)

Date: 10/05/2021

DEDICATION

To Almighty God thank you for the guidance, strength, power of mind, protection and skills and for giving me healthy life.

To my mother Baloyi Mthavini for your love, support and for always believing in me.

To my son Baloyi Blessed Hletelo for your marvellous love and always understanding.

ACKNOWLEDGEMENT

I wishers to express my sincerest gratitude and warm appreciation of the following people who had contributed much:

- To Dr LF Mushaphi my supervisor for her guidance in writing this dissertation.
- To Mr NS Mabapa my Co-supervisor for his valuable critique, support, encouragement, creative and comprehensive advice. I could not have imagine having a better adviser and a mentor for my study.
- To L Netshivhumbe, M Nemadevhele and TD Ndou my field-workers for their assistance and support thought data collection.
- To HE Chauke for her assistance and support in my study.
- To Professor AKA Amey my statistician for his assistance.
- To students of secondary schools in Vhembe district for lending me some of their precious time in giving their responses to the questionnaire
- To school principals for granting me permission and welcoming me in your schools.
- To Department of Education for permitting me to conduct my study in secondary schools.
- To my friends and colleagues for support and encouragement.
- To my family for their understanding, love, moral support, encouragements throughout the study.

LIST OF ABBREVIATIONS

AHA:	American Heart Association
BP:	Blood Pressure
BGL:	Blood Glucose Level
BMI:	Body Mass Index
CM:	Centimetres
CSI:	Chronic systemic inflammation
CRP:	C-Reactive Protein
DoE:	Department of Education
DBP:	Diastolic Blood Pressure
FFQ:	Food Frequency Questionnaire
GCP:	Good Clinical Practice
HDL-C:	High Density Lipoprotein-Cholesterol
IOTF:	International Obesity Task Force
LDL-C:	Low Density Lipoprotein -Cholesterol
OR:	Odds Ratio
SES:	Socio-economic status
SANHES:	South African National Health and Nutrition Survey
SANYRBS:	South African National Youth Risk Behaviour Survey
SPSS:	Statistical Package for Social Science
SSA:	Sub-Saharan Africa
SBP:	Systolic Blood Pressure
TV:	Television
TG:	Triglyceride
WC:	Waist circumference
WHR:	Waist to Hip Ratio
WHO:	World Health Organisation

ABSTRACT

Introduction: Globally obesity amongst adolescents is becoming one of the most challenging public health concerns. Prevalence of obesity among children and adolescent has dramatically increased in recent years in both developed and developing countries.

Aim: The aim of the study was to determine the prevalence and determinants of obesity among adolescents in Vhembe district.

Methods: A cross-sectional study was conducted in 377 adolescents aged 13-20years. The following measurements were carried out: anthropometric measurements, dietary assessment, biochemical measurements, blood pressure and physical activity level. A questionnaire was used to collect demographic information and dietary intake. Data were expressed as means and standard deviations. The statistical package for social sciences version 26 was used to analyse data. Binary logistics regression analysis was used to determine odds ratio (OR). A p-value of <0.05 was considered significant.

Results: The prevalence of obesity was high in females (20.3%) as compared to males (6%). Determinants of obesity in this study included gender, age, source of income, SBP, cholesterol and nutrients intake. Among male participants BMI was significantly associated with SBP (r=0.281, p=0.00), WC (r=0.661, p=0.00) and TC (r=0.223, P0.06). In female participants BMI was significantly associated with SBP (r=0.242, p=0.00), DBP (r=0.157, p=0.18) and TRIG (r=0.158 p=0.01) and negatively associated with HDL (-0.178, p=0.07). There was a high intake of macronutrients and low intake of micronutrients among adolescents in the current study. Most (males=30.7% vs females=60.8%) of adolescents had low physical activity indexes and living a sedentary lifestyle.

Conclusion: The results of the study suggest a double burden and trend of undernutrition and overnutrition.

Key Words: adolescents, determinants, obesity, prevalence.

Table of Contents

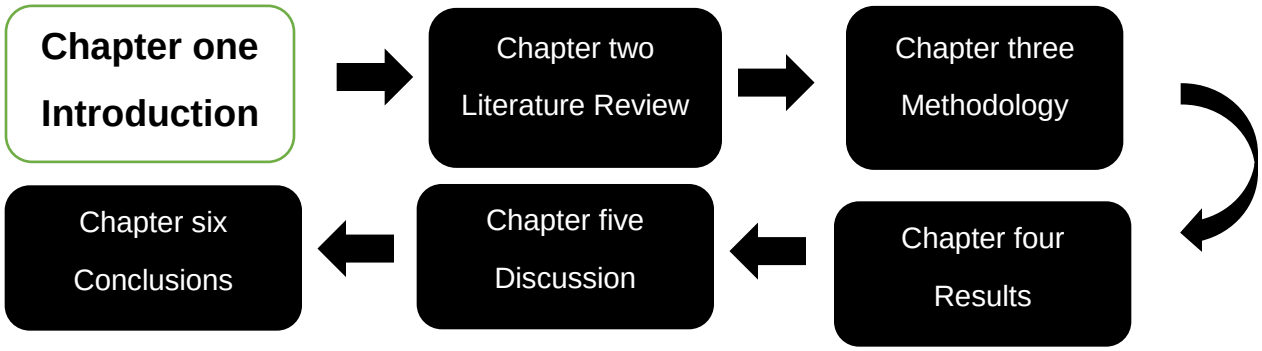
LIST OF TABLES

LIST OF FIGURES

CHAPTER 1

INTRODUCTION

1.1 Overview



1.2 Background of the study

Globally obesity amongst adolescents is becoming one of the most challenging public health concerns (Gebrie *et al.,* 2018). Prevalence of obesity among children and adolescent has dramatically increased in recent years in both developed and developing countries (Guo *et al.,* 2012; Negash *et al.,* 2017). Africa has an estimated prevalence of childhood overweight and obesity of 8.5% in 2010 and is still expected to reach 12.7% in 2020 (Raj, 2012). In Sub-Saharan Africa, there is an upcoming threat of a persistent increase in overweight and obesity among children and adolescents (Muthuri *et al.,* 2014). In South Africa, the prevalence of obesity among children and adolescents is increasing, though the prevalence varies with gender, age and race (Rossouw *et al.*, 2012). The prevalence of obesity in South Africa is high in urban areas than in rural areas and high in Kwa-Zulu Natal (44%), Gauteng (39.9%), and Western Cape (37.9%), there is low prevalent in Limpopo (32.6%) and North West (31.7%) province (Shisana *et al.,* 2013).

Obesity increases the risk of developing chronic metabolic disorders more especially in children and adolescents later in life (Kimani-Murage *et al.,* 2010; Guo *et al.,* 2013; Rodriguez-Hernández *et al.,* 2013). South Africa is experiencing multiple burdens of disease with non-communicable diseases being one of the leading health concerns (Department of Health, 2016). Risk of non-communicable diseases such as coronary heart diseases, stroke, type 2 diabetes mellitus, and hypertension as well as related mortality increase with the increasing body mass index (BMI) (Musa *et al.,* 2012; Kotian *et al.*, 2010; Menezes *et al.,* 2009; and World Health Organisation (WHO), 2010). High BMI is related to excessive adiposity which now affects mostly adolescents (Lee, 2009 and WHO, 2010). According to Rodriguez-Hernández *et al.* (2013), obesity has

increased economic burden and has indicated an increase in cost in associated comorbidities. Moreover, obesity executes a significant economic burden on an already strained health system and imposes a great cost to the country (Department of Health, 2016). Furthermore, obesity is recently viewed as chronic systemic inflammation (CSI) (Rocha and Folco, 2011). CSI is caused by pro-inflammatory markers produced by adipose tissue (Rodriguez-Hernández *et al.*, 2013). Raj. (2012) confirms that a variety of pro-inflammatory markers that are associated with cardio-metabolic dysfunction are influenced by obesity level.

There is existing evidence that adolescent's obesity contributes to the non-communicable burden of disease in South Africa (Rossouw *et al.*, 2012). Obesity among children and adolescents has a negative impact on their physical and psychological well-being (Rossouw *et al.,* 2012). Children and adolescents are handling chronic diseases that were considered an adult disease (Lee, 2009). Reduction of adolescents' obesity is a critical target in promoting healthy expectancy even for future generation (WHO, 2014).

Increased rate in obesity among children and adolescents has not yet received the public and media attention in countries where problem-related to obesity is frequently occurring (Reddy *et al.,* 2012). Global Nutrition Report (2015) further indicated that in Africa there are gaps between delivery and need, more especially in combatting malnutrition. Obesity cannot be addressed in isolation policies. Practices that intersect with nutrition should also address it (Global Nutrition Report, 2015). Obesity among children and adolescent should be considered as a chronic medical condition with medical and psychological consequences, which does not have an immediate impact but significant bearing on their health in adulthood (Lee, 2009).

1.3 Problem statement

Literature indicates a double burden of malnutrition residing in the same populations and households in rural South Africa, pointing both to over and under-nutrition in children and adolescents (Reddy *et al.,* 2010; Kimani-Murage *et al.,* 2010; Rossouw *et al.,* 2012; Mogre *et al.,* 2013; Manyanga *et al*., 2014). Such a consensus is in line with the Global Nutrition Report. (2015) that shows South Africa as one of the thirteen countries in Africa facing serious public health issue of under-nutrition and over-nutrition.

Although studies (Reddy *et al.,* 2010 and Shisana *et al.*, 2013) indicated Limpopo Province as having the lowest prevalence of obesity (2.8%) among adolescents, Guo *et al.* (2013) and Toriala

et al. (2012) observed that children and adolescents are the most affected by obesity. Obesity among children and adolescents indicates a higher risk of transition to adulthood which often begins at childhood (Kimani-murage *et al.,* 2010, and Freedman *et al.,* 2007). Furthermore, Zimmet *et al.* (2007) indicated that early identification of adolescents at risk of developing the metabolic syndrome, successively progression to type 2 diabetes and cardiovascular disease later in life must not be underestimated. Recently in Thohoyandou, a mall has been built and with it came fast food outlets that are associated with preponderance of energy dense foods over balanced diets. Therefore, it is crucial to identify the determinants of obesity and address the problem at an early age to prevent the transfer of these risks to adulthood (Kimani-Murage *et al.,* 2010). Understanding the context-specific factors and determinants of obesity is significant this will assist the country to implement effective interventions (Department of Health, 2016).

1.4 Aim of the study

The aim of the study was to determine the prevalence and determinants of obesity among adolescents in Vhembe district.

1.5 Objectives of the study

1.5.1 To determine the anthropometric status of adolescents using anthropometric measuring techniques.

1.5.2 To determine biochemical markers (C-reactive protein, cholesterol, and glucose) using biochemical methods.

1.5.3 To determine blood pressure levels of adolescents.

1.5.4 To determine the dietary intake of adolescents using quantified Food Frequency Questionnaire.

1.5.5 To determine physical activity levels of adolescents.

1.5.6 To correlate the anthropometric status of adolescents with their demographic characteristics, dietary intake, biochemical markers, blood pressure, and physical activity levels.

1.6 Significance of the study

The information on the prevalence and determinants of obesity amongst adolescents would be established in Vhembe district. Understanding the determinants of obesity is important for the development of scientifically based effective preventive strategies. The study could assist in the prevention and management of obesity among children and adolescent to prevent obesity in adulthood. The study could form a foundation fora multi-sectoral approach to be implemented to reduce obesity in Thulamela Municipality of Vhembe district. The Departments of Health and Education could be able to develop informed programmes for prevention and treatment of obesity among adolescents thus getting towards addressing the double burden of malnutrition in rural areas and promotion of healthy lifestyles both at school and at home.

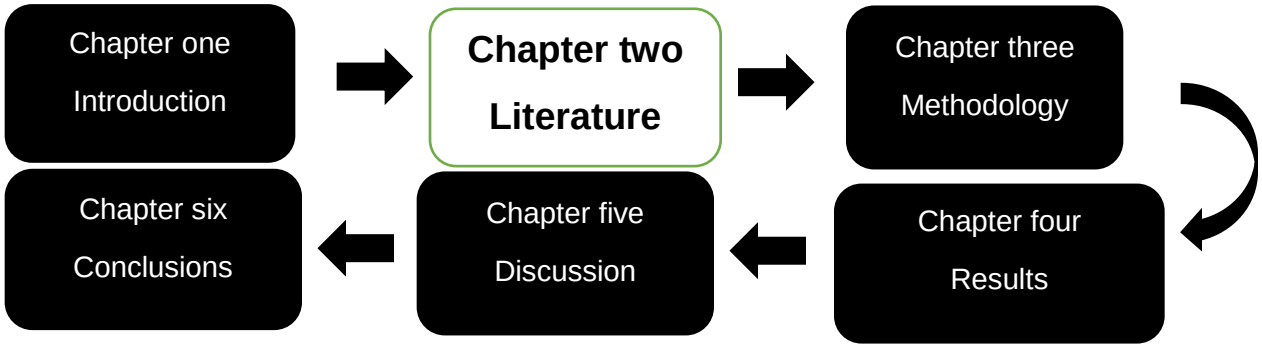
1.7 Structure of the dissertation

- Chapter 1 introduces the prevalence of obesity worldwide, in Africa, South Africa and in the province. It also presents the aims, objectives and the significance of the study conducted.
- Chapter 2 discusses background literature on obesity worldwide and covers the situation in South Africa.
- Chapter 3 describes the sampling methodology and the methods used during data and sample collection.
- Chapter 4 deals with results of the study which includes determinants of obesity, dietary intakes, BMI status, physical activity level, values of biochemical markers and blood pressure levels.
- Chapter 5 deals with the discussion of the results.
- Chapter 6 deals with conclusion and recommendations are made.
- At the end all references are listed well as appendices.

CHAPTER 2

LITERATURE REVIEW

2.1 Overview



2.2 Introduction

Adolescence is the period of human growth, maturation and increased nutritional requirements (Atiku and Yunusa, 2009). Adolescents perform greater independence in preparation for adulthood. Lifestyle decisions during adolescence may pave the foundation for later health behaviours and outcomes (Arora *et al.,* 2012). Furthermore, adolescents are nutritionally vulnerable because of change in eating patterns, lifestyles and explosive to new environmental influences (Ogunkunle and Oludele, 2013). The prevalence of obesity is becoming a leading health threat among children and adolescents (McKersie and Baard, 2014). Furthermore, obesity is rapidly becoming one of the most important medical and public health problems (Andegiorgish *et al.,* 2012). Obesity is a global epidemic not only in adults but also among children and adolescents (Sabageh and Ojofeitimi, 2013). Obesity is the consequences of a long-term imbalance between energy intake and energy expenditure, determined by food intake, physical activity and influenced by biological, behavioural and environmental factors (Kleiser *et al.,* 2009 and Guo *et al.,* 2013).

Reddy *et al.* (2012) indicated that in the United States it took 13 years for obesity rate among adolescent to double, but in South Africa, a similar trend was observed in 6 years. This is an indication that South Africa is experiencing a chronic disease risk transition. Lifestyle has changed in South Africa in response to rapid economic growth, improved food supplies, expansion of television and computers, and improved public transport. Changes in lifestyle contribute to the high prevalence of obesity among adolescents and long-term health impact (Andegiorgish *et al.,* 2012).

Exposure to the obesogenic environment is increasing across all socio-economic groups (WHO, 2016). An obesogenic environment is one of the risk factors that increase the risk of obesity in adolescents (Zimmet *et al.,* 2007). Home and school environment play an important role in the prevalence of obesity among adolescents (Rossouw *et al.,* 2012). Identification of risk factors contributing to the rapid increase of obesity among children and adolescents is the fundamental step in the prevention and management of obesity (Teshome *et al.,* 2013).

Opportunity for physical activities have declined in both in and out of school among adolescents, now they spent more time on the screen based and sedentary leisure activities (WHO, 2016). In rural areas in the past, people used to have little electricity, many activities and sleep were determined by sunrise and sunset (Poskitt, 2009). Television is now widespread in rural areas and adolescents are now subjected to an advertisement of food that is high in fats and sugar (Poskitt, 2009). Blood Pressure, lipids levels, body size and proportion change with age and development (Zimmet *et al.,* 2007). Obesity among adolescents should be taken seriously because of its potential devastating contribution to metabolic syndrome and cardiovascular diseases (Negash *et al.,* 2017).

2.3 Age

Obesity is identifiable from a young age and continues into adolescence (O'Dea *et al.,* 2014). Studies (Toriola *et al.,* 2012 and Shisana *et al.,* 2013) indicate that the prevalence of obesity increases with the age, peaking at age 12 and decline thereafter. The reason could be because of increased in adipose tissue and overall body weight in children during puberty (Kotian *et al.,* 2010). Muhihi *et al.* (2013) indicated that children aged above 10 years were 3 times likely to be obese. Kotian *et al.* (2010) found that the prevalence of obesity was high in age groups of 13 to 15 years. Tathiah *et al.* (2013) indicated a high prevalence of obesity in 9 to 10-year old age groups. A study conducted by Kimani-Murage *et al*. (2010) found that the risk of obesity increases with sexual maturation, indicating higher risk as the adolescents' transition to adulthood.

2.4 Gender

Africa has shown a rise in obesity amongst girls particularly as they mature (Poskitt, 2009). McKersie and Baard. (2014) reported that girls displayed double the occurrence of obesity in boys. Studies (Kimani-Murage *et al.,* 2010, South African National Health and Nutrition Survey (Shisana *et al.,* 2013; Tsolekile *et al*., 2014 and Gebrie *et al.,* 2018), shows that Obesity among

adolescents is higher in females than in males. Furthermore, the prevalence of obesity increases with age particularly after puberty in girls (Kruger *et al.,* 2005; and Kimani-Murage *et al.,* 2010). Teshome *et al.* (2013) also indicated that adolescent girls were 5.14 times more likely to be overweight and obese than boys. Tathiah *et al.* (2013) found that 3.8% of a female were obese while 9% were overweight in rural communities. The study conducted by Junaibi *et al.* (2013), reported a high prevalence of obesity in males than females, this could be possible that boys may have been allowed more freedom than girls and therefore, have easier access to energy-dense food.

In Sub-Saharan Africa (SSA) there is a cultural appeal that being overweight is an admired trait and seen as a sign of wealth and prestige, mostly in girls (Muthuri *et al.,* 2014). In South Africa, there is a strong cultural acceptance that obese individuals indicate health and wealth more especially in females (Craig *et al.,* 2015). The other reason may be that boys are more physically active than girls (Micklesfield *et al.,* 2014). Guo *et al*. (2013) indicated that females are more concerned about body shape and weight and may tend to follow bad eating behaviour. Mitolo et al. (2015) further indicated that the reason for the high rate of obesity in females could be nutritional deprivation in childhood, and the female hormone estrogen. Pedro *et al.* (2016) found that the majority of rural South African girls demonstrated body dissatisfaction (a desire to be fatter or thinner, and those who wanted to be fatter had a significantly higher BMI than those who wanted to be thinner. Craig *et al*. (2015) suggested that rural South African girls should be the focus in preventing obesity since they are the ones who are mostly affected during adolescents.

2.5 Socio-economic status

The socio-economic status (SES) plays a significant role in the growth of obesity among adolescents (Ahmad *et al.,* 2018). Villa-Caballero *et al.* (2006) revealed that the association between obesity and SES could result from unhealthy food choices in children living and attending school in low SES. Furthermore, Ahmad *et al.* (2018) indicated that household income influences eating behaviour among family members. High incidence of obesity among children and adolescents in rural areas may be because of low socio-economic background, resulting in not eat breakfast before attending schools, and not consume three full meals per day (Toriola *et al.,* 2012). However, adolescents from high income were seen to be associated with obesity in developing countries (Gebrie *et al.,* 2018). On the other hand, high SES as shown by a higher amount of money spent by kids at school per day was associated with increased risk of obesity. This could be attributed to the fact that money increases the chance of the child to buy fast food

while at school which may result in high risk of the child`s obesity (Muhihi *et al.,* 2013). In addition, Teshome *et al*. (2013) also indicated that adolescents from high SES were 7.19 times at higher risk of becoming overweight/ obese compared to those from low socio-economic status. This might be related to the diet as adolescents from high SES are well known to adopt western life resulting to higher consumption of food high in fat and energy which may substitute healthy traditional diets such as fruit, vegetables and more sedentary lifestyle (Gebrie *et al.,* 2018). Furthermore, high-income families lay the foundation to the affordability of high dense foods and access to a more sedentary lifestyle and mode of transport (Liu *et al.,* 2016).

In developed countries prevalence of obesity in children and adolescents was seen to be high in socially and economically disadvantaged communities (O'Dea *et al.,* 2014). Furthermore, obesity was found to be more common in children with low SES, even among those with favourable behaviours, compared to those with medium or high SES and unfavourable behaviours (Kleiser *et al.,* 2009). This predicts a higher future risk of obesity in adulthood and related ill-health concerns for children and adolescents from socially disadvantaged, low-income communities and schools.

Pocket money is positively related with BMI and risk of obesity (Li *et al.,* 2017). Pocket money is associated with the frequencies of consuming sugary beverages, snacks, and fast food (Li *et al.,* 2017). Nationally, about 55.45 of the learners receive R20 and 44.6% receive more than R20 per month (Reddy *et al.,* 2013). Majority of learners reported to buy food from the school tuck shop or vendors (Reddy *et al.,* 2013).

2.6 Educational level

Higher parental educational status usually reflects a higher SES (Ahmad *et al.,* 2018). Primary education and above have shown to be associated with obesity amongst adolescents in most developing countries (Gebrie *et al.,* 2018). In addition, Ahmad *et al.* (2018) show that a high rate of obesity was observed among adolescents with parents with tertiary and secondary education. Liu *et al.* (2016) also found high maternal education to be associated with a higher rate of obesity among children.

2.7 C-Reactive Protein (CRP)

Obesity is a pro-inflammatory state that increases the risk of chronic diseases including hypertension, diabetes, cardiovascular diseases (Güngör, 2014). CRP is one of the common

inflammatory markers that are associated with obesity (Stolzman and Bement, 2012). CRP is an acute-phase protein produced by the liver and released during infection, systemic infection and tissue damage (Schlenz *et al.,* 2014). CRP is a sensitive systematic marker of inflammation which have been proven to be an independent risk of coronary heart disease (Asztallos *et al.,* 2014). CRP is the most common marker used to assess systemic inflammation (DeBoer, 2013). Olza *et al*. (2012) and Brasil *et al. (*2007) reveal that high CRP obese children who have been proposed as CVD risk factors.

Chronic inflammation in adipose tissue is one of the characteristics of obesity and this chronic inflammation limits the ability of adipocyte to properly store nutrients and related to insulin resistance (Cho and Lumeng, 2011). Even though inflammatory-related diseases are more prevalent in adults, special attention must be paid to adolescents because they are experiencing the same problem (de Heredia *et al.,* 2012). Adolescents are at greater risk of developing health problems because they are also exposed to high inflammatory markers during their life (Stolzman and Bement, 2012). Obese children with a high level of inflammatory markers may experience physiological adaptation that negatively affects metabolic and cardiovascular health and predicts the risk of non-communicable diseases in adulthood (Stolzman and Bement, 2012). Furthermore, high inflammatory markers that occur with obesity are an initiating factor for impaired health, because of their influence on insulin sensitivity, glucose metabolism, and atherosclerosis (Stolzman and Bement, 2012).

Inflammatory markers are strongly associated with high BMI in children and this relationship starts at 3 years of life (Skinner *et al.,* 2010). Skinner *et al.* (2010) indicated that long exposure to an inflammatory state could increase the risk of vascular damage and morbidity. Illán-Gómez *et al*. (2012) indicated that development of atherosclerosis is associated with obesity due to the secretion of inflammatory markers cytokines by adipose tissue because it secretes factors that contribute to the regulation of metabolism and inflammatory responses.

2.8 Cholesterol level

Obesity epidemic has resulted in many children and adolescents with dyslipidaemia (Kavey, 2015). Furthermore, dyslipidaemia in children and adolescents is predictive of accelerated atherosclerosis and of early cardiovascular events in adulthood (Kavey, 2015). Adipose tissue is the biggest tissue in the body which can store a large number of lipids, which makes it a reservoir of cholesterol (Wang and Peng, 2011). The impact of adipose tissue on cholesterol metabolism

is possible to immerse, especially in obesity (Wang and Peng, 2011; Prendergast and Gidding, 2014). High Density Lipoprotein-Cholesterol (HDL-C) has the ability to prevent oxidation of Low Density Lipoprotein -Cholesterol (LDL-C) and promote reverse cholesterol transport, (Prendergast and Gidding, 2014). Low HDL-C is a common lipid disorder in obese individuals. (Wang and Peng, 2011). HDL-C level is associated with both the degree and distribution of obesity (Wang and Peng, 2011). The relationship between low HDL-C and obesity is mainly affected by central obesity which is characterised by visceral fat disposition. Obesity does not affect the concertation of HDL-C in plasma but affects the functioning of HDL.

2.9 Blood pressure

"Hypertension in children and adolescents is defined as average Systolic Blood Pressure (SBP) and/or Diastolic Blood Pressure (DBP) that is, greater than or equal to the 95th percentile for sex, age and height on the three or more occasion" (The fourth report on the diagnosis, evaluation, and treatment of high blood pressure in children and adolescents, 2005). Hypertension among adolescents is becoming a public health concern not only of its consequences but because it can track to adulthood (Noubiasp *et al.,*2017). Obesity was found to be a significant predictor of high blood pressure among adolescents (Senbanjo and Oshikoya, 2012; and Noubiap *et al.,* 2017). Behavioural risk factors which include alcohol consumption, smoking and sedentary lifestyle are significantly associated with hypertension (Mahanta *et al.,* 2018).

Noubiap *et al.* (2017) indicated the high prevalence of hypertension in the rural area than in urban. Mamabolo *et al.* (2011) indicated that higher BMI is related to SBP, with girls SBP related to peripheral fat while boy SBP was related to centrally located fat. Both SBP and DPB have been reported to be high in adolescents girls, which can be explained by the observation that most girls have a higher prevalence of obesity than boys (Mushengezi and Chillo, 2014). Furthermore, girls were more likely to report a family history of hypertension and sedentary lifestyle and both are known to be a risk factor for hypertension (Mushengezi and Chillo, 2014). Early diagnosis and control of hypertension among adolescents need to be addressed urgently to prevent devastating outcome (Mahanta *et al.,* 2018 and Noubiap *et al.,* 2017).

2.10 Dietary intake

Adolescents are nutritionally vulnerable (Harris *et al.,* 2019). Adolescence is characterised with rapid growth, during which the total nutrients are higher than in other phases in the life span (Napier and Oldewage-Theron, 2015). Diet and nutrition play a critical role in the growth and development of adolescents (Affenito *et al.,* 2012). Adolescents in developing countries consume high energy salty foods and food low in micronutrients that cost less and lower in nutrients quality (Gebrie *et al.,* 2018). Teshome *et al.* (2013) reported that adolescents are consuming low vegetables and fruits, which increases the chance for them to be obese. Harris *et al.* (2019) found that majority of adolescents in Western Cape, South Africa are not compliant with the recommendations of nutrients intake of fats, added sugar and sodium. Many rural areas are known to consume traditional and locally produced food which are minimally processed, plenty of vegetables and fruits (Ani *et al.,* 2014). WHO. (2014) further indicates that people shift from diets based on unprocessed foods to food high in fats, sugar, and salt, decrease in consumption of vegetables and fruits.

Dietary habits among adolescents are influenced by foods available not only at home but also at school where they spent most of their time (Affenito *et al.,* 2012). School environment and the food choices available at the school tuckshop contribute to the dietary intake of many adolescents (Harris *et al.,* 2019). Diet and nutrition factors play a crucial role in the development of non-communicable diseases, diabetes, and cancers (Steyn *et al.,* 2016).

2.11 Physical activity and inactivity

Physical activity in adolescents has become an important issue in public health because of its important role in many health conditions (Biddle *et al.,* 2011). According to WHO. (2018) globally three in four adolescents do not meet WHO global recommendation. Additionally, low physical activity has been reported in both developed and developing countries (WHO, 2017). American Heart Association (AHA). (2011) and WHO. (2018) indicated that physical activity has many health benefits including, skeletal health, mental health (good mood and cognitive function), cardiovascular disease, stroke, type 2 diabetes, obesity, some form of cancer and also improve quality of life and well-being. de Heeredia *et al.* (2012) indicated that physical activity may stabilise the consequences of excess body fats. Physical inactivity is a major contributor to the incidence of overweight and obesity among children and adolescents and are related to cardiovascular diseases (Toriola and Monyeki, 2012, and Gebrie et al., 2018).

Adolescents now have less opportunity to roam freely away from home together with the loss of some of the energy consuming activities of subsistence rural life lead to a considerable reduction in daily energy expenditure in adolescents. Adolescents no longer walk miles to school, to fetch water or herd animals, and help in the family (Poskitt, 2009). Use of transport to school contribute to physical inactivity among adolescents because they do not have to walk a distance to school, to fetch water or herd animals (Poskitt, 2009). Research shows that adolescents with low physical activity level are more likely to be overweight/ obese than those who are active, and the prevalence was lower to adolescents who were participating regularly in household chores (Teshome *et al.,* 2013). Affenito *et al.* (2012) indicated that low physical activity in girls may be due to lack of exercise facilities for girls.

Micklesfield *et al.* (2014) indicated that adolescents from rural communities are associated with less sedentary time, and low moderate physical activity in schools and clubs, the reason could be children from rural communities spend more time in assisting with household chores. Furthermore, those from urban areas spend more time in sedentary behaviour such as watching Television (TV), reading, and less time walking as a means of transport (Micklesfield *et al.*, 2014). Physical activity has decreased over the past years and has led to an increased rate of obesity even though rural communities show a high level of physical activity (Poskitt, 2009).

2.11.1 Sleeping patterns

Sleep like dietary intake and physical activity strongly influences many aspects of health including physical, cognitive and emotional health (Wu *et al.,* 2017 and Hirshkowitz *et al.,* 2018). Sleeping pattern is also related to cardio-metabolic dysfunction through a physical activity which reflects a combination of physiologic changes including change in appetite, disruption in the stress system, cytokine response, and behavioural change that includes decreased energy and exercise interest (Countryman *et al.,* 2013). The National Sleep Foundation recommends that adolescents aged 14-17 years sleep duration of 8 to 10 hours per day and young adults aged sleep duration of 7 to 9 hours per day (Hirshkowitz et al., 2018). Changing sleep patterns affect the balance between ghrelin and leptin in a way that contributes to the development of obesity among adolescents (Poskitt, 2009). Hormonal changes (ghrelin and leptin associated with control of appetite and fat deposition) contribute to energy imbalance and then lead to weight gain, (Poskitt, 2009; and Wu *et al.,* 2017). Sluggett *et al.* (2018) indicated that less sleep duration dysregulates homeostatically mediated energy intake. Sleep time was found to be one of the significant environmental factors in the development of obesity (Anuradha *et al.,* 2015). Furthermore, Wu *et al.* (2017); and

Hirshkowits *et al. (*2018) also indicated that less sleep time is a risk factor associated with obesity, poor health and low academic performance among adolescents.

Less sleep duration contributes to the development of many conditions (Anuradha *et al.,* 2015). Decreased sleep duration is reported to be a marker for pathophysiologic processes and release inflammatory cytokines and with the absence of physical activity can become more toxic (Countryman *et al.,* 2013). Less sleep duration among adolescents increases exposure to the obesogenic environment, increased energy consumption and decrease energy expenditure (Sluggett *et al.,* 2018). Adolescents who sleep for short time spend more time in sedentary activities such as TV viewing, use of smartphones, video games and computers (Sluggett *et al.,* 2018). The adolescent whose sleep duration is 7 hours or less per day are likely to become obese (Anuradha *et al.,* 2015). Liou *et al*. (2010) indicated that sleeping <7.75 hours/day increases the risk of obesity among adolescents.

2.11.2 Television viewing

Television is now available to all urban and most rural areas, which results in adolescents spending more time watching television (Poskitt, 2009). Prolong television viewing is associated with BMI in both adolescents and children worldwide (Braithwaite *et al.,* 2013). Furthermore, television viewing is associated with less sleep and inactivity which contribute to rising in adolescent obesity (Poskitt, 2009). Adolescents and children who watch television 1-3 hours per day have 10 to 27% increased the risk of being obese (Braithwaite *et al.,* 2013). While Liou *et al.* (2010) indicated that watching television for more than 2 hours increases the risk of obesity among adolescents. A female adolescent has a higher risk of being obese if they watch television for more than 5 hours than male (Braithwaite *et al.,* 2013). The reason could be biological differences of puberty which make the female more vulnerable to increased body size in response to a sedentary lifestyle (Braithwaite *et al.,* 2013). Braithwaite *et al.* (2013) further indicate that prolonged television viewing is common in children and adolescent.

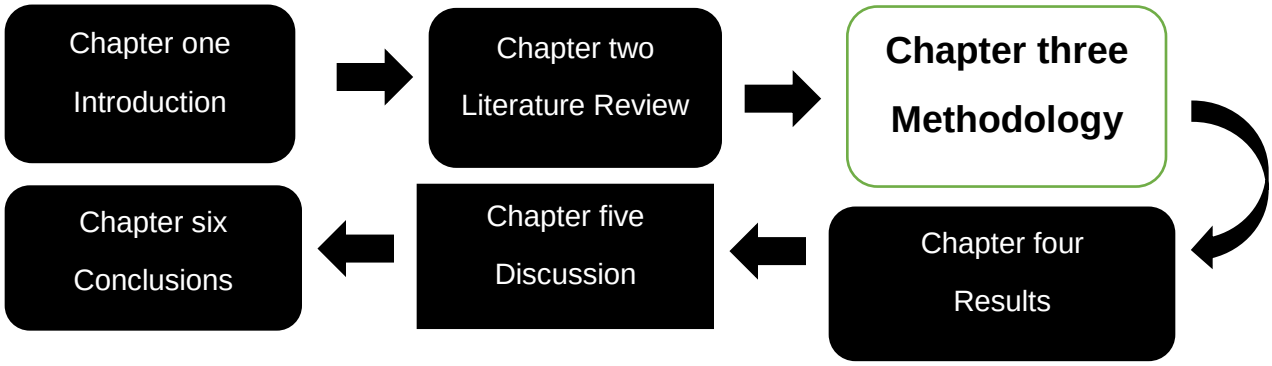
2.12 Conclusion

Obesity is a complex, multifactorial condition affected by genetic and non-genetic factors. Obesity among adolescents is a multifactorial condition with a wide range of etiological factors including genetic, socio-economic status, sedentary lifestyle, unhealthy diet, and socio-economic status. Obesity can be measured by use of anthropometric measurements, estimating body fats and biochemical markers (Sabageh and Ojofeitimi, 2013). Measurement of dietary intake and physical activity is critical among adolescents. Examination of obesity should evaluate the presence of co-morbidities and the underlying causes (Güngör, 2014). Measurement of anthropometric status, and biochemical markers, dietary intake physical activity help in identifying adolescents at risk of these co-morbidities (Güngör, 2014). The prevalence of obesity and its association with metabolic syndromes and cardiovascular diseases is increasing. Society must be made aware of the problem associated with obesity and the likelihood of progression to diseases in adolescents.

CHAPTER 3

METHODOLOGY

3.1 Overview



3.2 Study design

The study design was cross-sectional. The study was conducted at one time within the same participants (Polit and Hungler, 2012 Schneider *et al*., 2004). A cross-sectional study is suitable for observational or descriptive studies, where the researcher has no control over the exposure of interest (Margetts and Nelson, 1997). The researcher described the prevalence and determinants of obesity among adolescents. Data was collected and analysed using quantitative methods.

3.3 Study area

The study was conducted in secondary schools of Thulamela Municipality. Thulamela Municipality is one of the municipalities in Vhembe district. Vhembe district is one of five districts of Limpopo Province situated in the far north of the Province. It has a population of approximately 1 294 722 of which 34.9% are children under 15 years. It covers a geographic area that is mainly rural with 39% of the unemployment rate. The average household size is 4. Tshivenda and Xitsonga are the most spoken languages with 67.8% and 24.8% respectively (Stats SA, 2011). The district has four local municipalities namely, Makhado, Thulamela, Musina, and Mutale. The target population was adolescents from the secondary schools in Thulamela Municipality. Thulamela Municipality is the largest Municipality in Vhembe district in terms of population (47.7%) with 35.2% of the population under 15 years.

3.4 Target population

The target population was adolescents aged 13 to 20 years from public schools in Thulamela Municipality of Vhembe district. Thulamela Municipality has 127 secondary schools and 87 047 learners. Most schools do not meet the required norms and standard of having a functional school (IDP, 2018). This includes infrastructure backlog (shortage of classrooms, administration blocks and lack of reliable electricity), enrolment rate and distance travelled by learners. The majority of learners in Thulamela speak Tshivenda.

3.5 Sampling and sampling procedure

Thulamela Municipality was conveniently selected as a study area. The list of circuits and secondary schools was obtained from the Department of Education in Vhembe district. A simple random sampling was used to select schools and participants. Each school was assigned a number and the numbers were placed in a bowl and mixed thoroughly. The researcher picked one number at a time from a bowl blindfolded until the desired number was reached. In each school, 25 participants were selected. A simple random sampling was also used to select the participants. Yes and no were written in a small paper and mixed thoroughly and participants who were interested were asked to select a small paper and those who selected yes were included in a research.

The following (Slovin) formula was used to calculate the total sample size =377 where: n=N/ (1+ (Ne^2)) where n=sample size, N=total number of participants, and e= the accepted level of error, an additional of 10% was added for attrition.

Total number of participants

n= N/ (1+ $(Ne)^2$)

n=85431/ (1+ (85431×0.05^2))

n=85431/ (1+213, 5775)

n=85431/214, 5775

n=398

n=400 (participants)

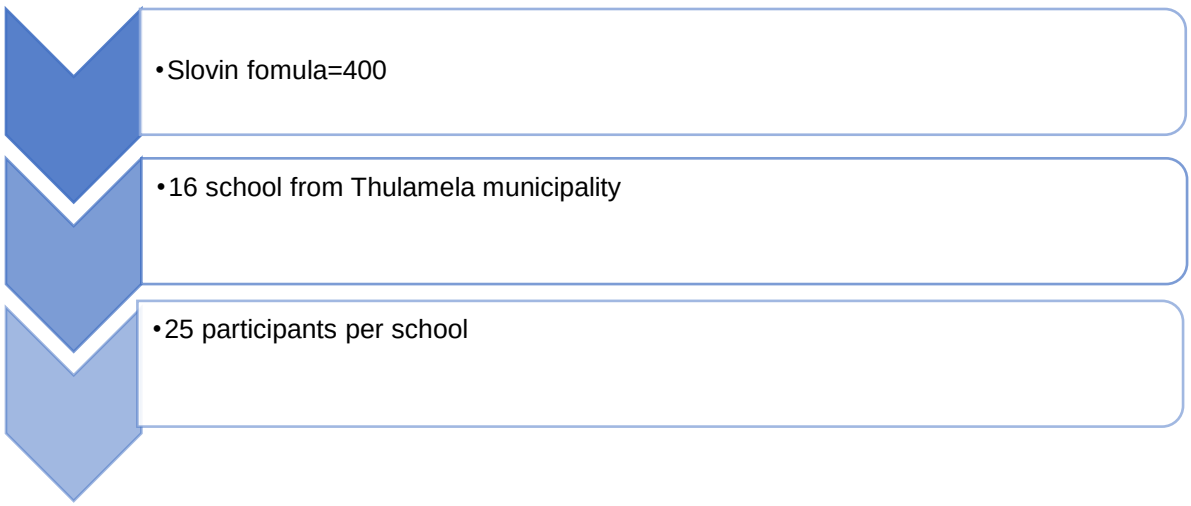


Figure 3. 1: Flow diagram of sampling and sampling size

The figure 3.2 below illustrates the number of participants recruited for the study and the actual number that participated from the beginning to the end of data collection. The number of samples is also illustrated in the diagram.

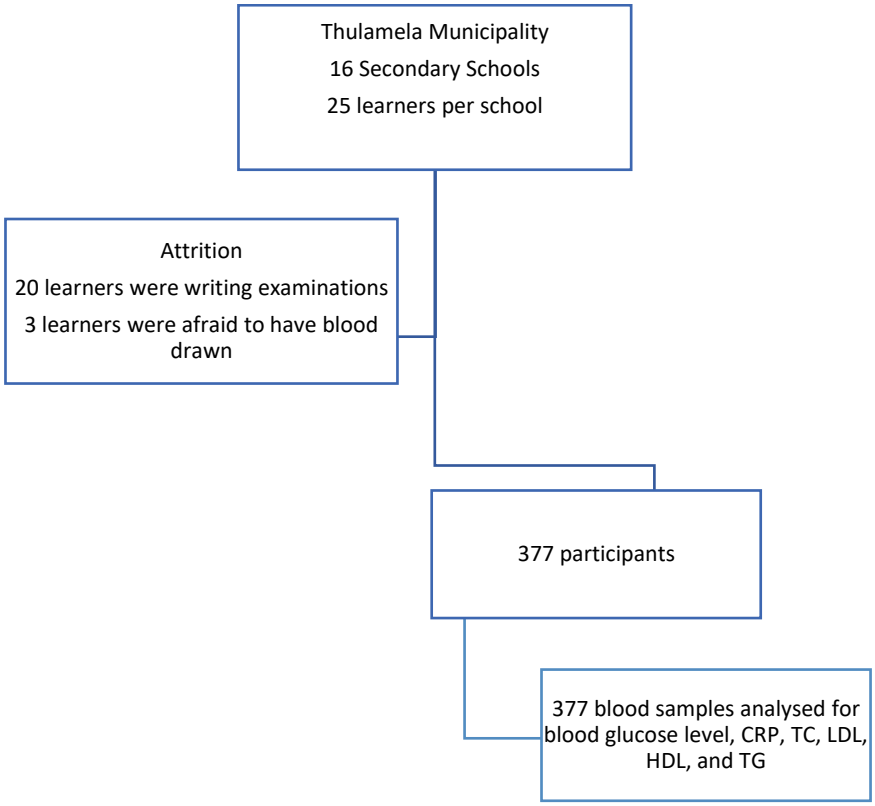


Figure 3. 2: Recruitment of participants and the actual sample size

3.6 Inclusion criteria

Adolescents who were attending public secondary schools in Thulamela Municipality and whose parents gave consent were included in the study.

3.7 Exclusion criteria

Adolescents with a known medical condition such as hypertension, diabetes, and epilepsy were excluded from the study, because medications that are used to treat these conditions contribute to weight gain and it can introduce errors to the study. Pregnant adolescents were also excluded from the study.

3.8 Subject recruitment

The researcher visited the schools two times before data collection.

First visit

The selected schools were visited to request permission and to explain the objectives and procedures of the study to the principal. The list of the students was also requested.

Second visit

During the second visit, the researcher gave the selected adolescents consent forms to take to their parents to sign as an indication that they agree to have their children participate in the study. Adolescents were asked to return the signed consents forms the following day and the principal kept them until the day of data collection. Some parents needed more explanations before giving consent and the researcher used the second visit to explain the study more to them.

3.9 Physical arrangements

On the day of data collection, a separate classroom was requested to set up data collection stations, where three stations were arranged. These stations included interviews, anthropometric and biochemical. The first station was for completing a questionnaire through interviews. The second station was for taking anthropometric measurements. The last station was for taking BP readings and drawing of blood. One participant was interviewed at a time to ensure privacy.

3.10 Measurements/ Assessments

The following measurements/assessments were taken: anthropometric measurements, dietary assessments, biochemical, and clinical. All measurements and samples were collected during the period of February - August 2018. The procedures and techniques of taking these measurements are described below.

3.10.1 Anthropometric measurements

Anthropometric measurements in this study were height, weight, waist circumference (WC), and hip circumference. Height and weight were measured to determine BMI while waist circumference and hip circumference were measured to determine Waist to Hip Ratio (WHR) and waist circumference to determine central obesity.

(i) Height

Height was taken using portable stadiometer (version: seca 213) where participants were barefooted and wearing light clothing. The participants stand with heels together, arms to the side, legs straight, and shoulder relaxed and head in the Frankurt horizontal plane ("look straight ahead''). Heels buttocks, scapular (shoulder blades) and back of the head were against the vertical surface of the stadiometer. The height was recorded in centimetres (cm) and rounded to the nearest 0.1 cm (Lee and Nieman, 2010: 162-163).

(ii) Weight

Body weight was obtained using an electronic scale (Tanita, model: UM-051), which was calibrated with known weight to ensure that correct measurement is taken. The participants stood still in the middle of the scale's platform without touching anything and the body weight equally distributed on both feet. The participant was weighed with light clothing and without shoes. The measurements were taken repeatedly and an average was determined. The measurements read to the nearest 0.1 kg. (Lee and Nieman, 2010: 164-165).

(iii) BMI

Height and weight were measured to determine the Body Mass Index (BMI) of participants. Body Mass Index was determined using the formula, weight in kilograms divided by height in meter squared. BMI was calculated and classified according to the extended International Obesity Task Force (IOTF) cut-off point for thinness, overweight and obesity in children and adolescent **(Table 3.1 and 3.2)** (Cole & Lobstein, 2012).

Table 3. 1: BMI classification, IOTF cut-off point for children and adolescents (males) (Cole and Lobstein, 2012).

Male								
BMI (KG/M^2) at age 18 years								
Age	16 (underweight)	17 (underweight)	18.5 (Normal)	23 (Normal)	25 (overweight)	27 (obesity)	30 (obesity)	35 (morbid obesity)
13	13.61	14.5	15.84	19.99	21.89	23.84	26.87	32.19
13.5	13.84	14.74	16.11	20.31	22.24	24.22	27.26	32.6
14	14.09	15.01	16.39	20.65	22.6	24.59	27.64	32.97
14.5	14.35	15.28	16.68	20.99	22.95	24.94	28	33.3
15	14.61	15.55	16.98	21.31	23.28	25.27	28.32	33.56
15.5	14.87	15.82	17.26	21.62	23.59	25.58	28.61	33.78
16	15.12	16.08	17.53	21.92	23.89	25.88	28.89	33.98
16.5	15.36	16.33	17.79	22.2	24.18	26.16	29.15	34.19
17	15.59	16.57	18.04	22.48	24.46	26.44	29.43	34.43
17.5	15.8	16.79	18.28	22.74	24.73	26.72	29.71	34.7
18 and above	16	17	18.5	23	25	27	30	35

Table 3. 2: BMI classification, IOTF cut-off point for children and adolescents (females) (Cole and Lobstein, 2012).

Female								
BMI (KG/M^2) at age 18 years								
Age	16 (underweight)	17 (underweight)	18.5 (Normal)	23 (Normal)	25 (overweight)	27 (obesity)	30 (obesity)	35 (morbid obesity)
13	13.92	14.84	16.23	20.53	22.49	24.49	27.57	32.91
13.5	14.2	15.13	16.55	20.91	22.9	24.92	28.03	33.39
14	14.47	15.42	16.86	21.27	23.27	25.31	28.42	33.78
14.5	14.74	15.71	17.16	21.59	23.6	25.64	28.74	34.07
15	15	15.97	17.43	21.88	23.89	25.92	29.01	34.28
15.5	15.24	16.21	17.68	22.13	24.13	26.15	29.22	34.43
16	15.45	16.42	17.9	22.35	24.34	26.36	29.4	34.54
16.5	15.63	16.61	18.08	22.54	24.53	26.53	29.55	34.64
17	15.78	16.76	18.24	22.7	24.7	26.69	29.7	34.75
17.5	15.9	16.89	18.38	22.86	24.85	26.85	29.85	34.87
18 and above	16	17	18.5	23	25	27	30	35

(iv) Waist circumference (WC)

Waist circumference was obtained using an inelastic flexible measuring tape. The participants were wearing light clothing. The researcher located the top of the right iliac crest, the highest point of the hip bone on the right side. The measuring tape was in a horizontal plane around the abdomen at the level of the iliac crest. The tape has not compressed the skin and reading was taken at a normal expiration. Average of two measurements were taken to ensure reliability, and record the measurements to the nearest 0.1 cm. (Lee and Nieman, 2010: 179-180). Waist circumference for adolescents 18 years and below was classified according to age and sex (Fernandez *et al.,* 2004). For adolescents above 18 years the WHO cut-off points of WC were used (WHO, 2011).

Table 3. 3: Estimated value for percentile regression for children and adolescents, according to sex (Fernandez* et al., *2004).

	Percentile for boys						**Percentile for girls**				
Age	10th	25th	50th	75th	90th		10th	25th	50th	75th	90th
13	60.3	63.2	66.9	72.7	85.3		60.2	63.4	69.4	78.8	90.5
14	61.8	64.9	68.7	74.9	88.5		61.7	65.1	71.5	81.6	94.2
15	63.4	66.6	70.6	77.1	91.7		63.3	66.8	73.6	84.4	97.9
16	64.9	68.3	72.5	79.3	94.9		64.8	68.5	75.8	87.2	101.6
17	66.5	70.0	74.3	81.5	98.2		66.4	70.3	77.9	90.0	105.2
18	68.0	71.7	76.2	83.7	101.4		68.0	72.0	80.0	92.9	108.9

Table 3. 4: WC interpretation (WHO, 2011).

Sex	**Cut-off point**	**Risk if metabolic complication**
Male	<90th percental or <94 cm	Normal
	≥90th percentile or ≥94 cm	Central obesity
Female	<90th percental or <80 cm	Normal
	<90th percental or ≥80 cm	Central obesity

(v) Hip circumference

The participant stood erect with arms at the side and feet together. The measurement was taken at the point yielding the maximum circumference over the buttocks, with the tape held in a horizontal plane, touching the skin but indenting the soft tissue (Gibson, 2005).

Waist and hip circumferences were measured to determine Waist-to-hip-ratio (WHR). WHR was calculated and the WHO cut-off points were used (WHO, 2011).

Table 3. 5: WHR cut-off point (WHO, 2011)

Sex	Cut-off points	Risk of metabolic complications
Male	<0.9cm	Normal
	≥0.9cm	Substantially increased
Female	<0.85	Normal
	≥0.85	Substantially increased

3.10.2 Blood collection

A professional nurse was responsible for collecting blood samples. One participant was brought to the room at a time. One needle was used per participant to minimise health risks associated with sharing needles. A professional nurse was always wearing non-powdered gloves and did not touch her hair or skin. Hair, skin, powdered gloves, and sweat may contaminate the blood specimen and influence the outcome of the analysis. The participant's skin was cleaned with alcohol-soaked gauze pads at the site of the antecubital vein. The occlusion of the participant's arm with tourniquet was restricted for <1 minute. A trace element-free siliconised 21-gauge minicath intravenous catheter was inserted into an antecubital vein, and 5ml blood was drawn into trace element-free evacuated tubes that were utilised siliconised rather than rubber.

I. CRP

Once the blood was obtained it was stored in a cooler box with crushed ice on site and taken to the laboratory the same day for analysis using standard methods. Capricon diagnostic laboratory carried out the analysis. An instrument used was HumaStar 600 chemistry analyser and the immunoturbidimetric testing method. Human CRP in patient, standard or control reacts with anti-CRP antibodies in the presence of enhancer buffer from the reagent. This generates turbidity which is proportional to the CRP concentration in the sample, and the instrument automatically calculates this. A calibration was performed on the instrument using the CRP standard commercially available and comes with an assigned value. For this method, a standard value of 140 mg/l was assigned, which passed perfectly. In linearity of the methods a linear from 3-160mg/l, and any values less than3 mg/l was generated as <3mg/l by the instrument. If a value was greater than 160mg/l, a dilution needed to be performed and the result is multiplied by the dilution factor. The normal range for this method was established at 0.0-8.0 mg/l and above 8.0 was consider high. CRP was classified according to laboratory standard.

II. Blood lipid and glucose level

A Cardio check device (model CE 0197) was used to determine HDL-C, LDL-C, Triglyceride (TG) and glucose level. The professional nurse always wore non-powdered gloves. A fingertip was cleaned with alcohol swamp and it was let to dry completely before pricking the finger. Sterile, auto-disabling, single-use lancet was used to puncture the side of the fingertip. The first drop of blood with a clean piece of gauze, the pressure was applied to the fingertip to accumulate a drop of blood. A pipet was used to collect blood drop to the test strip blood application window. The result was read after 90 seconds from Cardio check device.TC, LDL-C, HDL.C and TG were classified according to age and gender lipoprotein for adolescents **(Table 3.6 and Table 3.7)** (Jolliffe and Janssen, 2006). Glucose level was classified according to laboratory standards.

Table 3. 6: Age-specific Lipoprotein cut-point (in Millimoles per Liter) and corresponding percentile for boys (Jolliffe and Janssen, 2006).

Age, year	TC		LDL-C			HDL-C		**TG**	
	Borderline-High (86th percentile)	High (97th percentile)	Above normal (54th percentile)	Borderline-(86th percentile)	High (97thth percentile)	Low (26thth percentile)	Protective (13thth percentile)	Borderline-High (89th percentile)	High (95th percentile)
12	5.18	6.03	2.50	3.24	3.98	1.13	1.70	1.44	1.84
13	4.99	5.83	2.44	3.15	3.86	1.10	1.64	1.48	1.93
14	4.86	5.70	2.39	3.08	3.76	1.07	1.59	1.52	2.02
15	4.84	5.70	3.38	3.06	3.74	1.04	1.55	1.56	2.10
16	4.88	5.77	2.41	3.11	3.84	1.03	1.53	1.59	2.16
17	4.95	5.88	2.46	3.18	3.91	1.03	1.53	1.62	2.20
18	5.05	6.02	2.51	3.25	4.00	1.03	1.54	1.65	2.24
19	5.14	6.16	2.56	3.32	4.09	1.04	1.55	1.68	2.26
20	5.18	6.22	2.59	3.37	4.14	1.04	1.55	1.70	2.26

Table 3. 7: Age-specific Lipoprotein cut-point (in Millimoles per Liter) and percentile for girls (Jolliffe and Janssen, 2006).

Age, year	TC		LDL-C			HDL-C		**TG**	
	Borderline-High (78th percentile)	High (994th percentile)	Above normal (53rd percentile)	Borderline-(83rd percentile)	High (95thth percentile)	Low (26thth percentile)	Protective (13thth percentile)	Borderline-High (89th percentile)	High (95th percentile)
12	4.77	5.47	2.38	2.96	3.52	1.03	1.48	1.60	2.03
13	4.71	5.41	2.41	2.98	3.55	1.04	1.47	1.53	1.93
14	4.68	5.38	2.41	3.00	3.57	1.04	1.48	1.47	1.82
15	4.72	5.46	2.43	3.03	3.61	1.03	1.49	1.44	1.79
16	4.82	5.62	2.45	3.07	3.68	1.03	1.51	1.46	1.83
17	4.94	5.82	2.47	3.17	3.77	1.03	1.53	1.53	1.94
18	5.07	6.03	2.52	3.22	3.90	1.03	1.56	1.61	2.09
19	5.16	6.17	2.57	3.32	4.06	1.03	1.55	1.68	2.22
20	5.18	6.22	2.59	3.37	4.14	1.04	1.55	1.7	2.26

3.10.3 Clinical assessment

3.10.3.1 Blood pressure

A professional nurse was responsible for taking blood pressure readings. The participants had their feet on the floor and they were seated five minutes before the reading. All clothing covering the cuff location was removed. The middle of the cuff on the upper arm was level with the right atrium, at the midpoint of the sternum (AHA, 2005). Blood pressure reading was taken using a digital automated device OMRO (model CE0197). Each participant sat quietly for 5-10 minutes, after their arm was placed at heart level and blood pressure and were measured at least 3 times in 5 minutes' intervals. If blood pressure varied in these determinations by greater than 10mmHg, 3 additional trials were performed to measure systolic and diastolic blood pressure.

Blood Pressure (BP) for adolescent less than 18 years were classified according to sex, age, and height (The Fourth Report on the Diagnosis, Evaluation, and Treatment of High Blood Pressure, 2005). For adolescent ≥18 years will be classified according to AHA for adults (AHA, 2005) **(Table 3.8, Table 3.9 and Table 3.10)**.

Table 3. 8: Blood pressure classification

Interpretations	**Classification**
SBP	
Normal	SBP<90th percentile or SBP <120
Pre-hypertension	SBP 90th-<95th or SBP120-139
Stage I hypertension	SBP 95th -<99th percentile or SBP 140-159
Stage 2 hypertension	SBP >99th percentile or SBP 160 or higher.
DBP	
Normal	DBP<90th percentile or DBP <80
Pre-hypertension	DBP 90th -<95th or DBP 80-89
Stage I hypertension	DBP 95th -<99th percentile or DBP 90-99
Stage 2 hypertension	DBP >99th percentile or DBP 100 or higher.

Table 3. 9: Blood pressure level for Boys by age and height percentile

Age (years)	BP Percentile ↓	Systolic BP (mmHg) ←Percentile of height→							Diastolic BP (mmHg) ←Percentile of Height→						
		5th	10th	25th	50th	75th	90th	95th	5th	10th	25th	50th	75th	90th	95th
12	50th	101	102	104	106	108	109	110	59	60	61	62	63	63	64
	90th	115	116	118	120	121	123	123	74	75	75	76	77	78	79
	95th	119	120	122	123	125	127	127	78	79	80	81	82	82	83
	99th	126	127	129	131	133	134	135	86	87	88	89	90	90	91
13	50th	104	105	106	108	110	111	112	60	60	61	62	63	64	64
	90th	117	118	120	122	124	125	126	75	75	76	77	78	79	79
	95th	121	122	124	126	128	129	130	79	79	80	81	82	83	83
	99th	128	130	131	133	135	136	137	87	87	88	89	90	91	91
14	50th	106	107	109	111	113	114	155	60	61	62	63	64	64	65
	90th	120	121	123	125	126	128	128	75	76	77	78	79	79	80
	95th	124	125	127	128	130	132	132	80	80	81	82	83	84	84
	99th	131	132	134	138	138	139	140	87	88	89	90	91	92	92
15	50th	109	110	112	113	115	117	117	61	62	63	64	65	66	66
	90th	122	124	125	127	129	130	131	76	77	78	79	80	80	81
	95th	126	127	129	131	133	134	135	81	81	82	83	84	85	85
	99th	134	135	136	138	140	142	142	88	89	90	91	92	93	93
16	50th	111	112	114	116	118	119	120	63	63	64	65	66	67	67
	90th	125	126	128	130	131	133	134	78	78	79	80	81	82	82
	95th	129	130	132	134	135	137	137	82	82	83	84	85	86	87
	99th	136	137	139	141	143	144	145	90	90	91	92	93	94	94
17	50th	114	115	116	118	120	121	122	65	66	66	67	68	69	70
	90th	127	128	130	132	134	135	136	80	80	81	82	83	84	84
	95th	131	132	134	136	138	139	140	84	85	86	87	87	88	89
	99th	139	140	141	143	145	146	147	92	93	93	94	95	96	97

Table 3. 10: Blood pressure level for Girls by age and height percentile

Age (years)	BP Percentile ↓	Systolic BP (mmHg) ←Percentile of height→							Diastolic BP (mmHg) ←Percentile of Height→						
		5th	10th	25th	50th	75th	90th	95th	5th	10th	25th	50th	75th	90th	95th
12	50th	102	103	104	105	107	108	109	61	61	61	62	63	64	64
	90th	116	116	117	119	120	121	122	75	75	75	76	77	78	78
	95th	119	120	121	123	124	125	126	79	79	79	80	81	82	82
	99th	127	127	128	130	131	132	133	86	86	87	88	88	89	90
13	50th	104	105	106	107	109	110	110	62	62	62	63	64	65	65
	90th	117	118	119	121	122	123	124	76	76	76	77	78	79	79
	95th	121	122	123	124	126	127	128	80	80	80	81	82	83	83
	99th	128	129	130	132	133	134	135	87	87	88	89	89	90	91
14	50th	106	106	107	109	110	111	112	63	63	63	64	65	66	66
	90th	119	120	121	122	124	125	125	77	77	77	78	79	80	80
	95th	123	123	125	126	127	129	129	81	81	81	82	83	84	84
	99th	130	131	132	133	135	136	136	88	88	89	90	90	91	92
15	50th	107	108	109	110	111	113	113	64	64	64	65	66	67	67
	90th	120	121	122	123	125	126	127	78	78	78	79	80	81	81
	95th	124	125	126	127	129	130	131	82	82	82	83	84	85	85
	99th	131	132	133	134	136	137	138	89	89	90	91	91	93	93
16	50th	108	108	110	111	112	114	114	64	64	65	66	66	67	68
	90th	121	122	123	124	126	127	128	78	78	79	80	81	81	82
	95th	125	126	127	128	130	131	132	82	82	83	84	85	85	86
	99th	132	133	134	135	137	138	139	90	90	90	91	92	93	93
17	50th	108	109	110	111	113	114	115	64	65	65	66	67	67	68
	90th	122	122	123	125	126	127	128	78	79	79	80	81	81	82
	95th	125	126	127	129	130	131	132	82	83	83	84	85	85	86
	99th	133	133	134	136	137	138	139	90	90	91	91	92	93	93

3.10.4 Survey questionnaire

The questionnaire was developed in English and was used for data collection. The questionnaire was researcher administered. The questionnaire consisted of three sections namely; Section A, B and C. Section A included demographic information; section the B physical activity questionnaire and section C was the Food Frequency Questionnaire (FFQ). The demographic information included age, gender, income of the learners whereas section B and C included questions on physical activity, lifestyle habits and FFQ respectively.

Quantitative Food Frequency Questionnaire (**Appendix A**, Section C) was used for dietary assessment. A single 24-hour recall technique was used to derive FFQ items from commonly consumed foods by adolescents. Secondary schools were visited to compile a list of foods that are sold to adolescents by vendors. In addition, food items from school menus and from vendors were also added to the list. The list of commonly consumed foods was added to the FFQ which was used in the actual data collection.

A picture sort method was to collect data. Pictures of food were taken to make food cards. The researcher gave the participants pictures of food items and ask them to put pictures of foods that they consumed in the past 7 days on the left-hand side. These assisted the participants to easily recall what food items they consumed. The portion size was estimated using household measurements, food models and the DAEK manual sketches. The data gathered was analysed using the Food Finder computer software (version 1.1.3) to determine food intake. The aim of the analysis was to determine the amount of each nutrient and energy consumed per day. These nutrients included carbohydrates, lipids, proteins, minerals and vitamins.

A physical activity questionnaire by Sharkey and Gaskill, (2007) was adopted to assess the physical activity level. A questionnaire included physical activity pattern in and around the house, traveling to school and recreations that participants engaged in. Information such as sedentary lifestyle, after school activities, time spent on television viewing, and sleep duration frequency was included in the questionnaire. The following formula was used to calculate physical activity indices:

Intensity of activity X Duration of activity (in minutes) X Frequency (per week) = Score Total

Table 3. 11: Physical activity indices scores (Sharkey and Gaskill, 2007).

Evaluation of activity score		
Score	**Evaluation**	**Activity category**
81 to 100	Very active lifestyle	High
60 to 80	Active and healthy	Very good
40 t0 59	Acceptable but could be better	Fair
20 to 39	Not good enough	Poor
Under 20	Sedentary	
Score	Evaluation	Activity category

A lifestyle habits questionnaire by Balloc and Breslow, (1972) was adopted. The questionnaire consists of seven questions with yes and no answers. the lifestyle habits will be classified looking at number of yeses.

Table 3. 12: Lifestyle habits classification (Balloc and Breslow, 1972).

No of Yes	Classification of daily lifestyle	Interpretation
7	Very good	You are following the lifestyle keep up
5-6	Good	Not bad at all, out keep a close eye on yourself
4	Fair	Evaluate your lifestyle seriously. It is important that you consider some positive changes.
2-3	Bad	Your lifestyle is detrimental to your health; it is important that you commit yourself to serious changes.
1	Very bad	Your destructive lifestyle may pose serious health problems in your life. You personally as well as your company will benefit from your serious commitment to a healthy lifestyle.

Pre-test of instrument

The instrument was pre-tested to estimate the time needed to complete the questionnaire, to determine the ease with which the participants answer the questions, and to test the appropriateness and completeness of the questions within the questionnaire. Pre-tested was also done to reduce participants burden, and to determine whether participants are interpreting questions correctly.

3.11 Pilot Study

This research project was piloted to test the feasibility of the entire data collection plan and the competence of the interviewers. It also offered potential information needed to improve the quality of the data collection instruments. From the sample frame of schools, 10% of the sample size served as pilot schools. A simple random sampling was used to select the pilot schools from the

unselected potential study sites in the sample frame. This allowed an equal and independent selection of pilot schools from the list of schools not originally chosen for the study. This exercise assisted the researcher to gain important information on timing, cost and socio-demographic structures formed the essence of the pilot study. A small sample of about 40 was used for this exercise.

3.12 Validity

The instrument has been developed following the guidelines of the highly researched literature. Other steps have also been considered in ensuring the validity of the instrument. Firstly, instruments from similar researches guided the designing of the instrument. Secondly, the pilot study of this research included the pre-test of an instrument were primarily envisaged to establish the validity of the set instrument, as already highlighted. Thirdly, the professional instrument verification was solicited from both the project supervisors and obesity experts. Peer review was also used in the authentication of the validity of the instrument under the aegis of Masters in Public Nutrition proposal workshops. Finally, the project presentation to the University of Venda Higher Degrees Committee offered yet another professional avenue for the scrutiny of the research instrument.

3.13 Reliability

Reliability is the consistency with which a measuring instrument yields a certain result when the entity being measured has not changed (Leedy and Ormrod, 2005). To ensure reliability the researcher calibrated the weight scale daily with known weight. The average of the repeated anthropometric measurements were taken to ensure reliability and the field workers were trained to standardise data collection methods. The researcher interviewed the same participants twice on different days to determine if the results will be the same. On the other hand, the researcher interviewed the same participants the fieldworker interviewed to determine the level of variation. The questionnaires were taken to a statistician that ran some statistical tests which confirmed little or no variation.

3.14 Fieldworkers

A nutrition graduate and a professional nurse were recruited as field workers. The responsibility of the nutrition graduate was to assist the researcher with the interviews and taking the anthropometric measurements. The professional nurse was responsible for both clinical and biochemical assessments. The researcher was responsible for interviews, taking anthropometric

measurements, training of the field workers and the methods of data collection were pilot tested and standardised.

3.15 Institutional approval

The research proposal was submitted to the University Higher Degree (**Appendix F**) and Ethics Committee for approval before data collection. A letter together with ethical clearance certificate (**Appendix G**) and research proposal were submitted to the Department of Education (DoE) provincial office to request permission to use schools as a sample frame. After the permission was granted by the DoE provincial (**Appendix H** permission letter from DoE), the circuit managers (**Appendix I** permission letter from circuits) and principals were visited to seek permission to conduct research in schools (Figure 3.3).

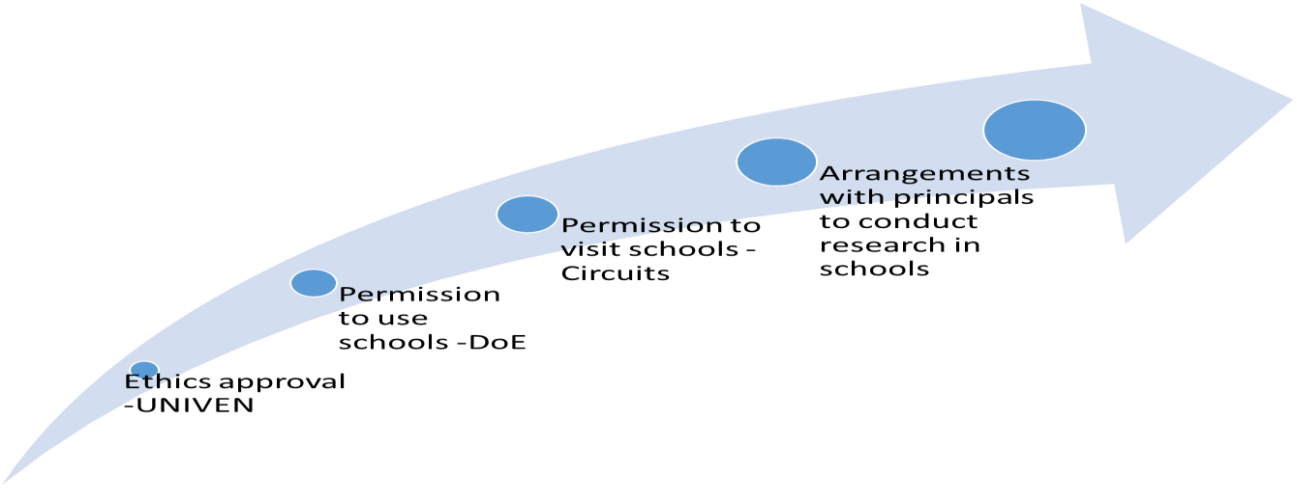


Figure 3. 3: Institutional approval

3.16 Tools and specific procedures

- Picture sort method was used to assist the participants to recall what they ate the previous days.

- DAEK manual sketches, kitchen utensils and food models were used to estimate portion sizes.

3.17 Ethical consideration

Adolescents under the age of 18 are vulnerable. This research constitutes no or minimal risks as the assessments are non-invasive, however, adolescents might have experienced a little pain

when blood was drawn. Participants participated in this study after protocol, information, consent form, and recruitment material have been approved in writing by the Higher Degree and Ethics Committee of the University of Venda (SHS/17/NUT/03/1506) **(Appendix G)**. The study was conducted in accordance with the principles of the Declaration of Helsinki (2013), Good Clinical Practice (GCP) and the laws of South Africa. No participant could participate in the study without a signed informed consent by parents **(Appendix B)** and assent forms by participants **(Appendix C)** after a full and adequate explanation of the study.

Participants had the right to withdraw from the study at any point without being disadvantaged in any way. Participants did not benefit from this study. Any health problems identified during the assessments, the participates were referred to the appropriate health professionals for assessments. The data obtained from the study were kept on a computer database in such a manner that it maintains the participants' confidentiality (a code was assigned to each participant for these purposes). For data verification and quality control purposes regulatory authorities and members of the Higher Degree and Ethics Committee of University of Venda may be permitted access to participant data under the conditions that strict confidentially is upheld

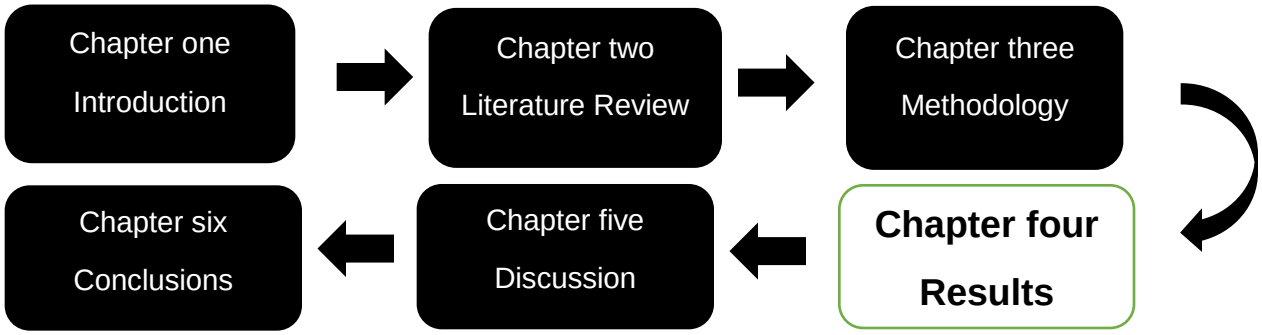
3.18 Statistical methods/analyses

The IBM Statistical Package for Social Science (SPSS) version 25 was used to analyse data. Data were checked for normality using Q-Q plots and the Shapiro Wilk test. Normally distributed data were presented as mean and standard deviation. Pearson correlation test was used to determine the statistical relationship between different variables. A strong correlation was $r>0.70$ or $r<-0.70$, moderate correlation was $r>0.30$ to 0.70 or $r<0.30$ to -0.70 and weak correlation was $r=0.00$ to 0.30 or $r=-0.00$ to -0.30. Multiple linear regression analysis was used to explore whether age, gender, income, dietary intake, SBP, DBP, TG, HDL, LDL were predictors of obesity (dependent variable). Furthermore, we examined the odds ratio (OR) for adolescents to have obesity using binary logistics regression analysis. A p-value of <0.05 was considered significant.

CHAPTER 4

RESULTS

4. 1 Overview



A total of 377 blood samples from adolescents were collected. The 377 blood samples that were collected, they were analysed for TC, HDL, LDL, Triglycerides, Blood Glucose, CRP representing 94.25% of samples that were analysed.

Table 4. 1: Variables measured from study participants

Variables	Males N	Females N
Age (13-20 years)	150	227
TC	150	227
HDL	150	227
LDL	150	227
Triglycerides	150	227
Blood Glucose	150	227
CRP	150	227
SBP	150	227
DBP	150	227
Weight	150	227
Height	150	227
Waist circumference	150	227

4.2 Demographic profile of participants

A total of 377 participants were interviewed with the majority (60.2%) of the participants being female and 39.8% being male. The age of study participants ranged from 13 to 20 years. About 18.7% of males were 18 years and 11% were females. Only a third (3.3%) of males had 13 years when data was collected compared to 7% of females. The grades of study participants ranged from grades 8 to 12. The grades were almost evenly distributed with 18% males and 18.1% females being in grade 8. The distribution differed across grades 9 to 12. Majority of male (98%) and female (96.9%) participants were TshiVenda speaking (**Table 4.2**).

Table 4. 2: Demographic profile of participants.

Age	**Male**		**Female**	
	N=150	**(%)**	**N=227**	**(%)**
13	5	(3.3%)	16	(7%)
14	17	(11.3%)	45	(19.8%)
15	25	(16.7%)	27	(11.9%)
16	17	(11.3%)	32	(14.1%)
17	21	(14%)	40	(17.6%)
18	28	(18.7%)	25	(11%)
19	16	(10.7%)	20	(8.8%)
20	21	(14%)	22	(9.7%)
Grade				
Grade 8	27	(18%)	41	(18.1%)
Grade 9	34	(22.7%)	46	(20.3%)
Grade 10	41	(27.3%)	47	(20.7%)
Grade 11	23	(15.3%)	50	(22%)
Grade 12	25	(16.7%)	43	(18.9%)
Ethnic group				
Venda	147	(98%)	220	(96.9%)
Tsonga	2	(1.3%)	3	(1.3%)
Sepedi	1	(0.7%)	4	(1.8%)

4.3 Demographic profile of parents/guardian of study participants

About 29.3% of male and 29.1% of female participants had married parents. Of the 377 participants 10.7% of males and 10.6% had divorced parents. The educational level was low in males compared to females. A total of 4% of male participants had parents who never attended school compared to 1.8% of female participants. Majority of male (65%) and female (73.5%) participants had parents with a secondary education. A third of male (33.3%) and more than a third of female (34.4%) participants had unemployed parents. Source of income ranged from salary to child support grant. A third (33.3%) of males and more than a third (38.3%) of females had parents receiving wages. A total of 29.3% of males and 26% of females had parent receiving monthly salaries. The number of family members in a household ranged from 5 to 6 members. Male (38.7%) and female (39.2%) had 5 to 6 family members (**Table 4.3**).

Table 4. 3: Demographic profile of parents/guardian of study participants

Marital status	**Male**		**Female**	
	N=150	**(%)**	**N=277**	**(%)**
Married	44	(29.3%)	66	(29.1%)
Divorced	16	(10.7%)	24	(10.6%)
Windowed	18	(12%)	23	(10.1%)
Living together	41	(27.3%)	59	(26%)
Single	31	(20.7%)	55	(24.2%)
Level of education				
Never attended	6	(4%)	4	(1.8%)
Primary school	23	(15.3%)	23	(10.2%)
Secondary school	98	(65%)	167	(73.5%)
Tertiary	23	(15.3%)	33	(14.5%)
Employment status				
Unemployed	50	(33.3%)	78	(34.4%)
Self-employed	24	(16%)	35	(15.4%)
Private company	54	(36%)	83	(36.6%)
Government	22	(14.7%)	31	(13.7%)
Source of income				
Salary	44	(29.3%)	59	(26%)
Wages	50	(33.3%)	87	(38.3%)
Pension	32	(21.3%)	35	(15.4%)
Child grant	22	(14.7%)	42	(18.5%)
Disability grant	-	-	4	(1.8%)
Pension and child grant	2	(1.4%)	1	(0.4%)
Number of people in a household				
1-2	17	(11.3%)	14	(6.2%)
3-4	49	(32.7%)	73	(32.2%)
5-6	58	(38.7%)	89	(39.2%)
7-8	23	(15.3%)	40	(17.6%)
9 and above	3	(2%)	11	(4.8%)

4.4 Anthropometric status of the study participants

The prevalence of obesity was 5.3% in males and 17.2% in females. Regarding morbid obesity, 0.7% were males and 3.1% were females. Furthermore, looking at abdominal obesity female participants came top with 8.8% and males with 1.3%. From the results of the current study, it is evident that the prevalence of obesity is higher in females than males (**Table 4.4**).

Table 4. 4: Anthropometric status

BMI category	Male		Female	
	N=150	(%)	N=227	(%)
Morbid obesity	1	(0.7%)	7	(3.1%)
Obesity	8	(5.3%)	39	(17.2%)
Overweight	8	(5.3%)	19	(8.4%)
Normal	114	(76%)	156	(68.7%)
Thinness	19	(12.7%)	6	(2.6%)
Waist circumference				
Normal	148	(98.7%)	207	(91.2%)
Abdominal obesity	2	(1.3%)	20	(8.8%)
Waist to Hip Ratio				
Normal	137	(91.3%)	208	(91.6%)
Substantially increased	13	(8.7%)	19	(8.4%)

4.5 Determinates of obesity

Table 4.5 below indicate the determinants of obesity (bold in text). **Gender** was discovered to be a determinant of obesity. Male participants were less likely to be obese than female participants with the estimated decrease in odds of 68%.

Age was also a determinant of obesity as the model predicts. Older participants are more likely to be obese. The estimated increase in odds is 28% for per one year in age.

The model also revealed **source of income** as a determinant of obesity. The results show that participants from households where the head earns a salary or wage are more likely to be obese than those from households that depends on social grants. The estimated increase in odds is 225%.

Another determinant of obesity was **SBP**. The results revealed that an increase in one unit of systolic BP is associated with an increase of the odds of obesity by 4.2%.

The **HDL, LDL** and **TC** were also revealed to be determinants of obesity in the current study. Participants with higher level of HDL were less likely to be obese. However, participants with high level of LDL was also less likely to be obese. Participants with higher level of TC/HDL ratio were more likely to be obese.

Participants whose diet contain more **energy** were less likely to be obese. An increase in 1 kj in diet was associated with 1% decrease in the odds of being obese.

Participants whose diet contain more **Total Fats** and **Total Trans fats** were more likely to be obese, with one extra gram of each in the diet was associated with a 24% and 89% respectively increase odds of being obese.

Participants whose diet contain more **carbohydrate** were more likely to be obese. One extra gram of carbohydrate in the diet was associated with 12% increase in the odds of being obese. Participants whose diet contain more **added sugar** were slightly less likely to be obese. One extra gram of added sugar in the diet was associated with 2% decrease in the odds of being obese.

Table 4. 5: Determinates of obesity

Determinates	Odds ratio (OR)	95%-CI	p-value
Gender	0.32	(0.12-0.82)	0.018**
Age	1.28	(1.05-1.56)	0.015**
Source of Income	3.25	(1.36-7.78)	0.008***
Moderate exercise	0.39	(0.12-1.2)	0.107*
Systolic BP	1.04	(1.02-1.07)	0.01**
LDL	0.25	(0.09-0.67)	0.006***
HDL	0.09	(0.02-0.34)	0.000***
TC/HDL	3.99	(2.17-7.31)	0.000***
Energy (KJ)	0.99	(0.99-1.00)	0.047**
Total fat (g)	1.24	(0.99-1.57)	0.067*
Total trans FA(g)	1.89	(1.04-3.43)	0.037**
Carbohydrate, avai.(g)	1.12	(1.00-1.25)	0.049**
Added sugar	0.98	(0.96-1.00)	0.063*

*** Highly significant (at alpha = 0.01), ** Significant (at alpha = 0.05), * Barely significant (at alpha = 0.10)

4.6 Correlation of anthropometric status, biochemical indicators and Clinical indicators

The results of the study indicate that the BMI of males had a weak significant association with SBP (r=0.281, p=0.00) and moderate significant association with WC (r=0.661, p=0.00). in addition, W/H had a moderate significant association with WC (0.623, P=0.00) and weak significant association with TC (r=0.223, P0.06).

Regarding female participants, BMI had a strong significant association with WC (r=0.772, p=0.00), moderate significant association with W/H (0.302, p=0.00), and weak significant association with SBP (r=0.242, p=0.00), DBP (r=0.157, p0.18), and TG (r=0.158 p=0.01). On the other hand, BMI had a negative weak significant association with HDL (-0.178, p=0.07). WC had weak significant association with SBP (r=0.185, p=0.05), DBP (r=0.175, p=0.08) and BGL (r=0.146, p=0.027). The results also indicate that W/H had weak positive significant association with BGL (r=0.179, p=0.07) and CRP (r=0.133, p=0.46). Additionally, a weak significant

association was observed between BGL, TC (r=0.152, p=0.022) and TG (r=0.164, p=0.013) (**Table 4.6 and 4.7**).

Table 4. 6: Correlations of the results for males

Pearson correlation		BMI	WC	W/H	SBP	DBP	BGL	TC	LDL	HDL	TIG	CRP
Males												
BMI	r p N	1 150	**.661**** **.000** **150**	.003 .967 150	**.281**** **.000** **150**	-.015 .857 150	.045 .583 150	.075 .360 150	.088 .283 150	.044 .591 150	.127 .122 150	.028 .737 150
WC	r p N	**.661**** **.000** 150	1 150	**.623**** **.000** **150**	.156 .057 150	.046 .572 150	.068 .409 150	.071 .389 150	.142 .084 150	.068 .406 150	-.028 .731 150	.042 .608 150
W/H	r p N	.003 .967 150	**.623**** **.000** **150**	1 150	-.085 .303 150	.016 .842 150	.034 .681 150	**.223**** **.006** **150**	.115 .163 150	.060 .467 150	-.122 .139 150	.013 .873 150
SBP	r p N	**.281**** **.000** **150**	.156 .057 150	-.085 .303 150	1 150	**.411**** **.000** **150**	-.047 .570 150	-.032 .694 150	.013 .872 150	.071 .385 150	.097 .237 150	.078 .344 150
DBP	r p N	-.015 .857 150	.046 .572 150	.016 .842 150	**.411**** **.000** **150**	1 150	.014 .861 150	.020 .812 150	.057 .486 150	.071 .388 150	-.021 .802 150	-.066 .422 150
BGL	r p N	.045 .583 150	.068 .409 150	.034 .681 150	-.047 .570 150	.014 .861 150	1 150	.105 .203 150	.089 .281 150	.013 .872 150	.106 .195 150	.123 .133 150
TC	r p N	.075 .360 150	.071 .389 150	**.223**** **.006** **150**	-.032 .694 150	.020 .812 150	.105 .203 150	1 150	**.162*** **.047** **150**	.030 .711 150	-.022 .792 150	-.022 .790 150
LDL	r p N	.088 .283 150	.142 .084 150	.115 .163 150	.013 .872 150	.057 .486 150	.089 .281 150	.162* .047 150	1 150	**.182*** **.026** **150**	**.231**** **.004** **150**	.004 .964 150
HDL	r p N	.044 .591 150	.068 .406 150	.060 .467 150	.071 .385 150	.071 .388 150	.013 .872 150	.030 .711 150	**.182*** **.026** **150**	1 150	.035 .669 150	-.081 .323 150
TG	r p N	.127 .122 150	-.028 .731 150	-.122 .139 150	.097 .237 150	-.021 .802 150	.106 .195 150	-.022 .792 150	**.231**** **.004** **150**	.035 .669 150	1 150	.081 .326 150
CRP	r p N	.028 .737 150	.042 .608 150	.013 .873 150	.078 .344 150	-.066 .422 150	.123 .133 150	-.022 .790 150	.004 .964 150	-.081 .323 150	.081 .326 150	1 150

****. Correlation is significant at the 0.01 level (2-tailed).**
***. Correlation is significant at the 0.05 level (2-tailed).**

Table 4. 7: Correlation of the results for females

Pearson correlation		BMI	WC	W/H	SBP	DBP	BGL	TC	LDL	HDL	TG	CRP
BMI	r	1	**.772****	**.302****	**.242****	**.157***	.096	.020	.028	**-.178****	**.158***	.086
	p		**.000**	**.000**	**.000**	**.018**	.148	.766	.673	**.007**	**.017**	.198
	N	227	**227**	**227**	**227**	**227**	227	227	227	**227**	**227**	227
WC	r	**.772****	1	**.523****	**.185****	**.175****	**.146***	-.012	.057	**-.140***	.104	.118
	p	**.000**		**.000**	**.005**	**.008**	**.027**	.860	.396	**.034**	.119	.076
	N	**227**	227	**227**	**227**	**227**	**227**	227	227	**227**	227	227
W/H	r	**.302****	**.523****	1	.017	.072	**.179****	.006	.125	-.052	.032	**.133***
	p	**.000**	**.000**		.799	.283	**.007**	.932	.060	.432	.633	**.046**
	N	**227**	**227**	227	227	227	**227**	227	227	227	227	**227**
SBP	r	**.242****	**.185****	.017	1	**.471****	.118	.067	-.048	-.017	.106	.055
	p	**.000**	**.005**	.799		**.000**	.076	.317	.472	.796	.110	.410
	N	**227**	**227**	227	227	**227**	227	227	227	227	227	227
DBP	r	**.157***	**.175****	.072	**.471****	1	.127	.039	.027	.021	.001	.107
	p	**.018**	**.008**	.283	**.000**		.056	.562	.684	.755	.991	.107
	N	**227**	**227**	227	**227**	227	227	227	227	227	227	227
BGL	r	.096	**.146***	**.179****	.118	.127	1	**.152***	.038	.103	**.164***	.096
	p	.148	**.027**	**.007**	.076	.056		**.022**	.569	.123	**.013**	.147
	N	227	**227**	**227**	227	227	227	**227**	227	227	**227**	227
TC	r	.020	-.012	.006	.067	.039	**.152***	1	**.235****	**.244****	.018	-.052
	p	.766	.860	.932	.317	.562	**.022**		**.000**	**.000**	.792	.435
	N	227	227	227	227	227	**227**	227	**227**	**227**	227	227
LDL	r	.028	.057	.125	-.048	.027	.038	**.235****	1	.093	**.164***	.087
	p	.673	.396	.060	.472	.684	.569	**.000**		.165	**.014**	.190
	N	227	227	227	227	227	227	**227**	227	227	**227**	227
HDL	r	**-.178****	-.140*	-.052	-.017	.021	.103	**.244****	.093	1	.008	-.101
	p	**.007**	.034	.432	.796	.755	.123	**.000**	.165		.901	.128
	N	**227**	227	227	227	227	227	**227**	227	227	227	227
TG	r	**.158***	.104	.032	.106	.001	**.164***	.018	**.164***	.008	1	.098
	p	**.017**	.119	.633	.110	.991	**.013**	.792	**.014**	.901		.140
	N	**227**	227	227	227	227	**227**	227	**227**	227	227	227
CRP	r	.086	.118	**.133***	.055	.107	.096	-.052	.087	-.101	.098	1
	p	.198	.076	**.046**	.410	.107	.147	.435	.190	.128	.140	
	N	227	227	**227**	227	227	227	227	227	227	227	227

****. Correlation is significant at the 0.01 level (2-tailed).**
***. Correlation is significant at the 0.05 level (2-tailed).**

4.7 Biochemical investigations

4.7.1 Blood glucose readings

A total of 3.1% of females had BGL in the high category. Most males (64.7%) and more than half of females (59.5%) had BGL in the low category.

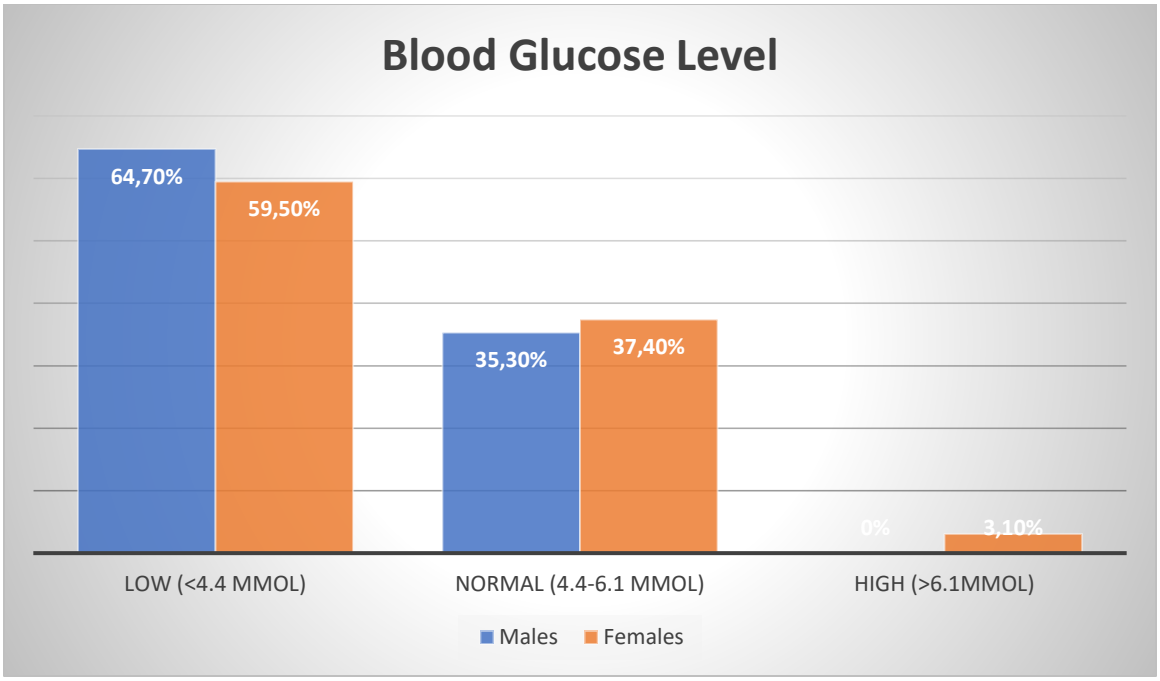


Figure 4. 1:Blood Glucose Readings

4.7.2 Cholesterol level of the study participants

Almost all (99.3%) male participants had TC in the normal range and only 0.7% were on borderline high. Only 0.4% of female participants had TC in the high category and almost all male participants (99.3%) had TC in the normal range. All male (100%) participants had LDL in the normal category, whereas 2.6% of female had LDL in high category. With regards to triglycerides 5.3% of males and 6.6% of females were in the high category. About half (52.7%) of males and one third (36.6%) of females had HDL-C in the low category (**Table 4.8**).

Table 4. 8: Cholesterol level

TC	Males		Females	
	N	(%)	N	(%)
Normal	149	(99.3%)	219	(96.5%)
Borderline high	1	(0.7%)	7	(3.1%)
High	-	-	1	(0.4%)
LDL				
Normal	150	(100%)	221	(97.4%)
Above normal	-	-	5	(2.2%)
Borderline high	-	-	1	(0.4%)
Triglycerides				
Normal	139	(92.7%)	203	(89.4%)
Borderline high	8	(5.3%)	9	(4%)
High	3	(2%)	15	(6.6%)
HDL				
Low	79	(52.7%)	82	(36.1%)
Normal	63	(42%)	110	(48.5%)
Protective	8	(5.3%)	35	(15.4%)

4.7.4 CRP of study participants

Majority of both male (93.3%) and female (92.5%) participants had CRP in the normal category, while 6.7% of males and 7.5% of females had CRP in high category.

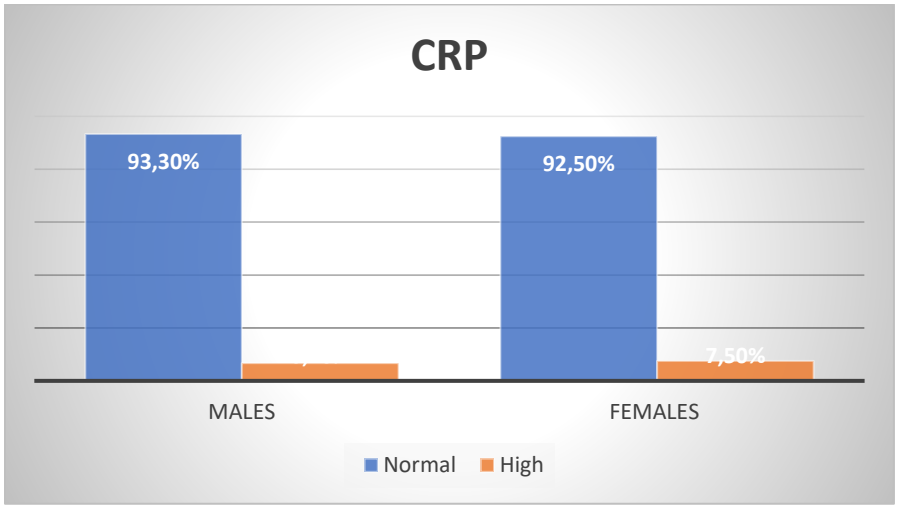


Figure 4. 2: C-reactive protein level

4.8 Blood pressure readings of the study participants

The table 4.8 below shows the results of the blood pressure reading of study participants. Amongst male participants a total of 26.7% and 11.3% had SBP and DBP in the pre-hypertensive category respectively. On the other hand, the percentage was lower in females with 6.2% and 9.4% having SBP and DBP in the pre-hypertensive category respectively. About 3.3% of males

and 4.4% of females had SBP in stage 1 hypertensive category, while1.3% of males and 9.4% of females had DBP in stage 1 hypertensive category (**Table 4.9**).

Table 4. 9 Blood pressure reading of the study participants

SBP category (mmHg)	**Males**		**Females**	
	N=150	**(%)**	**N=227**	**(%)**
Normal (<90th percentile or SBP <120)	101	(67.3%)	201	(88.5%)
Pre-Hypertension (SBP 90th-<95th or SBP120-139)	40	(26.7%)	14	(6.2%)
Stage 1 Hypertension (95th -<99th percentile or SBP 140-159)	5	(3.3%)	10	(4.4%)
Stage 2 Hypertension (>99th percentile or SBP 160 or higher)	4	(2.7%)	2	(0.9%)
DBP category (mmHg)				
Normal (<90th percentile or DBP <80)	130	(86.7%)	180	(79%)
Pre-Hypertension (90th -<95th or DBP 80-89)	17	(11.3%)	21	(9.4%)
Stage 1 Hypertension (95th -<99th percentile or DBP 90-99)	2	(1.3%)	21	(9.4%)
Stage 2 Hypertension (>99th percentile or DBP 100 or higher)	1	(0.7%)	5	(2.2%)

4.9 Dietary intake

4.9.1 Energy and nutrient intake of study participants

The energy and nutrients intake of adolescents are shown in Table 4.10. A slight low mean energy intake was observed in male and high mean energy intake in female was observed. In male participants mean total protein and carbohydrate was high compared to RDAs. Regarding micronutrients in males mean calcium intake was extremely low at 215.51mg/d when compared recommended amount of 1 300mg/d. Vitamin A(RE) and vitamin C was also low in male participants.

The study reports high mean total protein and carbohydrate in female participant. Like in male participant's calcium was also extremely low in females at 218.32mg/d when compared to recommended amount of 1 300mg/d. Low iron intake was also observed in females. With regards to vitamins in female low mean intake of vitamin A, folate and vitamin C was also observed.

Table 4. 10: Energy and nutrient intake

Nutrients	Males			Females		
	RDIs	Mean	Std. Deviation	RDIs	Mean	Std. Deviation
Energy (kJ)	12552[a]	11062.48	5373.06	9205[a]	10055.56	7094.74
Total protein (g)	52[a]	66.03	31.76	46 [a]	60.24	38.86
Total fat (g)	20-35[c]	49.94	25.45	20-35 [c]	49.61	30.01
Saturated FA (g)	-	10.87	5.57	-	11.06	6.91
Mono-unsaturated FA (g)	-	14.66	7.31	-	14.44	8.92
Polyunsaturated FA (g)	-	18.02	10.84	-	17.76	12.04
Total trans FA (g)	-	1.30	1.380	-	1.44	1.28
Cholesterol (mg)	-	177.65	173.25	-	174.91	186.89
Carbohydrate, avail. (g)	130 [a]	441.13	225.44	130 [a]	393.54	307.77
Starch (g) [b]	-	7.98	13.77	-	8.74	13.12
Total sugars (g)	-	20.76	35.78	-	16.61	33.67
Added sugar (g)	-	24.82	26.48	-	28.58	27.67
Total dietary fibre (g)	38[b]	35.25	18.38	26 [b]	30.18	24.41
Calcium (mg)	1 300 [a]	215.51	140.34	1 300 [a]	218.32	193.09
Iron (mg)	11 [a]	12.58	6.17	15 [a]	11.36	6.74
Magnesium (mg)	410 [a]	464.63	241.91	360 [a]	403.37	340.37
Phosphorus (mg)	1 250 [a]	863.96	418.16	1 2500	795.39	542.59
Potassium (mg)	3 000 [b]	1780.29	856.52	2 500 [b]	1620.07	1074.05
Sodium (mg)	1 500 [b]	1182.62	722.16	1 500 [b]	1192.80	716.88
Zinc (mg)	11 [a]	12.66	6.492	9 [a]	11.09	7.20
Selenium(mcg)	55 [a]	11.26	12.28	55 [a]	10.79	12.25
Vitamin A (RE) (mcg)	900 [a]	439.85	360.14	700 [a]	418.65	389.88
Thiamin (mg)	1.2 [a]	2.01	1.04	1.0 [a]	1.74	1.34
Riboflavin (mg)	1.3 [a]	1.69	1.35	1.0 [a]	1.87	1.50
Niacin (mg)	16 [a]	18.29	9.36	14 [a]	16.60	9.59
Vitamin B6 (mg)	1.3 [a]	3.64	2.08	1.2 [a]	3.26	2.02
Folate (mcg)	400 [a]	345.64	190.90	400 [a]	304.84	194.4
Vitamin B12 (mcg)	2.4 [a]	2.90	2.56	2.4 [a]	3.18	4.24
Biotin (mcg)	25[b]	37.21	25.05	25[b]	34.48	28.80
Vitamin C (mg)	75 [a]	52.37	106.93	65 [a]	41.10	120.64
Vitamin D (mcg)	15 [a]	3.23	3.09	15 [a]	3.39	3.93
Vitamin E (mg)	15 [a]	13.67	9.5	15 [a]	13.51	10.41
Vitamin K (mcg)	75 [b]	101.43	264.21	75[b]	92.66	122.82

a- Recommended Dietary Allowance (RDA), b- Adequate Intake (AI), c- Acceptable Macronutrients Distribution Range (AMDR)

4.9.2 Pocket money, lunch box and buying food at school by the participants

More than two thirds of male (67.3%) and female (67%) participants carry R5-R10 as pocket money. Majority (88%) of male participants and 67.8% of female participants never carry a lunch box to school. Half (50%) of male and 53.3% of female participants buy food at school daily (**Table 4.11**).

Table 4. 11: Pocket money, lunch box and buying food at school by the participants.

	Male		Female	
	N=150	**(%)**	**N=227**	**(%)**
Pocket money per day				
None	5	(3.3%)	5	(2.2%)
<R5	5	(3.3%)	29	(12.8%)
R5-R10	101	(67.3%)	152	(67%)
R10-R15	28	(18.7%)	35	(15.4%)
R15-R20	10	(6.7%)	6	(2.6%)
>R20	1	(0.7%)	-	-
Lunch box				
Never	132	(88%)	154	(67.8%)
1-2 times per week	7	(4.7%)	17	(7.5%)
3-4 times per week	4	(2.7%)	33	(14.5%)
Every day	7	(4.7%)	23	(10.1%)
Buying food at school				
Never	10	(6.7%)	17	(7.5%)
1-2 times per week	23	(15.3%)	26	(11.5%)
3-4 times per week	42	(28%)	63	(27.8%)
Every day	75	(50%)	121	(53.3%)

4.10 Physical activity and sedentary lifestyle

4.10.1 Physical activity index

Only 1.8% of female participants have high physical activity index and most (60.8%) of them were sedentary. However, male participants show high (12%) physical activity index and only 30.7% were sedentary (see Figure 4.3 below).

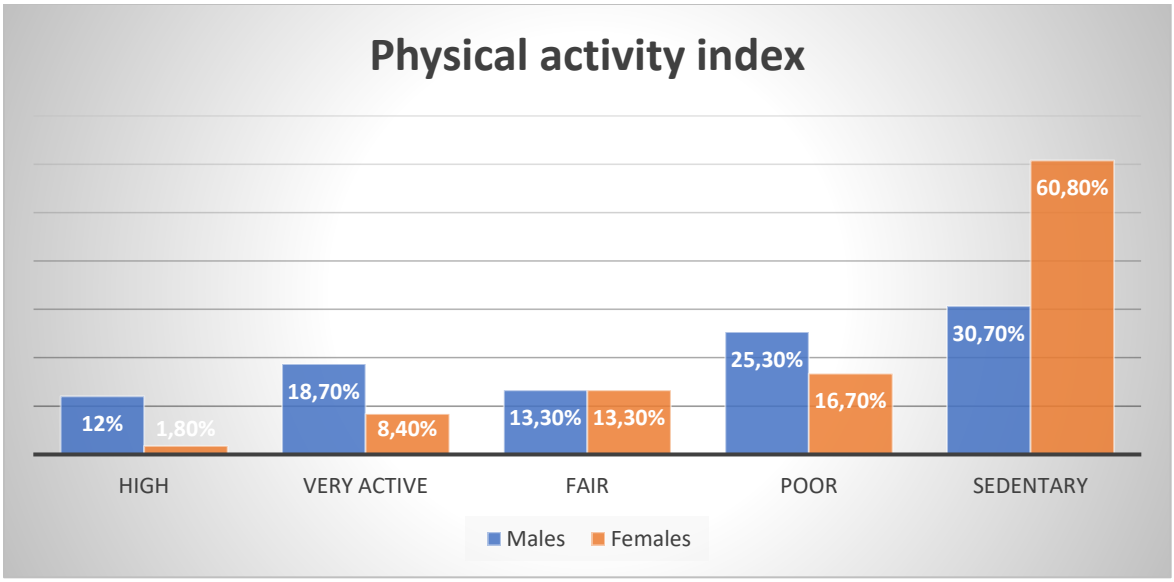


Figure 4. 3: Physical activity index

4.10.2 Activities of the participants in and around home

Table 4.11 below indicate the activities of the participants in and around home. Majority (60%) of male participants do not prepare food whereas 83.3% do shopping for food. The opposite was true for female participants with 28.6% preparing food. For males, a total of 90% do both browsing and shopping simultaneously while 92% is caring for children and 81.3% for the handicapped (80.6%). A total of 91.6% of females were browsing and shopping simultaneously.

Table 4. 12 Physical activity in and around home.

Preparation of food				
Number of times per week	**Males**		**Females**	
	N=150	**(%)**	**N=227**	**(%)**
None	90	(60%)	65	(28.6%)
Less than 1hour a week	23	(15.3%)	41	(18.1%)
1-3 hours a week	26	(17.3%)	75	(33%)
3-6 hours a week	5	(3.3%)	26	(11.5%)
6-10 hours a week	4	(2.7%)	13	(5.7%)
10-15 hours a week	2	(1.3%)	4	(1.8%)
More than 15 hours a week	-	-	3	(1.3%)
Shopping for food				
None	125	(83.3%)	191	(84.1%)
Less than 1hour a week	9	(6%)	13	(5.7%)
1-3 hours a week	12	(8%)	16	(7%)
3-6 hours a week	2	(1.3%)	6	(2.6%)
6-10 hours a week	1	(0.7%)	1	(0.4%)
10-15 hours a week	1	(0.7%)	-	-
Shopping and browsing				
None	135	(90%)	208	(91.6%)
Less than 1hour a week	9	(6%)	6	(2.6%)
1-3 hours a week	3	(2%)	8	(3.5%)
3-6 hours a week	2	(1.3%)	4	(1.8%)
6-10 hours a week	-	-	1	(0.4%)
10-15 hours a week	1	(0.7%)	-	-
Cleaning				
None	26	(17.3%)	14	(6.2%)
Less than 1hour a week	48	(32%)	71	(31.3%)
1-3 hours a week	59	(39.3%)	91	(40.1%)
3-6 hours a week	12	(8%)	28	(12.3%)
6-10 hours a week	4	(2.7%)	19	(8.4%)
10-15 hours a week	1	(0.7%)	3	(1.3%)
More than 15 hours a week	-	-	1	(0.4%)
Laundry				
None	27	(18%)	31	(13.7%)
Less than 1hour a week	59	(39.3%)	93	(41%)
1-3 hours a week	61	(40.7%)	81	(35.7%)
3-6 hours a week	2	(1.3%)	16	(7%)
6-10 hours a week	1	(0.7%)	5	(2.2%)
10-15 hours a week	-	-	1	(0.4%)
More than 15 hours a week	-	-	-	-
Caring for children				
None	138	(92%)	191	(84.1%)
Less than 1hour a week	7	(4.7%)	16	(7%)
1-3 hours a week	2	(1.3%)	7	(3.1%)
3-6 hours a week	2	(1.3%)	10	(4.4%)
6-10 hours a week	1	(0.7%)	2	(0.9%)
10-15 hours a week	-	-	1	(0.4%)
Caring for handicapped				
None	122	(81.3%)	183	(80.6%)
Less than 1hour a week	12	(8%)	21	(9.3%)
1-3 hours a week	13	(8.7%)	15	(6.6%)
3-6 hours a week	1	(0.7%)	4	(1.8%)

6-10 hours a week	2	(1.3%)	3	(1.3%)
10-15 hours a week	-	-	1	(0.4%)

4.10.3 Traveling to school

The results of the current study indicate that majority (83.2%) of male and female (80.6%) participants walked to school. Almost half (48%) of male and 51.5% of female participants travel approximately 2km to schools. Of those who walk to school, a total of 91.3% of male and 89.9% of female participants reported to be walking five times a week. (**Table 4.13**).

Table 4. 13 Travel to school.

Mode of transport	**Male**		**Female**	
	N=150	**(%)**	**N=227**	**(%)**
Walking	124	(83.2%)	183	(80.6%)
Public transport	19	(12.8%)	36	(15.9%)
car	4	(2.7%)	7	(3.1%)
Walking and public transport	2	(1.3%)	1	(0.4%)
Number of km				
1km	65	(43.3%)	93	(41%)
2km	72	(48%)	117	(51.5%)
3km	11	(7.3%)	12	(5.3%)
4km and above	2	(1.3%)	5	(2.2%)
Number of times traveling to school per week				
5 times	137	(91.3%)	204	(89.9%)
6 times	13	(8.7%)	22	(9.7%)
7 times	-	-	1	(0.4%)

4.10.4 Physical activity of the participants

The physical activity in this study ranged from swimming, running, weeding to playing soccer and netball. The result of the study indicates that in both males and female majority of them did not engage in skipping, cycling, watering, digging and weeding. However, majority of male were walking (70.5%), running (65.1%) and playing soccer (65.3%) as compared to female participants. Of the total of males who were walking, running and playing soccer 28.2% were walking 1-2 times week, 33.3% were running 1-2 times a week and 24% played soccer 1-2 times per week. The percentages were lower in females with 6.6% playing soccer 1-2 times per week, 26.4% running 1-2 times a week (**Table 4.14**).

Table 4. 14: Physical activity of the study participants.

Type of activity	Male		Female	
	N=150	(%)	N=227	(%)
Skipping				
No	144	(96%)	205	(90.3%)
1-2 times	6	(4%)	17	(7.5%)
3-4 times	-	-	4	(1.8%)
5-6 times	-	-	-	-
7times or more	-	-	1	(0.4%)
Walking				
No	44	(29.5%)	117	(51.5%)
1-2 times	42	(28.2%)	63	(27.8%)
3-4 times	19	(12.8%)	14	(6.2%)
5-6 times	18	(12%)	18	(7.9%)
7times or more	27	(18.1%)	15	(6.6%)
Cycling				
No	126	(84%)	223	(98.2%)
1-2 times	19	(12.7%)	3	(1.3%)
3-4 times	2	(1.3%)	1	(0.4)
5-6 times	-	-	-	-
7times or more	3	(2%)	-	-
Running				
No	52	(34.9%)	153	(67.4%)
1-2 times	50	(33.3%)	60	(26.4%)
3-4 times	22	(14.8%)	9	(4%)
5-6 times	12	(8.0%)	1	(0.4%)
7times or more	14	(9.3%)	4	(1.8%)
Watering				
No	113	(75.3%)	196	(86.3%)
1-2 times	15	(10%)	24	(10.6%)
3-4 times	16	(10.7%)	4	(1.8%)
5-6 times	3	(2%)	1	(0.4%)
7times or more	3	(2%)	2	(0.9%)
Digging				
No	109	(72.7%)	197	(86.8%)
1-2 times	38	(25.3%)	27	(11.9%)
3-4 times	3	(2%)	2	(0.9%)
5-6 times	-	-	1	(0.4%)
7times or more	-	-	-	-
Dancing				
No	102	(68%)	106	(46.7%)
1-2 times	28	(18.7%)	76	(33.5%)
3-4 times	7	(4.7%)	15	(6.6%)
5-6 times	2	(1.3%)	6	(2.6%)
7times or more	11	(7.3%)	24	(10.6%)
Weeding				
No	139	(92.6%)	224	(98.7%)
1-2 times	10	(6.7%)	3	(1.3%)
3-4 times	-	-	-	-
5-6 times	1	(0.7%)	-	-
7times or more	-	-	-	-
Type of activity	**Male**		**Female**	

	N=150	(%)	N=227	(%)
Soccer				
No	53	(35.3%)	207	(91.2%)
1-2 times	36	(24%)	15	(6.6%)
3-4 times	22	(14.7%)	4	(1.8%)
5-6 times	23	(15.3%)	-	-
7times or more	16	(10.7%)	1	(0.4%)
Netball				
No	150	(100%)	197	(86.8%)
1-2 times	-	-	21	(9.3%)
3-4 times	-	-	8	(3.5%)
5-6 times	-	-	-	-
7times or more	-	-	1	(0.4%)

4.10.5 Time spent in physical activity

Only 2.7% of males spent 30 minutes to 1 hour skipping whereas 2.6% of females spent less than 30 minutes skipping. About 23.3% of males spent 1 hour to 1hour 30 minutes playing soccer, and 4% of females spent 1 hour to 1 hour 30 minutes playing netball (**Table 4.15**).

Table 4. 15: Time spent on physical activity.

Time spend in PA	**Male**		**Female**	
Skipping	**N=150**	**(%)**	**N=227**	**(%)**
0	144	96%	205	(90.3%)
<30 minutes	4	(2.7%)	3	(2.6%)
30-1hour	2	(1.3%)	7	(3.1%)
1 Hr-1H30 minutes	-	-	7	(3.1%)
1 H 30 -2Hours	-	-	-	-
2 hours or more	-	-	2	(0.8%)
Walking				
0	44	(96%)	205	(90.3%)
<30 minutes	28	(18.8%)	35	(15.7%
30-1hour	29	(9.4%)	37	(16.4%)
1Hr-1H30 minutes	25	(16.7%)	26	(11.5%)
1 H 30 -2Hours	5	(3.4%)	2	(0.9%)
2 hours or more	19	(12.8%)	9	(4%)
Cycling				
0	126	(84%)	117	(51.5%)
<30 min	9	(6%)	2	(0.8%)
30min-1hr	5	(3.4%)	2	(0.8%)
1Hr-1hr30 min	5	(3.3%)	-	-
1 hr 30 -2hrs	1	(0.7%)	-	-
2 hrs or more	4	(2.6%)	-	-
Running				
0	52	(34.9%)	152	(67%)
<30 min	36	(24.1%)	43	(18.9%)
30min-1hr	25	(16.7%)	18	(7.9%)
1hr-1hr30 min	15	(10%)	9	(4%)
1 hr 30 -2hrs	7	(4.7%)	-	-
2 hrs or more	15	(10%)	5	(2.2%)

Watering				
0	113	(75.3%)	195	(86%)
<30 min	17	(11.3%)	16	(7%)
30min-1hr	15	(10%)	13	(5,7%)
1hr-1hr30 min	1	(0.7%)	3	(1.3%)
1 hr 30 -2hrs	1	(0.7%)	-	-
2 hrs or more	3	(2%)	-	-
Digging				
0	109	(72.7%)	196	(86.8%)
<30 min	10	(6.6%)	7	(3.1%)
30min-1hr	13	(8.7%)	9	(4%)
1hr-1hr30 min	10	(6.6%)	6	(2.6%)
1 hr 30 -2hrs	1	(0.7%)	2	(0.9%)
2 hrs or more	7	(4.7%)	6	(2.6%)
Dancing				
0	102	(68%)	105	(46.3%)
<30 min	34	(22.7%)	86	(37.9%)
30min-1hr	8	(5.3%)	18	(7.9%)
1hr-1hr30 min	1	(0.7%)	11	(4.8%)
1 hr 30 -2hrs	-	-	-	-
2 hrs or more	5	(3.3%)	7	(3.1%)
Weeding				
0	139	(92.6%)	223	(98.2%)
<30 min	11	(7.4%)	-	-
30min-1hr	-	-	1	(0.4%)
1hr-1hr30 min	-	-	1	(0.4%)
1 hr 30 -2hrs	-	-	-	-
2 hrs or more	-	-	-	-
Soccer				
0	52	(34.7%)	223	(98.2%)
<30 min	6	(4%)	6	(2.6%)
30min-1hr	14	(9.3%)	6	(2.6%)
1hr-1hr30 min	35	(23.3%)	7	(3.1%)
1 hr 30 -2hrs	18	(12%)	2	(0.9%)
2 hrs or more	25	(16.7%)	-	-
Netball				
0	150	(100%)	197	(86.8%)
<30 min	-	-	9	(4%)
30min-1hr	-	-	7	(3%)
1hr-1hr30 min	-	-	9	(4%)
1 hr 30 -2hrs	-	-	-	-
2 hrs or more	-	-	5	(2.2%)

4.10.6 Television (TV) viewing

The majority (75.3%) of males and two thirds (66.1%) of females did not watch TV during the weekday before six. On the other hand, about 15,5% of females watched TV for more than 3 hours after six as compared to 7.4% of males. During the weekend the results indicate that only 8.6 % of male and 16.7% of female participants watched TV for more than 3 hours or more before six. On the other hand, 16.7% males and 18% females watched TV for more than 3 hours after six (**Table 4.16**).

Table 4. 16: TV viewing period of the study participants.

No of hours	**Males**		**Female**	
Weekday before six	**N=150**	**(%)**	**N=227**	**(%)**
None	113	(75.3%)	150	(66.1%)
<1hr	16	(10.7%)	25	(11%)
1-2hrs	16	(10.7%	34	(15%)
2-3hrs	3	(2.0%)	9	(4%)
3-4hrs	1	(0.7%)	7	(3.1%)
More than 4hrs	1	(0.7%)	2	(0.9%)
Weekday after six				
None	63	(42%)	85	(37.4%)
<1hr	21	(14%)	31	(13.8%)
1-2hrs	35	(23.3%)	44	(19.4%)
2-3hrs	20	(13.3%	32	(14.2%)
3-4hrs	7	(4.7%)	24	(10.7%)
More than 4hrs	4	(2.7%)	11	(4.8%)
Weekend before six				
None	95	(63.3%)	136	(59.9%)
<1hr	8	(5.3%)	12	(5.3%)
1-2hrs	21	(14%)	28	(12.3%)
2-3hrs	13	(8.7%)	13	(5.7%)
3-4hrs	5	(3.3%)	11	(4.8%)
More than 4hrs	8	(5.3%)	27	(11.9%)
Weekend after six				
None	73	(48.7%)	104	(45.8%)
<1hr	11	(7.3%)	13	(5.7%)
1-2hrs	25	(16.7%)	42	(18.5%)
2-3hrs	16	(10.7%)	27	(11.9%)
3-4hrs	16	(10.7%)	23	(10.1%)
More than 4hrs	9	(6%)	18	(7.9%)

4.10.7 Sleeping patterns of the participants

The figure (Figure 4.4) below illustrates the number of hours' participants spend sleeping per day. Only 4% of males and 3.5% of females spend 4 hours sleeping while about half (54.7%) of males and 56.4% of females spend 8 hours and more sleeping.

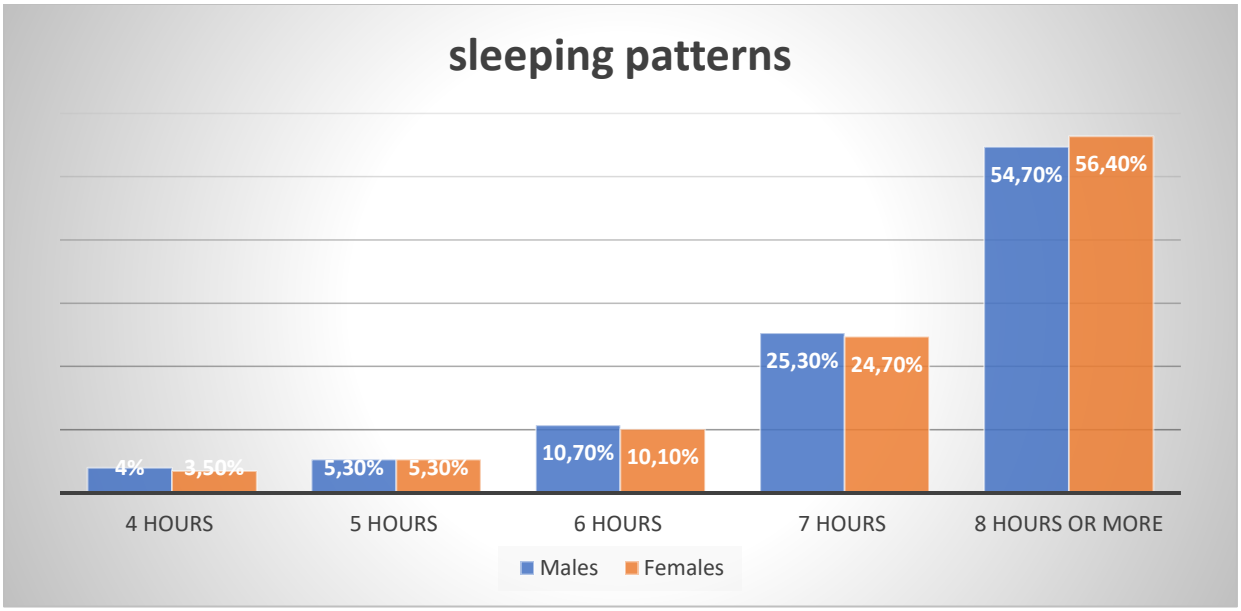


Figure 4. 4: Sleeping patterns

4.10.8 Lifestyle habits classification.

Only 4% of males had a "very good" daily lifestyle habit as compared to 0.9% of females. On the other hand, both males (2.7%) and females (2.6%) had a very bad daily lifestyle habit. Almost half (48%) of females and more than a third (37.4%) had a bad daily lifestyle (**Table 4.17**).

Table 4. 17: Lifestyle habits classification.

No of Yes	Classification of daily lifestyle	Interpretation	Male		Female	
			N=150	(%)	N=227	(%)
7	Very good	You are following the lifestyle keep up	6	(4%)	2	(0.9%)
5-6	Good	Not bad at all, out keep a close eye on yourself	37	(24.7%)	37	(16.3%)
4	Fair	Evaluate your lifestyle seriously. It is important that you consider some positive changes.	47	(31.3%)	73	(32.2%)
2-3	Bad	Your lifestyle is detrimental to your health; it is important that you commit yourself to serious changes.	56	(37.4%)	109	(48%)
1	Very bad	Your destructive lifestyle may pose serious health problems in your life. You personally as well as your company will benefit from your serious commitment to a healthy lifestyle.	4	(2.7%)	6	(2.6%)

4.10.9 Lifestyle habits

The results of the study indicate that almost two-thirds (64%) of males and half (52.9%) of females eat three meals per day. A total of 52.7% and 55.9% in males and females respectively were not eating breakfast every day. The majority of females (83.7%) did not engage in moderate exercise as compared to males (59.3%). About one third (39.3%) of male drink alcohol and 11.3% smoke, while in female participants 31.3% drink alcohol and only 3.1% smoke (**Table 4.18**).

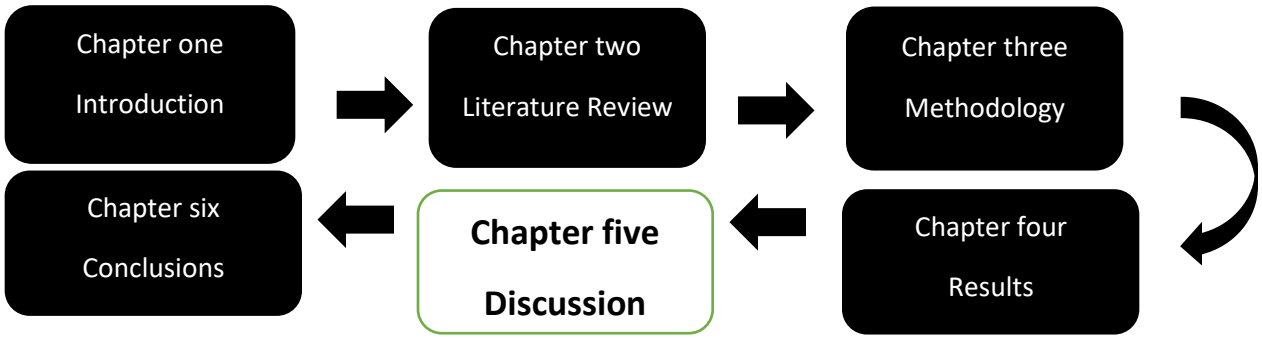
Table 4. 18: Lifestyle habits.

Questions asked in lifestyle habits	**Male**				**Female**			
	Yes		**No**		**Yes**		**No**	
	N	**(%)**	**N**	**(%)**	**N**	**(%)**	**N**	**(%)**
3 meals/day	96	(64%)	54	(36%)	120	(52.9%)	107	(47.1%)
Breakfast everyday	71	(47.3%)	79	(52.7%)	100	(44.1%)	127	(55.9%)
Participants in moderate exercise	61	(40.7%)	89	(59.3%)	37	(16.3%)	190	(83.7%)
Adequate sleep	92	(61.3%)	58	(38.7%)	139	(61.2%)	88	(38.8%)
None smoker	133	(88.7%)	17	(11.3%)	220	(96.9%)	7	(3.1%)
Maintain body weight	36	(24%)	114	(76%)	26	(11.5%)	201	(88.5%)
Consume little or no alcohol	91	(60.7%)	59	(39.3%)	156	(68.7%)	71	(31.3%)

CHAPTER 5

DISCUSSION

5.1 Overview



5.2 Demographic information of participants.

The study participants were adolescents from poor socio-economic backgrounds. The socio-economic status was measured by the poor road, lack of proper sanitation and poor infrastructure. Majority of these participants were females. Most studies (Reddy *et al.,* 2013; Nagesh *et al.,* 2017) tracking obesity have also reported the majority of participants being females than males. This is not surprising since more than half of the population in South Africa are females (Stats SA, 2018).

More than a third of the parents of the study participants were unemployed. This was evident when measuring the socio-economic backgrounds of the study participants. Although a third of the parents were receiving wages and almost thirty percent received salaries, it can be deduced that the income was not enough to cater for all the family members. According to Stats SA. (2019) an individual will need at least R561 to afford a minimum required daily energy intake. This is also commonly referred to as “extreme” poverty line. Further, there are two more poverty lines namely the lower and the upper bound poverty lines (Stats SA, 2019). Given the poor socio-economic backgrounds of study participants, one may conclude that most of the study participants lived below the poverty line. There are enduring associations between early life poverty and obesity (Lee *et al.,* 2014). In addition, children of low socio-economic status are 1.6 times likely to be obese than those from high socio-economic status and have steeper rates of increase in obesity.

The majority of the parents of the study participants had secondary education. This suggest that most parents may be knowledgeable about obesity and its consequences. This is evident in the small percentage of participants who are overweight and obese in the current study. Yoon *et al.* (2006) have indicated that higher levels of education resulted in lower BMI and waist

circumference. In summary, this may denote that educated parents may prevent the development of obesity in their children.

The results of the study also indicate that the family members ranged from five to six. According to the study done by Datar. (2017) having more siblings is associated with significantly lower BMI and lower likelihood of obesity. Children and adolescents with siblings have healthier diets and watch less television (Datar, 2017). In addition, larger family size may be protective of childhood and adolescence obesity.

5.3 Prevalence of obesity

Obesity can be defined as BMI ≥30kg/m^2 (WHO, 2003). The results of the study show that the prevalence of obesity was 20.3% in females and 6% in males. The prevalence of obesity in the current study is higher than that of 3rd South African National Youth Risk Behaviour Survey (SANYRBS) 2011 study, which reported the prevalence of obesity to be 6.9% (Reddy *et al.,* 2013). In addition, the current prevalence of obesity was higher than the provincial prevalence of 4% reported in the SANYRBS (2011) by Reddy *et al.* (2013). The results show a worsening trend of obesity in rural areas of South Africa.

The results also revealed that overweight and obesity were more prevalent in girls than in boys. The results of the study are supported by Shisana *et al.* (2013); Pedro *et al.* (2014) and Monyeki *et al.* (2015) where the prevalence of overweight and obesity was reported to be high in girls than in boys. Recently Mashiane *et al.* (2018) reported the prevalence of obesity to be 25.8% and 3.1% in females and males respectively. The high prevalence of obesity in female participant reflects the adult patterns in the country where women have markedly higher levels than men (Negash *et al.,* 2017). The high prevalence of obesity among females maybe attributable to their body composition of having more fats deposition in peripheral for healthy pregnancy (Alberga *et al.,* 2012).

Obesity is a major risk factor of number of NCDs including cardiovascular conditions, diabetes and cancer (Ford *et al.,* 2017). Abdominal obesity is associated with metabolic abnormalities, type 2 diabetes and cardiovascular diseases (Shisana *et al.,* 2013). Furthermore, abdominal obesity is related to cardiometabolic risk factors leading to the inflammatory process responsible for hypertension and type 2 diabetes mellitus and its complications (Ngwenya and Ramukumba,

2017). Adolescents with abdominal obesity are more prone to cardio-metabolic risk factors (Kelishadi *et al.,* 2015).

5.4 Determinants of obesity

Determinant is a factor which decisively affects the nature or outcome of something (Oxford dictionary). In the current study the following were found to be determinants of obesity: gender, age, socio-economic status, SBP, cholesterol, and nutrient intake.

5.4.1 Gender

Gender was associated with obesity in the current study. The results of the study suggest that being female was a determinant of obesity in the present study. This is not surprising given the anatomical make up of females, that is the fat distribution in preparation for child bearing (Vella *et al.,* 2002). Concurrently, Whitney and Rolfes (2008) reported that fat accumulation is higher in females than in males, due to essential body fat deposited in the mammary glands and pelvic region in preparation for child bearing. Female adolescents tend to have higher BMI as a result from rapid growth and early sexual maturity (Ahmad *et al.,* 2018). On the other hand, male participants had an estimated decrease of being obese in odds of 68%. This simply means gender male was a protective mechanism against obesity. Studies (Aryeetey *et al.,* 2017; Negash *et al.,* 2017) tracking the determinants of obesity arrived at similar conclusions where it was reported being female was a determinant of obesity and females were twice likely to be obese than males. Ahmad *et al.* (2018) maintains that girls engage in less physical activity and sport as compared to boys. Furthermore, there is a great concern that culturally girls do not move around than boys leading to physical inactivity and eventually the development of obesity (Gebrie *et al.,* 2018).

5.4.2 Age

The results of the current study suggest that older participants are more likely to be obese. Similarly, the study conducted in India reported that adolescents above 14 years and older had 2.09 time more odds of being obesity (Nirmal *et al.,* 2018). Studies tracking the prevalence of obesity indicate that prevalence of obesity increases with the age, peaking at age 12 years and decline thereafter (Toriola *et al.,* 2012 and Shisana *et al.,* 2013). This may be due to the increase in adipose tissue and overall body weight in adolescents during puberty (Kotian *et al.,* 2010). According to Kimani-Murage *et al*. (2010) the risk of obesity increases with sexual maturation, indicating higher risk as the adolescents' transition to adulthood. These studies together with the current study demonstrate a trend that BMI increase with age.

5.4.3 Socio-economic status

In the current study parent source of income was strongly associated with obesity. The results of the current study show that parent source of income is an important determinant of obesity among adolescents. Affordability may influence the adolescents to consume high energy dense food which may lead to overweight and obesity. According to Choukem *et al.* (2017) high SES was strongly associated with obesity among children, with almost 2.5 times more likely to be obese than those from low SES. Concurrently a study conducted in Moroccan adolescents, reported that high family income was a determinant of obesity (Kabbaoui *et al.,* 2018). Money gives children a certain degree of autonomy in purchasing and consumption (Roberts *et al.,* 2003; van Ansem *et al.,* 2015) some of which entail health risks (Jung *et al.,* 2010) such as smoking and substance abuse (Ausems *et al.,* 2003; Mohan *et al.,* 2005; Chen *et al.,* 2013; Guo *et al.,* 2015; Ma *et al.,* 2013). Studies from US, Europe, India, Korea and Vietnam suggest that pocket money is a potential risk factor for the child's unhealthy eating thus overweight and obesity (Roberts *et al.,* 2003; Wang *et al.,* 2007; Lachat *et al.,* 2009; Jung *et al.,* 2010; Jensen *et al.,* 2012; Punitha *et al.,* 2014; van Ansem *et al.,* 2015).

High prevalence of obesity in adolescents is a public health predicament because they are likely to have metabolic syndrome in adult life including cancer, stroke, coronary heart disease, type 2 diabetes (Allender and Rayner, 2007). In developing countries like South Africa, high SES group have easy access to sedentary lifestyle, and highly processed food which are the primary risk factor of obesity (He *et al.,* 2014). Further, Choukem *et al.* (2017) point out that SES is a trigger of parental factors that may play a role in the risk of obesity by access to obesogenic food. The study also revealed that participants from households where the head earns a salary or wage are more likely to be obese than those from households that depend on social grants. Contrary to the findings of the current study, is the study conducted by Galf *et al.* (2016) which pointed out that adolescents whose mothers were housekeepers had high prevalence of obesity than those who were employed. The current study suggests that parents should be informed and educated of the potential adverse health impacts of children's pocket money and empowered to assist children develop healthy consumption behaviours (Li *et al.,* 2017). For example, money, could be used to promote children's engagement in sports and other physical activities (Li *et al.,* 2017).

5.4.4 Systolic Blood Pressure (SBP)

SBP was also associated with obesity in the current study. It was revealed that one unit of SBP was associated with an increase of the odds of obesity by 4.2% in the present study. Concurrently, Boukhatem *et al.* (2017) and Negash *et al.* (2017) reported that hypertension increase the odds of being obese among adolescents. Furthermore, studies conducted in South Africa reported that SBP was associated with obesity (Nkeh-Chungag *et al.,* 2015 and Sebati *et al.*,2019). The association of hypertension and obesity among adolescents may highlight that cardio-metabolic comorbidities which do not only occur in adults but may develop in children and adolescents, particularly in the presence of obesity (Negash *et al.,* 2017). Obese participants are disposed to hypertension, and hypertensive participants also seem to be disposed to weight gain (Narkiewicz, 2006). Literature (Narkiewicz, 2006; and Jiang et al., 2016) shows that the epidemic of obesity and obesity related hypertension is accompanied by an increase in the incidence of diabetes mellitus, CVD and chronic kidney disease. The relationship between hypertension and obesity decrees effects which may be attributable to the nutrition transition which results in sedentary living and overfeeding (Nkeh-Chungag *et al.,* 2015).

5.4.5 Cholesterol

The present study revealed that high TC and low HDL-C as the determinants of obesity. Similarly, a study conducted by Ghomari-Boukhatem *et al.* (2017) reported that elevated TC, LDL-C, TG and low HDL-C as a risk factor of obesity. The relationship between TC and HDL-C has been shown in a study conducted in the USA among children and adolescents. The results of the latter study show that youth with obesity had a higher prevalence of high TC and low HDL-C than those with normal weight (Nguyen *et al.,* 2015). Furthermore, Bibilon *et al.* (2015) stated that obese children were associated with the existence of at least one abnormal lipoprotein concentration.

Studies tracking lipoprotein concentration and its association with obesity (Miller *et al.,* 2005; Daniels and Greer, 2008; and Gupta *et al.,* 2017) reported abnormalities in these lipoproteins as a strongest risk factors of CVD. Miller *et al.* (2005); and D'Adamo *et al.* (2015) maintain that atherogenesis is associated with lipoprotein and obesity. Surprisingly, the current study also found that adolescents with high LDL-C to be less likely to be obese. Although, the current study indicated that high LDL decreases the odd of obesity, literature shows that high LDL-C initiate and progresses coronary atherosclerosis (Gupta *et al.,* 2017). Atherosclerosis process start in childhood and represents an increasing health problem in obese children and adolescents (D'Adamo *et al.,* 2015).

5.4.6 Nutrient intake

High consumption of total fats, total trans fats and carbohydrates were reported as determinants of obesity in the current study. Similarly, Allioua *et al.* (2015) reported that high consumption of fats was associated with obesity among adolescents. A high-energy intake is a major risk factor of obesity in children and adults (Shisana *et al.,* 2013). In addition, high energy intake together with high total fats, high saturated fats, high carbohydrate, high added sugar and low fibre intake has been classified as western diet which contribute to the development of chronic diseases (Shisana *et al.,* 2013). Moreover, high intake of fats and sugar increases the risk of childhood obesity, as well as the non-communicable diseases such as type 2 diabetes and CVD, later in life (Muthuri *et al.,* 2014; Steny, 2016 and Harris *et al.,* 2019).

Adolescents are nutritionally vulnerable, they frequently make poor food choices (Harris *et al.,* 2019). Furthermore, school children spend more time at school and most venders sell energy dense food such as crisps, fat cakes, French fries, sweets, and carbonated sweet drinks (Steny *et al.,* 2015). Contrary, the current study also reveals that adolescents consuming more added sugar were less likely to be obese. The association of high total fats, trans fats and carbohydrate intake and obesity in the present study suggest that there is a peak in the nutritional transition and weight status in rural communities.

5.5 Correlation of anthropometric status, biochemical indicators and Clinical indicators

With regard to females, BMI was significantly positively associated with SBP, DBP and TG and negatively associated with HDL, while in male BMI was significantly associated with SBP. Similarly, Ghomari-Boukhatem *et al.* (2017) also found that BMI was significantly related to SBP, DBP, LDL-C, TC, TG and negatively related to HDL-C among adolescents. Noubiap *et al.* (2017) reported that increased BMI to be significantly associated with elevated blood pressure. Lozano *et al.* (2016) found that BMI to be strongly associated with TG. In the present study WC was significantly associated with both SBP and DBP among females. Mkhoto and Mabaso. (2012) reported that elevated SBP and DBP has a strong positive relationship with BMI and WC in both genders among school-going adolescents in Limpopo. In a study conducted in rural Limpopo among young adults also found that WC was significantly associated with both SBP and DBP (Sebati *et al.,* 2019). Ghomari-Boukhatem *et al.* (2017) reported that high SBP and DBP values were noted in 72% of overweight and obese adolescents. The present study further report that W/H was significantly associated with BGL in females and in males it was significantly associated with TC.

Furthermore, W/H was significantly associated with CRP only in female participants. Contrary, Sanip *et al*. (2013) found that CRP was inversely correlated to W/H. Harmse and Kruger. (2010) found that WC and BMI were significantly associated with serum CRP among girls. Furthermore, the association indicate the link between body fats and inflammation in girls (Harmse and Kruger, 2010). A possible reason may be that most boys are relatively fit and active than girls (Harmse and Kruger, 2010). The present study shows a significant association between dyslipidaemia, BP, CRP BGL, and anthropometric status among adolescents.

5.6 CRP of study participants

The results of the study show that the majority of the study participants had normal levels of serum CRP. However, 6.7% of males and 7.5% of females had CRP in high category. Similarly, Harmse and Kruger. (2010) found that the majority of children had serum CRP concentration within the normal range and only a few had raised level. Studies (Warnbery *et al.*, 2004; Gөbel *et al.,* 2012 and Choi *et al.,* 2013) have shown that obesity among children and adolescents is associated with elevated CRP (chronic low-grade inflammatory response). Choi *et al.* (2013) further found that the association is stronger in women as compared to man among adults. Obesity and abdominal adipose tissue accumulation are a contributing factor to elevated CRP in both lean and overweight adolescents (Sanip *et al.,* 2013). Goulart *et al*. (2017) stated that adipose tissue is an important secretor of proinflammatory markers linked to the development of atherosclerosis. The rise in CRP result from response to the increase secretion of cytokines such as TNF-α and IL-6, induced by adipocytes in obese participants (Wu *et al.,* 2003; and Warnbery *et al.*, 2004). Additionally, the release of these cytokines from the adipose tissue may induce low grade of systemic inflammation in obese individuals (Wu *et al.,* 2003 and Goulart *et al.,* 2017). High CRP is considered as a cardiovascular risk factor (Warnbery *et al.*, 2004; Soria-Guillen *et al.,* 2008 and Choi *et al.,* 2013). CRP could be a useful tool for early detection of cardiovascular risk factor among children and adolescents (Soria-Guillen *et al.,* 2008; Rensbury *et al.,* 2012; Choi *et al.,* 2013 and Goulart *et al.,* 2017). It can be assumed that the majority of the study participants are not at risk of cardiovascular diseases given the normal ranges of CRP levels.

5.7 Blood glucose level (BGL)

The results of the current study show that the majority of the study participants had BGL in the low and normal ranges. This suggests that chances of participants getting type 2 diabetes mellitus are slim. Only a few of female (3.1%) participants had a BGL in high category. Similarly, Sekokotla *et al.* (2017) also found that 3.5% of female adolescents had a BGL in high category, however

the results also indicated that 6.9% of male had a BGL in high category. It may be assumed that BGL in the high category during adolescence may result in Type 2 diabetes later in life. Type 2 diabetes is emerging as a global epidemic among children and adolescents mostly because of obesity and physical inactivity (Singh *et al.,* 2004 and Osman *et al.,* 2013). Like in the current study most of the male and female participants were physically inactive this placed them at risk of type 2 diabetes mellitus. Puberty also play a vital role in the development of type 2 diabetes in children and adolescents due to physiological decreases in insulin sensitivity during this period (American Diabetes Association, 2000 and Alberti *et al.,* 2004). Type 2 diabetes can lead to micro-vascular (kidney failure and blindness) and macro-vascular (heart disease, stroke and limb amputation) complications (Singh *et al.*, 2004; and Reinehr, 2013).

5.8 Cholesterol level

Sengwayo *et al.* (2012) indicated that it is recommended for individuals to have raised blood HDL-C, low LDL-C, and low triglycerides to reduce the incidence of chronic diseases such as CVD, arterial thrombosis and hypertension. The results of the current study attest to what Sengwayo *et al.* (2012) have alluded to since the majority of the study participants (males=47.3% vs females=63.9%) had HDL-C in the normal ranges. This would mean that the study participants are protected against chronic diseases. More than half of the male participants and a third of females had HDL-C in the low category. This is comparable to the study conducted in South Africa where the low prevalence of low HDL-C with 37.9% of males and 24.7% of female was reported (Sekokotla *et al.,* 2017). Nguyen *et al.* (2015) also found a low prevalence of low HDL-C 13.4% among adolescents. Lartey *et al.* (2018) also reported that 28.4% of children had HDL-C level that indicate high or borderline cardiovascular risk. In addition, adolescents with obesity were reported to have high prevalence of low HDL-C than normal adolescents (Nguyen *et al.,* 2015).
The results of the present study also revealed that the prevalence of increased TC was high in female (4%) than in males (0.7%). Similarly, Sengwayo *et al.* (2012); Nguyen *et al.* (2015) arrived at the same conclusion where they reported that the prevalence of TC was also high among girls (8.9%) than in boys (5.9%).

Although majority of the study participants (males=92.7% vs females=89.4%) had normal triglycerides levels, the results also found that 7.3% of males and 10.6% of females had Triglycerides in high category. Sekokotla *et al.* (2017) found almost similar results where it was reported that 9.5% of males and 8.2% of females had a Triglycerides in high category. The current study shows that there is a presence of abnormal cholesterol among rural adolescent. The results

are confirmed by the findings of Nguyen *et al.* (2015) where they concluded that one in five children and adolescents (21%) had at least one abnormal cholesterol. It has been reported that children and adolescents with obesity had high prevalence of high level of TG, LDL-C, TC and low HDL-C (Nguyen *et al.,* 2015; Lartey *et al.,* 2018).

5.9 Blood pressure readings of study participants

According the Fourth Report on the Diagnosis, Evaluation, and Treatment of High Blood Pressure (2005) SBP of <90th percentile or SBP <120mmHg and DBP of DBP<90th percentile or DBP <80mmHg denotes normotensive. The results of the study suggest that the majority of the study participants were normotensive. More than a third (38%) of male and almost ten percent (9.4%) of female participants had both SBP and DBP in pre-hypertension category, while a few (8%) of male and 16% of female participants had both SBP and DBP in hypertension category in the current study. The study conducted in Kwa-Zulu Natal province of South Africa among grade 8 reported a high prevalence of prehypertension and hypertension in male and female which were 52.5% and 38.3%, respectively (Bhimma *et al.,* 2018). In the study conducted in Mthatha, South Africa reported that the prevalence of pre-hypertension and hypertension was 13.6% and 22% in males and 11.7% and 20.9% in females respectively (Nkeh-Chungag *et al.,* (2015). Mkhoto and Mabaso (2012) reported that adolescents in Limpopo, boys had a significant higher SBP than their counterparts while girls had higher DBP than boys. Ujunwa *et al.* (2013) in study conducted in Nigeria among adolescents the prevalence of pre-hypertension and hypertension was lower than in the present study with 17.3% and 5.4% respectively.

Noubiap *et al.* (2017) reported that individuals with high BMI have excess fat leading to elevated blood pressure via an increase in sympathetic activity and subsequent sodium reabsorption and increased peripheral vascular resistance. Furthermore, hypertension play a role of a mediator in the association of obesity with increased risk of cardiovascular diseases (Narkiewicz, 2006 and Essouma *et al.,* 2015). Bhimma *et al.* (2018) reported that increased rate of obesity and its association with hypertension is due to transition to westernised lifestyle with more sedentary lifestyle and dietary habits consisting of processed foods. With obesity epidemic increasing among children and adolescents, the incidence of elevated blood pressure has increased to a point of raising public health concern as it can track from childhood to adulthood (Nkeh-Chungag *et al.,* 2015 and Noubiap *et al.,* 2017).

5.10 Energy and nutrient intake of study participants

The current study reports a mean intake of energy slightly lower than RDI in males and a higher than RDI in females. Contrary, Wrottesley *et al.* (2019) reported that rural South African boys to have higher energy intake than girls. Studies tracking nutrient intakes (Park *et al.*, 2004; and Ochola and Masibo, 2014) reported insufficient energy intake among adolescents. Carbohydrate, total protein and total fats was above recommended among adolescents in the current study. Wrottesley *et al.* (2019) reported that increasing adiposity in adolescents is determined by high intake of energy dense food and food high in sugar and fats but low in essential micronutrients nutrients. Furthermore, consumption of fats and high-energy food to be a contributing factor of obesity (Ochola and Masibo, 2014).

The present study also reported low intake of micronutrients such as iron, calcium, zinc, selenium, vitamin A, vitamin C, vitamin D, vitamin E, and folate in female and low intake in vitamin A, vitamin C, vitamin D, vitamin E, folate, selenium and calcium in male. The results of the study are congruent to the study done in South African adolescents where a low intake of calcium, iron, zinc, selenium, vitamin A, riboflavin, nicotinic acid and vitamin 6 was reported (Mackeown *et al.,* 2007). Ochola and Masibo (2014) reported minimum intake of micronutrients among school going children and adolescents. There has been a change (ALjaradah *et al*.,2019) in eating patterns of youth which led to increased consumption of added sugar, saturated fats with inadequate consumption of micronutrients such as iron, calcium zinc and potassium as well as vitamin A, C, D and folic acid. Energy dense, high fat, low fibre intake is associated with obesity and cardiometabolic risk factors among adolescents (Appannah *et al.,* 2015). The results of the study conducted by Wrottesley *et al.* (2019) in South African adolescent confirm that dietary intake demonstrates a transition towards energy dense, food high in sugar and fats but low in essential micronutrients. ALjaradah *et al.* (2019) conveyed that the majority of adolescents are not attentive of long-term complications and consequences of their current dietary intake and unhealthy dietary habits and behaviour.

In the current study, the mean calcium intake was extremely low in both males (215.51mg/d) and females (218.32 mg/d) in the current study. The results suggest that the study participants did not meet the daily calcium requirements. The results of the current study are in agreement with the study conducted by Mackeowon *et al.* (2007) where it was reported that 95% of South African children had their mean calcium intake less than half of the recommended RDA. In addition, studies (Park *et al.,* 2004; Napier and Theron, 2015 and Allioua *et al.,* 2015) reported low

consumption of calcium among adolescents. Low calcium intake is associated with increased appetite and overconsumption of fats which result in increased adiposity (Major *et al.,* 2008 and Allioua *et al.,* 2015).

5.11 Pocket money, lunch box and buying food at school by the participants

Almost all male (96%) and female (97.8%) participants carried R20 or less as pocket money. Shisana *et al.* (2013) reported similar results where the majority of both boys (97.1%) and girls (98.1%) took R20 or less to school as pocket money. Reddy *et al.* (2013) found that over half (55.4%) of the learners receiving less than R20 pocket money. Pocket money is a risk of obesity and was positively associated with frequency of consuming sugar beverages, snacks and fast food (Li *et al.,* 2017). The reason could be that a study has shown that pocket money influences dietary intake of school children, because many children prefer to buy what they want most of which are food high in energy, fats and sugar (Shisana *et al.,* 2013). Neumark-Sztainer *et al*. (2005) confirms that adolescents purchase snacks and soft drinks.

The present study further reported that half of male (50%) and more than half of female (53.3%) participants buy food at school daily. It was reported that 70% of South African adolescents purchase unhealthy food items at school (Wrottesley et al., 2019).

The present study further report that the majority of male (88%) and female (67.8%) participants never carried a lunch box to school. Congruently, a study conducted by Sedibe *et al.* (2018) reported that more than 70% of adolescents were irregular lunchbox users. Shisana *et al.* (2013) also found that 53.5% of males and 48.7% females did not take a lunch box to school. In addition, black African children were less likely to take a lunch box to school compared to children from another race groups (Shisana *et al.*, 2013) and this is confirmed by the results of the current study. Adolescents spend most of the time in school and have at least one meal a day there (Sallis and Glanz, 2009). According to ALjaraedah *et al.* (2019), adolescents reported that their eating habits are influenced by unhealthy food sold by venders and canteens. Given the researcher's observation and ALjaraedah *et al.* (2019) report, it can be concluded that majority of school venders and canteens offer unhealthy food products which may contribute to development of obesity.

5.12 Physical activity and sedentary lifestyle

5.12.1 Physical activity index

In the present study, more than three quarters (77.5 %) of female and above half (55%) of male participants had poor physical activity indices. The results suggest that participants were leading a sedentary lifestyle. Guthold *et al.* (2020) found that globally prevalence of insufficient physical activity among adolescents was 78.45% for boys and 84.4% for girls. Nationally, almost half of females (47.5%) and more than a third of males (37.7%) participated in insufficient or no physical activity (Reddy *et al.,* 2013). Moreover, Hanson *et al*. (2019) also reported that the majority of males (82%) and all females did not meet the WHO recommendation for daily physical activity. The current study is similar to the findings of WHO (2016) where it was reported that physical activity level is low among adolescents with under 50% meeting the current guide line of 60 minutes of moderate-vigorous physical activity per day in all countries. Furthermore, studies (WHO, 2016; Biljon *et al.,* 2018; Hanson *et al.,* 2019 and Guthold *et al.,* 2020) show that the level of physical activity are lower among girls. As seen in the results of the current study most males engaged in walking, running and played soccer as compared to females. Female participants in the current study were involved in household chores such as preparation of food, cleaning and laundry. Wrottesley *et al.* (2019) also confirms that rural girls were more involved in household chores.

It is known that higher level of physical activity is associated with lower odds of obesity (Katzmarzyk *et al.,* 2015). Sedentary behaviour and low level of physical activity are associated with obesity and chronic conditions including diabetes, hypertension, cardiovascular diseases and several forms of cancer (WHO, 2016). Additionally, low level of physical activity can affect concentration and productivity at school and contribute to social exclusion (WHO, 2016). Progressing technology which is linked to sedentary behaviour compound the challenges of physical activity (Kumar *et al.,* 2015). On the other hand, Biljon *et al.* (2018) stated low physical activity to be partly responsible for the obesity epidemic in South African population.

5.12.2 Traveling to school

The results of the current study indicate that the majority of male (83.2%) and female (80.6%) participants walked to school. The results suggest that study participants were partially physically active since they walked to school on a daily basis although their physical activity indices rendered them physically inactive. The results of the current study are comparable to the findings of the 3rd

SANYRBS (2011) where it was found that the majority (71.4%) of youth reported using non-automated mean (walking and cycling) to go to school (Reddy *et al.,* 2013). Children who walk to school or use bikes are less likely to be overweight than those who use motorised transport (Andegiorgish *et al.,* 2012). As seen in the current study, Sedibe *et al.* (2018) affirm that the majority of rural adolescents walk long distance to school. Walking to school add an amount of physical activity within a daily routine (Kumar *et al.,* 2015). In addition, walking to school provide first steps towards an active lifestyle (Kumar *et al.,* 2015). Any level of physical activity is better than none (WHO, 2016).

5.12.3 Television (TV) viewing

The results of the study indicate that females (15.5%) and males (7.4%) watched TV for 3 hours or more during the week. In Low Middle Income Countries (LMIC) a quarter (27%) of adolescents spend 3 hours or more per day in sedentary behaviour (Ashdown-Franks *et al.,* 2019). Nationally one third (33.1%) of female and more than a quarter (27.4%) of males watched TV for more than 3 hours per day (Reddy *et al.,* 2013). Greater leisure-time in sedentary behaviour (screen time) is associated with high intake of fast food and carbonated drinks (Ramos *et al.,* 2013; and Ashdown-Franks *et al.,* 2019). Draper *et al.* (2014) reported that South African adolescents spent much of their time in sedentary behaviour, the utmost concerning of which is screen time. Adolescent who watch TV more than 2 hour a day are more likely to eat unhealthy food resulting in obesity (Ramos *et al.,* 2013).

5.12.4 Sleeping patterns of the participants

The results of the study show that almost half males (45.3%) vs females (43.6%) of the study participants sleep for 7 hours or less. According to the National Sleep Foundation (2015) the study participants are not sleeping adequately (Hirshkowitz *et al.,* 2015). Studies (Tzischinsky, 2016; Jansen *et al.,* 2018; Gohil and Hannon, 2018) confirm that adolescents sleep 7 hours or less. Insufficient sleep is associated with obesity prevalence and markers of cardo-metabolic risk including insulin resistance, dyslipidaemia and high blood pressure in youth (Tzischinsky, 2016; Chaput and Dutil, 2016; Gohil and Hannon, 2018; Jansen *et al.,* 2018; and Miller *et al.,* 2018). Reasons for this could be that short sleepers have more time and more opportunities for eating because they spend more time awake and on screen time (Chaput and Dutil, 2016).

5.12.5 Lifestyle habits

The present study show that female (37.4%) and of male (48%) had their lifestyle habits were in the 2-3 category. The results suggest that these participants bad lifestyle habits. It can be assumed that their lifestyle habits was detrimental to their health. More than half of males (52.7%) and females (55.9%) were not eating breakfast every day. The results of the study are similar to the findings of Musaiger and Kalam (2014) where it was reported that 52.4% of females and 43% males were more likely to skip breakfast. The prevalence of participants who did not eat breakfast in the current study was higher than the national prevalence of 17.7% (Reddy *et al.,* 2013). Not consuming breakfast daily is associated with obesity (Sedibe *et al.,* 2018). Sedibe *et al.* (2018) found that irregular consumption of eating breakfast to be higher among girls than in boys.

Male (39.3%) and female (31.3%) participants consumed alcohol in the current study. The 3rd SANYRBS (2011), reported that 49.2% of the learners had drank one or more drinks of alcohol in their life time, with more males (53.8%) than female (44.9%) (Reddy *et al.,* 2013). Studies, (Croezen *et al.,* 2007; Loureco, Olivera and Lopes, 2012; and Chakraborty, 2014) show that heavy and excessive consumption of alcohol is positively associated with overall and central obesity among adolescents.

The present study found that male (11.3%) and female (3.1%) smoke. Similarly, Odey *et al.* (2012) also found that 13% of male and 2.1% of female were smokers. Smoking is positively associated with abdominal obesity (Chiolero *et al.,* 2008; Farhat *et al.,* 2010; and Bertoni *et al.,* 2018). Chiolero *et al*. (2008) found that smoking increases insulin resistance resulting in fat accumulation in abdominal region. Odey *et al*. (2012) stated that the prevalence of smoking is increasing among adolescents, posing the risk of cardiovascular diseases among these group (Chiolero et al., 2008). Tobacco use is growing in low-income country targeting these vulnerable population (Farhat *et al.,* 2010).

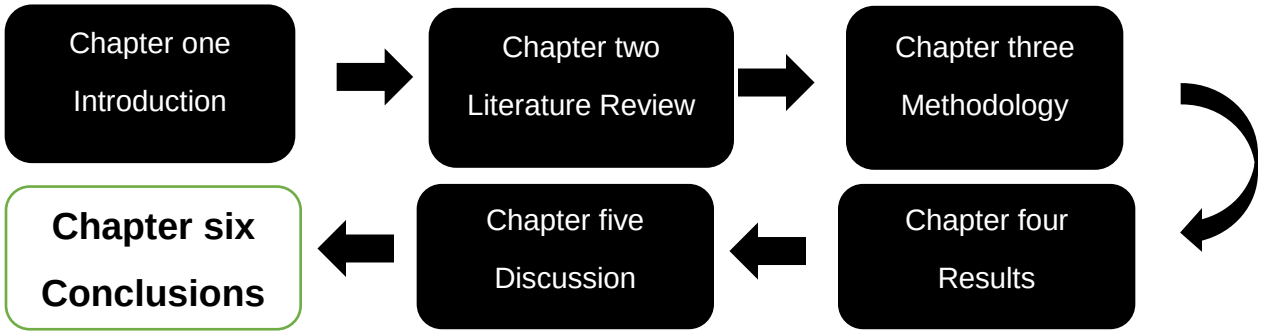
5.13 Limitations of the study

The study has several limitations. The study was a cross-sectional in nature using adolescents from different geographical area within Thulamela municipality. The number of adolescent included in the study was small and generalisability within this group would be limited. The study did not determine BMI and dietary intakes of the parents. The study did not use all anthropometric measurements used to determine fat distribution in the body.

CHAPTER 6

CONCLUSION AND RECOMMENDATION

6.1 Overview



6.2 Summary

The aim of this study was to determine the prevalence and determinants of obesity among adolescents in Vhembe district. A quantitative, cross-sectional study was use to described the prevalence and determinants of obesity among adolescents. To achieve the aim of the study the following objectives had to be achieved:

- To determine the anthropometric status of adolescents using anthropometric measuring techniques.
- To determine biochemical markers (C-reactive protein, cholesterol, and glucose) using biochemical methods.
- To determine blood pressure levels of adolescents.
- To determine the dietary intake of adolescents using quantified Food Frequency Questionnaire.
- To determine physical activity levels of adolescents.
- To correlate the anthropometric status of adolescents with their demographic characteristics, dietary intake, biochemical markers, blood pressure, and physical activity levels.

6.3 Conclusion

- The prevalence of obesity is higher in females than in males. The results observed in the study confirms the trend that is observed in urban children and adolescents. The results of the study suggest a double burden and trend of undernutrition and overnutrition.

- Lifestyle and diet modification should be encouraged to curb the onset of obesity. The predictors of obesity in this study can be modified and avoided to prevent obesity. These predictors include total fat, carbohydrate, SBP and source of income.
- Most of the nutrients consumed by the study participants did not meet their daily requirements. Adolescents tends to eat food that contain sugar and salt and avoid eating fruits and vegetables which contains considerably high amount of micronutrients.
- The results of the current study suggest that the study participants let a sedentary lifestyle. Sedentary lifestyle is associated with chronic diseases of lifestyle later in life. These include Type 2 diabetes, hypertension, and coronary heart diseases.

6.4 RECOMMENDATIONS

- The study recommends the introduction of an effective 60 minutes' physical activity at school per day.
- The DoE should infuse nutrition and physical activity education components in school curriculum and promote active lifestyle.
- Nutrition education about healthy eating should be given to school children.
- The DoE should develop nutrition guideline for food sold by vendors.
- The DoE need to revisit its school feeding scheme for optimal benefits
- There is a need to conduct more studies to address gaps in government intervention programmes in South Africa with a view to promoting adolescent health.

REFERENCES

Affenito SG, Franko DL, Striegel-Moore RH and Thompson D. 2012. Behavioural determinants of obesity: Research findings and policy implications. *Journal of obesity*. Doi: 10.1155/2012/150732

Ahmad A, Zulaily N, Shahril MR, Abdullah SEFH, and Ahmed A. 2018. Association between socioeconomic status and obesity among 12-year-old Malaysian adolescents. PLoS ONE 13(7): e0200577. https://doi.org/10.1371/journal.pone.0200577

Alberga AS, Sigal RJ, Goldfield G, Prud' homme D and Kenny GP. 2012. Overweight and obese teenagers: why is adolescence a critical period? *Paediatric Obesity*.7:261–273. doi:10.1111/j.I2047T-6310.201Y1.00046.x

Alberti G, ZImmet P, Shaw J, Bloomgarden Z, Kaufman F, and Silink M. 2004. Type 2 Diabetes in the Young: The Evolving Epidemic.The International Diabetes Federation Consensus Workshop. *Diabetes Care*. 27 (7): 1798-1811.

ALjaraedah TY, Takruri HR, Tayyem RF. 2019. Dietary practices and nutrient intake among adolescents: A general review. Journal of *Obesity Medicine*.16:100145. https://doi.org/10.1016/j.obmed.2019.100145

Allender S and Rayner M. 2007. The burden of overweight and obesity-related ill health in the UK. Obesity Review. 8,467-473

Allioua M, Djaziri R, Mahdad MY, Gaouar SB, Derradji H, Boudjemaa BM, and Belbraouet S. 2015. Dietary fat intake, micronutritient and obesity among adolescent in Tlemcen (Western Algeria). *Food and Nutrition Sciences*. 6(10):860.

American Heart Association (AHA). 2005. New AHA Recommendations for Blood pressure measurement. *American family physician*. http://www.aafp.org/afp/2005/1001/p1398.html. (Accessed 05 April 2016)

American Heart Association (AHA). 2011. Understanding childhood obesity. Statistical sourcebook. Greenville Avenue Dallas 5/11LN1684

Andegiorgish AK, Wang J, Zhang X, Liu NX, and Zhu Hong. 2012. Prevalence of overweight, obesity and associated risk factors among school children and adolescents in Tianjin, China. *European Journal of paediatrics*, 171:697-703

Ani PN, Uvere PO, and Ene-Obong HN. 2014. Prevalence of overweight, obesity, and thinness among adolescents in rural and urban areas of Enugu State, Nigeria. *International Journal of Basic and Applied Sciences*, 3(1):1-7

Ann & Robert H. Lurie Children's Hospital of Chicago. (2019, May 21). Only half of US kids and teens have ideal cholesterol levels. *Science Daily*. Retrieved January 28, 2020 from www.sciencedaily.com/releases/2019/05/190521135655.htm

Anuradha R K, Sathyavathi R B, Reddy T M, Themalatha R, Sudhakar G, Geetha P, and Reddy K K. 2015. Effect of social and environmental determinants on overweight and obesity prevalence among adolescent school children. *Indian Journal of Endocrinology and Metabolism*, 19(2): 283-287

Appannah, G., Pot, G. K., Huang, R. C., Oddy, W. H., Beilin, L. J., Mori, T. A., … Ambrosini, G. L. (2015). Identification of a dietary pattern associated with greater cardiometabolic risk in adolescence. *Nutrition, metabolism, and cardiovascular diseases : NMCD*, *25*(7), 643–650. doi:10.1016/j.numecd.2015.04.007

Arora M, Nazar GP, Gupta VK, Perry CL, Reddy KS, and Stigler MH. 2012. Association of breakfast intake with obesity, dietary and physical activity behavior among urban school-aged adolescents in Delhi, India: results of a cross-sectional study. *BMC Public Health*. 12(1):881. http://www.biomedcentral.com/1471-2458/12/881

Aryeetey R, Lartey A,Grace SM, Nti H, Colecraft E and Brown P. 2017. Prevalence and predictor of overweight and obesity among school-aged children in urban Ghana. *BMC Obesity Journal*.4:38. DOI:10.118/s40608-017-0174-0

Ashdown-Franks G, Vancamfort D, Firth J, Smith L, Sabiston CM, Stubbs B and KoyanaginA. 2019. Association of leisure-time sedentary behaviour with fast food and carbonated soft drink consumption among 133,555 adolescents aged 12-15 years in 44 low- and middle-income countries. *International journal of behavioural nutrition and physical activity*. 16(35):1-11. Doi.org/10.1186/s12966-019-0796-3

Asztalos B F, Michael SH, Katalin VH, Ann YM, Naga PC, and Ernst JS. 2014. "Obesity Associated Molecular Forms of C-Reactive Protein in Human." *PLoS ONE* 9 (10): 1–6. doi: 10.1371/journal.pone.0109238.

Atiku MK and Yunusa. 2009. Body Mass Index Variations among adolescents from Kano Metropolis, Nigeria. *Bayero Journal of pure and applied sciences*. 2 (2):102-104

Belloc N B, Breslow L. 1972. Relationship of physical health status and health practices. Preventive medicine1(3):409-21.

Bertonia N, de Almeidaa LM, Szklob M, Figueiredoc VC,and Szkloa AS. 2018. Assessing the relationship between smoking and abdominal obesity in a National Survey of Adolescents in Brazil. *Preventive Medicine* .111:1–5. https://doi.org/10.1016/j.ypmed.2018.02.017

Bibiloni MdM, Salas R, Novelo HI, Villarreal JZ, Sureda A, Tur JA .2015. Serum Lipid Levels and Dyslipidaemia Prevalence among 2–10 Year-Old Northern Mexican Children. *PLoS ONE* 10(3): e0119877. doi:10.1371/journal.pone.0119877

Biddle SJH, Gorely T, Pearson N, and Bull FC. 2011. An assessment of self-reported physical activity instruments in young people for population surveillance: Project ALPHA. International Journal of Behavioral Nutrition and Physical Activity. 8(1). http://www.ijbnpa.org/content/8/1/1

Biljon AV, McKune AJ, DuBose KN, Kolanisi U, and Semple SJ. 2018. Physical activity levels in urban-based South African learners: Across-sectional study of 7 348 participants. *South African Medical Journal*. 108(02): 126-131.DOI:10.7196/SAMJ. 2018.v108i2.12766

Bhimma R, Naicker E, Gounden V, Nandlal L, Connolly C, Hariparshad S. 2018. Prevalence of Primary Hypertension and Risk Factors in Grade XII Learners in KwaZulu-Natal, South Africa. *International journal of hypertension*. 2018.http://doi.org/10.1155/2018/3848591

Boncler M, Wu Y. and Watala C. (2019) 'The Multiple Faces of C-Reactive Protein-Physiological and Pathophysiological Implications in Cardiovascular Disease', *Molecules (Basel, Switzerland)*, 24(11). doi: 10.3390/molecules24112062.

Braithwaite I, Stewart AW, Hancox RJ, Beasley R, Murphy R, and Mitchell EA. 2013. The worldwide Association between television viewing and obesity in children and adolescents: Cross-sectional study. *PLoS ONE* 8(9): e74263. Doi:10.1371/*journal.pone*.0074263

Brasil A R, Norton2R C, Rossetti M B, Leão E, and Mendes R P.2007. C-reactive protein as an indicator of low intensity inflammation in children and adolescents with and without obesity. *Journal of paediatric.83 (5):477-480*

Chakraborty S. 2014. Analysis of NHANES 1999-2002 data reveals noteworthy association of alcohol consumption with obesity. Annals of Gastroenterology: Quarterly Publication of the Hellenic Society of Gastroenterology.27(3):250-257.

Chaput J and Dutil C. 2016. Lack of sleep as a contributor to obesity in adolescents: impacts on eating and activity behaviours. *International Journal of Behavioural Nutrition and Physical Activity* 13(103). DOI 10.1186/s12966-016-0428-0

Cho KW and Lumeng CN. 2011. SirT1: A Guardian at the gates of adipose tissue inflammation. Commentary. *Diabetes journal*. 60 (12):3200-3102. https://doi.org/10.2337/db11-1308

Choi J, Joseph L and. Pilote L. 2013. Etiology and Pathophysiology/Obesity Comorbidities. Obesity and C-reactive protein in various populations: a systematic review and meta-analysis. *obesity reviews.*14: 232–244. doi: 10.1111/obr.12003

Choukem SP, Kamdeu-Chedeu J, Leary SD, Mboue-Djieka Y, Nebongo DN, Akazong C, Mapoure YN, Hamilton-Sheild JP, Gautier J and Mbanya JC. 2017. Overweight and obesity in children aged 3-13 years in urban Cameroon: a cross-sectional study of prevalence and association with socio-economic status. *BMC Obesity journal*. 4:7. Doi 10.1186/s40608-017-0146-4

Chiolero A, Faeh D, Paccaud F, Cornuz J. 2008. Consequences of smoking for body weight, body fat distribution, and insulin resistance. *The American journal of clinical nutrition*. 87(4):801–809, https://doi.org/10.1093/ajcn/87.4.801

Cole TJ and Lobstein T. 2012. Extended international (IOTF) body mass index cut-off for thinness, overweight, and obesity. *Pediatric obesity*.7:284-294

Countryman AJ, Saab PG, Llabre MM, Penedo FJ, McCalla JR and Schneiderman N. 2013. Cardio-metabolic risk in adolescents: Associations with physical activity, fitness and sleep. Annals of Behavioural Medicine: *A Publication of the society of behavioural Medicine*, 45(1):121-131

Craig E, Reilly JJ and Bland R. 2015. Risk factors for overweight and over-fatness in rural South African children and adolescents. *Journal of Public Health*.doi:10.1093. ISSN:1741-3850

Croezen S , Visscher TLS, Bogt NCW, Veling ML and Haveman-Nies A. 2009. Skipping breakfast, alcohol consumption and physical inactivity as risk factors for overweight and obesity in adolescents: results of the E-MOVO project. *European Journal of Clinical Nutrition* .63: 405–412. doi:10.1038/sj.ejcn.1602950

Daniels SR, Greer FR. 2008. Lipid Screening and Cardiovascular Health in Childhood. *American Academy of Paediatrics.*122(1):198-208. DOI: 10.1542/peds.2008-1349

Datar A.2017. The more the heavier? Family size and childhood obesity in the U.S. *Journal of Social science and medicine*. 180:147-151.http://dx.doi.org/10.1016/j.socscimed.2017.03.035

DeBoer MD. 2013. Obesity, systemic inflammation, and increased risk for cardiovascular disease and diabetes among adolescents: A need for screening tools to target interventions. Review. *Nutrition Journal*, 29:379-386

De Heredia FP, Gómez-MartÍnez S and Marcos A. 2012. Chronic and degenerative diseases obesity, inflammation and the immune system. 5th international immune-nutrition workshop. *NS proceeding of the Nutrition Society*, 71: 332-338

Department of Health. 2016. Strategy for the prevention and control of obesity in South Africa 2015-2020. South Africa.

Dev DA, McBride BA, Fiese BH, Jones BL, and Cho H. 2013. Risk factors for overweight/Obesity in Preschool Children: An Ecological approach. Mary Ann Liebert, Inc. 09(05)

Draper C, Basset S, de Villiers A, Lambert EV, and the HAKSA Writing Group. 2014. Results from South Africa's 2014 Report Card on Physical Activity for Children and Youth. *Journal of Physical Activity and Health.* 11(1): S98-S104. http://dx.doi.org/10.1123/jpah.2014-0185

Duncan S, Duncan EK, Fernandes RA, Buonani C, Bastos K D-N, Segatto AFM, Codogno JS, Gomes IC, and Freitas Jr IF. 2011. Modifiable risk factor for overweight and obesity in children and adolescents from São Paulo, Brazil. *Bio Medi Central Public Health.* 11:585

D'Adamo E, Guardamagna O, Chiarelli F, Bartuli A, Liccardo D, Ferrari F, and Nobili V. 2015. Atherogenic dyslipidemia and cardiovascular risk factors in obese children. *International journal of endocrinology*. 2015 (912047). https://doi.org/10.1155/2015/912047

Essouma M, Noubiap JJ, Bigna JJ, Nansseu JR, Jingi AM, Aminde LN, Zafack J. 2015. Hypertension prevalence, incidence and risk factors among children and adolescents in Africa: a systematic review and meta-analysis protocol. BMJ open. 5(9):e008472.doi: 10.1136/bnjopen-2015-008472

Farhat T, Iannotti R J, Simons-Morton BG. 2010.Overweight, Obesity, Youth, and Health-Risk Behaviours. *American Journal of Preventive Medicine*.38(3):258–267.doi: 10.1016/j.amepre.2009.10.038

Fernandez JR, Redden DT, Pietrobelli A and Allison DB. 2004. Waist circumference percentiles in nationally representative samples of African-American, European-American, and Mexican-American children and adolescents. *Journal of paediatric*. 145:439-344

Ford ND, Patel SA, and Narayan KM V. 2017. Obesity in Low- and Middle-Income Countries: Burden, Drivers, and Emerging Challenges. Annual Review of Public Health. 38:145–164. https://doi.org/10.1146/annurev-publhealth-031816-044604

Freedman DS, Mel Z, Srinivasan SR, Berenson and Dietz WH. 2007. Cardiovascular risk factors and excess adiposity among overweight children and adolescents: The Bagalusa Heart study. *Journal of pediatric*, 150: 12-17

Galfo M, D'Addezio L, Censi L, Roccaldo R, Martone D. 2016. Overweight and obesity in Italian adolescents: examined prevalence and socio-demographic factors. *Central European journal of public health*. 24(4):262-267.http://dx.doi.org/10.21101/cejph.a4367

Ghomari-Boukhatem H, Bouchouicha A, Mekki K, Chenni K, Belhdj M and Bouchenak M. 2017. Blood pressure, dyslipidaemia and inflammatory factors are related to body mass index in scholar adolescents. *Archives of Medical Science*. 1:46-52. Doi:10.5114/aoms.2017.64713

Giordano P, Vecchio GCD, Cecinati V, Delvecchio M, Altomare M, De Palma F, De Mattia D, Cavallo L, and Faienza MF.2011. Metabolic, inflammatory, endothelial and haemostatic markers in a group of Italian obese children and adolescents. *European Journal Pediatric*, 170: 845-850.

Gebrie A, Alebel A, Zegeye A, Tesfaye B and Ferede A. 2018. Prevalence and associated factors of overweight/ obesity among children and adolescents in Ethiopia: a systematic review and meta-analysis.BioMed Central Journals,5:19

Gibson RS. Principles of nutritional assessment. Oxford university press, USA; 2005.

Global Nutrition Report .2015. Africa brief actions and accountability to advance nutrition and sustainable development

Gohil A and Hannon TS. 2018. Poor Sleep and Obesity: Concurrent Epidemics in Adolescent Youth. *Frontiers in Endocrinology*. 9(364). doi: 10.3389/fendo.2018.00364

Goulart M, Schuh D, Moraes D, Barbiero S, Pellanda L. 2017. Serum C-reactive protein levels and body mass index in children and adolescents with CHD. *Cardiology in The Young*.27(6):1083-1089.

Gupta R, Rao RS, Misra A and Sharma SK. 2017. Recent trends in epidemiology of dyslipidaemias in India. *Indian Heart Journal*. 69 (382-392). Doi.org/10.1016/j.ihj.2017.02.020

Guo X, Zheng L, Li Y, Zhang X, Yu S, Yang H, Zhang X, Sun Z, and Sun Y. 2013. Prevalence and risk factors of being overweight or obese among children and adolescents in Northeast China. *International Pediatric Research Foundation Inc*,74(4):443-449

Guthold R, Stevens GA, Riley LM, Bull FC. 2020. Global trends in insufficient physical activity among adolescents: a pooled analysis of 298 population-based surveys with 1· 6 million participants. *The Lancet Child and Adolescent Health.* 4(1):23-35. https://doi.org/10.1016/S2352-4642(19)30323-2Get rights and content

Gøbel RJ, Jensen SM, Frøkiær H, Mølgaard C and Michaelsen KF. 2012. Obesity, inflammation and metabolic syndrome in Danish adolescents. Foundation Acta Pædiatrica. 101:192–200. ISSN 0803–5253. DOI:10.1111/j.1651-2227.2011.02493.x

Güngör NK. 2014. Overweight and obesity in children and adolescents. *Journal of clinical research in paediatric endocrinology*. 6(3):129-143. doi: 10.4274/jcrpe.1471

Hanson SK, Munthali RJ, Micklesfield LK, Lobelo F, Cunningham SA, Hartman TJ, Norris SA and Stein AD. 2019. Longitudinal patterns of physical activity, sedentary behaviour and sleep in urban South African adolescents, Birth-To-Twenty Plus cohort. Hanson et al. *BMC Paediatrics* .19(241). https://doi.org/10.1186/s12887-019-1619-z

Harmse B and Kruger HS. 2010. Significant differences between serum CRP levels in children in different categories of physical activity: the PLAY study. *Cardiovascular Journal of Africa* .21(6):316-322

Harris T, Malczyk S, Jaffer N, Steyn NP. 2019. How well are adolescents in the Gouda district of Western Cape meeting the South African food-based dietary guidelines for fat, sugar and sodium? *Journal of Consumer Sciences*. 4

He W, James SA, Merli MG and Zheng H. 2014. An increasing socioeconomic gap in childhood overweight and obesity in China. *American journal of public health.* 104(1):14-22

Hirshkowitz M, Whiton K, Albert SM, Alessi C, Bruni O, DonCarlos L, Hazen N, Herman J, Adams Hillard PJ, Katz ES, Kheirandish-Gozal L, Neubauer DN, O'Donnell AE, Ohayon M, Peever

J, Rawding R, Sachdeva RC, Setters B, Vitiello MV, and Ware JC. 2015. National Sleep Foundation's updated sleep duration recommendations: Final report. Sleep Health. *Journal of the national sleep Foundation.* 1(4): 233-243. http://dx.doi.org/10.1016/j.sleh.2015.10.0042352-7218/© 2015 National Sleep Foundation.

Illain-Gomez T, Gonzalez-Ortega M, Orea-Soler I, Alcaraz-Tafalla MS, Aragon-Alonso A, Pascual-Diaz M, Perez-Paredes M, and Lozano-Aimela ML. 2012. Adiponectin, C-Reactive protein, Tumor Necrosis Factor-α, and interleukin-6 after bariatric surgery, *Plos One*, 22: 950-955

Illán-Gómez F, Gonzálvez-Ortega M, Orea-Soler I, Alcaraz-Tafalla MS, Aragón-Alonso A, Pascual-Díaz M, Pérez-Paredes M, Lozano-Almela ML. 2012. Obesity and inflammation: change in adiponectin, C-reactive protein, tumour necrosis factor-alpha and interleukin-6 after bariatric surgery. Obesity surgery.22(6):950-955.

Jansen EC, Dunietz GL, Chervin RD, Baylin A, Baek J, Banker M, Song PXK, Cantoral A, Rojo MMT, and Peterson KE. 2018. Adiposity in Adolescents: The Interplay of Sleep Duration and Sleep Variability. *The journal of paediatrics.203:309-316* https://doi.org10.1016/j.jpeds.2018.07.087

Jiang S, Lu W, Zong X Ruan H and Liu Y. 2016. Obesity and hypertension (Review). *Experimental and Therapeutic Medicine*. 12:2395-2399. DOI:10.3892/etm.2016.3667

Jolliffe CJ and Janssen, I. 2006. Distribution of Lipoprotein by age and gender in adolescents. *Circulation Journal of American Heart Association*,114:1056-1062

Junaibi A Al, Abdule A, Sabri S, Hag-Ali M, and Nagelkerke N. 2013.The prevalence and potential determinants of obesity among school children and adolescents in Abu Dhabi, United Arab Emirates. Int*ernational Journal of Obesity*,37: 68-74

Kabbaoui EM, Chda A, Bousfiha A, Aarab L, Bencheikh R and Tazi A.2018. Prevalence of and risk factors for overweight and obesity among adolescents in Morocco*. East Mediterranean Health Journal*. 24(6):512–521. https://doi.org/10.26719/2018.24.6.512

Katzmarzyk P T, Barreira T V, Broyles S T, Champagne C M, Chaput J P, Fogelholm M, Hu G, Johnson W D, Kuriyan R, Kurpad A, Lambert E V, Maher C, Maia J, Matsudo V, Olds T, Onywera V, Sarmiento O L , Standage M, Tremblay M S, Tudor-Locke C, Zhao P, and Church T S. 2015. Physical Activity, Sedentary Time, and Obesity in an International Sample of Children. *Medical Science in Sports Exercise*. 47(10):2062–2069. https://doi.org//10.1249/MSS.0000000000000649

Kavey RW. 2015. Combined dyslipidaemia in childhood. Journal of Clinical Lipidology.9(S41-S56. http://dx.doi.org/10.1016/j.jacl.2015.06.008.

Kelishadi R, Mirmoghtadaee P, Najafi H, Keikha M. 2015. Systematic review on the association of abdominal obesity in children and adolescents with cardio-metabolic risk factors. *Journal of Research in Medical Science*.20:294-307

Kimani-Murage EW, Kahn K, Pettifor JM, Tollman SM, Dunger DB, Gómez-Olivé XF and Norris SA. 2010. The prevalence of stunting, overweight and obesity, and metabolic disease risk in rural South African children. *Bio Med central Public Health*.10:158. http:www.biomedcentral.com/1471-2458/10/158

Kleiser C, Rosario AS, Mensink GBM, Prinz-Langenohl R, and Kurth B. 2009. Potential determinants of obesity among children and adolescents in Germany: result from the cross-sectional KIGGS study. *Bio Med Central Public health,* 4(5)379-385

Kotain MS, Ganesh KS, and Kotian SS. 2010. Prevalence and determinants of overweight and obesity among adolescent school children of South Karnataka, India. *Indian Journal of Community Medicine*, 35(1): 176-178

Kruger HS, Puoane T, Senekal M, Van Der Merwe MT. 2005. Obesity in South Africa: challenges for government and health professionals. *Public health nutrition*.8(5):491-500. DOI: 10.1079/PHN2005785

Kumar B, Robinson R and Till S. 2015. Physical activity and health in adolescence. *Clinical Medicine*.15 (3): 267–72

Lartey A, Marquis G S, Aryeetey R, and Nti, H. 2018. Lipid profile and dyslipidemia among school-age children in urban Ghana. *BMC Public Health*, 18(1), 320. https://doi.org/10.1186/s12889-018-5196-0

Lee RD and Nieman DC. 2010. *Nutritional Assessment*. 5th edition. McGraw-Hill International Companies Inc

Lee YS. 2009. Consequences of childhood obesity. Annals Academy of Medicine, Singapore; 38(1):75-81

Lee H, Adrew M, Gebremariam A, Lumeng JC and Lee JM. 2014. Longitudinal Association Between Poverty and Obesity from Birth through adolescence. *American journal of Public Health*. 104(5):70-76

Leedy PD and Ormord JE. 2005. *Practical research; planning and design*. 8th edition. Person Merill Hall

Li M, Xue H, Jai P, Zhao Y, Wang Z, Xu F and Wang Y. 2017. Pocket money, eating behaviors, and weight status among Chinese children: The children obesity study in China mega-cities. *Preventive Medicine Journal*.100:208-215.

Liou YM, Liou T and Chang L. 2010. Obesity among adolescents: sedentary leisure time and sleeping as determinants. *Journal of Advanced Nursing*. Blackwell Publishing Ltd

Liu W, Liu R, Li B, Pallan M, Cheng KK, and Adab P. 2016. Socio-economic determinants of childhood obesity among primary school children in Guangzhou, China. *BMC Public Health*, 16:482

Lumeng CN and Cho KW. 2011. SirT1: A guardian at the gates of adipose tissue inflammation. Commentary. *Diabetes journal*, 60: 3100-3102

Lumeng CN and Saltiesl AR. 2011. Inflammatory links between obesity and metabolic disease. Review series. *Journal of Clinical Investigation*, 121(6): 2111-2117

Lourenc S, Oliveira A and Lopes C. 2012. The effect of current and lifetime alcohol consumption on overall and central obesity. *European Journal of Clinical Nutrition*. 66:813-818. doi:10.1038/ejcn.2012.20;

MacKeown J M, Pedro T M and Norris S A.2007. Energy, macro- and micronutrient intake among a true longitudinal group of South African adolescents at two interceptions (2000 and 2003): The Birth-to-Twenty (Bt20) Study. *Journal Public Health Nutrition*. 10(6): 635–643. DOI: 10.1017/S1368980007258483

Mahanta TG, Mahanta B, Deyri A, Baruah S, Rasalley R, and Mahanta B.2018. determinants of hypertension amongst school going adolescents aged 13-15 years in Assam. *Clinical Epidemiology and Global Health*, 6:137-146

Mamabolo RL, Van Rooyen JM, Alta E, Schutte M, Monyeki A, and Kruger HS. 2011. Association between blood pressure, measures of body composition and lifestyle factors in township adolescents, North-west Province, South Africa. *Africa journal for physical, Health Education, Recreation and Dance (AJPHERD),*17(1):51-68

Manyanga T, El-Sayed H, Doku DT, and Randall JR. 2014. The prevalence of underweight, overweight, obesity and associated risk factors among school-going adolescents in seven African countries. *BioMedical Central of Public Health*,14:887

Mashiane JTM, Monyeki KD, Kengne AP, Rosina NM, and Monyeki MS. 2018. Ellisras Longitudinal Study conference 2017 The relationship between dietary intake and body mass index among young rural adults in South Africa aged 18 to 30 years: the Ellisras longitudinal study (ELS18). Cardiovascular 2 journal of Africa. 29.DOI: 10.5830/CVJA-2018-033

McKersie J and Baard ML. 2014. Obesity in 7-10-year-old children in urban primary schools in Port Elizabeth. SAJSM.26(2):55-58

Menezes IH, Neutzling MB, and Tadder deAC. 2009. Risk factor for overweight and obesity in adolescents of a Brazilian university: a case-control study. *Nutrición Hospitalaria,* 24 (1): 17-24

Mkhonto SS, Mabaso MLH. 2012. Relationship between obesity and blood pressure in school-going adolescents in the Limpopo Province of South Africa. *Obesity Research and Clinical Practice*.237: doi:10.1016/j.orcp.2012.02.001

Micklesfield LK, Pedro TM, Kahn K, Kinsman J, Pettifor JM, Tollman S and Norris SA. 2014. Physical activity and sedentary behaviour among adolescents in rural South Africa: levels, patterns and correlates. *BMC Public Health*.14(40). http://www.biomedcentral.com/1471-2458/14/40

Miller WM, Nori-Janosz KE, Lillystone M, Yanez J, and McCullough PA. Obesity and Lipids. *Current Cardiology Reports* 2005. 7:465–470. ISSN 1523-3782

Mitolo LT, Dare WN, and Chris-Ozoko LE. 2015. Body Mass Index (BMI) and Waist Hip Ratio (WHR) among young adults of Delta State Origin. *World Journal of Medical Sciences*, 12(1):21-25

Mogre V, Gaa PK, and Abukari RNS. 2013. Overweight, obesity and thinness and associated factors among school-aged children (5-14 years) in Tamale Northern Ghana. *European Science Journal,* 9(20). ISSN: 1857-7881

Monyeki MA, Awotidebe A, Strydom GL, de Ridder JH, Mamabolo RL, and Kemper HCG. 2015. The challenges of underweight and overweight in South African children: Are we winning or losing the battle? A Systematic Review. *International Journal of Environmental Research and Public Health*. 12(1156-1173). Doi:10.3390/ijerph120201156

Muhihi AJ, Mpembeni RNM, Njelekela MA, Anaeli A, Chillo O, Kubhoja S, Lujani B, Manhembe M, and Ngarashi D. 2013.Prevalence and determinants of obesity among primary school children in Dar es Salaam, Tanzania. *Archives of Public Health,* 71:26

Musa DI, Toriola AL, Monyeki MA, Lawal B. 2012. Prevalence of childhood and adolescent overweight and obesity in Benue State, Nigeria. Tropical Medicine & International Health. Nov;17(11):1369-75. https://doi.org/10.1111/j.1365-3156.2012.03083.x

Musaiger AO, Kalam F. 2014. Dietary habits and lifestyle among adolescents in Damascus, Syria. *Annals of Agricultural and Environmental Medicine*. 21(2): 416–419. doi: 10.5604/1232-1966.1108616

Mushengezi B and Chillo P. 2014. Association between body fats composition and blood pressure level among secondary school adolescent in Dar es Salaam, Tanzania*. Pan African Medical Journal,* 19: 327

Muthuri SK, Francis CE, Wachira LM, LeBlanc AG, Sampson M, Onywera VO, and Tremblay MS. 2014. Evidence of an overweight/Obesity transition among school-aged children and youth in Sub-Saharan Africa: A Systematic Review. Plos One 9(3):e92846. doi10.1371

Napier C, Oldewage-Theron W. Dietary intake and nutritional status of adolescent girls and young women in Durban, South Africa. 2015.Journal of family Ecology and Consumer Sciences. 43. ISSN 0378-5254

Narkiewicz K. 2006. Obesity and hypertension the issue is more complex than we thought. Nephhrol Dail Transplant journal. 21:264-267. Doi:10.1093/ndt/gfi290

Negash S, Agyemang C, Metsha TE, Peer N, Erasmas RT, and Kengne AP. 2017. Differential prevalence and association of overweight and obesity by gender and population group among school learners in South Africa: A cross-sectional study. *BioMedical Central Obesity*, 4:29

Neumark-Sztainer D, French SA, Hannan PJ, Story M and Fulkerson JA. 2005. School lunch and snacking patterns among high school students: Associations with school food environment and policies. *International Journal of Behavioural Nutrition and Physical Activity.* 2 (14) doi:10.1186/1479-5868-2-14

Nguyen D, Kit B, and Carroll M. 2015. Abnormal Cholesterol Among Children and Adolescents in the United States, 2011–2014. NCHS Data Brief. Number 228

Ngwenya NA and Ramukumba TS. 2017. Prevalence of adolescent obesity at a high school in the City of Tshwane'. *Curationis* 40(1), a1662. https://doi.org/10.4102/curationis.v40i1.1662

Nkeh-Chungag B N, Sekokotla AM, Sewani-Rusike C, Namugowa A, Iputo JE. 2015. Prevalence of Hypertension and Pre-hypertension in 13-17-Year-Old Adolescents Living in Mthatha - South Africa: A Cross-Sectional Study. *Central European Journal of Public Health*. 23(1):59-64. DOI: 10.21101/cejph. a3922

Nirmala A, Venkataraman P, Kanniammal C, Rani A, Arulappan J.2018. Prevalence of Obesity and Associated Risk Factors among Adolescents in Kancheepuram, South India. *International Journal of Nursing Education, January-March.*10(1): 55-60.DOI 10.5958/0974-9357.2018.00012.0

Noubiap JJ, Essouma M, Bigna JJ, Jingi AM, Aminde LN, and Nansseu JR. 2017. Prevalence of elevated blood pressure in children and adolescents in Africa: A systematic review and Met-analysis. Lancet Public Health,2: e375-e386. https://doi.org/10.1016/S2468-2667(17)30123-8

Ochola S, and Masibo PK. 2014. Dietary intake of schoolchildren and adolescents in developing countries. *Annals of Nutrition and Metabolism*. 64(2):24-40. https://doi.org/10.1159/000365125

Odey FA, Okokon IB, Ogbeche JO, and Terver G. 2012. Prevalence of cigarette smoking among adolescents in Calabar city, south-eastern Nigeria. *Journal of Medicine and Medical Sciences.* 3(4):237-242.

Ogunkunle MO, and Oludele AS. 2013. Food intake and meal pattern of adolescents in school in Ila Orangun, South-west Nigeria. *South African Journal of Clinical Nutrition*, 26(4):188-193

Oliveria SA, Ellison RC, Moore LL, Gillman MW, Garrahei EJ, and Singer MR. 1992. Parent-child relationship in nutrient intake: the Framingham Children's study. *American Journal of Clinical Nutrition*, 56: 593-598

Olza J, Aguilera CM, Gil-Campos M, Leis R, Bueno G, Martínez-Jiménez MD, Valle M, Cañete R, Tojo R, Moreno LA and Gil A. 2012. Myeloperoxidase is an early Biomarker of inflammation and cardiovascular risk in pre-pubertal obese children. *American Diabetes Association*, 35(11): 2373-2376

O'Dea JA, Chiang H, and Peralta L. 2014. Socioeconomic patterns of overweight, obesity but not thinness persists from childhood to adolescence in a 6-year longitudinal cohort of Australian school children from 2007 to 2012. *BioMed Central journal*. ISSN 1471-2458

Osman HAM, Elsadek N, Abdullah MA. 2013. Type 2 Diabetes in Sudanese children and Adolescents. *Sudan Journal of Paediatrics*.13(2):17-23.

Park S, Paik H, Skinner JD, Spindler AA, and Park H. 2004. Nutrient intake of Korean-American, Korean, and American adolescents. *Journal of the American Dietetic Association*. 104:242-245. Doi: 10.1016/j.jada.2003.11.015.

Pedro TM, Micklesfied LK, Kahn K, Tollman SM, Pettifor M and Norris SA. 2016. Body Image satisfaction, Eating Attitudes and perceptions of female body silhouettes in rural South African adolescents. PLOS ONE 11(5): e0154784. Doi:10.1371/journal.pone.0154784

Pedro TM, Kahn K, Pettifor JM, Tollman SM, and Norris SA. 2014. Under and overnutrition and evidence of metabolc disease risk in rural black South African children and adolescents. South *African Journal of Clinical Nutritio*.27(4):194-200

Poskitt EME. 2009. Countries in transition: undernutrition to obesity non-stop. *Annals of Tropical Paediatrics*, 29:1-11

Prendergast C, Gidding SS. 2014. Cardiovascular risk in children and adolescents with type 2 diabetes mellitus. Current diabetes reports. 14(2):454.

Raj M. 2012. Obesity and cardiovascular risk in children and adolescents Review Article. *Indian Journal of Endocrinology and Metabolism.* Doi:10.4103/2230-8210.91176

Ramos E, Costa A, Araujo J, Severo M, and Lopes C. 2013. Effect of television viewing on food and nutrient intake among adolescents. *Nutrition Journal.* 29:1362–1367

Reddy SP, James S, Sewpaul R, Koopman F, Funani NI, Josie J, Masuka P, Kambaran NS, Omardien RG. 2010. Umthente Uhlaba Usamila- The South African Youth Risk Behaviour Survey

2008. Cape Town: *South African Medical Research Council*. ISBN: 978-1-920014-70-4.http:www.ncbi.nlm.nih.gov/pmc/articles/PMC3483977/

Reddy SP, Resnicow K, James S, Funanil N, Kambaran NS, Omardien ARG, Masuka P, Sewpaul R, Vaughan RD and Mbewu A. 2012. Rapid increase in overweight and obesity among South African adolescents: Comparison of data from South African National Risk Behaviour Survey in 2002 and 2008. *American Journal of Public Health*, 102(2):262-268

Reinehr T. 2013. Type 2 diabetes mellitus in children and adolescents. *World Journal of Diabetes.* 4(6): 270-281 DOI: http://dx.doi.org/10.4239/wjd.v4.i6.270

Rocha VZ, Folco EJ. 2011. Inflammatory concepts of obesity. *International journal of inflammation*. 2011(52906).https://doi.org/10.4061/2011/529061

Rodriguez-Hernandez H, Simentak-Mnia LE, Rodriguez-Ramirez G, and Reyes-Romero MA. 2013. Obesity and inflammation: Epidemic, Risk Factors, and Markers of Inflammation. *International Journal of Endocrinology*. Doi 10/1155/2013/678159

Rossouw HA, Grant CC, and Viljoen. 2012. Overweight and obesity in children and adolescents: The South African problem. *South African Journal of Science*.108 (5/6), Art.#907,7.http://dx.doi.org/10.4102/sajs.v108i5/6.907

Rensburg MA, Matsha T, Hoffmann M, Hassan MS, Erasmus RT. 2012. Distribution and association of hs-CRP with cardiovascular risk variables of metabolic syndrome in adolescent learners. *African Journal of Laboratory Medicine*. 1(1). http://dx.doi. org/10.4102/ajlm.v1i1.10

Sabageh AO, Ojofeitimi EO. 2013. Prevalence of obesity among adolescents in Ile-Ife, Osun state, Nigeria using body mass index and waist hip ratio: A comparative study. *Nigerian medical journal: journal of the Nigeria Medical Association*. 54(3):153-156. doi: 10.4103/0300-1652.114566

Sallis JF, Glanz K. 2009. Physical activity and food environments: solutions to the obesity epidemic. *The Milbank Quarterly*. 87(1):123-54.https://doi.org/10.1111/j.1468-0009.2009.00550.x

Sanip Z, Ariffin FD, Al-Tahami BA, Sulaiman WA, and Rasool AH. 2013. Obesity indices and metabolic markers are related to hs-CRP and adiponectin levels in overweight and obese females. Obesity research & clinical practice.7(4):e315-e320. https://doi.org/10.1016/j.orcp.2012.05.002

Schlenz H, Intemann T, Wolters M, González-Gil EM, Nappo A, Fraterman A, Veidebaum T, Molnar D, Tornaritis M, Sioen I, Mårild S, Iacoviello L and Ahrens W .2014. C-reactive protein reference percentiles among pre-adolescent children in Europe based on the IDEFICS study population. *International journal of obe*sity. 38: s26-s31

Sebati RB, Monyeki KD, Monyeki MS, Motloutsi B, Toriola AL, and Monyeki MJL. 2019. Ellisras Longitudinal Study 2017: The relationship between waist circumference, waist-to-hip ratio, skinfolds and blood pressure among young adults in Ellisras, South Africa (ELS 14). *Cardiovascular Journal of Africa* .30(1): 24–28.DOI: 10.5830/CVJA-2018-056

Sedibe MH, Pisa PT, Feeley AB, Pedro TM, Kahn K and Norris SA. 2018. Dietary Habits and Eating Practices and Their Association with Overweight and Obesity in Rural and Urban Black South African Adolescents. *Nutrients*. 10(145). doi:10.3390/nu10020145

Sekokotla MA, Goswami N, Sewani-Rusike CR, Iputo JE, and Nkeh-Chungag BN. 2017. Prevalence of metabolic syndrome in adolescents living in Mthatha, South Africa. *Therapeutics and Clinical Risk Management*.13: 131–137

Senbanjo IO and Oshikoya KA. 2012. Obesity and blood pressure levels of adolescents in Abeokuta, Nigeria. *Cardiovascular Journal of Africa*, 23(5)260-264

Sengwayo DG, Moraba MM, and Motaung SC. 2012. Prevalence of obesity and dyslipidaemia in a rural black community in Limpopo Province: peer reviewed original article. Medical Technology SA. 26(2):43-48. https://hdl.handle.net/10520/EJC129523

Skinner AC, Steiner MJ, Henderson FW, and Perrin EM. 2010. Multiple Markers of inflammation and weight status: Cross-sectional Analyses throughout childhood. National Institute of Health. *PMC*. Doi:10.1542/peds.2009-2182

Sharkey BJ, Gaskill SE, 2007, Fitness and health 6th edition (Champaign, IL Human kinetics)

Shisana O, Labadarios D, Rehle T, Simbayi L, Zuma K, Dhansay A, Reddy P, Parker W, Hoosain E, Naidoo P, Hongoro C, Mchiza Z, Steyn NP, Dwane N, Makoae M, Maluleke T, Ramlagan S, Zungu N, Evans MG, Jacobs L, Faber M, & SANHANES-1 Team .2013. *South African National Health and Nutrition Examination Survey (SANHANES-1)*. Cape Town: HSRC Press

Singh R, Shaw J, and Zimmet P. 2004. Epidemiology of childhood type 2 diabetes in the developing world. *Pediatric Diabetes*. 5: 154—168

Sluggette L, Wagner SL and Harris RL. 2018. Sleep Duration and Obesity in children and Adolescents. *Canadian Journal of Diabetes*.

Soriano-Guille L, Herna´ndez-Garcı´a B, Pita J, Domı´nguez-Garrido N, Rı´o-Camacho GD and Rovira A. 2008. RAPID COMMUNICATION. High-sensitivity C-reactive protein is a good marker of cardiovascular risk in obese children and adolescents. *European Journal of Endocrinology*. 159: R1–R4. DOI: 10.1530/EJE-08-0212

Steyn NP, Jaffer N, Nel J, Levitt N, Steyn K, Lombard C, Peer N. 2016. Dietary intake of the urban black population of cape town: The Cardiovascular Risk in Black South Africans (CRIBSA) study. *Nutrients*.8(5):285. DOI:10.3390/nu/805285

Stelzer I, Zelzer S, Raggam RB, Pruller F, Truschnig, Wilder M, Meinitzer A, Sclinedl WJ, Reeves G, Postolache, TT and Mangge H. 2012. Brief Report: Link between Leptin and Interlueken-6 levels in the initial phase of obesity-related inflammations, 159: 118-124

Stats SA.2018. South Africa is young and female-Stats SA Report

Stolzman S, and Bement MH. 2012. Inflammatory markers in pediatric obesity: Health and physical activity implications. ICAN: *Infant, child, and adolescent nutrition*. 04(05)

Tathiah N, Moodley I, Mubaiwa V, Denny L and Taylor M. 2013. South Africa's nutrition transition: Overweight, obesity, underweight and stunting in female primary school learners in rural KwaZulu-Natal, South Africa. *South African Medical Journal*, 103(10):718-723

The fourth report on the diagnosis, evaluation, and treatment of high blood pressure in children and adolescents. 2005. National Institute of Health. U.S. Department of Health and Human Services. NIH Publication No.05-5267

Teshome T, Singh P, and Moges D. 2013. Prevalence and Associated Factors of Overweight and Obesity among High School Adolescents in Urban Communities of Hawassa, Southern Ethiopia. *Current Research in Nutrition and Food Science Journal*, 1(1), 23-36.

Toriola AL, Moselakgomo VK, Shaw BS, and Goon DT. 2012. Overweight, obesity and underweight in rural black South African children. *South African journal of clinical nutrition*, 25(2):57-61

Toriola OM and Monyeki MA. 2012. Health-related fitness, body composition, and physical activity status among adolescent learners: The PAHL study. *African journal for physical*, Health *Education, Recreation and Dance*,18(4)795-811

Tsolekile LP, Lerebo W, Muzigaba M, Puoane T. 2014. Challenges in combating childhood obesity in black township schools of South Africa: health and quality of life. *African Journal for Physical Health Education, Recreation and Dance*. 20(2):121-35.

Tzischinsky O. 2016. The association between sleeping patterns, eating habits, obesity, and quality of life among Israeli adolescents. *Cogent Psychology* 3:(1223903). http://dx.doi.org/10.1080/23311908.2016.1223903

Ujunwa FA, Ikefuna AN, Nwokocha AR, Chinawa JM. 2013. Hypertension and prehypertension among adolescents in secondary schools in Enugu, South East Nigeria. *Italian journal of pediatrics*.39(1):70.

Van Der Merwe MT. 2012. Obesity in childhood and adolescence. *South African Medical Journal (SAMJ),* 102(05)

Villa-Caballero L, Caballero-Solano V, Chavarria-Gamboa M, Linares-Lomeli P, Torres-Valencia E, Medina-Santillán R, and Palinkas LA. 2006. Obesity and socioeconomic status in children of Tijuana. *American Journal of preventive medicine*, 30(03)

Vella CA, Kravitz L, Kravitz MS. 2002. Gender differences in fat metabolism. IDEA Health and Fitness Source. 2002 Jan 1;20(10):36-46.

Wang H and Peng D. 2011. New insight into the mechanism of low high-density lipoprotein cholesterol in obesity. Lipids in health and disease. *BioMed Central journal* 10(176). http://www.lipidworld.com/content/10/1/176

Whitney E, Rolfes SR . 2008. Understanding Nutrition. Belmont, CA: Thomson & Wadsworth

World Health Organization. 2010. Global status report on non-communicable disease. ISBN 978 92 4 156422 9

World Health Organisation. 2006. Definition and diagnosis of diabetes mellitus and intermediate Hypoglycaemia. Geneva, Switzerland

World Health Organisation. 2011. Waist circumference and Waist-Hip Ratio. Report of a WHO expert consultation. 8-11 December 2008. Geneva, Switzerland. ISBN 9789241501491

World Health Organisation.2016. Report of the commission on ending childhood Obesity. ISBN 978 9241510066

WHO. 2016.Physical activity in adolescents. Fact Sheet. Europe

World Health Organisation.2018. Acting on childhood obesity. (World Obesity) Geneva, Switzerland

Wrottesley SV, Pedro TM, Fall CH and Norris SA. 2019. A review of adolescent nutrition in South Africa: transforming adolescent lives through nutrition initiative. *South African Journal of Clinical Nutrition*. DOI: 10.1080/16070658.2019.1607481

Wu D, Chu N, Shen M, and Chang J. 2003. Plasma C-reactive protein levels and their relationship to anthropometric and lipid characteristics among children. *Journal of Clinical Epidemiology*. 56: 94–100. PII: S0895-4356(02)00519-X

Wu Y, Gong Q, Zou Z, Li H and Zhang X. 2017. Short sleep duration and obesity among children: A systematic review and meta-analysis of prospective studies. *Obesity research and clinical practice journal*, 11(140-150)

Yoon KH, Lee JH, Kim JW, Cho JH, Choi YH, Ko SH, Zimmet P, Son HY. 2006. Epidemic obesity and type 2 diabetes in Asia. The Lancet. 368(9548):1681-1688. https://doi.org/10.1016/S0140-6736(06)69703-1

Zimmet P, Alberti K George MM, Kaufman F, Tajima N, Silink M, Arslanian S, Wong G, Bennett P, Shaw J, Caprio S; IDF Consensus Group. 2007. The metabolic syndrome in children and adolescents – an IDF consensus report. *Paediatric Diabetes.* 8: 299–306.

Zhu, Zheng, Yan Tang, Jie Zhuang, Yang Liu, Xueping Wu, Yujun Cai, Lijuan Wang, Zhen-Bo Cao, and Peijie Chen. 2019. “Physical Activity, Screen Viewing Time, and Overweight/Obesity among Chinese Children and Adolescents: An Update from the 2017 Physical Activity and Fitness in China-the Youth Study.” *BMC Public Health* 19 (1): 197. doi:10.1186/s12889-019-6515-9.

APPENDIXES

APPENDIX A: QUESTIONNAIRE

Participant's code | | | | |

Title of the study: Prevalence and determinants of obesity among adolescents in Vhembe district, Limpopo province

Date of interview……..

Name of the interviewer…….

Researcher: Ms Baloyi B, University of Venda

I would like to thank you for agreeing to participate in this study and your information is going to help us a lot. We are doing a research on prevalence and determinants of obesity among adolescent in Vhembe District. Obesity is a public health concern that increases the risk of developing chronic metabolic disorders more especially in children and adolescents. The questionnaire have following sections demographic information (section A), physical activity (Section B), Food frequency questionnaire (Form 1), anthropometric measurements (form 2) of weight, height, waist circumference, and hip circumference, and blood pressure (form 3) will also be taken.

Remember there are no wrong answers, this is not a test. Please answer all the questions as honestly and accurately as you can, this is very important.

Section A: Demographic information of adolescent

1. Gender

Male	1
Female	2

2. Date of birth of the child……..
3. Age…….

4. Indicate the grade you are in

Grade 8	1
Grade 9	2
Grade 10	3

Grade 11	4
Grade 12	5

5. Indicate your ethnic group

Tsonga	1
Venda	2
Sepedi	3
Other please specify	4

6. Amount of pocket money you usually carry per day

None	1
<R5	2
R5-R10	3
R10-15	4
R15-20	5
>R20	6

7. How often do you carry a lunch box in a week?

1-2 times	1
3-4 times	2
everyday	3
Never	4

8. How often do you buy food at school?

1-2 times	1
3-4 times	2
everyday	3
Never	4

9. Source of income of the head of the household

Salary	1
Pension grant	2

Child support grant	3
Wage	4
Disability grant	5
Other, specify……..	6
Pension and social grant	7

10. Marital status of the household

Married	1
Divorced	2
Windowed	3
Living together	4
Single	5

11. Highest level of education of the head of the household

Never attended school	1
Primary education	2
Secondary education	3
Tertiary education	4
Other specify……	5

12. Type of employment of the head of the household

Government	1
Private company	2
Self employed	3
Unemployed	4
Other specify……	5

13. Number of people who are staying in the household

1-2	1
3-4	2
5-6	3
7-8	4

9 and above	5

SECTION B: Physical activity questionnaire

We are trying to find out about your level of physical activity from the past 7 days (in a week). Physical activities includes sports or dance that make your legs feel tired, or games that make you breathe hard, like tag, skipping, running, climbing, and others.

Activities in and around home: **Put a tick on every line**

Approximate number of hour each week	none	Less than 1 hour a week	1 to 3 hours a week	3 to 6 hours a week	6 to 10 hours a week	10 to 15 hours a week	More than 15 hours a week
14. preparing food, cooking and washing up							
15. shopping for food and groceries							
16. Shopping and browsing in shops for other items (e.g clothes, toys)							
17. Cleaning the house							
18. Doing the laundry and ironing							
19. Caring for pre-school children or babies at home							
20. Caring for handicapped, elderly or disabled people at home							

21. Roughly how many km was it from home to school	
22. How many time a week did you travel from home to school	

23. How did you normally travel to school	Always	Usually	Occasionally	Never or rarely
1. By car				
2. By public transport				
3. By bicycle				
4. Walking				

Physical activity in your spare time: have you done any of the following activities in the past 7 days (last week)? If yes, how many times?

Activity						Average time per episode	
	No (0)	**1-2**	**3-4 times**	**5-6 times**	**7 times or more**	**Hours**	**Minutes**
24. Skipping							
25. Walking for pleasure (you should not include walking as a means of transportation)							
26. Cycling for pleasure, not as a means of transport							
27. Running							
28. Watering the lawn or garden							
29. Digging, shovelling or chopping wood							
30. Dancing							
31. Weeding or pruning							
32. Soccer							
33. Netball, Volleyball/ Basketball							

TV Or Video Viewing

34. Hours of TV or Video watched per day	Average over the last 12 months					
	None	<1hr a day	1-2 hrs a day	2-3 hrs a day	3-4 hrs a day	More than 4 hrs
35. On the weekday before 6pm						
36. On the weekday after 6pm						
37. on the weekend day before 6pm						
38. On the weekend day after 6pm						

39. How many hours do you usually sleep

4 hours	1
5 hours	2
6 hours	3
7 hours	4
8 hours or more	5

40. Dietary habits

Lifestyle questions	**Yes**	**No**
1. Eating three meal per day		
2. Eating breakfast daily		
3. Engaging in moderate exercise three to four times a week		
4. Getting adequate sleep (7-8 hours per night)		

5. Not smoking		
6. Consuming little or no alcohol		
7. Maintaining a moderate body weight		

Physical activity index

Evaluate your current exercise programme by selecting your score for each category

	Score	**Activity**
Intensity	5	Sustained heavy breathing and perspiration (running for long)
	4	Intermitted heavy breathing and perspiration (run and stop)
	3	Moderately heavy, as in cycling and other recreational sports
	2	Moderate, as in soccer, netball
	1	Light as in fishing
Duration	4	Over 30 minutes
	3	20 to 30 minutes
	2	10 to 20 minutes
	1	Less than 10 minutes
Frequency	5	6 to 7 times per week
	4	3 to 5 times per week
	3	1 to 2 times per week
	2	A few times per month
	1	Less than once a month

Intensity X Duration X Frequency= Score Total

41. Your score _____X_____X_____=_____

	Evaluation of activity score		
	Score	**Evaluation**	**Activity category**
1	81 to 100	Very active lifestyle	High
2	60 to 80	Active and healthy	Very good
3	40 t0 59	Acceptable but could be better	fair
4	20 to 39	Not good enough	poor
5	Under 20	sedentary	

Section C: Food frequency questionnaire

Step 1

Explain to the learner that now we are going to ask about what they are eating in the past week. Emphasise that this is not a test and there is no right or wrong.

Step2

- Ask what him/her to think about the week before.
  - ❖ Firstly, what they usually do on week days e.g. went to school, what they did after school, late afternoon, evening etc.
  - ❖ Secondly, what they ate on different days day.
- Give them the cards and the following instructions:
  - ❖ Please look at each picture very carefully. If you did eat any foods on the card, put it on your right side; if you did not eat it, put it on your left side.
  - ❖ Do this for every card in the pile.

Step 3

Take the pile of pictures that the learner indicated that he/she ate during the past week and proceed to determine the following:

- ❖ Frequency (how many times) they ate it during the past week; you can help them to count.
- ❖ Typical portion size (use portion size estimation guidelines and tools).

Step 4

Check the completed questionnaire immediately after the interview has been completed; double check any aspect that seems unclear with the leaner

CODE

Food item	Per week				Per day				Portion size estimation				Comments relating to *Time at school, at home or bought from vendors *Frequencies that needed to be explored further (seemed unlikely high) *preparation
									Standard (std)	Portion size			
Tea/coffee	Did not eat	1-2 per week	3-4 per week	5-6 per week	1 per day	2 per day	3 per day	4 per day	Std=1full mug/ glass use mug/ glass kit	½ x std	1x std	1 ½ x std	
Milk full cream	Did not eat	1-2 per week	3-4 per week	5-6 per week	1 per day	2 per day	3 per day	4 per day	Std=1full mug/ glass use mug/ glass kit	½ x std	1x std	1 ½ x std	
Inkomazi	Did not eat	1-2 per week	3-4 per week	5-6 per week	1 per day	2 per day	3 per day	4 per day	Std=1full mug/ glass use mug/ glass kit	½ x std	1x std	1 ½ x std	
Yoghurt	Did not eat	1-2 per week	3-4 per week	5-6 per week	1 per day	2 per day	3 per day	4 per day	Use unit volume	75 ml	100 ml	125 ml	
Bread-brown	Did not eat	1-2 per week	3-4 per week	5-6 per week	1 per day	2 per day	3 per day	4 per day	DAEK pictures	Thin	Med	Thick	
Bread-white	Did not eat	1-2 per week	3-4 per week	5-6 per week	1 per day	2 per day	3 per day	4 per day	DAEK pictures	Thin	Med	Think	
cheese	Did not eat	1-2 per week	3-4 per week	5-6 per week	1 per day	2 per day	3 per day	4 per day	1 slice Std = DEAK pictures	½ x std	1x std	1 ½ x std	
Archar	Did not eat	1-2 per week	3-4 per week	5-6 per week	1 per day	2 per day	3 per day	4 per day	Spoons: DEAK pictures or wood spoon in kit	Tea sp	Tab sp	Ladle	

Margarine	Did not eat	1-2 per week	3-4 per week	5-6 per week	1 per day	2 per day	3 per day	4 per day	Card	Thin	Med	Think	
Peanut butter	Did not eat	1-2 per week	3-4 per week	5-6 per week	1 per day	2 per day	3 per day	4 per day	Card	Thin	Med	Think	
Jam	Did not eat	1-2 per week	3-4 per week	5-6 per week	1 per day	2 per day	3 per day	4 per day	Card	Thin	Med	Think	
Polony	Did not eat	1-2 per week	3-4 per week	5-6 per week	1 per day	2 per day	3 per day	4 per day	How big (small or Big slice) How think	Thin	Med	Think	
Vienna	Did not eat	1-2 per week	3-4 per week	5-6 per week	1 per day	2 per day	3 per day	4 per day	Use DEAK pictures (shorter / longer vienna)				
Eggs	Did not eat	1-2 per week	3-4 per week	5-6 per week	1 per day	2 per day	3 per day	4 per day	Spoons: DEAK pictures or wood spoon in kit	Tea sp	Tab sp	Ladle	
Pap	Did not eat	1-2 per week	3-4 per week	5-6 per week	1 per day	2 per day	3 per day	4 per day	Use flour model	¼ cup	½ cup	1 cup	
Rice- white	Did not eat	1-2 per week	3-4 per week	5-6 per week	1 per day	2 per day	3 per day	4 per day	Use flour model	¼ cup	½ cup	1 cup	
Pasta	Did not eat	1-2 per week	3-4 per week	5-6 per week	1 per day	2 per day	3 per day	4 per day	Use flour model	¼ cup	½ cup	1 cup	
Samp and beans	Did not eat	1-2 per week	3-4 per week	5-6 per week	1 per day	2 per day	3 per day	4 per day	Use flour model	¼ cup	½ cup	1 cup	
Chicken coked	Did not eat	1-2 per week	3-4 per week	5-6 per week	1 per day	2 per day	3 per day	4 per day	Wing, Thy, Drumstick, Ribcage (20) Std = DAEK picture	< Std	= Std	> Std	
chicken fried	Did not eat	1-2 per week	3-4 per week	5-6 per week	1 per day	2 per day	3 per day	4 per day	Specify the type. Std DEAK picture	< Std	= Std	> Std	

Chicken intestine	Did not eat	1-2 per week	3-4 per week	5-6 per week	1 per day	2 per day	3 per day	4 per day	Spoons: DEAK pictures or wood spoon in kit	Tea sp	Tab sp	Ladle
Chicken gizzard	Did not eat	1-2 per week	3-4 per week	5-6 per week	1 per day	2 per day	3 per day	4 per day	Spoons: DEAK pictures or wood spoon in kit	Tea sp	Tab sp	Ladle
Chicken heart	Did not eat	1-2 per week	3-4 per week	5-6 per week	1 per day	2 per day	3 per day	4 per day	Spoons: DEAK pictures or wood spoon in kit	Tea sp	Tab sp	Ladle
Chicken feet	Did not eat	1-2 per week	3-4 per week	5-6 per week	1 per day	2 per day	3 per day	4 per day	One size only	30g		
Beef stew	Did not eat	1-2 per week	3-4 per week	5-6 per week	1 per day	2 per day	3 per day	4 per day	Spoons: DEAK pictures or wood spoon in kit	Tea sp	Tab sp	Ladle
Beef grill	Did not eat	1-2 per week	3-4 per week	5-6 per week	1 per day	2 per day	3 per day	4 per day	Use flour model of matchboxes(mbox)	X1 mbox	X2 mbox	X3 mbox
Beef offal	Did not eat	1-2 per week	3-4 per week	5-6 per week	1 per day	2 per day	3 per day	4 per day	Spoons: DEAK pictures or wood spoon in kit	Tea sp	Tab sp	Ladle
Boerewors	Did not eat	1-2 per week	3-4 per week	5-6 per week	1 per day	2 per day	3 per day	4 per day	Use DEAK picture, indicate in centimeters	……cm		
pork	Did not eat	1-2 per week	3-4 per week	5-6 per week	1 per day	2 per day	3 per day	4 per day	Spoons: DEAK pictures or wood spoon in kit	Tea sp	Tab sp	Ladle
Fish pilchards	Did not eat	1-2 per week	3-4 per week	5-6 per week	1 per day	2 per day	3 per day	4 per day	Spoons: DEAK pictures or wood spoon in kit	Tea sp	Tab sp	Ladle
Fish cooked	Did not eat	1-2 per week	3-4 per week	5-6 per week	1 per day	2 per day	3 per day	4 per day	Spoons: DEAK pictures or wood spoon in kit	Tea sp	Tab sp	Ladle
Fish fried	Did not eat	1-2 per week	3-4 per week	5-6 per week	1 per day	2 per day	3 per day	4 per day	Unit weight (no of fish)			

Soya mince	Did not eat	1-2 per week	3-4 per week	5-6 per week	1 per day	2 per day	3 per day	4 per day	Spoons: DEAK pictures or wood spoon in kit	Tea sp	Tab sp	Ladle	
Morogo	Did not eat	1-2 per week	3-4 per week	5-6 per week	1 per day	2 per day	3 per day	4 per day	Spoons: DEAK pictures or wood spoon in kit	Tea sp	Tab sp	Ladle	
cabbage	Did not eat	1-2 per week	3-4 per week	5-6 per week	1 per day	2 per day	3 per day	4 per day	Spoons: DEAK pictures or wood spoon in kit	Tea sp	Tab sp	Ladle	
Mileas on the cob	Did not eat	1-2 per week	3-4 per week	5-6 per week	1 per day	2 per day	3 per day	4 per day	Use DEAK picture, indicate in centimeters	……cm			
Apple	Did not eat	1-2 per week	3-4 per week	5-6 per week	1 per day	2 per day	3 per day	4 per day	Use DEAK pictures	Small	Med	Large	
Banana	Did not eat	1-2 per week	3-4 per week	5-6 per week	1 per day	2 per day	3 per day	4 per day	Use DEAK pictures	Small	Med	Large	
orange	Did not eat	1-2 per week	3-4 per week	5-6 per week	1 per day	2 per day	3 per day	4 per day	Use DEAK pictures	Small	Med	Large	
mango	Did not eat	1-2 per week	3-4 per week	5-6 per week	1 per day	2 per day	3 per day	4 per day	Use DEAK pictures	Small	Med	Large	
pawpaw	Did not eat	1-2 per week	3-4 per week	5-6 per week	1 per day	2 per day	3 per day	4 per day	Use DEAK pictures	Small	Med	Large	
Potato chips	Did not eat	1-2 per week	3-4 per week	5-6 per week	1 per day	2 per day	3 per day	4 per day	Unit weight				
Pizza	Did not eat	1-2 per week	3-4 per week	5-6 per week	1 per day	2 per day	3 per day	4 per day	Std = DEAK picture	½ x std	1x std	1 ½ x std	
Fat cakes	Did not eat	1-2 per week	3-4 per week	5-6 per week	1 per day	2 per day	3 per day	4 per day	Std= DEAK picture	small	Med	Large	

Cream doughnut	Did not eat	1-2 per week	3-4 per week	5-6 per week	1 per day	2 per day	3 per day	4 per day	Std= DEAK picture	½ x std	1x std	1 ½ x std	
scones	Did not eat	1-2 per week	3-4 per week	5-6 per week	1 per day	2 per day	3 per day	4 per day	Std= DEAK picture	½ x std	1x std	1 ½ x std	
cake	Did not eat	1-2 per week	3-4 per week	5-6 per week	1 per day	2 per day	3 per day	4 per day	Std= DEAK picture	½ x std	1x std	1 ½ x std	
Biscuits	Did not eat	1-2 per week	3-4 per week	5-6 per week	1 per day	2 per day	3 per day	4 per day	Unit weight = 1 biscuits				
Biscuits with cream	Did not eat	1-2 per week	3-4 per week	5-6 per week	1 per day	2 per day	3 per day	4 per day	Unit weight = 1 biscuits				
Simba-jiggies	Did not eat	1-2 per week	3-4 per week	5-6 per week	1 per day	2 per day	3 per day	4 per day	Use unit weight				
Simba-wiznacks	Did not eat	1-2 per week	3-4 per week	5-6 per week	1 per day	2 per day	3 per day	4 per day	Use unit weight				
Simba-others	Did not eat	1-2 per week	3-4 per week	5-6 per week	1 per day	2 per day	3 per day	4 per day	Use unit weight				
Pop corn	Did not eat	1-2 per week	3-4 per week	5-6 per week	1 per day	2 per day	3 per day	4 per day	Use unit weight				
Skopas	Did not eat	1-2 per week	3-4 per week	5-6 per week	1 per day	2 per day	3 per day	4 per day	Use unit weight				
Mageu	Did not eat	1-2 per week	3-4 per week	5-6 per week	1 per day	2 per day	3 per day	4 per day	Std = 1 full mug / glass	½ x std	1x std	1 ½ x std	
Ice block	Did not eat	1-2 per week	3-4 per week	5-6 per week	1 per day	2 per day	3 per day	4 per day	Std= 1 ice block	½ x std	1x std	1 ½ x std	

Cool time	Did not eat	1-2 per week	3-4 per week	5-6 per week	1 per day	2 per day	3 per day	4 per day	Std = 1 cool time (200ml)	½ x std	1x std	1 ½ x std	
Cool drink	Did not eat	1-2 per week	3-4 per week	5-6 per week	1 per day	2 per day	3 per day	4 per day	Std = 1 full mug / glass	½ x std	1x std	1 ½ x std	
Squash	Did not eat	1-2 per week	3-4 per week	5-6 per week	1 per day	2 per day	3 per day	4 per day	Std = 1 full mug / glass	½ x std	1x std	1 ½ x std	
Dairy juice	Did not eat	1-2 per week	3-4 per week	5-6 per week	1 per day	2 per day	3 per day	4 per day	Std = 1 full mug / glass	½ x std	1x std	1 ½ x std	
100% juice	Did not eat	1-2 per week	3-4 per week	5-6 per week	1 per day	2 per day	3 per day	4 per day	Std = 1 full mug / glass	½ x std	1x std	1 ½ x std	

Form 2: Information sheet

42. Weight (Kg) 1…….. 2…….. Average……
43. Height (m) 1……. 2…… Average……
44. BMI=……..
45. Waist circumference (cm) 1…….. 2…… Average……...
46. Hip circumference (cm) 1……. 2……..... Average……
47. Systolic Blood Pressure: 1……. 2……..Average……..
48. Diastolic Blood Pressure: 1…… 2…….....Average……
49. Blood sugar level (mmol)……..
50. C - reactive protein……..
51. Total Cholesterol……..
52. Low-density Lipoprotein……..
53. High-density Lipoprotein……

APPENDIX B1: CONSENT FORM FOR THE PARENTS

Title of research: Prevalence and determinants of obesity among adolescents in Vhembe district, Limpopo province

Researchers: Ms B Baloyi, MSc PNUT student, University of Venda
Dr LF Mushaphi, Department of Nutrition, School of Health Sciences, University of Venda
Mr NS Mabapa, Department of Nutrition, School of Health Sciences, University of Venda

We kindly invite your child to participate in a study conducted by **Brenda Baloyi**, a Master's Degree student at the University of Venda. The aim of the study is to determine the prevalence and determinants of obesity among adolescents in Vhembe district. This study was approved by ethics committee of the University of Venda. This committee makes sure that it is safe for your child to take part in the study.

The child will be required to participate in four activities including:

- Completion of a questionnaire regarding your background information, physical activities you engage in and food you eat.
- Taking of your weight, height and body fat measurements.
- Taking of your blood pressure (BP) measurements.
- Drawing of blood to test for protein, cholesterol and glucose.

There will be no direct benefits from the study besides helping us understand the prevalence and determinants of obesity among adolescents. This study is not expected to be harmful to your child but might be uncomfortable when the blood sample is drawn.

All the information we collect will be kept secret and your child does not have to share any of her/his answers in the questionnaire with anybody else. We will not use your child's name so everything will remain private.

By signing this form, you are showing that you understand what you are being told and what is going to happen in this study. If there is anything that you do not understand you can ask as many questions as you like. You can also ask questions later if you cannot think of them now. Also note that you can always withdraw your child from the study should you wish to do so later.

I, …….. Agree that my child participates in this study. The purpose and procedures of this study as well as how my child will participate have been well explained to me by the researcher.

Parent's signature……. Date……

Researcher's signature…….. Date……

For any questions concerning the research project at any stage of the project, contact: Ms B Baloyi at 0839227054 or Dr LF Mushaphi at 015 962 8334 or Mr NS Mabapa at 015 962 8685.

APPENDIX B2: FOMO YA THENDELO YA VHABEBI

Thoho ya Thoduluso: Prevalence and determinants of obesity among adolescents in Vhembe district, Limpopo province

Vhatodulusi: 1. Ms B Baloyi, MSc PNUT student, University of Venda

2. Dr LF Mushaphi, Department of Nutrition, School of Health Sciences, University of Venda

3. Mr NS Mabapa, Department of Nutrition, School of Health Sciences, University of Venda

Ri khou ramba nga vhulenda nwana wavho u shela mulenzhe kha thoduluso ine ya khou rangiwa phanda nga Brenda Baloyi, mutshudeni wa Master's Degree Gudedzini la pfunzo dza ntha la Venda. Tshipikwa tsha thoduluso iyi ndi u divha u anda na zwiitisi zwa u vha na mivhili yo kalulaho kha vhaswa tshitirikini tsha Vhembe. Thoduluso iyi yo rwelwa tari nga Komiti ya Ethics ya Univesiti ya Venda. Komiti hei i khwatishedza tshireledzo ya nwana wavho musi a tshi shela mulenzhe kha thoduluso iyi.

Nwana wavho u tea u shela mulenzhe kha ndowendowe nna dzi tevhelaho:

- U dadza dzimbudziso malugana na zwidodombedwza zwawe, nyonyoloso dzine a dzi ita na zwiliwa zwine a la zwone.
- U kaliwa tshileme, vhulapfu na mapfura a muvhili.
- U lavheleswa mutsiko wa malofha.
- U dzhiiwa malofha a u ita ndingo dza cholesterol na glucose

A huna malamba a ne ado a fhiwa ka thoduluso iyi. Nga nnda ha u thusa vhatodulusi u pfesesa u anda na zwiitisi zwa u vha na mivhili yo kalulaho kha vhaswa, hei thoduluso a i ngo lavhelelwa u huvhadza nwana wa vho, fhedzi hunga vha na upfa nyana vhutungu musi hutshi dzhiiwa malopfa.

Zwidodombedzwa zwothe zwine ra do zwi kuvhanganya zwido vhewa tshiphirini na uri nwana wa vho ha ngo tea u kovhela/vhudza muthu phindulo. Ri nga si shumise dzina la nwana wa vho, zwidodombedzwa zwa nwana wavho zwido dzula tshiphirini.

Nga u saina fomo hei, vha dovha vhakhou sumbedza uri vha a pfesesa zwine vha khou vhudzwa zwone na uri hu do bvelela mini kha thoduluso hei. Arali huna zwinwe zwine a vha zwi pfesesi, vha vhudzisa dzimbudziso uya nga hune vhafuna. Vho tendelwa u nga vhudzisa dzimbudziso nga murahu kharali vhasina mbudziso zwino. Vha dzhielenzhele u ri vho tendeliwa u nga litshisa nwana wavho u vha tshipida tsha thoduluso hei tshifhinga tshinwe na tshinwe

Nne , ……. ndi khou tenda uri nwana wanga a dzenelele thoduluso hei. Thipikwa na matshimbidzele, u katela na uri nwananga u do shela hani mulenzhe kha thoduluso hei ndo talutshedziwa zwonwe zwavhudi nga muthodulusi.

Tsaino nga mubebi …….. Datumu……

Tsaino nga mutodulusi…….. Datumu……

Arali vha ngavha na mbudziso malugana na thoduluso iyi tshifhinga tshinwe na tshinwe, vha nga kwama : Ms B Baloyi kha 0839227054 kana Dr LF Mushaphi kha 015 962 8334 kana Mr NS Mabapa kha 015 962 8685.

APPENDIX C1: ASSENT FORM FOR THE PARTICIPANT (LEARNER)

Title of research: Prevalence and determinants of obesity among adolescents in Vhembe district, Limpopo province

Researchers: Ms B Baloyi, MSc PNUT student, University of Venda
Dr LF Mushaphi, Department of Nutrition, School of Health Sciences, University of Venda
Mr NS Mabapa, Department of Nutrition, School of Health Sciences, University of Venda

You kindly are invited to participate in a study conducted by **Brenda Baloyi**, a Master student at the University of Venda. The aim of the study is to determine the prevalence and determinants of obesity among adolescents in Vhembe district. This study was approved by ethics committee of the University of Venda. This committee makes sure that it is safe for you to take part in the study.

You will be required to participate in four activities including:

- Completion of a questionnaire regarding your background information, physical activities you engage in and food you eat.
- Taking of your weight, height and body fat measurements.
- Taking of your blood pressure (BP) measurements.
- Drawing of blood to test for protein, cholesterol and glucose.

You will have no direct benefits from the study aside from helping us understand the prevalence and determinants of obesity among adolescents. This study is not expected to be harmful to you but might be uncomfortable when the blood sample is drawn.

All the information we collect will be kept secret and you do not have to share any of your answers in the questionnaire with anybody else. We will not use your name so everything will remain private.

Although we have asked your parent(s) or caregiver whether they/she/he agree(s) that you participate in this study, we want to know if you also agree.

By signing this form, you are showing that you understand what you are being told and what is going to happen in this study. If there is anything that you do not understand you can ask as many questions as you like. You can also ask questions later if you cannot think of them now. Also note that you can always withdraw from the study should you wish to do so later.

I, …… agree to participate in the study. The purpose and procedures of this study as well as how I will participate have been well explained to me by the researcher.

Learner's signature…….. Date……

Researcher's signature…….. Date……

For any questions concerning the research project at any stage of the project, contact: Ms B Baloyi, at 0839227054 or Dr LF Mushaphi, at 015 962 8334 or Mr NS Mabapa, at 015 962 8685.

APPENDIX C2: FOMO YA THENDELANO YA MUGUDISWA

Title of research: Prevalence and determinants of obesity among adolescents in Vhembe district, Limpopo province

Vhathodulusi: Ms B Baloyi, MSc PNUT student, University of Venda
Dr LF Mushaphi, Department of Nutrition, School of Health Sciences, University of Venda
Mr NS Mabapa, Department of Nutrition, School of Health Sciences, University of Venda

Ri ni ramba nga vhulenda u shela mulenzhe kha thoduluso ine ya khou rangiwa phanda nga **Brenda Bayoli,** mutshudeni wa Masters Degree Univesithi ya Venda. Tshipikwa tsha thoduluso hei ndi u divha u anda na zwiitisi zwa u vha na muvhili wo kalulaho kha vhaswa Tshitirikini tsha Vhembe. Thoduluso iyi yo rwelwa tari nga Komiti ya Ethics ya Universiti ya Venda. Komiti iyi i khwatisedza tsireledzo ya nu musi nitshi shela mulenzhe kha thoduluso iyi.

Ni tea u shela mulenzhe kha ndowendowe nna dzitevhelaho:
U dadza dzimbudziso malugana na zwidodombedwza zwa nu, nyonyoloso dzi ne na dzi ita na zwiliwa zwine na la zwone.

- U kaliwa tshileme, vhulapfu na mapfura a muvhili
- U lavheleswa mutsiko wa malofha
- U dzhiwa malofha a u ita ndingo dza phurotheini, cholesterol na glucose

A huna malamba a ne na doa fhiwa kha thoduluso iyi, nga nnda ha u thusa vhatodulusi u pfesesa u anda na zwiitisi zwa u vha na muvhili wo kalulaho kha vhaswa. Iyi thoduluso a i ngo lavhelelwa u ni huvhadza, fedzi hu nga vha na u pfa nyana vhutungu musi hutshi dzhiiwa malofha.
Zwidodombedzwa zwothe zwine ra do zwi kuvhanganya zwi ndo vhewa tshiphirini na uri inwi a ni tea u kovhela/vhudza muthu phidulo dza nu. Ri nga si shumise dzina la nu, zwidodombedzwa zwa nu zwido dzula tshiphirini.
Saizwi rhovha rono humbela thendelo kha mubebi/vhabebi kana muthogomeli wa nu uri ni shele mulenzhe kha thoduluso iyi. Ri toda u divha uri na i nwi ni a tenda naa.

Nga u saina fomo iyi, vha do vha khou sumbedza uri vha a phesesa zwine vha khou vhudzwa zwone na uri hu do bvelela mini kha thodiluso iyi. Arali huna zwinwe zwine a vha zwi pfesesi, vha vhudzisa dzimbudziso uya nga hune vhafuna. Vho tendelwa u nga vhudzisa dzimbudziso nga murahu arali vhasina mbudziso zwino. Vha dzhiele nzhele u ri vho tendeliwa u nga litshisa nwana wa vho u vha tshipida tsha thoduluso iyi tshifhinga tshinwe na tshinwe.

Nne, …… ndia tenda u shela mulenzhe kha thoduluso iyi. Thipikwa na matshimbidzele, u katela na uri nne ndido shela hani mulenzhe kha thoduluso iyi ndo talutshedziwa zwone zwavhudi nga mutodulusi

Tsaino nga mugudi…….. Datumu……

Tsaino nga muthodulusi…….. Datumu……

Arali vha nga vha na mbudziso malugana na thoduluso iyi tshifhinga tshinwe na tshinwe, vha nga kwama: Ms B Baloyi kha 0839227054 kana Dr LF Mushaphi kha 015 962 8334 kana Mr NS Mabapa kha 015 962 8685

APPENDIX D: LETTER TO DEPARTMENT OF EDUCATION

The department of education

Provincial office

Polokwane

0700

Re: REQUEST FOR PERMISSION TO CONDUCT RESEARCH IN SECONDARY SCHOOLS

Dear Sir / Madam

My name is Brenda Baloyi, and I am an MSc Public Nutrition student at the University of Venda (UNIVEN). The research I wish to conduct for my Master's dissertation involves "Prevalence and determinants of obesity among adolescents in Vhembe District, Limpopo Province". This project will be conducted under the supervision of Dr CN LF Mushaphi (Senior Lecturer, Department of Nutrition, UNIVEN) and Mr NS Mabapa (Lecturer, Department of Nutrition, UNIVEN).

I am hereby seeking your consent to approach a number of rural schools in the Vhembe district to provide participants for this project. I have provided you with a copy of my proposal which includes copies of the measure and consent and assent forms to be used in the research process, as well as a copy of the approval letter which I received from the UNIVEN Research Ethics Committee (Human).

Upon completion of the study, I undertake to provide the department of Education with a bound copy of the full research report. If you require any further information, please do not hesitate to contact me on 015 962 8685, cell 083 922 7054, **fax 0866906836 and Brenda.baloyi@univen.ac.za. Thank you for your time and consideration in this matter.**

Yours Sincerely

Brenda Baloyi

APPENDIX E: RECRUITMENT LETTER

To: The Principal

RESEARCH PROJECT: Cross sectional survey to determine the Prevalence and determinants of obesity among adolescents in Vhembe District, Limpopo Province.

Researchers

Ms Brenda Baloyi MSc student (University of Venda),

Dr Lindelani Mushaphi PHD, Department of Nutrition, School of Health Sciences, University of Venda

Mr Solomon Mabapa MSc, Department of Nutrition, School of Health Sciences, University of Venda

Dear sir/Madam

Your school have been randomly selected to be part of the above mentioned cross-sectional study.

The aim of the study is to determine the Prevalence and determinants of obesity among adolescents in Vhembe District, Limpopo Province. Obesity with its consequences is rising in South Africa more especially in children and adolescents. Obesity among adolescents has negative impact on their physical and psychological well-being. Risk of non-communicable diseases such as coronary heart diseases, stroke, type 2 diabetes mellitus, and hypertension as well as related mortality increase with the increasing body mass index. Adolescents now have to handle chronic diseases that were considered as adult disease. Reduction of adolescents' obesity is a critical target in promoting healthy expectancy even for future generation. It is crucial to identify determinants of obesity and address the problem at an early age to prevent the transfer of these risks to adulthood.

We would like to recruit 6 leaners from each grade 8 to 12 (13 to 19 years old) in your school, thus a total of 30 learners. To identify the learners, we would like to invite them to participate in the study, we need to randomly draw six names from the class list of each year group.

The following will be expected from each learner during data collection point 1:

- To answer questions on demographic information
- To answer questions about the food they eat, how much and how often
- To answer questions about their physical activities. The questions will be asked by registered Nutritionist.

The following will be expected from each learner during data collection point 2:

- To have his/her weight, height, hip circumference, waist circumference measured in a private area. The learner will need to take off his shoes for this, but will not have to remove clothing except jackets or jerseys.

The following will be expected from each learner during data collection point 3:

- To have his/her Blood pressure readings
- To provide blood sample to determine cholesterol level, glucose level and C-reactive protein. These will be taken by Professional Nurse.

The following will be expected of the school for each of the data collection point

- Provide a venue where learners can be interviewed, with either an adjoining private room to conduct the anthropometric, biochemical and clinical measurements or the possibility to create two private corners in the larger room.
- Identify a time of one hour during which learners can complete assessments that will not impact negatively on their learning.

Please note that learners will not be harmed in any way if they participate in this study, however learners might experience pain when blood is drawn. They will not benefit directly, but the information we get will help us to determine the prevalence and determinants of obesity among adolescent in Vhembe district.

There are few other important things that we would like you to know:

- This study was approved by the Research Ethics Committee of the University of Venda. (please see attached the ethic certificate)
- Learners who participate in the study will remain anonymous as we give each of them a code number so that nobody knows the answers any individuals gave.
- Learners are free to withdraw from the study at any time, it does not matter what the reason is. This will not count against them or the school in any way.

If you have any questions about the study you can phone Dr Lindelani Mushaphi on 015 962 8334 or Ms Brenda Baloyi on 015 962 8685. You may also phone the University of Venda Research Ethic Committee on 015 962 8000 if you are worried about the way the study will be done.

APPENDIX F: UHDC

UNIVERSITY OF VENDA

OFFICE OF THE DEPUTY VICE-CHANCELLOR: ACADEMIC

TO : MR/MS B. BALOYI

SCHOOL OF HEALTH SCIENCES

FROM: PROF J.E. CRAFFORD

DEPUTY VICE-CHANCELLOR: ACADEMIC

DATE : 02 MAY 2017

DECISIONS TAKEN BY UHDC OF 24TH APRIL 2017

Application for approval of Master's research proposal in Health Sciences: B. Baloyi (111561999)

Topic: "Prevalence and determinants of obesity among adolescents in Vhembe District, Limpopo Province."

Supervisor	UNIVEN	Dr. C.N Nesamvuni
Co-supervisor	UNIVEN	Mr. N.S Mabapa

UHDC approved Master's proposal

PROF. J.E CRAFFORD
DEPUTY VICE-CHANCELLOR: ACADEMIC

APPENDIX G: ETHICAL CLEARANCE CERTIFICATE

RESEARCH AND INNOVATION
OFFICE OF THE DIRECTOR

NAME OF RESEARCHER/INVESTIGATOR:
Ms B Baloyi

Student No:
11561999

PROJECT TITLE: Prevalence and Determinants of Obesity among Adolescents in Vhembe District, Limpopo Province.

PROJECT NO: SHS/17/NUT/03/1506

SUPERVISORS/ CO-RESEARCHERS/ CO-INVESTIGATORS

NAME	INSTITUTION & DEPARTMENT	ROLE
Dr CN Nesamvuni	University of Venda	Supervisor
Mr N.S Mabapa	University of Venda	Co- Supervisor
Ms B Baloyi	University of Venda	Investigator – Student

ISSUED BY:
UNIVERSITY OF VENDA, RESEARCH ETHICS COMMITTEE

Date Considered: June 2017
Decision by Ethical Clearance Committee Granted
Signature of Chairperson of the Committee: .....
Name of the Chairperson of the Committee: Prof. G.E. Ekosse

UNIVERSITY OF VENDA
DIRECTOR
RESEARCH AND INNOVATION
2017 -06- 15
Private Bag X5050
Thohoyandou 0950

University of Venda
PRIVATE BAG X5050, THOHOYANDOU, 0950, LIMPOPO PROVINCE, SOUTH AFRICA
TELEPHONE (015) 962 8504/8313 FAX (015) 962 9060
"A quality driven financially sustainable, rural-based Comprehensive University"

APPENDIX H: PERMISSION FROM DEPARTMENT OF EDUCATION

LIMPOPO
PROVINCIAL GOVERNMENT
REPUBLIC OF SOUTH AFRICA

DEPARTMENT OF
EDUCATION

Ref: 2/2/2 Enq: MC Makola PhD Tel No: 015 290 9448 E-mail:MakolaMC@edu.limpopo.gov.za

Baloyi B
University of Venda
Private Bag X5050
Thohoyandou
0950

RE: REQUEST FOR PERMISSION TO CONDUCT RESEARCH

1. The above bears reference.
2. The Department wishes to inform you that your request to conduct research has been approved. Topic of the research proposal: **"PREVALENCE AND DETERMINANTS OF OBESITY AMONG ADOLESCENTS IN VHEMBE DISTRICT, LIMPOPO PROVINCE ".**
3. The following conditions should be considered:

3.1 The research should not have any financial implications for Limpopo Department of Education.

3.2 Arrangements should be made with the Circuit Office and the schools concerned.

3.3 The conduct of research should not anyhow disrupt the academic programs at the schools.

3.4 The research should not be conducted during the time of Examinations especially the fourth term.

3.5 During the study, applicable research ethics should be adhered to; in particular the principle of voluntary participation (the people involved should be respected).

REQUEST FOR PERMISSION TO CONDUCT RESEARCH BALOYI B

CONFIDENTIAL

Cnr. 113 Biccard & 24 Excelsior Street, POLOKWANE, 0700, Private Bag X9489, POLOKWANE, 0700
Tel: 015 290 7600, Fax: 015 297 6920/4220/4494

The heartland of southern Africa - development is about people!

3.6 Upon completion of research study, the researcher shall share the final product of the research with the Department.

4 Furthermore, you are expected to produce this letter at Schools/ Offices where you intend conducting your research as an evidence that you are permitted to conduct the research.

5 The department appreciates the contribution that you wish to make and wishes you success in your investigation.

Best wishes.

Ms NB Mutheiwana
Head of Department

13/09/17
Date

REQUEST FOR PERMISSION TO CONDUCT RESEARCH BALOYI B

CONFIDENTIAL

LIMPOPO
PROVINCIAL GOVERNMENT
REPUBLIC OF SOUTH AFRICA

DEPARTMENT OF
EDUCATION
VHEMBE DISTRICT

REF: 14/7/R
ENQ: MATIBE M.S
TEL: 015 962B 1029

DEPARTMENT OF EDUCATION
VHEMBE DISTRICT
2017 -12- 13
PRIVATE BAG X 2250 SIBASA 0970
TEL: 015 962 1313/4 FAX: 015 962 6039
LIMPOPO PROVINCE

BRENDA BALOYI
UNIVERSITY OF VENDA
PRIVATE BAG X 5050
THOHOYANDOU
0950

RE: REQUEST FOR PERMISSION TO CONDUCT RESEARCH IN SECONDARY SCHOOLS

1. The above matter refers to your request for permission to conduct research in schools in the District.
2. Kindly be informed that permission has been granted to you to obtain participants in rural schools for your research project.
3. You are expected to produce this letter together with the copy of approval from the Head of Department to the Circuit Manager and Principals of participating schools.
4. Wishing you the best in your studies.

DISTRICT DIRECTOR

2017-12-13
DATE

Thohoyandou Government Building, Old Parliament, Block D, Private Bag X2250, SIBASA, 0970
Tel: (015) 962 1313 or (015) 962 1331, Fax: (015) 962 6039 or (015) 962 2288

The heartland of southern Africa - development is about people!

APPENDIX I: PERMISSION FROM THE CIRCUITS

LIMPOPO
PROVINCIAL GOVERNMENT
REPUBLIC OF SOUTH AFRICA

DEPARTMENT OF
EDUCATION

TSHILAMBA CIRCUIT

Ref: 13/3/2/1
Enq: Mamphodo S

BALOYI B

APPLICATION FOR PERMISSION TO CONDUCT RESEARCH UNDER TSHILAMBA CIRCUIT: YOURSELF.

1. The above matter bears reference.
2. Your application for permission to conduct research at Tshilamba Circuit on the topic **"PREVALENCE AND DETERMINANTS OF OBESITY AMONG ADOLESCENCE IN VHEMBE DISTRICT, LIMPOPO PROVINCE."** has been approved.
3. You are kindly requested to observe the following conditions:
   3.1 Inform the Principal of affected School prior to your visits.
   3.2 Ensure that your interactions with participating principal, teachers and learners do not disrupt teaching and learning activities.
4. Wishing you the best in your academic endeavours.

DEPARTMENT OF EDUCATION
TSHILAMBA CIRCUIT
14-02-2018
CIRCUIT MANAGER
PRIVATE BAG X1195
LIMPOPO

.....
CIRCUIT MANAGER: TSHILAMBA.

14/02/2018
DATE

Tshilamba, Private Bag X1195, MUTALE, 0956
Tel: (015) 9670086 Fax: (015) 96700

The heartland of southern Africa - development is about people!

LIMPOPO
PROVINCIAL GOVERNMENT
REPUBLIC OF SOUTH AFRICA
DEPARTMENT OF
EDUCATION
VHEMBE DISTRICT

EDUCATION

REF: 14/7/R
ENQ: MUVHALI M.R
CELL: 082 424 9173

MUTSHINDUDI CIRCUIT
P/BAG X4000
TSHIDIMBINI
0972

16 JANUARY 2018

Baloyi B
Private Bag X5050
THOYANDOU
0950

PERMISSION TO CONDUCT RESEARCH IN SECONDARY SCHOOLS UNDER MUTSHINDUDI CIRCUIT.

1. The above matter refers.

2. Kindly be informed that permission has been granted to you.
3. Conduct of this research should not disrupt the school programs.
4. Attached are letters from the head of Department and District Director.
5. Wishing you the best.

CIRCUIT MANAGER

DATE 16/01/2018

RECEIVED
DEPARTMENT OF EDUCATION
16 JAN 2018
PRIVATE BAG X4000
0972 TSHIDIMBINI
THOHOYANDOU DISTRICT

LIMPOPO
PROVINCIAL GOVERNMENT
REPUBLIC OF SOUTH AFRICA

DEPARTMENT OF
EDUCATION
VHUMBEDZI CIRCUIT

Ref: 14/7/R

Enq: Muedi F.P

Cell: 071 476 0702

Baloyi B

University of Venda

Private Bag X5050

Thohoyandou

0950

PERMISSION TO CONDUCT RESEARCH IN VHUMBEDZI CIRCUIT SECONDARY SCHOOLS: YOURSELF

1. The above matter bears special reference
2. Permission is hereby granted to you to conduct research in Vhumbedzi Circuit on "Prevalence and determinants of obesity among adolescents in the Vhembe District, Limpopo Province"
3. We strongly advice that the research process should never interrupt the normal learning and teaching time.
4. Wishing you all the best in your in your research.

CIRCUIT MANAGER: Muedi F.P

14/02/2018
DATE

Private Bag X1120, TSHAULU, 0978
Tel: (015) 978 3364

The heartland of southern Africa - development is about people!

LIMPOPO
PROVINCIAL GOVERNMENT
REPUBLIC OF SOUTH AFRICA

DEPARTMENT OF
EDUCATION

SAMBANDOU CIRCUIT

REF: 13/2/3/1
ENQ: Netshituni K.N
Cell : 082 476 0623

Baloyi B
University of Venda
Private Bag X5050
Thohoyandou
0950

DEPARTMENT OF EDUCATION
SAMBANDOU CIRCUIT
15-02-2018
P/BAG X1195
MUTALE 0956
LIMPOPO PROVINCE

PERMISSION TO CONDUCT RESEARCH IN SECONDARY SCHOOLS: YOURSELF

1. The above matter bears special reference.
2. Permission is hereby granted to you to conduct research in Sambandou Circuit Secondary Schools.
3. We strongly advice that the research process should never interrupt the normal learning time.
4. Wishing you all the best.

.....
SAMBANDOU CIRCUIT MANAGER

14/02/2018
.....
DATE

Private Bag X1195, MUTALE, 0956
Tel: (015) 9631979 Fax: (015) 9631979

The heartland of southern Africa - development is about people!

LIMPOPO
PROVINCIAL GOVERNMENT
EDUCATION
VHEMBE DISTRICT

REF NO 14/7/R
ENQ: MAHAMBA R
TEL: 015 963 1048

MVUDI CIRCUIT
PRIVATE BAG X2166
SIBASA
0970
15 JANUARY 2018

TO: BALOYI B
UNIVERSITY OF VENDA
PRIVATE BAG X5050
THOHOYANDOU
0950

PERMISSION TO CONDUCT RESEARCH OF: PREVALENCE AND DETERMINANTS OF OBESITY AMONG ADOLESCENTS SECONDARY SCHOOLS IN VHEMBE DISTRICT (LIMPOPO PROVINCE).

1. The above matter refers.
2. Our office received your request for permission to conduct research in our schools within Mvudi Circuit, Vhembe district.
3. Our office has no objection on your request to conduct research within our area of jurisdiction as permission has been granted by provincial office, however you need to take into cognisance that you do not interrupt with the normal activities of the school.
4. Principal of the school is expected to ensure that this research adheres to the above stated directive.
5. Wishing you the best in all you endeavours for the completion of your studies.

2018:01:15

CIRCUIT MANAGER **DATE/STAMP**

The heartland of southern Africa - development is about people!

LIMPOPO
PROVINCIAL GOVERNMENT
DEPARTMENT OF
EDUCATION
TSHINANE CIRCUIT

Enq : Mulaudzi N.P
Cell : 071 675 2206
Date : 16/01/2018

PERMISSION TO CONDUCT RESEARCH IN SECONDARY SCHOOLS.

1. The above matter refers to your request for permission to conduct research in schools in the District.

2. Kindly be informed that permission has been granted to you to obtain participants in rural schools for your research project.

3. The conduct of research should not anyhow disrupt the academic programs at the schools.

4. The research should not be conducted during the time of Examinations especially the fourth term.

5. You are expected to produce this letter together with the copy of approval from the Head of Department to the Principals of participating schools.

6. Wishing you the best in your study.

CIRCUIT MANAGER (SIGNATURE)

DEPARTMENT OF EDUCATION
TSHINANE CIRCUIT OFFICE
2018 -01- 16
PRIVATE BAG X 4000
0972 TSHIDIMBINI
VHEMBE DISTRICT

16/01/2018
DATE

Makwarela Government Offices, Private Bag X4000, TSHIDIMBINI, 0972
Tel: (015) 963 1895 Fax: (015) 9631383

The heartland of southern Africa - development is about people

LIMPOPO
PROVINCIAL GOVERNMENT
REPUBLIC OF SOUTH AFRICA

DEPARTMENT OF EDUCATION

DZINDI CIRCUIT
Private Bag x1406
LWAMONDO
0985

Ref: 11561999
Enq: Nemurarate H
Cell: 076 411 2582

DEPARTMENT OF EDUCATION
DZINDI CIRCUIT OFFICE
15 JAN 2018
P.O. BOX 1406
LWAMONDO 0985
LIMPOPO PROVINCE

BALOYI BRENDA
UNIVERSITY OF VENDA
PRIVATE BAG X5050
0950

APPROVAL FOR PERMISSION TO CONDUCT RESEARCH IN DZINDI CIRCUIT SCHOOLS.

1. The above matter refers.
2. Your letter requesting to conduct research in Dzindi Circuit Secondary Schools.
3. You are hereby informed that your request for permission to conduct research on *"Prevalence and Determinants of obesity among adolescents in Vhembe district, Limpopo"* has been granted.
4. You are expected to adhere to research ethical considerations, particularly those relating to confidentiality, anonymity and informed consent your research subjects.
5. Yours in service.

TBMuthu
CIRCUIT MANAGER (DZINDI)

15/01/2018
DATE

APPENDIX J: EDITING CERTIFICATE

[redacted]

Balote Projects (Pty) Ltd

Cell no: 084 255 2164 **Email:** matlou.moloto@gmail.com
P O Box 1106, Faunapark, 0787
Reg No: 2017/113184/07
Tax Ref: 9299915224

EDITING CERTIFICATE- DISSERTATION
23 March 2020

TO WHOM IT MAY CONCERN

This serves as confirmation that I Matlou Moloto have edited the dissertation document of Ms Brenda Baloyi, entitled "**Prevalence and determinants of obesity among adolescents in Vhembe district, Limpopo province**" to be submitted for the degree; Masters of Science Degree in Public Nutrition in the Department of Nutrition in School of Health Science, University of Venda, South Africa.

I therefore, declare that the document is to my knowledge devoid of language errors which may deprive the said persons' work from being accepted for the degree and publication.

I am contactable at the above contact details should you have queries.

Matlou Moloto (Miss)

[redacted]

Tech Candidate (Tshwane University of Technology) MPhil Second Language Studies (Stellenbosch) BEd Language Methodology (University of Limpopo) BA Languages (University of Limpopo) Higher Education Diploma (University of Limpopo) member of the Professional Editors Group (PEG)

[redacted]